Report of Consultancy Study on Smart City Blueprint for Hong Kong

June 2017

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1. Background

1.1. Purpose of this Document

The objective of this report is to advise and provide recommendations to the Government of the Hong Kong Special Administrative Region (the Government) for formulating a blueprint for long-term smart city planning and development in Hong Kong. The document will cover various urban challenges in Hong Kong and provide a strategy to address these challenges and drive Hong Kong towards achieving its smart city vision. The document also provides Hong Kong with suggestions for governance arrangement, digital framework (including relevant technical standards), development plans, legal framework, public-private partnership, and possible pilot projects.

Development plans in the areas of Smart Living, Government, Economy, Environment, Mobility, and People, are included with analyses of challenges, leading practices, and potential projects and activities in the short, medium, and long term. The governance structure will include the key roles that various bureaux and departments (B/Ds) can play in overseeing smart city development. A digital framework is included along with analyses of components that will drive smart services. Legal matters on possible legislative amendments needed for smart services, and public-private partnership models will be examined for application in Hong Kong. This document will also look into potential pilot projects for early implementation in Hong Kong.

The Government can utilise this document to drive discussion amongst key departments and stakeholders. The document can also serve as a reference and guidance tool that will allow the Government to assess and choose from various possible projects to be implemented.

1.2. Urbanisation Challenges and Trends

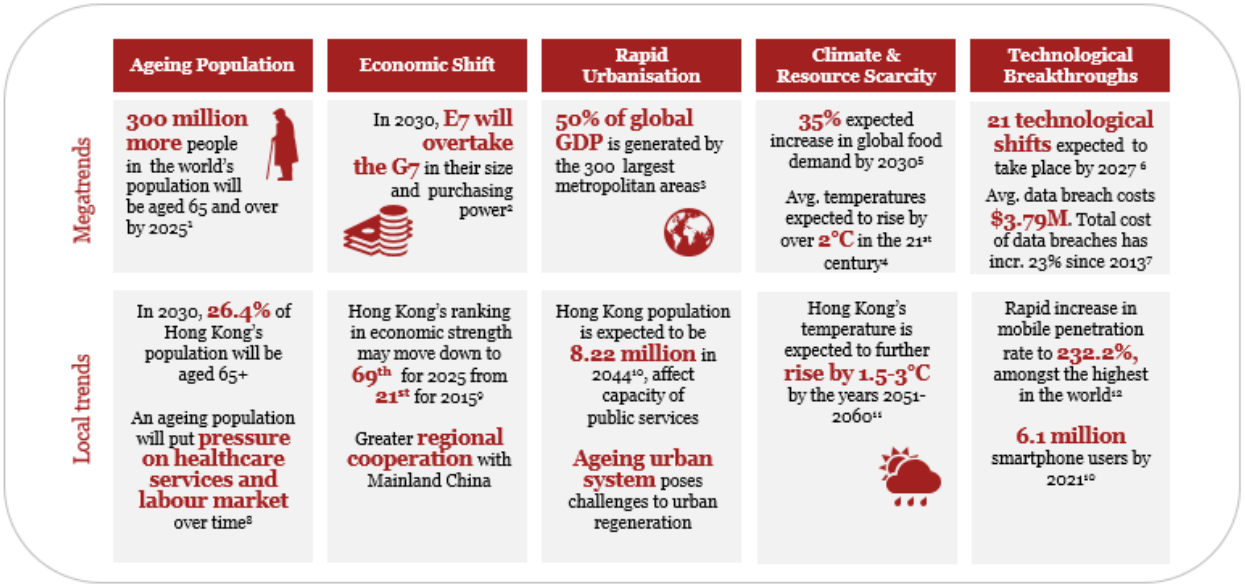
City challenges vary, while many are experiencing unprecedented rates of urbanisation and population growth, others are experiencing shrinking populations. Many of the associated challenges are omnipresent: people are living longer leading to increased demands on healthcare; the climate is changing resulting in extreme and often-catastrophic weather events and rising sea levels; burning of fossil fuels and improperly treated effluence discharge into surface waters is resulting in large-scale pollution in cities. Regardless of how a city is being affected by these challenges, one thing remains constant – the need to provide core urban infrastructure and deliver city services as efficiently and cost effectively as possible to all city dwellers.

Hong Kong[1], a leading global city with its high urban density, is no exception in facing similar challenges –population growth has strained infrastructure and resources and challenged its ability to provide a high-quality living and working environment with sufficient provision of affordable housing, high quality healthcare and efficient means of transportation.

Given the current challenges around a rapidly ageing population, environmental sustainability, connectedness between city and citizens, Hong Kong can concurrently adopt learnings from other leading cities and rapidly innovate to surpass the challenges it currently faces in its urban landscape. This will ensure that the city beneficiaries get the very best that Hong Kong can continue to offer.

To maintain its global competitiveness and foster a more sustainable, liveable, inclusive and innovative city that fulfils the aspirations of its people, Hong Kong will need to consider the opportunities and overcome the challenges posed by urbanisation and other trends when undertaking its smart city plan and initiatives. These mega and local trends are summarised and shown in **Figure 1.1** below.

Figure 1.1 Mega and Local Trends for Hong Kong



1 UN Population Division, World Population Prospects (2012); 2 PwC World in 2050 Projections (2015); 3 Brookings Institution (2012); 4 Intergovernmental Panel on Climate Change (2007) 5 'Global Trends 2030: Alternative Worlds', National Intelligence Council (2012); 6 World Economic Forum (2015) Deep Shifts Technology; 7 Smart Cities Council (June 2015) Is your city prepared for a security breach?; 8 Census and Statistics Department (September 2016) Projected Mid-year Population by Age Group and Sex, 2017 - 2064; 9 Economist Intelligence Unit (2015) Hot Spots 2025 Benchmarking the Future Competitiveness of Cities; 10 Census and Statistics Department (September 2015) Hong Kong Population Projections 2015-2064; 11 Hong Kong Observatory; 12 Office of Communications Authority (September 2016) Key Communications Statistics

1.2.1. *Impacts of Megatrends on Global Cities and Hong Kong*

Cities across the world as well as Hong Kong are already experiencing the impacts of these megatrends across multiple dimensions of city life and its infrastructure. The development plans set out in Section 3 will outline approaches and ways to address these challenges.

[1] Refer to Appendix A1 for the profile and sectoral details of Hong Kong

- **Individuals and society:** A recent World Economic Forum report shows that global demographic trends are reaching a turning point, with workforce population (between ages 15-64) starting to decline and elderly population (65 and up) beginning to rise. The report projects that the elderly population could account for approximately 16% of the global population (which is a significant increase from 5% in 1960) by 2050.[2] In terms of education, there are changing trends observed with regard to international student mobility. In 2014 the countries with the highest proportion of international students' enrollment are the United States, the United Kingdom, France, Australia, Germany, Russia, Japan, Canada and China[3]. In 2015, China, India, and Germany are the major sources for internationally mobile students[4].

  With the highest longevity in the world, Hong Kong's ageing problem is pronounced, with close to 2 in 5 (36%) of the population to be 65 and above by 2043. In particular 10% of the population will be 85 or above[5] by then. Currently, over 70% of elderly suffer from one or more chronic diseases[6]. Diabetes is one of the top-ten causes of death in Hong Kong; the disease accounted for 15,313 in-patient discharges and in-patient deaths at all hospitals and 390 registered deaths in 2014[7]. The growing size of the elderly population will give rise to the need for more effective chronic disease management[8,9]. An ageing population will also put pressure on the labour market overtime.

  In recent years, Hong Kong's total fertility rate (TFR)[10] has been similar to that of other developed Asian economies (i.e. South Korea, Singapore, and Taiwan), which is much lower than that of western countries[11]. The World Bank reported that in 2015, the TFR in Hong Kong was 1.195 births per woman[12], which is far below the replacement rate of 2.1 births per woman.

  In terms of education, Hong Kong had spent 3.265% of its Gross Domestic Product (GDP) on education in 2015[13]. Adult literacy is relatively high – about 94.3% in 2016[14]. In 2016, three of Hong Kong's universities were listed in the top 80 universities in the annual Times' Higher Education World Reputation Rankings. In 2015, six universities

[2] https://www.weforum.org/agenda/2015/10/how-are-global-demographics-changing/
[3] https://www.theguardian.com/higher-education-network/blog/2014/jul/17/top-20-countries-international-students
[4] http://data.uis.unesco.org/Index.aspx?queryid=172
[5] Census and Statistics Department, Baseline Population Projections up to 2064 (http://www.statistics.gov.hk/pub/B1120015062015XXXXB0100.pdf)
[6] http://www.elderly.gov.hk/english/healthy_ageing/mental_health/coping_with_chronic_illness.html
[7] http://www.chp.gov.hk/en/content/9/25/59.html
[8] http://www.elderlycommission.gov.hk/en/library/Ex-sum.htm
[9] http://www.hkmj.org/system/files/hkmj144326.pdf
[10] The TFR is the sum of the age specific fertility rates (AFRs) in a given year and represents the average number of children that would be born alive to 1 000 women during their lifetime if they were to pass through their childbearing ages 15 to 49 experiencing the AFRs prevailing in that year.
[11] http://www.statistics.gov.hk/pub/B71512FB2015XXXXB0100.pdf
[12] http://data.worldbank.org/indicator/SP.DYN.TFRT.IN?locations=HK
[13] http://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS?locations=HK
[14] Literacy is defined as age 15 and over has ever attended school (Not including pre-primary education) http://www.bycensus2016.gov.hk/data/16bc-summary-results.pdf

from Hong Kong and one from Macau were listed in the top 100 Times High Education Asia University Rankings. Moving forward, there are additional challenges in education for continued improvement in these ratings and increased entrepreneurship and ICT opportunities for students.

- **Physical environment:** As climate change has accelerated in recent years, it has become clear that given rapid urbanisation, the planet is unable to support current modes of production and consumption. The growing global population is expected to demand roughly 35% more food, 40% more water, and 50% more energy by 2030. Cities around the world are starting to experience extreme weather, such as extreme rainfall that is likely to result in overwhelming the draining system causing urban flooding. Global mean sea level is rising as well. Research has estimated that by the year 2100 approximately 150-200 million people will be on the move from land which is underwater. [15] The Paris Agreement produced governmental agreement to limit increased warming by an average of two degrees above pre-industrial level. In order to stay within the two-degree limit, global carbon intensity must be reduced by 6.5% every year until 2100. [16]

  In Hong Kong, temperatures are expected to rise a further 1.5-3 degrees Celsius by the years 2051-2060 under the high greenhouse gas concentration scenario[17].Further to establishment of carbon reduction targets for up to 2020, carbon reduction target for 2030 was announced in January 2017[18]. The city has more than 50,000 buildings, and close to 70% of the city's electricity is consumed by the commercial sector[19]. Hong Kong also has a very low rate of building replacement – while the UK and the United States (US) have a building replacement rate of 1-4%, 0.6-1.3% respectively, Hong Kong's building replacement rate is 0.4%.

- **Technology:** Approximately 95% of the world's population live in areas covered by a mobile-cellular network. Mobile-broadband networks are accessible by 84% of the population and Long Term Evolution (LTE) networks reach roughly 53% of the population. [20] The rise of new technologies such as autonomous vehicles, machine learning, and 3D printing emphasise the merging of the physical and virtual worlds as well as the emergence of algorithmic business (where people are not directly involved).[21]

[15] https://www.pwc.co.uk/issues/megatrends/climate-change-and-resource-scarcity.html#2 ; http://www.climatecentral.org/news/new-analysis-global-exposure-to-sea-level-rise-flooding-18066
[16] http://www.pwc.es/es/publicaciones/sostenibilidad/low-carbon-economy-index-2016.pdf
[17] Hong Kong Observatory
[18] Press release issued by the Government on 20 Jan 2017 (http://www.info.gov.hk/gia/general/201701/20/P2017012000736.htm,)
[19] http://www.emsd.gov.hk/filemanager/en/content_762/HKEEUD2016.pdf
[20] http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2016.pdf
[21] http://www.gartner.com/newsroom/id/3143521

As of March 2017, Hong Kong had a mobile penetration rate of 238.4%, and more than 17 million mobile subscribers[22]. By 2021, there will be 6.1 million smartphone users. There were four mobile network operators and 225 internet service providers in Hong Kong as of December 2016. As of April 2017, Hong Kong had eight submarine cable landing stations connecting to ten regional and trans-Pacific submarine cable systems. Hong Kong is also connected to the Mainland of China via a number of overland cables. As of December 2016, the total equipped capacity of external telecommunications facilities was over 45 Tbps. Facebook and Google are building the fastest trans-pacific cable (bandwidth of 120 Tbps) connecting Hong Kong and Los Angeles which will come on-line in 2018. Together with other submarine cable systems being constructed, the total capacity will approach 200 Tbps by the end of 2018.

Companies in Hong Kong's technology sector specialise in commercialisation, application and industrial engineering. Both local and overseas companies are active in the sector. Electronics-related players, including those in the semiconductor sector and those involved with the manufacturing of a wide array of parts and components, are the more prominent technology-related businesses in Hong Kong[23]. The Government's effort to invest more to encourage ventures in fast-growing fields of innovation has led to the building of a Data Technology Hub (in 2020) and an Advance Manufactory Centre (in 2021-22). There are also plans to build more innovation hubs in the Hong Kong – Shenzhen Innovation and Technology Park to be developed in the Lok Ma Chau Loop.

There were about 11,000 electric vehicles (EV) on Hong Kong's roads as of May 2017, up from less than 100 at the end of 2010[24]. Hong Kong has yet to reach a stage suitable for the adoption of citywide autonomous vehicles, but driverless forms of transportation are already in use in Hong Kong. This includes driverless trains in the Hong Kong International Airport (known as the Automated People Mover, APM) that take passengers between terminals[25] and some of the Mass Transit Railway (MTR) routes including the Disneyland Resort Line[26] and the South Island Line. Moving forward, there will be challenges in implementing the policies, standards, and the digital infrastructure necessary to support these new technologies.

Megatrends aside, due to its physical environment and citizens' expectations, Hong Kong faces specific challenges in areas spanning mobility, living, environment, human resources, economic development and city administration. These challenges, and the ways they may be addressed with smart city solutions and initiatives, are discussed in the Smart City Development Plans (Section 3 of this Report).

[22] http://www.ofca.gov.hk/en/media_focus/data_statistics/key_stat/
[23] http://hong-kong-economy-research.hktdc.com/business-news/article/Hong-Kong-Industry-Profiles/Technology-Industry-in-Hong-Kong/hkip/en/1/1X000000/1X09U6YK.htm
[24] http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/promotion_ev.html
[25] https://www.hongkongairport.com/eng/passenger/arrival/t1/airport-services-facilities/in-terminal-transport.html
[26] https://www.travelchinaguide.com/cityguides/hongkong/transportation/metro-disney-line.htm

1.2.2. *Transforming Hong Kong into a Smart City*

Across Hong Kong and internationally, cities are increasingly recognising the role of innovation and technology in enhancing all areas of urban life. Appropriate integration of technology is quickly becoming a defining feature that sets cities apart in terms of economic advantage and competitiveness. Beyond economic incentives, the smart city movement has opened up a host of potential synergies between technology, innovation and the established strategic directions for Hong Kong.

The city of Hong Kong has positioned itself well to become a leading smart city due to its advanced ICT infrastructure and its movement towards adoption of Internet of Things (IoT) and other emerging technologies. Public and private organisations and several Government B/Ds have begun to deploy additional sensors and advanced technologies to achieve greater efficiencies in city operations. Some examples include:

- The Water Supplies Department's progressive establishment of a Water Intelligent Network (WIN) with sensors installed in the water distribution network to enable continuous monitoring of the network condition and facilitate determination of the most cost-effective means to maintain the healthiness of the network.

- The Drainage Services Department uses of intelligent ultrasonic sensors to detect water levels in manholes to prioritise maintenance, and remote control systems in operational hydraulics to manifest the concept of total water management. The department also widely adopts the concept of co-use/co-location within its facilities for better and efficient use of the scarce land resources.

- The Transport Department deployed sensors at busy road intersections to collect real-time data to monitor traffic conditions.

- Customs and Excise Department's deployment of E-Lock systems to trace the customs clearance process between Hong Kong and the Mainland securely and efficiently via Global Positioning Systems (GPS).

- The Civil Engineering and Development Department's use of sensors to detect landslides by monitoring changes in conditions of landslide-resisting barriers.

In addition, the Government has also:

- Committed to expanding the "*Wi-Fi.HK*" common brand coverage to double the current number of free Wi-Fi hotspots to 34,000 by 2019. The Wi-Fi expansion will cover hospitals, markets, parks, sitting-out areas, housing estates, promenades, land boundary control points, transport interchanges, and tourist spots. In addition, the speed of Wi-Fi in government venues will be bolstered along with improved security.

- Revamped its Public Sector Information (PSI) portal which now provides close to 7,000 datasets at no cost to the general population from departments, public bodies and private organisations.

Kowloon East[27] - Smart City Pilot Area

The Government announced in the 2015 Policy Address that Kowloon East would be used as a pilot area to explore the feasibility of developing a smart city. The Energizing Kowloon East Office (EKEO) of the Development Bureau has formulated a smart city framework strategy for Kowloon East[28]. A number of smart city initiatives as well as proof of concept (PoC) trials are being piloted in Kowloon East.

Since November 2016, requirements for the provision of smart water meter system and electric vehicle charging facilities have been stipulated for new land sale sites in Kowloon East. Supply of real-time parking vacancy information is also required at appropriate land sale sites. New government buildings in Kowloon East will generally comply with the same conditions. In addition, the CLP Power Ltd. is piloting various elements of a smart energy grid in Kowloon East, comprising smart energy meters, photovoltaic panels, electric vehicle charging facilities with load management capabilities and demand response control systems, etc. The Kai Tak and King Yip Nullahs are also being transformed into blue-green infrastructures, providing high-quality green public spaces and strengthening pedestrian connectivity to promote walkability. These measures would ensure the neighbourhood is planned with smart city development in mind.

The implementation of PoC trials aims to examine the effectiveness of different innovative solutions and related implementation strategies. These trials aim at demonstrating the benefits of smart city development and facilitate better understanding of the feasibility of such trials for wider application. The trials are being taken forward progressively with the first one on crowd management conducted in January 2017 during an annual marathon event in Kowloon East. To improve the efficiency of crowd management, CCTV surveillance cameras with video analytics were used to automatically detect crowd flow and identify abnormal conditions. The second PoC trial, which provides pedestrian way-finding and recommends walking routes according to personal preference (i.e. sheltered path) and needs (e.g. barrier-free access) was launched in June 2017. Other PoC trials including a system to monitor real-time energy consumption in residential premises to encourage behavioural change, a loading and unloading bay monitoring system to deter illegal usage, disseminating real-time roadworks information, multi-purposes poles using LoRA and NB-IoT as communication layers and a system to optimise waste collection regime and fleet management, etc. will be rolled out progressively.

A mobile application “My Kowloon East” has already been launched to promote smart city development in Kowloon East and serves as an interactive platform for real-time data sharing.

[27] Kowloon East comprises the Kai Tak Development Area, and the Kwun Tong and Kowloon Bay Business Areas.
[28] Details of the smart city framework can be found on <www.smartke.hk>

Real-time parking vacancy data are now made available through the app. The data are also shared with the Transport Department for dissemination and via the PSI Portal in API format.

Besides Government efforts, EKEO also encourages universities and research institutes to develop innovative smart city solutions. Five such research projects have already secured research funding from various sources, including the Innovation and Technology Fund as a major contributor. Research topics include: a scalable digital platform for city-wide data sharing, advanced data mining techniques, a real-time air quality monitoring and prediction system for microenvironment, tree risks advance warning system, and cost benefit analysis tool for prioritising smart city projects.

In order to advance to the next level of a more efficient and smarter city, Hong Kong must apply technology in even more innovative and coordinated ways under a holistic and consistent framework to effectively address urban challenges, enhance city management, and improve the quality of living and sustainability practices. The city must also enhance its attractiveness to global businesses and talents in its efforts to inspire continuous innovation and sustainable economic development. These objectives should guide the development of the Smart City Blueprint for Hong Kong by the Innovation and Technology Bureau (ITB).

2. Smart City Vision, Policy and Strategy

2.1. Vision for Hong Kong

Hong Kong is aspiring to become a liveable, competitive and sustainable “Asia’s World City”. The overarching planning goal to achieve this vision is "to champion sustainable development with a view to meeting our present and future social, environmental, and economic needs and aspirations”.[29]

2.2. Smart City Objectives

In his 2016 Policy Address, the Chief Executive re-affirmed the government’s commitment to developing Hong Kong into a smart city. The main objectives are to:

- Make use of innovation and technology to address urban challenges to enhance city management and improve quality of living, sustainability, efficiency, and safety;
- Enhance city attractiveness to global business and talent; and
- Inspire continuous city innovation and sustainable economic development.

These objectives are effectively underpinned by a set of guiding principles[30] articulating the important factors for consideration when developing Hong Kong into a smart city:

- **People-centric:** Given the fact that the ultimate objective in smart city development is to improve peoples' quality of life, Hong Kong should adopt a people-centric approach to its smart city development to enable the smart/creative use of technology and smart/creative service delivery.

- **High-level coordination:** Adoption of a more proactive role for the government may facilitate smart city development; for example, the ITB is well placed to lead the formulating of strategies and coordination among bureaux to meet economic, environmental, and social development needs using innovation and technology.

- **Overall and long-term strategy:** In order to facilitate smart city development, a long-term strategy and integrated framework should build upon the Digital 21 strategy as well as embrace the foundation established by various B/Ds to address the various economic, environmental and social needs.

- **Participation by all sectors:** In order to create a sustainable smart city, the Government should set relevant standards, guidelines, and practices as well as cooperate with NGOs, the

[29] HK 2030+
[30] The Central Policy Unit, Research Report on Smart City (http://www.cpu.gov.hk/doc/en/research_reports/CPU%20research%20report%20-%20Smart%20City(en).pdf)

business sector, government departments, academic and research institutes, and the private sector on integrating smart city functions and services.

- **Promotion of innovation and technology:** Apart from adopting technology, the implementation of policies/measures to foster innovation and technological advancement is important to the development of Hong Kong into a smart city.

2.3. Policy Directives and Strategic Plans

ITB was established in 2015 with the main objective to coordinate, support and complement the development of Hong Kong's innovation and technology industry. The development of Kowloon East as a smart city pilot area for smart city is also well underway with a range of PoC trials being rolled out progressively. Building on efforts in previous years, the Chief Executive highlighted further efforts in developing Hong Kong into a smart city during his Policy Address in 2017[31], including:

- The Government is using Kowloon East as a smart city pilot area, leveraging people-centric information and communications technology solutions for the sharing of data to improve the use of resources and enhance the management of pedestrians and vehicular traffic flows.
- The Government is striving to promote the establishment of a Common Spatial Data Infrastructure (CSDI) to provide government departments as well as public and private organisations with an information infrastructure to share spatial data, supporting various smart city applications.
- Under the Wi-Fi Connected City Programme launched in the middle of 2016, the number of free Wi-Fi hotspots is 19,300. The target is to increase the number of such hotspots to 34,000 by 2019.
- The Government has set up the $500 million TechConnect initiative under the ITB to assist government departments in using technology to enhance the quality of public services.
- The Government has launched the $500 million Innovation and Technology Fund for Better Living to fund innovation and technology projects which will make people living more conveniently, comfortably and safely, or projects that address the needs of specific community groups.

In addition, a list of the relevant plans and strategies is appended below:

- **A Clean Air Plan for Hong Kong**, published by the Environment Bureau (ENB) in collaboration with the Transport and Housing Bureau (THB), the Food and Health Bureau (FHB) and the Development Bureau (DEVB), in March 2013, sets out in detail the measures

[31] Policy Address 2017 (http://www.policyaddress.gov.hk/2017)

to tackle air pollution. A set of new air quality objectives, which were benchmarked against the World Health Organisation's Air Quality Guidelines, also came into effect in January 2014;

- **Hong Kong Blueprint for Sustainable Use of Resources 2013-2022**, published by ENB in May 2013, promulgates comprehensive action plans to reduce waste through enhanced social mobilisation, coupled with appropriate policies and legislation. In particular, it targets to reduce municipal solid waste disposal rate by 40% on a per capita basis by 2022 compared to 2011 levels;
- **Digital Strategy 21 – "Smarter Hong Kong, Smarter Living" Strategy** sets out the proposed framework for Hong Kong to leverage new technologies to propel continuous economic development, build platforms for sharing and collaboration, deliver intuitive and integrated e-services to the public and foster a thriving ICT industry;
- **A Food Waste & Yard Waste Plan for Hong Kong 2014-2022**, published by ENB in February 2014, maps out the comprehensive strategy, targets, policies and action plans for the management of such waste in the coming years. Its key target is to reduce food waste disposal to landfills by 40% by 2022 when compared with 2011 level;
- **Population Policy** – Strategies and Initiatives, published by the Chief Secretary for Administration Office in January 2015, lays out some 50 initiatives to optimise Hong Kong's population for the future;
- **Energy Saving Plan for Hong Kong's Built Environment 2015~2025+**, published by ENB in collaboration with THB and DEVB in May 2015, is the first ever energy saving plan for Hong Kong. Its key target is to reduce Hong Kong's energy intensity by 40% in 2025 using 2005 as the base;
- **Hong Kong 2030+**: Towards a Planning Vision and Strategy Transcending 2030 was launched in October 2016 by DEVB and Planning Department (PlanD) to collect views from the public on the updated territorial development strategy. It represents the Government's vision, policy and strategy for territorial development in Hong Kong beyond 2030; and
- **Hong Kong's Climate Action Plan 2030+**[32] sets out in greater detail the new Hong Kong's carbon emissions reduction target for 2030 and key measures on mitigation, adaptation and resilience to combat climate change.

2.4. *Policy Objectives and Strategy*

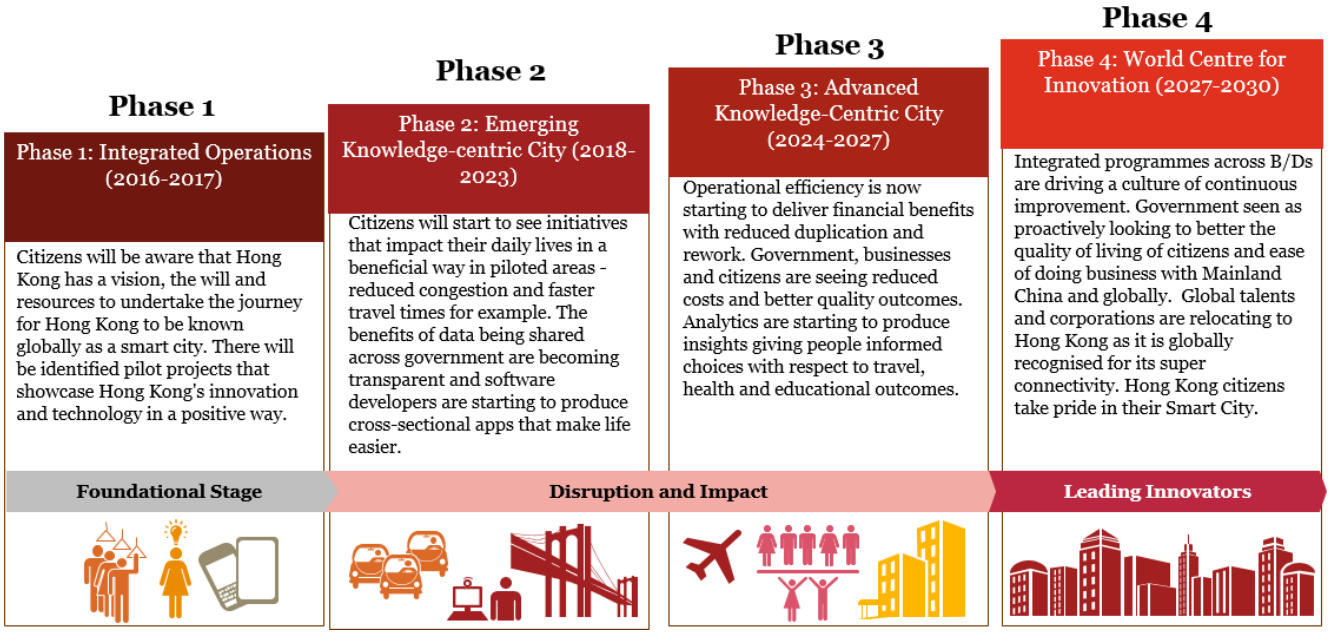
2.4.1. *Smart City Maturity*

A robust smart city strategy allows Hong Kong to advance from where the city currently is to where the city aspires to go in an effective and efficient manner. There is a need for the strategy to have a sufficient degree of flexibility in addressing the varying levels of the city's maturity in different policy/operational areas that it currently exhibits (and thus the gaps between the "as-is" and "to-be"). A Smart City Maturity Model has been used to describe the evolutionary

[32] http://www.enb.gov.hk/sites/default/files/pdf/ClimateActionPlanEng.pdf

path of increasing maturity and levels of capabilities in the progression towards becoming a leading smart city. **Figure 2.1** below illustrates the four-phased Smart City Maturity Model from Integrated Operations, Emerging Knowledge-Centric City, Advanced Knowledge-Centric City, and eventually to World Center for Innovation.

Figure 2.1 Smart City Maturity Model for Hong Kong



- **Phase I: Integrated Operations:** Phase I includes the planning and establishment of a cross-government governance structure to manage the implementation of the Smart City Blueprint for Hong Kong and the technology deployments needed to lay the foundation for the city-wide sharing of data. The shared data platform is key to enabling new services and/or an expansion of existing city-wide services in each of the six smart city themes: Smart Living, Smart Government, Smart Economy, Smart Environment, Smart Mobility, and Smart People. Foundational technologies comprise the system of sensors, networks, communications, and data repositories that establish the basic means to sense, collect, and aggregate city service and infrastructure conditions and parameters. This capability establishes the basic foundation for Phase II, where data will be used to monitor, analyse and control city-wide operations and the provision of services.

- **Phase II: Emerging Knowledge-Centric City:** Phase II begins with the implementation of the Blueprint. Initiatives will build upon existing city services and capabilities. Foundational technologies are deployed to enable the sharing of data city-wide and improved analytics support better decision making across city

functions. Additional sensors are deployed utilising existing shared infrastructure to the extent possible to capture additional data needed for expansion of existing or new city services. Projects/pilots across the initiatives provide additional technology, people and process changes to enable better city management, improved safety, and efficiency of city-wide services and operations.

- **Phase III: Advanced Knowledge-Centric City:** Phase III includes activities that continue to build on Phase II capabilities to realise greater efficiencies in operating new and expanded city services and infrastructure and in managing regional assets. Phase III also brings an increased emphasis on achieving greater automation and optimisation across the built environment, resource usage, and the city's ability to provide services and infrastructure improvements for better living. Collectively, these projects help the city become highly efficient operationally in terms of people, infrastructure, and resources.

- **Phase IV: World Centre for Innovation:** Phase IV includes activities across multiple projects that have achieved a high degree of efficiency and effectiveness in city services and operations across the city. Integration of data and applications across B/Ds verticals build on deployed advanced capabilities to optimise benefits to the city. Projects are focused on continuous innovation, growth of technology centres of excellence, expansion of the Hong Kong economy, and achieving of a high level of liveability and comfort for its people.

This maturity not only provides a broad framework for conceptualising different levels of smart city development in Hong Kong but also provides a coherent structure for mapping the short-term to long-term development plan in different areas.

2.4.2. *Hong Kong Smart City Vision*

Based on a review of Hong Kong's current capabilities and future city aspirations, a vision statement has been developed along with several potential taglines for the city's future development.

- A vision statement is a directional statement, about where the city will be headed. A vision is a future oriented statement, and an embodiment of the city it wants to become.
- A tagline is a short, powerful phrase that is associated with the city. It aims to represent the tone, sentiment, and feeling the city wants its residents and visitors

to feel when in Hong Kong. The taglines, like the vision, do not vary or change over time, unless there is a redefinition of the city's vision[33].

- A mission describes the city's purpose. It aims to align the city's public and private stakeholders towards achieving the core purpose of the pursuit.

Figure 2.2 Key Considerations for Smart City vision and taglines

Four factors (**Figure 2.2**) were considered when generating the smart city vision and taglines for Hong Kong:

1. The vision and accompanying tagline(s) should resonate with the influencers of Hong Kong as well as key stakeholders in the private sector, appealing to their respective views and missions;

2. The vision should leverage the existing Brand HK as the "Asia's World City" and focus on an angle that resonates with the identity of the people of Hong Kong;

3. The vision should focus on designing, building and implementing a portfolio of smart city development activities and programmes that leverage technology and innovation to improve citizens' experiences; and

4. The vision for smart city Hong Kong is to use emerging and new technologies to enhance safety and efficiency, and sustain success of Hong Kong.

This has led to the following vision statement and taglines for the Government's consideration:

[33] https://www.quora.com/Whats-the-difference-between-a-tagline-slogan-and-mission-statement

Vision Statement: Smart Hong Kong - Embracing innovation and technology to build a strong economy, bring quality living and make Hong Kong a well-known Smart City.

Suggested Taglines:

- Super connector, linked, gateway, hub
- Quality of living, livable
- Adaptable, resilient
- Energetic, active, dynamic
- Vibrant city, thriving economy, lively, animated
- Asia's Smart Gateway, Asia's Digital Gateway
- Knowledge society, economy, value, cashless

Mission:

1. People will be happier, healthier, smarter and more prosperous. The city will be more livable, green, clean, sustainable, resilient and competitive.
2. Businesses will continue to capitalise on Hong Kong's renowned business-friendly environment, foster innovation, transform the city into a living lab and test bed for development and accelerate into local and global markets.
3. As a member of the global community, Hong Kong will be more environmentally friendly and consume less resources whilst maintaining its efficiency, livability and vibrancy.
4. The elderly and youth will be better cared for, and there will be a stronger sense of community. Businesses, people and the Government will be more technologically savvy as the city continues to be more digitally enabled.

2.4.3. *Smart City Strategies to Address Urban Challenges*

Nine smart city strategic actions can be adopted for guiding the journey for Hong Kong towards a smart city based on our understanding of Hong Kong's current capabilities, city challenges, and aspirations for the future:

- **Invigorate the ecosystem for innovation to support the development, commercialisation, scaling up and export of smart solutions:** The existing ecosystem for innovation can be enhanced by providing better access to data and technologies as well as appropriate and targeted support throughout the entire innovation process. An innovation value chain should be developed , providing large and small enterprises, start-ups, academics and research institutes with channels to network and exchange ideas, acquire the necessary knowledge, technological and financial support, use Hong Kong as a testbed for pilot projects as well as commercialise,

scale up and market their products overseas. A well-designed ecosystem will create the conditions for sustainable innovation, creating a key competitive advantage for Hong Kong.

- **Engage the public and business and co-create smart solutions with stakeholders to better meet the needs and fulfil the aspirations of the people:** Given that smart city initiatives should ultimately meet the needs and fulfil the aspirations of the people living in Hong Kong, different segments of society should be engaged to allow the Government to effectively prioritise resource allocation to matters of concern to the people. Apart from engaging the public, the Government can capitalise on the knowledge and experience of the private sector, non-governmental organisations and the academia in co-creating smart solutions. The involvement of relevant stakeholders will better ensure that the solutions are not only commercially and technologically sound, but are also fit for purpose, transparent to the public and with societal impact.

- **Cultivate a culture of embracing changes and collaboration for smart city development:** To create a conducive environment for innovation and to encourage joined-up efforts of multiple stakeholders within and beyond the Government, it will be integral to encourage a culture of embracing changes and collaboration. The Government can demonstrate a higher tolerance for risk at reasonable and manageable costs through the provision of appropriate assistance and support, e.g. physical space for testing ideas, access to streamlined funding, to encourage experimentation. Likewise, proof of concepts (together with leadership support as well as the establishment of appropriate governance structure and accountability system) can be used to demonstrate the feasibility and benefits of collaborative smart solutions for Hong Kong.

- **Improve preparedness, prevention, and mitigation of adverse events:** Adverse events can range from natural disasters to manmade hazards including cyberattacks. Smart solutions can be pursued to support the overall resilience objectives and increase the city's ability to prepare for and pre-empt adverse events. In particular, greater attention will need to be given to the protection of critical systems and the development of cybersecurity capabilities so as to provide the public with the confidence in the technologies deployed for developing a Smart Hong Kong.

- **Establish a sound digital framework to support further improvement to the operations of urban infrastructures and provision of services:** Through a greater degree of infrastructural integration and data sharing, the performance of existing urban infrastructures and services can be optimised. This will need to be underpinned by a set of common operating standards and protocols to ensure interoperability. The establishment of an integrated, open, adaptive and secured digital

infrastructure will build a strong foundation for smart city development and place Hong Kong in a better position to tap into the potential of new technologies for developing smart city initiatives in the future.

- **Provide support to reduce the digital divide and ensure inclusiveness of smart city development:** All segments of society should be able to enjoy the benefits of a smarter Hong Kong. Building upon existing government efforts, stakeholder groups, such as low income households, elderly persons and people with disabilities, can be provided with targeted assistance to acquire digital access and skills to benefit from the smart city initiatives that will bring about greater convenience and improve their quality of life. A more focused approach to address the needs of the underprivileged groups in the further expansion of free public Wi-Fi services will be advisable, to ensure the Internet connectivity required to access common services like e-Government and on-line / mobile banking services.

- **Equip students and workforce with the knowledge and skills to seize opportunities in a smart city:** There will be a need for a continued emphasis on Science, Technology, Engineering and Mathematics (STEM) education in schools and the development of smart city-related programmes in tertiary institutions. In addition, working adults should be encouraged to further their digital skills to better seize the job and business opportunities arising from a smart economy.

- **Develop an innovative strategy for procuring smart solutions:** Unlike the procurement for other city infrastructural projects that tend to be large scale with long development periods and relatively more established records of previous implementation, many smart solutions are likely to be of a mixed scale with various development periods and higher degree of risk. Public-Private Partnership (PPP) should be considered where applicable. Refinement to current Government procurement policies may be needed, especially to allow a greater role of local SMEs in developing and delivering specific smart city solutions.

- **Integrate with city planning:** The strategy on smart city should be closely integrated with city planning (i.e. Hong Kong 2030+ and Hong Kong's Climate Action Plan 2030+), urban and infrastructure development, ICT development and environment sustainability for a clear message to local citizens, business and international investors.

2.4.4. *Key Performance Indicators*

Key Performance Indicators (KPIs) are a set of quantifiable measures and metrics that are used to gauge performance over time. A well-designed set of KPIs help organisations and agencies

ensure that they are on the right path towards their strategic goals and aims to focus attention on the tasks and processes to reach that goal.

In recent years, ISO 37120 Sustainable Development of Communities has emerged as the first international standard on global city indicators. ISO 37120 establishes a set of standardised indicators and a uniform approach for measuring the state of city services and quality of life in a city. ISO 37120 defines 100 city performance indicators that could or should be measured, and how. Specifically, ISO 37120 defines 46 core and 54 supporting indicators that cities either "shall" (core) or "should" (supporting) track and report. In addition, ISO 37120 also provides for a set of profile indicators, such as population and GDP, to help cities determine which cities are most relevant for comparisons. ISO 37120 is part of an integrated suite of standards for sustainable community development under the ISO's Technical Committee 268.

It is important to recognise that the complete set of ISO 37120 indicators may not suit every city and requires extensive data definition, collection and processing efforts. The Government would determine which indicators best represent what Hong Kong strives to achieve (at that particular stage); and which should be used for public reporting/internal monitoring, in the light of operating and practical experiences. Targets could then be set against the selected set of indicators to assess the policy outcome, and guide the policy formulation and operation of the Government.

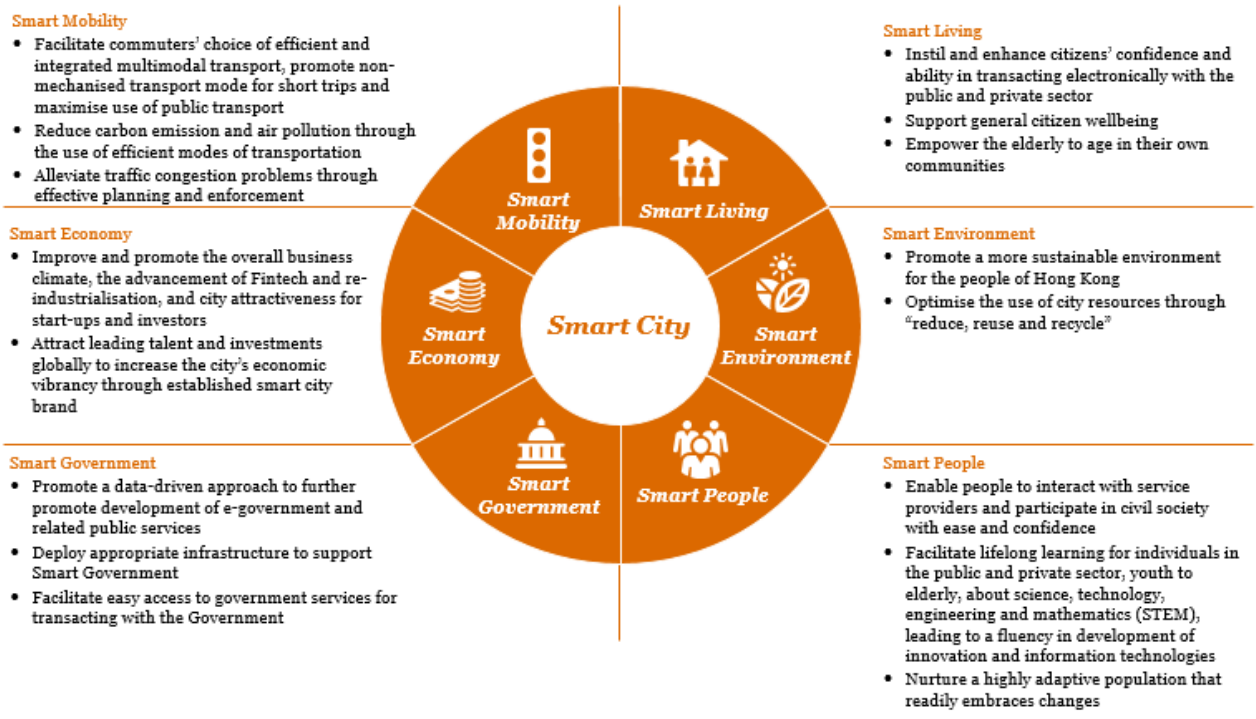
ISO 37122 is currently under development by ISO to provide a set of indicators specifically for Smart Cities. It is believed that cities will progressively adopt ISO 37122 after it is released. The Government may wish to review the contents of ISO 37122 when it is formally released. This will facilitate the Government measuring the progress of smart city developments and compare with other cities against indicators commonly used by those other cities.

3. Smart City Development Plans

The Development Plans ("Plans") underpinning the smart city strategy, organised under the six themes in alignment with the Boyd Cohen model which is commonly used by researchers and experts as a basic analytic framework, create a direct relation between the current problems and challenges of Hong Kong and the projects and activities selected to solve them. The Boyd Cohen model is particularly useful in the case of Hong Kong, given its usage in previous official reports including CPU's Report on the subject matter of smart city. Policy objectives are nested under each of the six themes, which, upon successful implementation of the Plans, will be reached (see **Figure 3.1**). The Plans are formulated based on the leading overseas practices and insights/findings from the stakeholder engagement process that involved public and private sector organisations as well as the community at large through the Ideas Crowdsourcing Portal.

The proposed projects and initiatives sections in each development plan start off by setting the objectives Hong Kong should aim for to achieve smarter mobility, living, environment, ,people government and economy. To achieve each objective, possible projects that Hong Kong can undertake are listed, and the descriptions of the projects are provided. Under each project, activities can be done within the short, medium, and long term. Various activities that standalone or serve as underlying enablers of multiple projects and/ or are referred to as cross-project activities.

Figure 3.1 Smart City Themes and the Respective Policy Objectives



Future scenarios are subject to uncertainties and the evolvement of new technologies and standards. To this end, the descriptions of potential scene/outcome in Sections 3.1 to 3.6 are possible scenarios based on the understanding of the current technology landscape and trends. It should be emphasised that some of these scenarios/outcomes require the participation or cooperation of the private sector and enactment/amendment of legislation which is subject to the approval of the Legislative Council. It should also be noted that whilst the Government is not in a position to set a timeframe for a certain technology to be mature enough for its application in Hong Kong, the possibility for Hong Kong deploying a new technology also depends on an enabling environment and a strong culture to adopt innovations and applications in different walks of life.

3.1. Smart Mobility

"Smart Mobility" enhances people mobility through efficient and targeted capital deployment models and infrastructure investments. Additionally the initiatives lay the foundations (through policy, regulations, private and public funding, innovative technology and partnership with the private sector) to achieve cheaper, faster, pedestrian and environmentally friendly travel in the city. Smart Mobility is enabled by integrated multimodal transportation, which combines the city's current multiple modes of public and private transport, with new modes of transportation (e.g. connected vehicles, alternate fuel vehicles, autonomous vehicles, car pooling/sharing), to create a seamless, customer-centric travel experience that also accommodates the needs of elderly and disabled people in Hong Kong. Smart Mobility improves the flow of people, while providing high service quality for users as well as minimising the impact on environment.

Progress to date

Hong Kong has long been adopting information and communication technologies (ICT) to enhance the mobility of citizens. For example, it pioneered the application of computerised area traffic control technology in Southeast Asia in the 1970's to synchronise traffic signals of road junctions along major routes to minimise stoppage and delay to vehicles. Since 2003, Hong Kong progressively installed Journey Time Indication Systems (JTISs) and Speed Map Panels (SMPs) in the vicinities of three cross harbour road tunnels as well as tunnels connecting the New Territories with Kowloon to advise motorists of the expected journey times crossing the tunnels. Since 2011, Hong Kong launched three mobile applications to promote smart mobility: HK eTransport advises road users alternative commuting routes and fares by public transport; HK eRouting advises on the driving routes, real-time traffic conditions and parking information; and eTraffic News provides and updates traffic news and alerts any public transport service disruptions, as well as notifications on temporary traffic and transport arrangement.

The following projects related to smart mobility are on-going:

- Installation of traffic detectors covering 80% of the strategic routes of Hong Kong. These detectors will collect real-time traffic information, including traffic speed and volume, for traffic and transport management purposes. Consideration is now given to extend the coverage of traffic detectors to the remaining strategic routes as well as other major roads, and to install additional SMPs or JTISs to enable commuters to make informed route choice.
- Installation of smart devices at road junctions to facilitate pedestrian crossing – upon the tapping of designated smart cards, the pedestrian flashing green time will be extended so that the elderly and the disabled could cross road junctions at a more comfortable speed.

- Enhancement of electronic audible traffic signals, which aims to strike a balance between the need of the visually impaired persons for a clear audible traffic signal during crossing and the need for a quiet environment at other times.
- Implementation of a comprehensive and co-ordinated strategy of "Walk in HK" to promote walkability, including the use of technology to facilitate planning of walking routes.
- Installation of smart parking meters which can accept payment through a variety of electronic means and can automatically detect and report occupancy.
- A trial scheme for using Closed Circuit Television (CCTV) Systems with video analytic capabilities for monitoring loading and unloading activities and related traffic enforcement will start shortly.

3.1.1. Policy Objectives

To achieve smart mobility for Hong Kong, the Government should aim to:

1. Facilitate commuters' choice of efficient and integrated multimodal transport, promote non-mechanised transport mode for short trips and maximise use of public transport;
2. Reduce carbon emission and air pollution through the use of efficient modes of transportation; and
3. Alleviate traffic congestion problems through effective planning and enforcement.

3.1.2. Key Issues and Challenges in Hong Kong

To move forward, the following key issues will have to be addressed and challenges overcome:

- Adoption of electric vehicles (EV) is not widespread enough.
- Limited popularity of in-vehicle unit that enables non-stop, automatic payment for using tolled tunnels and roads. At present, the Autotoll system which is an electronic payment system involving the installation of an in-vehicle unit in each vehicle and charges a nominal monthly fee is only used by about half of the vehicles paying tolls for using tolled tunnels, bridges and roads. Wider installation of in-vehicle units will not only enable automatic payment of tolls, but can also enable automatic collection of car park fees, collection of much more data about car-journey speeds and real-time traffic situation. The Government has pointed out that installation of in-vehicle unit is necessary if Dedicated Short-range Communications is to be adopted as the charging mechanism in the future electronic road pricing pilot scheme for Central and its adjacent areas. Protection of privacy may be a consideration of some drivers if the installation of in-vehicle units is made mandatory.
- Penetration of Octopus payment and other emerging e-payment systems are not sufficient e.g. not yet popular for taxi.

- Insufficient parking vacancy information for drivers – majority of public car parks run by the private sector have not yet consented to feed information into the Government application showing real-time public car park vacancy information (HKeRouting).
- More smart solutions on pedestrian friendly mobility for senior residents - the city should continue enhancing commuting for the ageing population by employing smart solutions. The use of information technology to allow longer pedestrian green time at road junctions for the elderly and other needy people is just a first step.
- Challenges to encourage or mandate private companies operating public transport services and public transport infrastructure to share data – Hong Kong's public transport is run by private companies on commercial principles. The data behind their operation is private property. Thus if the companies are not willing to share them at no cost with the community, under the existing statutory framework, the Government at present has no power to mandate such sharing. The same with private companies operating transport infrastructure like car parks. Consideration needs to be given to how to encourage the sharing of data, or even mandating the sharing of data for public good through legislation (and/or compensation), subject to due considerations on the legal issues involved (e.g. protection of private property rights by promotion of public good).
- Enforcement of traffic congestion-related contraventions requires intensive efforts by law enforcement officers at present. More widespread use of smart technologies for traffic enforcement could enhance effectiveness and help alleviate road traffic congestions.
- Green Transport - Urban areas are very busy with heavy traffic. Biking is therefore not a safe means of commuting in these areas. More environmentally-friendly fuel for passenger ferry services is not yet available.
- The Hong Kong International Airport faces capacity constraints in terms of runway slots, terminal space and associated facilities until the launch of the third runway systems in 2024.
- Meanwhile, the increasing trend of global travellers in using smart services in terms of automation, mobility, personalization and self-services also poses a higher expectation for the airport to deliver a smarter travel experience.

3.1.3. Overseas and China Leading Practices

- London offers "source London", an on-line service for reserving EV charging stations ahead of time[34].
- The UK is currently testing a beyond line of sight drone delivery programme that will enable companies to deliver packages to customers via drones to their doorsteps[35].

[34] https://www.sourcelondon.net/
[35] https://www.theguardian.com/technology/2016/jul/25/amazon-to-test-drone-delivery-uk-government

- US cities such as San Francisco, Phoenix, Austin, Kirkland, and Pittsburgh are currently running pilots with leading technology companies to enable self-driving cars in the city[36].
- The United States has issued a Federal Automated Vehicles Policy to drive a proactive safety approach and promote innovation in the development and adoption of autonomous vehicle technology[37].
- Dubai is testing electric buses, driverless cars, and a fully automated metro system[38,39].
- Barcelona has redesigned city bus routes to simplify travel to require fewer transfers between stops[40].
- Singapore has commenced "project bus stop" which provides free Wi-Fi and e-books to citizens waiting for rides[41].
- San Francisco has introduced SF Park which works with smart parking meters to adjust rates dynamically[42].
- Singapore and UK use electronic road pricing scheme to manage traffic congestion in Central Business District (CBD) during peak hours [43,44].
- Singapore mandates the installation of in-vehicle units for its electronic road pricing scheme. Users may use the in-vehicle units to pay parking fees for car parks installed with Singapore's Electronic Parking System.
- Singapore has enacted legislation to clearly allow the use of private motor cars for the carriage of passengers and the recovery of the cost and expense incurred by the journey from passengers.
- Britain's first self-driving car conceptualised in Milton Keynes is now paving the way for public trials across the UK[45].
- Guangzhou's smart airports will use an automatic sensing and intelligent processing system, and the ground command and scheduling system will be made more comprehensive. The relevant agency will provide a one-stop service for logistics approval and real-time tracking of goods and electronic cargoes. Electronic ticketing, mobile ticketing and electronic baggage tags will also be promoted[46].

[36] http://fortune.com/2016/10/04/driverless-cars-uber-lyft-google-baidu/
[37] https://www.transportation.gov/AV
[38] http://www.arabiansupplychain.com/article-11275-dubai-begins-nine-month-trial-of-electric-bus/
[39] https://www.mhi-global.com/company/technology/review/pdf/e492/e492001.pdf
[40]http://ajuntament.barcelona.cat/ecologiaurbana/en/bodies-involved/citizen-participation/new-bus-network
[41] http://www.straitstimes.com/lifestyle/home-design/bus-stops-fun-stops
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[45] http://www.telegraph.co.uk/technology/news/11866132/First-self-driving-pod-unleashed-on-Britains-roads.html
[46] Guangzhou Municipal Government (2012), 中共廣州市委廣州市人民政府關於建設智慧廣州的實施意見, http://www.gzgh.org.cn/_layouts/ghpub/specialtopic/city/view/view07.html

3.1.4. *Description of Potential Scene/Outcome*

Building on the foundation of smart mobility as mentioned in paragraph 3.1.2 and taking account of the latest ICT available, the potential scenarios/outcomes of the smart mobility is outlined in the following table.

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
Commuters/tourists	• Access real-time schedule and wait times across the multiple modes of transportation • Ride on pilot EV bus/mini-bus • Enhanced biking facilities for use • Experience seamless transit, immigration and other airport services at Hong Kong International Airport as the Hong Kong Government continues to develop a leading passenger hub in Asia, outshining competition from neighbouring cities	• Make payments through a variety of electronic means (e.g. wearables, card, phone) • View alternative routes based on current schedule and available capacity of the public transportation and road condition • Experience an enhanced pedestrian experience while walking indoors across buildings with navigation commands in multiple languages through clear and user-friendly walking maps and sign • Be able to easily identify, plan and take pedestrian friendly routes which improve walkability around the city	• Experience improved air quality • Traffic signals responding to actual traffic conditions at junctions where intelligent transport systems are implemented • In-vehicle units installed in all vehicles if public support can be obtained
Drivers	• Access more parking vacancy information provided by private car park operators through a single mobile application • Use new generation on-street parking meters with multiple electronic payment means, including payment by phones, and access vacancy information through mobile application • Install more	• Access to more real-time traffic/road information based on V2X communication technology • For those who have in-vehicle units installed in their vehicles: no stopping required to make payment for tunnels, tolled roads and car parks • Pay congestion charges that may vary during the day for	• Experience improved air quality • See AVs on selected roads • All have installed in-vehicle units hence no need to stop to make payments for tunnels, tolled roads and car parks • Pay congestion charges that may vary during the day for entering or driving in different designated charging

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	universal EV charging stations • Receive automated notification suggesting less congested routes • Government and some public transport vehicles start to be installed with in-vehicle units to collect traffic data • More car pooling and sharing activities around the city • Pilot on use of smart technology on traffic enforcement	entering or driving in piloted areas under the Electronic Road Pricing Pilot Scheme (e.g. Central) • Start to experience Autonomous Vehicles (AV) pilots at some locations such as the airport, HKSTP, and Lok Ma Chau Loop • More car pooling and sharing activities around the city • More widespread use of smart technologies for traffic enforcement	areas in Hong Kong. Traffic signals responding to actual traffic conditions at junctions where intelligent transport systems are implemented

3.1.5. Proposed Initiatives

The following are potential projects and initiatives that may be considered to achieve the objectives under this theme.

Some of these potential projects can be considered for pilot, as indicated by a  .

Description of Potential Projects

- Intelligent Transport Systems (ITS):

  Develop an ITS strategic road map to map out the short-term and long-term goals of smart mobility, with the development of various ITS initiatives interacting with each other using real-time city wide traffic data. The road map will serve as a framework for ITS development to achieve a connected and interactive ITS systems for long term deployment in Hong Kong.

- Smart Public Transport Interchange or Major Bus Stops: 

  The project will involve transforming selected public transport interchanges (PTIs) or major bus stops to allow for functions and features such as integration of sensors into poles to demonstrate multi-functionalities (e.g. traffic detection and air quality) and provisioning of access of free Wi-Fi. Additionally, the smart PTIs or major bus stops may include a multi-purpose touch screen offering a range of information (e.g. news, weather conditions, estimated time of arrival of the buses to the bus stops, the passenger's estimated time of arrival to the destination based on traffic, bus occupancy, bus options that passengers can opt for based on buses' arrival time, destinations and traffic, dynamic

digital map showing bus routes/bus stops). This proposed project is considered for a smart city pilot.

- All-in-One Transport Mobile Application ("HKeMobility"):

  Develop an integrated platform for the three existing mobile applications viz. "HKeTransport", "HKeRouting" and "eTraffic News" and the proposed mobile application on "Walkability" that aims at providing pedestrian facilities information. The integrated platform will provide greater convenience to those who need to use the service provided by more than one of TD's mobile applications at any one time.

- Smart Parking: 

  This project involves integrating monitoring systems for available parking spaces through usage of IoT sensors. Applications can be created to provide real-time information on parking space vacancy in off-street parking, guide drivers to the nearest available space. Another feature optional for consideration is allowing for reserving of parking spots. The system will provide guidance to the drivers on available parking spaces and the drivers will be guided to the vacant parking spaces instantly without having to circulate unnecessarily around the car park. It also involves smart payment for new parking meters, smart meters that are able to accept multiple forms of electronic payment. This proposed project is considered for a smart city pilot.

- Intelligent Signalised Junctions and Pedestrian Lights: 

  This project involves the integration of technologies such as control systems, and vehicle or pedestrian presence detection sensors to allow for communication between traffic infrastructures and improve traffic management for vehicles and pedestrians. It aims at minimising unnecessary waiting time for both pedestrians and vehicles at signalised junctions to facilitate smooth traffic flow and enhance pedestrian movement. This proposed project is considered for a smart city pilot.

- Smart Airport:

  This project involves implementing technology and tools that will enable the Airport Authority Hong Kong to undergo digital transformation. The focus on automation, mobility, personalisation and self-service aims to promote greater efficiency and superior passenger experience. In addition, this project aims to provide all features of integrated multi-modes of transport to plan journeys from/to airport for regular air passengers and visitors.

- Connected Vehicles:

  This project involves integrating technologies into vehicles to equip them with internet access and wireless connectivity to allow for vehicle-to-everything communications (vehicle-to-vehicle, vehicle-to-pedestrian, vehicle-to-infrastructure, vehicle-to-network). Vehicle-to-everything (V2X) uses wireless connectivity to enhance road safety by allowing

vehicles to sense and "speak to" other objects such as surrounding vehicles or road-side equipment. Some of its applications include vehicle forward collision warning, do-not-pass warning, vehicle queue warning, curve speed warning, blind intersection notification, and emergency vehicle alert. V2X enables cooperative adaptive cruise control and platooning, and can assist users in discovering parking and charging facilities. This will allow all vehicles to provide various services to drivers such as collision warning and parking location. It should be noted that different communication standards are now being developed in USA, Europe and other countries. It might take some time before a de-facto industrial standard can be established and available for wider application.

- Electronic Road Pricing:

  Implementing infrastructure for electronic road pricing can provide the capability of vehicle recognition and automatic charging when users pass a point in a road. This project involves integration of technology that enables congestion charging that may vary by time and collection of charges through alternative electronic payments such as smart vehicles plates and wearables.

- Use of Smart Buses:

  A Smart Bus project will integrate buses with sensors and utilise data shared through buses and other transportation systems to improve bus services to individuals. Individuals can access applications to receive real time information on bus capacity, routes, and location. Buses can also be provided with information to detect congestions or other traffic events.

- Use of Autonomous Vehicles:

  The project should set up intelligent traffic systems integrated with sensors to enable autonomous vehicles. Ultimately, the project will increase usage of autonomous vehicles on a city-wide basis in a longer term. Autonomous vehicles, used for the delivery of goods or the movement of passengers, can take the form of robots or drones, and may be piloted in areas such as the airport, Science Park, and Lok Ma Chau Loop.

- Promotion of Car Pooling and Sharing:

  Car pooling is the sharing of a car in trip-making so that a car carries more than one person. In Hong Kong, car pooling is legal provided that the driver/owner of the car does not carry his travelling companion(s) for hire or reward. To promote car pooling, reference can be made to Singapore's approach in spelling out clearly in legislation or in other forms that the recovery of the part of the journey cost such as fuel and road/tunnel toll due to his travelling companion(s) is permitted. Hong Kong may also develop a mobile application to facilitate the pairing of travelling companions.

  Under the car sharing arrangement, the car owners (either companies or individuals) allow others to use their cars (i.e. without provision of chauffeurs), usually for a rental charge based on usage. This type of car sharing with proper insurance coverage is legal in Hong Kong. For individuals who only occasionally need a car, they may opt to rent the car,

instead of owning the car, which help reduce the overall car ownership rate. The per-usage charging scheme may also discourage the renters from driving more than they actually need.

- Bike Facilities:

  In comparison with urban area, new towns or new development areas (NDAs) offer a better road environment for using bicycles as a supplementary mode for short-distance travel. Where the situation permits, cycle tracks and ancillary facilities should be enhanced so that cyclists can safely ride for recreational purposes and short distance travel for first or last mile. The information on cycling facilities should also be uploaded on an internet-based platform for public reference.

- Installation of In-Vehicle Unit:

  Apart from being a payment instrument in an electronic road pricing scheme, in-vehicle units can supplement traffic detectors in the collection of real-time traffic data (including traffic speed and travelling time) and facilitate automatic toll collection, car park (including on-street parking) fee payment and even facilitate enforcement of traffic laws. As a start, the Government may install in-vehicle units in all government vehicles and some public transport vehicles. In the medium term, the Government may consider promoting the installation in private cars through an incentive scheme. Upon having sufficient public support, the Government may then map out a programme for mandating the installation of in-vehicle units in all vehicles in the long term.

- Use of Environmentally-Friendly Ferries for Passenger Ferry Services:

  The project should look into the technical feasibility of Hong Kong adopting a green ferry to be propelled by alternative fuel such as LNG or electricity, and /or built by lightweight materials such as carbon fibre. As to alternative fuel, this entails not just the vessel itself, but also the required supporting facilities such as refuelling or recharging facilities and pier design. The green ferry would need to be proven to be technologically capable of meeting the local operational needs of ferry used as a means of heavily patronised public transport service.

- Adoption of Smart Technologies in Traffic Enforcement:

  The project should look into the adoption of suitable smart technologies in traffic enforcement, thereby increasing the efficiency of enforcement and reducing the intensive efforts required by law enforcement officers. If the trial scheme for using CCTV Systems with video analytic capabilities for monitoring loading and unloading activities and related traffic enforcement is successful, such systems could be set up at black spots for enforcement of traffic offences and the concerned legislation should be amended to remove any legal hurdles that could hinder the use of smart technologies in traffic enforcement.

Proposed Initiatives to Meet the Objectives

(Initiatives marked with "(#)" are on-going ones.)

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
1. Facilitate commuters' choice of efficient and integrated multimodal transport, promote non-mechanised transport mode for short trips and maximise use of public transport	<u>Intelligent Transport Systems</u> • Develop an ITS strategic road map with short, medium and long term goals of smart mobility, with the development of various ITS initiatives	<u>Intelligent Transport Systems</u> • Implement the planned activities outlined in the ITS road map (#)	<u>Intelligent Transport Systems</u> • Review the progress of the implementation plan of the activities outlined in the ITS road map (#)
	<u>HKeMobility</u> • Enhance TD's mobile application to provide travel time comparison of different transportation modes (including walking). • Smart pedestrian programme: easier pedestrian access through studying measure to enhance infrastructure and signage (#)	<u>HKeMobility</u> • Develop an all-in-one integrated platform that streamlines TD's mobile applications (#) • Smart pedestrian programme: easier pedestrian access through infrastructure upgrades and navigation through the use of clear and user-friendly walking maps and signage with multiple language support (#)	
	<u>Smart Public Transport Interchanges or Major Bus Stops</u> • Pilot project of smart public transport interchanges or bus stops which integrate sensors and other technologies to provide new services to users • Install mobile phone charging outlets at public transport interchanges or major	<u>Smart Public Transport Interchanges or Major Bus Stops</u> • Implement a city-wide Smart Public Transport Interchange or Major Bus Stop project • Enhance inter-modal transport hubs for quick transfers (#)	

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	bus stops (and in public vehicles) • Continue to plan better inter-modal transfer facilities (#)		
	<u>Smart Airport</u> • Implement the next generation passenger check-in kiosk and mobile check-in desk to provide passengers with fast travel experience (#) • Expand the off airport baggage check-in services to more downtown locations such as convention centres, cruise terminals, hotels, etc. • Implement indoor positioning technologies to allow passenger self-wayfinding in terminal and provide location-based marketing offers (#) • Implement one single token for passenger journey using with facial recognition technology to provide fast and seamless journey for passenger in the airport • Smart luggage tag to provide bag arrival notification to alert passenger • Passenger self-service transfer kiosk passenger to provide 24x7 services including boarding	<u>Smart Airport</u> • Explore driverless vehicles such as driverless tractors and dollies, self-driving at airside • Automated car parking facilities • Application of drones in runway, apron and terminal inspections • Build intelligent infrastructure through advanced robotics and machine learning technologies • Enhance people-centric services through wearables, artificial intelligence • Establish speedy data-driven decision support through enhanced big data analytics technologies • Incorporate the latest smart airport services and infrastructure into the Three-runway System	<u>Smart Airport</u> • Evaluate technology needed to implement the initiatives explored and enhance services and process under Three-runway System

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	pass printing and baggage enquiry • Enhance self bag drop process and extend self bag drop enabled counters to more locations (#) • Smart use of mobile app (HKG My Flight) to provide passengers with personalised airport experience, from pre-airport trip planning to flight status tracking, from personalised boarding alerts to baggage arrival notification, and from automatic airport Wifi connect to way finding in terminal (#) • Explore GPS tracking for motorised and non-motorised equipment in airside to facilitate effective resource deployment, such as on tractors and dollies (#) • Explore crowd management system to allow automatic detection of passenger queue in terminal • Implement trolley management system to track baggage trolleys by using video analytics (#) • Explore robotics applications: deploy customer service robot, operation surveillance robot,		

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	such as cleaning robot, and security robot to conduct autonomous patrolling, face recognition • Explore the application of virtual reality to airfield's operation training and airport contingency drills and exercises		
	<u>Promotion of Car Pooling and Sharing</u> • Promote car pooling and car sharing	<u>Promotion of Car Pooling and Sharing</u> • Facilitate city-wide car pooling programme	
		<u>Use of Smart Buses</u> • Explore to incorporate franchised bus fleets with capabilities to allow for real-time information sharing	
2. Reduce carbon emission through the use of efficient modes of transportation	<u>Bike Facilities</u> • Continue to improve biking facilities (#)		
		<u>Use of Environmentally-Friendly Ferries for Passenger Ferry Services</u> • Source vessels using cleaner fuel and plan for the infrastructure required for their use such as fuel storage facilities and charging facilities for electric vessels (#)	<u>Use of Environmentally-Friendly Ferries for Passenger Ferry Services</u> • Introduce the use of vessels with cleaner fuel (#)
3. Alleviate traffic congestion problems and through	<u>Intelligent Transport Systems</u> • Collect traffic data from strategic roads installed with traffic detectors and	<u>Intelligent Transport Systems</u> • Expand the installation of traffic detectors to full coverage of strategic	<u>Intelligent Transport Systems</u> • Implement information and communication technologies to

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
effective planning and enforcement	promptly provide accurate traffic news and incidents • Expand the existing Speed Map Panel and Journey Time Indication systems at major routes to provide motorists with on-board real-time traffic information to facilitate the choice of routing for saving travel time (#) • Work with public transport operators to assess current payment system capabilities and explore alternatives (#)	routes and at major urban roads	facilitate law enforcement of traffic violations
	<u>Install of In-Vehicle Units</u> • Install in-vehicle units in government vehicles and some public transport vehicles	<u>Install of In-Vehicle Units</u> • Implement incentive scheme for installation of in-vehicle units in all vehicles	<u>Install of In-Vehicle Units</u> • In-vehicle units installed in all vehicles if public consensus can be reached
	<u>Electronic Road Pricing:</u> • Conduct in-depth feasibility study for implementing the Electronic Road Pricing Pilot Scheme in Central and its neighbouring areas[47] (#)	<u>Electronic Road Pricing</u> • Design and implement differential tolls for selected tunnels (#) • Design and implement the Electronic Road Pricing Pilot Scheme in Central and its adjacent areas for levying congestion charges that may vary during the day for	<u>Electronic Road Pricing</u> • Implementation of differential tolls for all tunnels (#) • Expansion of the electronic road pricing scheme from Central and its adjacent areas to other designated charging areas in Hong Kong for levying congestion charges that may

[47] http://www.info.gov.hk/gia/general/201606/22/P201606220362.htm

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
		entering or driving in the area (#)	vary during the day for entering or driving in the areas
	<u>Smart Parking</u> • Continue to encourage private car park operators to release real-time vacancy information through Government's mobile applications (#) • Install parking bay display, guidance systems and car searching systems at multi-storey car parks under the management of TD • Introduce a new generation of parking meters with new features and functions (e.g. accepting multiple payment means considering the currently available electronic payment options, facilitating purchase of additional parking time may also be considered for payment by mobile phone platform) (#)	<u>Smart Parking</u> • Review pilot smart parking meters which accept multiple forms of electronic payment and expand programme (#)	
	<u>Adoption of Smart Technologies in Traffic Enforcement</u> • Conduct pilot project on curbside loading/unloading bay monitoring system and consider its wider implementation for traffic	<u>Adoption of Smart Technologies in Traffic Enforcement</u> • Implement curbside loading/unloading bay monitoring and traffic offence enforcement system at congested locations or locations with high pedestrian flow (#)	

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	enforcement (#)		
	Intelligent Signalised Junctions and Pedestrian Lights • Explore the use of information and detection technologies in enabling existing traffic signal system to interact with the real-time demand of pedestrian and vehicles (emergency vehicles in particular) for optimised use of traffic signal green time (#)	Intelligent Signalised Junctions and Pedestrian Lights • Implement intelligent signalised junctions at congested locations or locations with high pedestrian flow (#)	
	Connected Vehicles • Pilot vehicles with integrated internet access (#)	Connected Vehicles • Assess additional technologies and services that can be incorporated into vehicles such as forward collision warnings, emergency vehicle alerts, and discover parking and charging (#)	
		Use of Autonomous Vehicles • Undertake a pilot project on AVs and associated intelligent traffic systems at selected locations (e.g. airport, HKSTP, Lok Ma Chau Loop) (#)	Use of Autonomous Vehicles • Geared up in various aspects for the use of AVs on selected public roads

3.1.6. Benefits

The following are the key benefits that the citizens, the city, and businesses will be able to take advantage of:

	Benefits

Citizen	• The availability of more advanced and efficient modes of transportation (e.g. autonomous vehicles) will enable safer and quicker travel and transport • Availability of applications to facilitate commuting will allow for easy journey planning and payment • Real-time traffic insights will allow citizens to plan their journeys more efficiently
City	• With more charging facilities, vehicles can have longer range and hence will be able to cover longer distance • Adoption of new technologies such as autonomous vehicles may lead to improved road safety • Better traffic planning and management through enhanced use of technologies will lead to lower congestion in the city and reduce the need for heavy capital investment for new infrastructure • Reduced road traffic congestions will increase the efficiency of citizens' mobility and many other business activities
Business	• Additional revenue opportunities through the use of new technologies • Reduced expenditure on fuel • Non-mechanised transport means in particular walking improves citizen participation in local community and businesses • Collaboration between public and private provides opportunities to drive greater integration of services, information and payment

3.1.7. Major Stakeholders

3.1.7.1. Bureaux/Departments (B/Ds)

- Transport and Housing Bureau (THB) and its group of departments
- Environment Bureau and Environmental Protection Department

3.1.7.2. Public Bodies

- Airport Authority Hong Kong
- Research and development institutions, e.g. universities, Automotive Parts and Accessory Systems R&D Centre
- Disability service and solutions providers
- Construction Industry Council

3.1.7.3. Private Sector

- Public-transport operators
- Telecom providers
- Delivery service providers
- Parking lot providers
- Mobile app developers
- Robots and drones solution providers
- Autonomous Vehicles and Connected Vehicle technology and solution providers
- Toll operators
- Construction industry

3.1.7.4. Other Key Stakeholders

- Legislators and district councillors

3.1.8. Legal and Regulatory Matters

	Short-term (2017 – 2020)	**Medium term (2021 – 2025)**	**Long term (2026 – 2030+)**
Smart Mobility	Balancing privacy protection and data sharing in relation to capturing data generated from city-wide sensors (including CCTVs, drones, smart vehicle plates) and privacy and smoother traffic flow in relation to the use in-vehicle units in all vehicles: • The Personal Data (Privacy) Ordinance, Cap 486 • Guidance on CCTV Surveillance and Use of Drones (issued by the Office of the Privacy Commissioner) Allowing for changes in the toll level: • The Road Tunnels (Government) Ordinance, Cap. 368 Different regulations governing the tolling of government tunnels shall be also considered	Providing the legal basis for autonomous vehicle driving in Hong Kong, electronic road pricing and car sharing: • The Road Traffic Ordinance, Cap 374 • New legislation for electronic road pricing system • Other relevant legislation Facilitating the use of drone for commercial applications: • Air Transport (Licensing of Air Services) Regulations, Cap 448A, Air Navigation (Hong Kong) Order 1995, Cap 448C, or other relevant aviation regulations	

3.2. Smart Living

"Smart Living" enhances the overall living experience of the people of Hong Kong, across age groups and demographics. The proposed projects under Smart Living focus on improving an individual's ability to interact with electronic services, and on improving general wellbeing and health. The aim is to create a safer, more secure, accessible, and happy society.

Smart Living is enabled by the general public's confidence in using electronic services with ease for payments, authentication, and other transactions. As digital payments become more prevalent, Smart Living aims to enable citizens to pay for services quickly and efficiently, and aims to provide timely receipts of transaction data and funds. This sets the scene for moving the city towards a cashless society, and optimise users and business' experiences.

Smart Living will also leverage new technologies in health monitoring, telehealth, and smart hospital facilities to improve and streamline healthcare services to the elderly, and general public. Smart Living will help to offer preventative healthcare services and tailored medical advice to individuals.

All these initiatives in combination will facilitate improvement in, and the management of, the living environment and quality of life.

The Government launched the $500 million Innovation and Technology Fund for Better Living (FBL)[48] in May 2017 to encourage the use of information and technology in developing projects that aim at improving people's daily living or benefiting specific community groups. The new funding source will boost up local innovations by transforming ideas into deliverables for benefiting the society.

3.2.1. Policy Objectives

To achieve Smart Living in Hong Kong, the Government should aim to:

1. Instil and enhance citizens' confidence and ability in transacting electronically with the public and private sector;
2. Support general citizen wellbeing; and
3. Empower the elderly to age in their own communities.

3.2.2. Key Issues and Challenges in Hong Kong

It is observed that citizens lack confidence to perform transactions electronically. There are:

- Limited adoption of current digital certificates and associated infrastructure amongst

[48] http://www.itb.gov.hk/en/fbl/

public and private service providers.

- Lack of coordination and consistency in mechanisms used for validation and compliance.
- Dedicated (and proprietary) payment devices for transactions for individual digital payment methods, resulting in multiple payment devices being required when a variety of digital payment methods are offered.
- Change in consumer behaviour resulting in a large increase in the number of faster payments being made by consumers using mobile devices in small amounts outside traditional business hours, which demands a faster payment system.
- Need for improving existing requirements and channels in obtaining and verifying citizens' personal data in a secure manner in public and private services e.g. duplication of effort.

It is observed that there are gaps in the provision and support for the elderly to age in their own community and elderly homes. Such observations include:

- Although there are channels for the public to understand their medical needs[49], the health needs for some elderly patients could be complex. Sometimes the elderly may be unaware of or find it difficult to navigate the various types of services provided by the Government and non-governmental organisations (NGOs).
- Limited understanding by elderly on availability of subsidies and assistance, such as Community Care Service Vouchers for Elderly.
- According to local survey, over 70% of elderly suffer from one or more chronic disease(s)[50]. In addition, the growing size of the elderly population will likely give rise to the need for more effective chronic disease management[51,52].
- Elderly home operators, especially the smaller ones, have limitations in making better use of ICT and they may not have the necessary funding, physical space or system support to adopt the new technology and apply innovative solutions to improve the wellbeing of the elderly living in the homes, increasing operational efficiency, reducing the workload of the staff, and reducing the financial and labour costs of service provision[53].
- Insufficient supply of elderly homes and related manpower.

There is a need to improve general wellbeing of citizens. Key considerations include:

- An ageing demographic with over 35% of the population at 65 and above by 2064, in particular, 10% of the population would be classified as old-old (85 or above)[54].
- Local survey has shown that 75% of local people aged 65 or over, and 45% of people in

[49] http://www.hkmj.org/system/files/hkmj144326.pdf
[50] http://www.elderly.gov.hk/english/healthy_ageing/mental_health/coping_with_chronic_illness.html
[51] http://www.elderlycommission.gov.hk/en/library/Ex-sum.htm
[52] http://www.hkmj.org/system/files/hkmj144326.pdf
[53] Meeting with SWD, Hong Kong Housing Society, and Private Elderly Home Operators
[54] Census and Statistics Department, Baseline Population Projections up to 2064
http://www.statistics.gov.hk/pub/B1120015062015XXXXB0100.pdf

the 45 to 64 age groups are suffering from one or more chronic diseases, with diabetes, heart disease and chronic bronchitis common among the older persons according to a local survey. In terms of the impact of these chronic diseases and conditions on the health system, over 46% of the hospital day-beds are occupied by older persons while they represent only about 11% of the total population[55].

3.2.3. Overseas and China Leading Practices

The overseas leading examples that demonstrated the ability for citizens to perform transaction electronically include the following:

- Netherlands uses DigID, a digital authentication system to provide its residents with government services on-line. Individual attributes are held in a national registry and verified when a DigID username and password is created. Once created this national identifier is used to authenticate citizens for services[56].
- Denmark uses NemID, an electronic ID, digital signature and secure email solution providing individuals access to public and private services. The government provides this service through a private agency (i.e. federated authentication)[57].
- The Government of Singapore launched "MyInfo" which is centralised personal data platform containing government-verified personal details that enables residents to provide their personal data once to the government, and retrieve their personal details for all subsequent on-line applications for government services and financial services[58].
- The Monetary Authority of Singapore is currently building a Centre of Excellence to leverage Distributed Ledger Technology (Blockchain) for increasing transparency and reducing the cost for financial institutions[59].
- The Transport of London utilised Mastercard's contactless payment technology to upgrade their ticketing system to create a converged device capable of accepting multiple payment methods such as contactless cards, NFC enabled smartphones, and other contactless payment types[60].
- Pingshan New District will focus on building smart urban systems to bring greater convenience to citizens. For instance, for citizens with children going to school, they will be able to gain a greater understanding on the school's environment, school placements and teachers qualification through an internet platform. Students may also register for enrolment through the internet platform. The creation of such systems will also facilitate the standardisation of government work. Against the backdrop of big data analytics, government bodies will be able to obtain the latest information at a quicker pace, thereby enabling more reasonable and smarter decision-making. The system will also allow citizens to provide feedbacks and make services a less passive experience for citizens.

[55] http://www.elderlycommission.gov.hk/en/library/Ex-sum.htm#2
[56] http://www3.weforum.org/docs/WEF_A_Blueprint_for_Digital_Identity.pdf
[57] http://www3.weforum.org/docs/WEF_A_Blueprint_for_Digital_Identity.pdf
[58] https://www.singpass.gov.sg/myinfo/intro
[59] http://www.ibtimes.co.uk/r3-partners-monetary-authority-singapore-launches-asia-blockchain-centre-excellence-1590490
[60] https://www.engadget.com/2014/09/16/contactless-card-nfc-payments-london-tube/

The following are leading practices that empower elderly to age in their own community:

- Vienna uses eHealth and mHealth (mobile health) to provide easier access to health services for seniors[61, 62].
- Japan is using robots to care for seniors and keep them company[63].
- In Singapore, certain providers sell iPhones preloaded with useful apps to make access easier for seniors[64].
- In Hangzhou, the Smart elderly care services cloud platform includes building a platform that utilises IoT technology and various kinds of sensors to remotely monitor the daily life of the elderly including remote alert of falling down, blood pressure tracking, remote monitoring of heartbeat, remote psychological treatment. If an elderly forgets to turn off the gas, the sensor installed in the kitchen will give an alert. It will automatically start the cleaning programme and close the valve. Through the platform, the elderly can also apply for the stay at the public pension institutions. Last year, Xihu District was the first to test the platform in the province[65].

The following are leading practices for improving general wellbeing of citizens:

- Singapore uses guided tracks in hospitals to facilitate the movement of guided vehicles for the delivery of meals[66].
- Dubai launched an electronic medical record system and a patient data exchange scheme to allow a powerful analysis of what services are needed in Dubai as well as helping the improvement of patient care and safety, risk management and organisational quality[67].
- Researchers at MIT have developed a system to collect, analyse, and visualise biochemical information from sewage water to learn about eating habits, genetic tendencies, and overall health[68].
- In the US, health organisations are using predictive analytics to identify who is at risk for disease (e.g. diabetes) and to allow healthcare providers to intervene[69].
- In Guangzhou, smart public safety aims to promote intelligent application of public safety surveillance, to achieve a comprehensive network of video surveillance points across the city, to build “safe campuses” as well as to establish a citywide facilities safety monitoring system.

[61] https://smartcity.wien.gv.at/site/projekte/gesundheit-soziales/mobile-health/ (website in Deutsch)
[62] https://www.wien.gv.at/gesundheit/einrichtungen/planung/ehealth/ (website in Deutsch)
[63] http://www.businessinsider.com/japan-developing-carebots-for-elderly-care-2015-11
[64] http://www.straitstimes.com/singapore/smart-solutions-to-empower-seniors
[65] Taikungpao.com (10 January 2015), 杭州主動適應新常態，加快轉變發展方式,
[66] http://www.straitstimes.com/singapore/health/hospitals-turn-to-cutting-edge-robots-and-technology-for-healthcare-assistance
[67] http://www.thenational.ae/uae/health/one-stop-shop-for-dubai-patient-data
[68] https://dusp.mit.edu/news/underworlds
[69] http://managedhealthcareexecutive.modernmedicine.com/managed-healthcare-executive/news/using-predictive-modeling-prevent-diabetes

3.2.4. *Description of Potential Scene/Outcome*

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
Citizens	• Start the pilot use of biometric authentication to improve user experience in public / private e-services • Become better aware of public healthcare services available • Gain access to one's health records from/to public and private providers • Development of evidence-based mobile health applications to improve patient-centred care such as individualised information about prescriptions, self-health monitoring, treatment and appointment scheduling, etc. • Increased use of wearables relating to disease monitoring, action alarms, and other indicators where feasible. • Access mobile applications providing information to facilitate better accessibility in the city, wheelchair accessibility, etc. for people with disabilities	• Ability to use user-friendly digital persona to acquire services • Become better aware of the treatment available for chronic diseases such as dementia and diabetes through relevant information • Realise the new service models for community healthcare services and associated benefits as an alternative to hospitalisation • Increased access to telehealth or remote healthcare options • Start noting improvements in over-utilisation of public hospitals due to better preventative healthcare services initiative	• Increased access to advanced telehealth or remote healthcare options • Increased use of telehealth services as an accepted method of consultation • Explore use of new technology or AI to improve disease diagnosis • Analytics may be applied to an individual's health data, collected and monitored in the long run, so that potential health problems maybe flagged up in advance, and future medical complications may be avoided • Regard the new service model for community healthcare services as successful and expect them to be adopted extensively by major stream of care providers
Businesses	• Easily and confidently use digital identity for the provision of services and the use of digital payment • Provide more informed care and treatment services	• Reduce response time and cost to offer services, determine eligibility and payment settlements • Provide more information on wait times, health services, doctor schedules, appointment bookings and cost estimates so as to facilitate patients'	• Improve coordination of healthcare services across different types of care providers

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
		choice of service • Prepare the storage and analysis of data collected from wearables and applications to improve health services to optimise healthcare services	
Government	• Offer more digital payment options for public services • Note an increase in the usage of electronic medical records • Improve bandwidth of public hospitals by leveraging private sector to provide eligible services	• Offer streamlined provision of access, eligibility determination and other personalised services • Has the ability to respond to healthcare demand through dynamic allocation of such demand to public and private healthcare service providers with improved access to patient health records • Equip hospitals with smart features and services, increasing operational efficiency, and quality of services to patients	• Retrofit hospitals with more smart features

3.2.5. Proposed Initiatives

The following are potential projects and initiatives that may be considered to achieve the objectives under this theme.

Description of Potential Projects

- Digital Persona:

  A Digital Persona project will involve improvement on the current digital certificate by simplifying the acquisition process and increasing adoption of across public and private services providers. The use of the Digital Persona in various services/industries, for example in banking and insurance industries, could provide convenient and reliable means for identification and access to e-services. For healthcare providers, use of digital persona will also provide users with convenient authentication to the services.

- Digital Payments:

  Digital Payments will allow individuals to pay for services using a variety of payment options using innovative means (e.g. a single converged device/terminal regardless of payment type) across points of service and allow service providers timely receipts of transaction data and funds, allowing citizens the flexibility and experience of living in a cashless society and an optimal user experience.

  This project will involve policies that require service providers to accept a diverse range of commonly used electronic methods. Local innovation would be visible through successful deployment of pilots and select services. Furthermore, enhancements to the payment infrastructure in Hong Kong, such as the Hong Kong Monetary Authority's proposed Faster Payment System (FPS), will increase and improve businesses' and individuals' payment and fund transfer services.

- Smart Community Healthcare:

  A Smart Community Healthcare project will involve the creation of a predictive and preventative health and living environment for the people. Through the use of gerontechnology to include assistive technology and inclusive design, it helps the elderly to live in the community and institutions comfortably, healthily and independently while remaining closely connected to the community and their families. Activities can include the use of teleconsultation and remote health monitoring at community level, and the pilot use of care robots. New channels such as kiosks and service centers may be created to increase the convenience and access to health services for the frail, disabled and elderly. The acceptance and widespread use of wearable technology to track health and fitness, and further advancements in the medical applications of wearable technology, may also be considered.

- Smart Hospital Services:

  A Smart Hospital project will involve building new hospitals and retrofitting old ones as far as practicable with smart features and services which are enabled by technology-driven solutions and products, and are aimed at improving service provisions and user experience at all parts of a hospital journey. This includes leveraging technology during the patient registration process, in the waiting rooms, consultation rooms, treatment rooms and wards, operating theatres, as well as during patient checkout, and post-hospital visitation and care. A Smart Hospital will improve the patient and the patient's family experiences, as well as the efficiency and experiences of hospital staff, from administrators to doctors. The Hospital Authority has started working on the planning and design for the next phase of new hospital and redevelopment projects in the next two decades. The project will also involve near-term-solutions to improve the convenience and efficiency for existing hospitals such as self-services where appropriate and – the provision of more information quickly to patients, doctors, relatives, and the hospital.

- Smart Workplace:

This project facilitates the development and enhancement of office technologies, cloud-based management, VR for team design and collaborations, AI in business operations and network connectivity that replicate office structure and connectivity anywhere to encouraging flexible working. Flexibility on the job allows better time management, which in turn, affords individuals with more time for exercise and family. This project also involves exploring the use of ICT to encourage greater physical activity, such as fitness and health interaction with wearables. Concerted efforts and promotion by both public and private sectors will be required.

Proposed Initiatives to Meet the Objectives

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
1. Instil and enhance citizens' confidence and ability in transacting electronically with the public and private sectors	<u>Digital Persona</u> • Create an easy mechanism that allows citizens to acquire public and private services by linking their Digital Persona with service providers • Promote citizen adoption of digital persona • Pilot use of biometric authentication for identity verification in selected business areas (e.g. mobile banking) • Assess the need and feasibility of establishing an integrated account management mechanism for validation of identity (e.g. through the use of Digital Persona) and identify potential pilots in selected business areas (e.g. financial services) • Pilot programmes to explore the use of Distributed Ledger Technology (blockchain)	<u>Digital Persona</u> • Expand the adoption of an integrated account management mechanism for validation of identity through the use of Digital Persona in other areas (e.g. when visiting public or private healthcare providers) • Expand the use of biometric authentication for identity verification	<u>Digital Persona</u> • Create public access API's for validation, authentication, and compliance of eligibility for benefits provided by the Government and/or public organisations
	<u>Digital Payments</u> • Define policies for	<u>Digital Payments</u> • Explore scaling up	<u>Digital Payments</u> • Move towards a

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	requiring public and private service providers to accept a set of acceptable forms of digital payments • Assess impacts and requirements on payment types (e.g. cards, mobile wallets, wearables) if using a single converged terminal for payments and settlements • Innovate a converged device that supports a wide range of popular types of payment methods and an interface that ensures timely settlement of transaction data and amounts • Assess and deploy pilots of converged payment devices at select locations for transport and other services where most digital payment transactions occur • Further enhance the payment infrastructure in Hong Kong through HKMA's proposed Faster Payment System (FPS) to allow banks that provides customers with faster and more convenient payment and fund transfer services • Facilitate the payment service providers to define Service Level Agreements (SLA) for transaction reporting and payment settlements	the adoption of converged payment devices for additional services • Actively explore new payment channels to integrate into the converged payment device	cashless society by allowing digital payments for different forms of transactions • Incorporate additional options (i.e., license plates for tolls) by giving citizens the flexibility to define payment options for various services • Conduct ongoing reviews of best practices and the changing technology landscape and adopt as necessary

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
2. Support general citizen wellbeing	<u>Smart Community Healthcare</u> • Consider a pilot programme for selected NGOs to deliver integrated services to the needy through coordinating service requests, developing new solutions, and optimising resources for NGOs • Continue to roll out and optimise the Electronic Health Record Sharing System[70] • Encourage further usage of wearables by citizens especially elderly to provide additional data for healthcare services (workplace improvement, chronic disease monitoring, health monitoring and medication/action alarms) • Encourage eligible healthcare providers, including NGOs, to join the Electronic Health Record Sharing System	<u>Smart Community Healthcare</u> • Explore the development of a patient portal for facilitating patients to access the Electronic Health Record Sharing System	<u>Smart Community Healthcare</u> • Explore the use of health analytics to improve health and healthcare services in terms of disease detection and prognosis • Design models that can support and maintain smart healthcare services, as well as improve the sustainability and successful uptake of smart health
	<u>Smart Hospital Services</u> • Assess the feasibility of projects that aim to improve the provision of care to patients more efficiently in hospitals; those activities include: - Providing information quickly to patients, doctors,	<u>Smart Hospital Services</u> • Review pilot Smart Hospital activities and features executed in the short term • Design appropriate and feasible smart hospital features in the hospitals • Extended use of an	<u>Smart Hospital Services</u> • Aim to retrofit most of the existing public hospitals with proven smart hospital features

[70] http://www.ehealth.gov.hk/filemanager/content/pdf/en/new_era/eHRSS_GOPCPPP.pdf

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	relatives, and hospital administrators - Encouraging self-service where appropriate - Using telehealth to complement services at hospitals where appropriate - Using technology to increase flexibility, mobility and efficiency of care providers • Develop an enhanced and new clinical care model, improve hospital workflow efficiency & other hospital clinical settings, and quality & risk management of care delivery. Further development of clinical systems being adopted in hospitals incorporating "Paperless workflow", "Closed Loop capability", "Protocol-driven approach"," more Personalised features" and "Patient centric-care model" • Provide more digital collaboration capabilities for clinical service providers to enhance sharing and exchange of clinical care knowledge with a view to improving clinical workflow efficiency • Enhance clinical big data analytics capabilities for	enhanced clinical care model, hospital workflow efficiency & other hospital clinical settings, and quality & risk management of care delivery. Completion of development of clinical systems being adopted in hospitals incorporating "Paperless workflow", "Closed Loop capability", "Protocol-driven approach"," more Personalised features" and "Patient centric-care model" • Wider use of digital collaboration capabilities for clinical service providers to enhance sharing and exchange of clinical care knowledge with a view to improving clinical workflow efficiency • Further use of clinical big data analytics capabilities for efficient planning on hospital facilities, patient care clinical decision support features and better preparation on urgent disease outbreak	

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	efficient planning on hospital facilities, patient care clinical decision support features and better preparation on urgent disease outbreak		
	<u>Smart Workplace</u> • Explore ICT and wearables that can be used with physical activities • Design and create flexible working arrangements and options for civil servants where appropriate • Consider technology options (e.g. cloud-based office solutions, VR for team collaboration, AI in business operations) that support flexible working arrangements		
3. Empower the elderly to age in their own communities	<u>Smart Community Healthcare</u> <u>(1) Elderly at Home</u> • Review the outcome of eHealth projects, such as HKJC's Community eHealth Care Project which leverages health related big data analytics and cloud storage solutions to monitor health at community centres • Adopt the use of technology such as telehealth and assistive measures in elderly centres and day care centres/units for the elderly at community	<u>Smart Community Healthcare</u> • Explore adopting risk prediction models to enhance treatment and prevention for chronic diseases • Explore the integration of healthcare providers cognition apps in prescription and treatment plans for senior patients	<u>Smart Community Healthcare</u> • Possible use of artificial intelligence to enhance disease treatment and prevention

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	level (2) Elderly Residential Care Homes • Encourage wider adoption of successful smart-elderly care projects • More use of care robots at care homes for elderly to reduce care taker's work load • More adoption of electronic nursing and drugs management system (3) Others • Consider developing models for identification and prioritisation of treatment for high risk adults with emphasis on prevention based on robust research findings • Assess further developments to the current mobility applications for disabled and handicapped on accessibility and connection to the outside world[71] • Explore further developments to the apps for improving senior cognition (brain games)		

3.2.6. Benefits

The following are the key benefits the citizens, the city, and businesses will be able to take advantage of:

[71] http://www.ogcio.gov.hk/en/community/develop_mobile_apps/

	Benefits
Citizen	• Improved identity validation conducted by a trusted authority (i.e. employer, government, bank, etc.) that has undergone a thorough physical verification tied to the digital identity • Enables secure single point access to private and public services • Improved security because only identity attributes required for making a decision are used • Enabled remote on-boarding for services that are used to require face-to-face visits for account opening e.g. open a new banking account • Improved quality of life / overall citizen well-being • Greater awareness of healthcare solutions
City	• Provides the government with accurate and real time data about the usage of services by the citizens • Improved sense of community • Greater awareness of problems/issues of the elderly • Decrease operating costs • Provides the government with increased revenue potential through private APIs and usage based pricing (to private service providers)
Business	• Reduces development time and increases adoption of services • Easier access to business services through an efficient and effective user experience • Easier provisioning through centralised access based resource allocation • Increased security due to a standards based approach • Improved efficiency for healthcare providers in terms of patient records management • e-Know Your Customer (e-KYC) can be potentially facilitated by digital persona • Health-related and community care business opportunities

3.2.7. Major Stakeholders

3.2.7.1. Bureaux/Departments (B/Ds)

- OGCIO
- Food and Health Bureau (Health Branch) (FHB(H)) and departments under FHB(H)
- Social Welfare Department (SWD) and Labour and Welfare Bureau (LWB)

3.2.7.2. Public Bodies

- Hospital Authority
- Public healthcare and service providers
- NGOs
- Research and development institutions, i.e. universities, R&D Centres
- Hong Kong Monetary Authority
- Securities and Futures Commission

- Insurance Authority

3.2.7.3. Private Sector

- Hong Kong Payment System participants and Stored Value Facilities licenses
- Private healthcare and service providers
- Elderly residential care homes
- Mobile app developers
- Financial institutes

3.2.7.4. Other Key Stakeholders

- Legislators and district councillors

3.2.8. Legal and Regulatory Matters

	Short term (2017 – 2020)	**Medium term (2021 – 2025)**	**Long term (2026 – 2030+)**
Smart Living	Improve and enhance the security/privacy protection under the Electronic Health Record Sharing System: • Electronic Health Record Sharing System Ordinance, Cap.625 (eHRSSO)[72] • eHR Code of Practice[73] • The Personal Data (Privacy) Ordinance, Cap.486 Establish the legal basis for telehealth in Hong Kong: • Medical Registration Ordinance, Cap.161 • Code of Professional Conduct (issued by the Medical Council of Hong Kong) Regulate the sales and dispensing processes of drugs and poisons under the telehealth arrangement:	Establish the legal basis for recognising Biometric authentication (e.g. fingerprints, voice, retinal, and iris patterns): • Electronic Transactions Ordinance, Cap.553 Facilitate the use of robots for medical applications: • New legislation to be considered for enactment	

[72] http://www.ehealth.gov.hk/en/ehr_related_information/faq/ehrss_ordinance.html
[73] http://www.ehealth.gov.hk/en/ehr_related_information/faq/code_of_practice.html

	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	• Pharmacy and Poisons Ordinance, Cap.138[74] • Antibiotics Ordinance, Cap.137[75] • Dangerous Drugs Ordinance, Cap.134[76] Chinese Medicine Ordinance, Cap.549[77]		

[74] https://www.elegislation.gov.hk/hk/cap138!en@2016-08-05T00:00:00
[75] https://www.elegislation.gov.hk/hk/cap137!en@2006-11-30T00:00:00
[76]https://www.drugoffice.gov.hk/eps/do/en/pharmaceutical_trade/other_useful_information/drug_regulatory_system.html
[77] http://www.cmchk.org.hk/eng/main_ord_cap549.htm

3.3. Smart Environment

"Smart Environment" changes how the Government manages Hong Kong's built and natural environment in the interest of improving Hong Kong people's everyday life and quality of living. These projects and corresponding initiatives, enabled by the use of technology, sensors, awareness campaigns, conservation programmes and goal setting, will help drive systemic and cultural changes in city-wide pollution and waste management, as well as regulatory changes that will encourage the incorporation of more sustainable design, standards, and management of buildings. The coordinated efforts in creating a smart environment, supported by technological solutions, will help reduce waste production, monitor and manage pollution, improve the emission rates of the built environment. Smart Environment will foster greater integration and optimisation across urban planning to improve efficiency and minimise impacts on the environment. Sustainable planning and development of land, the built environment, and management of resources will be integrated with leading ecological and resource conservation practices for resilience against adverse events.

In Hong Kong, the Government entered into the post-2018 Scheme of Control Agreements (SCAs) with the power companies in April 2017. The terms of the agreements have put a greater emphasis on the promotion of energy efficiency and conservation and the development of renewable energy. On the former, existing incentive schemes in relation to the promotion of energy efficiency and conservation will be expanded while new elements will be introduced. These initiatives include expanded incentive schemes in relation to energy audits as well as energy savings from such audits, setting up of funds to support the carrying out of retrofitting and retro-commissioning, and implementation of building-based smart/IT technologies in the existing buildings. A new Community Energy Saving Fund will also be established to, inter alia, encourage customers to replace or upgrade their electrical appliances to more energy-efficient models.

A new five-year energy saving target will be set based on the power companies' achievement in relation to energy saving measures under the new SCAs. The power companies will also introduce demand response programmes to help reduce maximum demand. As for the promotion of renewable energy, feed-in tariff and renewable energy certificates will be introduced in the next agreement period. Feed-in tariff should help encourage the private sector to consider investing in renewable energy (such as solar photovoltaic systems) as the power generated could be sold to the power companies at a rate higher than the normal electricity tariff rate to cover the costs of investment in the renewable energy systems and those of generation. In addition, the power companies will facilitate grid connection and improve the relevant arrangements. Incentive schemes in relation to the power companies' performance in the promotion of energy efficiency and conservation and the development of renewable energy will also be in place such that the power companies will be incentivised to perform in these areas, which would contribute toward Smart Environment.

Environmental Protection Department (EPD) has accorded high priority to improve the water environment of Hong Kong. With progressive implementation of the sewerage projects and enforcement of environmental legislations, the beach, marine and river water quality of Hong Kong has improved significantly over the past three decades. The organic pollution load of most major rivers had been largely reduced by up to 96%. The key remaining water pollutants to rivers in the rural areas mainly come from unsewered villages, expedient connections in old districts and livestock farm discharges.[78]

3.3.1. Policy Objectives

To achieve a smarter environment for Hong Kong, the Government should aim to:

1. Promote a more sustainable environment for the people of Hong Kong; and
2. Optimise the use of city resources through "reduce, reuse and recycle".

3.3.2. Key Issues and Challenges in Hong Kong

There is the need for more sustainable environment for the people in Hong Kong, as observed below:

- Need for more sustainable/green buildings.
- Increasing number of ageing properties in Hong Kong[79].
- Increasing total Greenhouse Gas (GHG) Emissions - Hong Kong's annual GHG emissions in 2014 was 45,000 kilotonnes CO2e. From 2011 to 2014, Hong Kong has seen a steady rise in total GHG emissions[80].
- High roadside air pollution.
- Air pollution and carbon dioxide in the air, contributed to by power generation, the transportation sector, other end use of fuels, and waste[81].
- Light nuisance[82].

It has been observed that there is a sub-optimal use of city resources. The key observations include:

- Inefficient food waste and food surplus management
  - Minimal food (organic waste) waste separation from rubbish (there is currently no legislation aimed to improving food waste separation)

[78] http://wqrc.epd.gov.hk/en/overview/index.aspx
[79] http://hub.hku.hk/bitstream/10722/34025/1/FullText.pdf
[80] http://www.epd.gov.hk/epd/sites/default/files/epd/english/climate_change/files/HKGHG_Trend_201612.pdf
[81] http://www.legco.gov.hk/research-publications/english/1617issh21-greenhouse-gas-emissions-of-hong-kong-20170314-e.pdf
[82] http://www.enb.gov.hk/sites/default/files/pdf/ExternalLightingEng.pdf

- Large volumes of food waste from restaurants and homes, exacerbated by low/mid cultural awareness
- Legislation is not yet available for promoting the donation of "low risk" food, which limits the NGO's ability to reuse nutritious food for those in need[83]
- Fragmented food surplus recycling system[84].

- Limited waste management for construction waste, with gradual steps taken to improve the situation in the 2017 Policy Address[85].
- Inefficient waste classification and reuse[86]
  - Insufficient recycling facilities/systems
  - Growing waste loads/rapidly filling landfills.

3.3.3. Overseas and China Leading Practices

The leading examples of efforts towards sustainable city environment include the following:

- Singapore is pursuing eco-friendly buildings with strategies such as vertical gardens to offer shade[87].
- San Francisco's home owners are provided tax incentives to voluntarily achieve energy efficiency through retrofits[88].
- Sydney's rooftop trigeneration system aims to cut carbon emissions by 3% and reducing energy bills by an average of $140,000 per year as part of Sustainable Sydney 2030[89].
- The US Government's General Service Administration (GSA) has a programme dedicated to green buildings with a focus on leading the "greening" of federal buildings, supporting innovation and collaboration on new technologies, and supplying the market with information and best practices. GSA also performs audits on existing buildings to minimise energy waste[90] .
- Copenhagen offshore wind supplies enough power to cover most of the city's electricity needs. Heating is being addressed by expansion of combined heat and power plants[91].
- Burlington in Vermont USA is run completely on renewable energy using biomass, hydroelectric, solar and wind. Its biggest power generator is hydro, which the city acquires from dams both locally and elsewhere in the region[92].

[83] http://www.hkreform.gov.hk/en/docs/essay2017_no_5.pdf
[84]http://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/food_waste_challenge.html
[85] http://www.policyaddress.gov.hk/2017/eng/p141.html
[86] http://www.epd.gov.hk/epd/english/environmentinhk/waste/prob_solutions/food_waste_challenge.html
[87] http://inhabitat.com/worlds-largest-vertical-garden-at-the-singapore-tree-house-condominium-sets-new-guinness-record/
[88] http://engineeredtaxservices.com/energy-tax-benefits-to-be-focus-in-san-francisco/
[89] http://www.cityofsydney.nsw.gov.au/vision/towards-2030/sustainability/carbon-reduction/trigeneration
[90] http://energy.gov/eere/femp/guiding-principles-sustainable-federal-buildings
[91] http://www.dac.dk/en/dac-cities/sustainable-cities/all-cases/energy/copenhagen-cities-can-run-on-wind-energy/
[92] http://www.triplepundit.com/2015/02/burlington-vermont-runs-100-renewable-energy/

- Vancouver's ambition to become a leading city that employs green technology includes extensive usage of hydroelectricity with an increasing contribution from renewables including wind and solar[93].
- Portland has instituted a city-wide garbage and compost scheme that recycles greater than 50% of city waste[94].
- British Columbia is in the process of introducing wooden skyscrapers; building with wood creates fewer greenhouse gas emissions and also stores carbon dioxide. Wooden buildings are expanding in Japan/ Australia[95].
- Los Angeles, after a number of successful trials, decided to undertake a major LED conversion programme in 2009. In total, 140,000 street lights have now been converted over a 4 year period. As part of the initiative, the city installed a remote monitoring system that gives city management control over the output of the lights. The total cost of the initiative was $57m, with $40m initial cost covered by a utility energy efficiency loan that the city secured from the Los Angeles Department of Water and Power. This investment is now producing energy savings of $7.5m a year and a maintenance saving of $2.5m for year, with an overall programme payback period estimated at 7 years. The utility loan secured is being paid back using these savings, with the rest of the savings going to the city procurers. In total, the city has seen a reduction of 40,500 tons of CO2 each year[96].
- Milan and Turin are retrofitting their traditional street lamps with LED lighting technology, aiming at high energy efficiency, aesthetics and lower operational costs[97].
- Chicago replaced its street lamps with energy-efficient, low-maintenance LED lighting systems and reduce its energy costs and estimates the savings to pay for the investment in under five years[98].
- Shenzhen uses IoT technology to establish and improve early warning systems for different aspects of the environment such as weather, droughts, fire, water, air quality, and the marine ecosystem[99,100].

The leading practices that optimise the use of city resources through "reduce, reuse and recycle" include the following:

- Melbourne has 50 sensor-equipped rubbish bins that notify waste management upon reaching 70 percent capacity to optimise garbage pickup routing. Compactor

[93] http://www.vrec.ca/
[94] https://www.portlandoregon.gov/bps/41461
[95] http://www.cbc.ca/news/canada/british-columbia/b-c-wood-highrises-1.3469605
[96] https://www.theclimategroup.org/sites/default/files/archive/files/LONDON-Working-Document-finance.pdf
[97] http://luxreview.com/article/2015/03/turin-follows-milan-in-going-led
[98] http://chicagoinfrastructure.org/initiatives/smartlighting/ ,
https://www.cityofchicago.org/city/en/progs/env/green_buildings_andhomes.html
[99] Shenzhen Municipal Government, 智慧深圳規劃綱要（2011-2020 年）,
http://www.szjmxxw.gov.cn/Upload/admin/20120521/17/2012052101.doc
[100] SmartTimes, 深圳通過了《智慧深圳規劃綱要》, http://www.iot-online.com/xinwen/2012/0403/18296.html

bins have also been implemented in Federation Square to compress internal garbage, reducing collections, truck emissions and congestion[101].

- Barcelona has municipal services for the collection of household/commercial waste to provide waste collection to citizens with the overall objective of providing a clean and healthy space. All citizens have recycling collection containers located less than 100 meters from their home. Pneumatic collection is available in a number of waste points or bins which are all connected to a central suction point by a network of underground pipes. Barcelona has a network of more than 21 neighbourhood green dots, two mobile green dots at schools and two mobile green points for recycling waste that can't be thrown into street bins[102].
- The Swedish Government is introducing tax breaks on repairs to white goods, such as fridges, freezers, and washing machines, to discourage discarding of items [103]. Other proposals include slashing Value-Added Tax (VAT) rate on repairs on clothing and shoes and allowing individuals to tax rebates on labour cost of repairs[104].
- The city of Sydney has an annual electronic waste (e-waste) collection day. Annually, 95% of e-waste is locally recycled[105].
- The Dublin City Council is in the process of creating a thermal treatment plant to treat municipal waste that cannot be recycled; the facility will generate energy for 80,000 homes[106].
- San Francisco creates policies for increased access to recycling and composting as well as a reduction in waste. Other policies span areas of waste prevention, recycling, composting, producer responsibility and city government[107].
- UK has various energy plants which take methane produced from landfills for energy, either in the same way as combustion plants do, or by injecting the methane into the national gas grid as a form of energy[108].

3.3.4. *Description of Potential Scene/Outcome*

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
Citizens	• Experience timely and responsible disposal of all forms of waste	• Make excess-food donations through newly established efficient donation mechanisms	• Live in a greener and sustainable environment bringing health

[101] https://www.iothub.com.au/news/melbourne-reveals-its-smart-city-ambitions-418252
[102] http://ajuntament.barcelona.cat/ecologiaurbana/en/services/the-city-works/maintenance-of-public-areas/waste-management-and-cleaning-services/household-waste-collection
[103] http://www.huffingtonpost.ca/2016/11/14/sweden-tax-break-for-repairs_n_12965428.html
[104] https://sweden.se/nature/the-swedish-recycling-revolution/
[105] http://www.cityofsydney.nsw.gov.au/live/waste-and-recycling/e-waste-and-chemicals/e-waste
[106] https://www.covanta.com/Our-Facilities/Dublin-Waste-to-Energy
[107] http://sfenvironment.org/overview/legislation-related-to-waste-prevention
[108] https://www.gov.uk/guidance/generating-energy-from-waste-including-anaerobic-digestion#overview

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	• Participate in programmes that will improve the recycling effort in the city • Start experiencing less pollution, improved hygiene in public spaces and an integrated approach to waste management • Able to utilise smart home mobile apps to monitor household energy consumption • Recognise and appreciate the value of green measures to mitigate, adapt and build resilience to combat climate change		benefits to citizens
Businesses	• Experience timely and responsible disposal of all forms of waste • Monitor and manage the building stock and improve operational efficiencies	• Transform and develop buildings that are more self-sufficient and sustainable by leveraging on designs and materials that help generate energy, harvest rainwater, reuse water, control light, regulate temperature and filter air • Capitalise on new business opportunities emerging from waste managing and recycling	• Consider waste management and recycling as a well-established and sustainable business model
Government	• Provide efficient waste management and recycling facilities for residents and business • Properly monitor violations of environmental regulation with an established penalty mechanism	• Lower operation costs for building energy consumption, street lights etc. • Minimise the amount of untreated or unsorted waste that goes to a landfill	• Move closer to a "circular economy" by minimising waste generation, maximising resource recovery from waste and efficient recycling

3.3.5. *Proposed Initiatives*

The following are potential projects and initiatives that may be considered to achieve the objectives under this theme.

Description of Potential Projects

- Climate Action Plan 2030+:
  - The Climate Action Plan 2030+ (CAP 2030+), announced in January 2017, outlines the Government's action plans to combating climate change and setting out the carbon emission reduction target for 2030. Specifically for Smart Environment, it covers activities such as:
    - The expanding of renewable energy such wind or solar in Hong Kong;
    - The potential use of building management systems (BMS), Combined Cooling, Heating, Power (CCHP) with energy storage, energy utilisation indexes and benchmarks, remote building audits, green building material and standards, advanced metering infrastructure (AMI), automated space controls for lighting, heating, ventilation and air conditioning (HVAC);
    - The adoption of electric vehicles for both public and private transportation sectors and infrastructure expansion of electric vehicle charging facilities; and
    - The implementation of "Reduce, Reuse and Recycling" programme, conversation programmes as well as the exploring of new sources of energy such as that from waste in Hong Kong.

Separately, China Light and Power Company Limited has just launched a one-year pilot on AMI, the Smart Energy Programme, in June 2017 with a view to exploring how to effectively implement AMI in the future[109] .

CAP 2030+ includes a wide range of initiatives contributing toward Smart Environment. Further initiatives beyond those described in the CAP 2030+ could be considered in order to achieve Smart Environment that leverages technology to better manage Hong Kong's built and natural environment.

- Green and Intelligent Buildings:

  This project utilises technology in construction and maintenance to efficiently manage resources and energy use in buildings.

- Smart Grid:

[109] https://www.clp.com.hk/en/Current%20Releases/20170615_en.pdf

This involves the integration of ICT into an electrical network to create a grid that interconnects various sensors, meters, and appliances to allow for remote monitoring of energy usage and for users to manage their own energy demand and shift peak hours of energy usage. The energy consumption pattern collection can help stipulate the requirements of energy efficiency standards for building services installation of buildings.

- Intelligent Waste Management:

  This project focuses on the creation of various infrastructure and processes to maximise landfill diversion, increase recycling, and increasing efficiency in the overall waste management processes.

- Pollution Management:

  This project expands the use of remote sensing technology to monitor and reduce pollution.

- LED Lighting:

  It is expected that this project will present significant energy efficiency and create controls on electricity usage in commercial settings (e.g. in neon signs and illuminated signboards).

Proposed Initiatives to Meet the Objectives

Objectives	**Short term (2017 – 2020)**	**Medium term (2021 – 2025)**	**Long term (2026 – 2030+)**
1. Promote a more sustainable environment for the people of Hong Kong	<u>The Climate Action Plan 2030+</u> • Implement the plans as outlined in the CAP 2030+ and review action for submission to the United Nations by 2020	<u>The Climate Action Plan 2030+</u> • Implement the plans as outlined in the CAP 2030+ and review action for submission to the United Nations by 2025	<u>The Climate Action Plan 2030+</u> • Implement the plans as outlined in the CAP 2030+ and review action for submission to the United Nations by 2030
	<u>Other initiatives in addition to those in CAP 2030+:</u> <u>Green and Intelligent Buildings</u> • Promote and support households to utilise smart home mobile apps to monitor household energy consumption and related information, and set targets • Use of building Information Modelling		

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	cum Asset Management system (BIM-AM) technology for intelligent building operation and maintenance and potential energy saving • Retro-commissioning of existing buildings by - Encourage the constant review of E&M system performance by re-commissioning to improve on energy efficiency and create opportunity to strive for more green buildings - Consider plans to leverage technology for rejuvenating E&M plants to improve on energy efficiency		
	<u>Smart Grid</u> • Study the pilot schemes (undertaken by the two power companies to test the application of smart grid technologies) to determine the method to pursue smart grid technology in the future	<u>Smart Grid</u> • Consider designing and undertaking pilot smart grid technology projects, as determined fit by study of the smart grid application completed in the short term	<u>Smart Grid</u> • Review smart grid technology projects and determine feasibility for further expansion
	<u>Pollution Management</u> • Consider the roadmap to implement remote sensing technology (LIDAR), to detect and measure three-dimensional pollution distributions (roadside, aerial) • Consider plans to incorporate sensors for	<u>Pollution Management</u> • Explore feasibility of remote technologies like sensors and drones through pilot tests to detect pollution using shared infrastructure (marine, roadside, aerial)	<u>Pollution Management</u> • Implement the use of sensors and drones to detect pollution using shared infrastructure on a city-wide basis subject to satisfactory outcome from the

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	water pollution detection		pilot tests (roadside, aerial)
	<u>LED Lighting</u> • Encourage the use of LED lighting and retrofitting of existing lights in commercial settings (e.g. in neon signs and illuminated signboards) to improve energy efficiency and create controls on electrical usage		
		<u>Intelligent Waste Management</u> • Enhance the recycling infrastructure to promote closed-loop waste management and improve the efficiency of recycling and uptake in Hong Kong (e.g. water recycling, food recycling, recycling facilities in homes and offices) • Review and enhance the implementation of waste charging scheme[110] (e.g. construction waste)	<u>Intelligent Waste Management</u> • Continue to enhance the recycling infrastructure
2. Optimise the use of city resources through "reduce, reuse and recycle"	<u>Pollution Management</u> • Consider and assess the stipulation of construction materials recycling/reuse programmes		
	<u>Intelligent Waste Management</u> • Based on the outcomes	<u>Intelligent Waste Management</u> • Consider the	<u>Intelligent Waste Management</u> • Refine and

[110] The Government plans to introduce the bill for implementing municipal solid waste charging later this year. Meanwhile, the new construction waste charges took effect in April 2017. Refer to http://www.policyaddress.gov.hk/2017/eng/p141.html

	of the study commissioned by EPD on developing a territory-wide plan and strategy for waste treatment and bulk waste transfer facilities to meet Hong Kong's needs up to 2041, assess and consider the implementation of the recommended plan and strategy for development of identified additional strategic and regional waste facilities (maximise landfill diversion, maximise recovery of resources, optimise the transportation arrangement and enhance synergy with land use planning • Provide more recycling bins to support the Municipal Solid Waste (MSW) charging scheme • Assess the impact and success of Social Innovation and Entrepreneurship Development Fund (SIE Fund)[111] project aimed to provide a centralised platform to consolidate all efforts in food surplus recycling and identify further improvement opportunities • Assess the need for an integrated, city-wide waste management plan, having regard to leading practices	implementation of an integrated, city-wide waste management, with activities such as: - Expand the waste-to-energy processes - Assess the need for further measures to promote food donation practice by commercial operators including supermarkets and food producers, having regard to the effectiveness of existing measures including the Food Safety Guidelines and funding support provided by the Environment and Conservation Fund.	continue to expand waste-to-energy processes

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	overseas. • Consider measures to reduce or discourage the use of one-time use disposable products • Increase the public's environmental awareness and participation in city greening activities by providing incentives		

3.3.6. *Benefits*

The following are the key benefits that the citizens, the city, and businesses will be able to take advantage of:

	Benefits
Citizen	• Improved air quality and citizen health • Better thermal comfort through improved building management • Help mitigate the impact of tariff increase • Less pollution • Increased awareness of environmental impacts • Increased recycling/reuse • Reduced risk of health issues • Improve streetscape appeal
Business	• Reduced utility costs due to efficient usage • New building and technology jobs • Reduced O&M costs • Technology development and applications for export • Tax breaks for pollution reduction • Additional revenue options by recycling initiatives • Increase in jobs from waste management • Investment opportunity • Lower strain from additional energy requirements as city expands

3.3.7. *Major Stakeholders*

3.3.7.1. Bureaux/Departments (B/Ds)

- Environment Bureau (ENB) and EPD
- Electrical and Mechanical Services Department (EMSD)

[111] http://www.sie.gov.hk/en/

- Food and Environmental Hygiene Department
- B/Ds in collaboration to meet targets of the Climate Action Plan 2030+

3.3.7.2. Public Bodies

- Construction Industry Council
- Housing Authority
- Hong Kong Green Building Council
- Construction related regulatory bodies
- Public utilities
- Professional Institutions
- Academia

3.3.7.3. Private Sector

- Construction industry
- Systems and product (devices and sensors) manufacturers
- Building owners/occupants
- Food wholesalers and retailers
- Private waste management providers
- Relevant waste collectors and/or facility operators as appropriate
- Property management companies
- Waste recycling industry
- Business chambers

3.3.7.4. Other Key Stakeholders

- Legislators and district councillors

3.3.8. Legal and Regulatory Matters

	Short-term (2017 – 2020)	**Medium term (2021 – 2025)**	**Long term (2026 – 2030+)**
Smart Environment	Stipulate the requirements of energy efficiency standards (Building Energy Code) and standard scope of energy audit (Energy Audit Code) for central building services installation of prescribed buildings (including government buildings): • Buildings Energy Efficiency Ordinance, Cap 610	Reflect the more stringent city pollution reduction targets: • Air Pollution Control Ordinance, Cap.311 • Waste Disposal Ordinance, Cap.354 • Water Pollution Control Ordinance, Cap.358 • Noise Control Ordinance, Cap.400	

	Short-term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	• Building Energy Code (BEC)[112] • Energy Audit Code (EAC) Stipulate the requirements for submission of waste disposal (and location tracking) data to the Government: • Waste Disposal Ordinance, Cap.354 • Dumping at Sea Ordinance, Cap.466 • Product Eco-responsibility Ordinance, Cap.603 Introduce the legislative framework for implementing municipal solid waste charging Introduce new legislation to enable supply of recycled water from the waterworks of Water Authority	• Ozone Layer Protection Ordinance, Cap.403 • Dumping at Sea Ordinance, Cap.466 • Product Eco-responsibility Ordinance, Cap.603 • Motor Vehicle Idling (Fixed Penalty) Ordinance, Cap.611)	

[112] http://www.beeo.emsd.gov.hk/en/mibec_beeo.html

3.4. Smart People

"Smart People" aims to fundamentally transform the way that people access public and private sector services in their capacity as individuals, businesses, parents, investors, employees and employers, and facilitate retooling of talents and lifelong learning. With more streamlined services, the people of Hong Kong can interact with public and private service providers more easily, efficiently, and confidently. This will promote an environment of social inclusiveness, creativity, open-mindedness, greater connectedness, resilience and collaboration across citizens and government to spur innovation.

3.4.1. Policy Objectives

To achieve Smart People, the Government should aim to:

1. Enable people to interact with service providers and participate in civil society with ease and confidence;
2. Facilitate lifelong learning for individuals in the public and private sector, youth to elderly, about science, technology, engineering and mathematics (STEM), leading to a fluency in the development of innovation and information technologies; and
3. Nurture a highly adaptive population that readily embraces changes.

3.4.2. Key Issues and Challenges in Hong Kong

It is observed that there are limited integrated services to enable simple interaction with service providers, including:

- Some current e-government services require citizens and businesses to interact with multiple service sites and providers (B/Ds) to complete a set of tasks. While the Government already provides one-stop services for some tasks - such as one-stop on-line services to apply for government jobs, change of address and 1823 on-line, there could be room for more joint-up e-government services.
- Existing services have their own ICT infrastructure (duplication) with limited integration across the B/Ds.

It is observed that there is a need for Hong Kong to facilitate lifelong learning and retooling for individuals about innovation and technology. Observations include:

- Science, technology, engineering, and mathematics (STEM) education, particularly in primary and secondary schools, to be further enhanced.

- Relatively low entrepreneurial spirit of Hong Kong's young generation, which needs to be strengthened in response to the increasingly dynamic global business and economic landscape[113].
- A need for smart city related skills to be offered by enterprises in addition to schools.
- Gaps in both the supply and demand of specialists with knowledge of data science. The data science job market is relatively less mature when compared with leading jurisdictions like the UK or the US. While there is a rising trend in the demand of skilled professionals in data science and data analytics across all sectors in Hong Kong since early 2015, the industries operating in Hong Kong do not recognise the profession of data scientist as distinctively as in the US, where more jobs carry the title 'data scientists'.
- The rise of concerns over the widespread use of artificial intelligence replacing certain jobs that currently performed by human. People need continuous learning to equip with new skills for the fast changing world[114] .

3.4.3. Overseas and China Leading Practices

The leading practices on enabling people to interact with service providers and participate in civil society include the following:

- City of Chicago tracks and makes available about 40 measures (including hold times for 311 service requests, time to repairs etc.) from data that affects its residents through its city website cityofchicago.org/performance[115].
- Singapore has a mobile application called mGov@SG that provides over 300 different types of government and non-government services[116].
- El Paso Texas has a one-stop shop for on-line city services, with links to other government sites that offer e-Government services[117].
- UK has an 'engage', a cloud-based SaaS, designed to help local government develop more effective ways of working, by creating agile councils that focus on better outcomes for their citizens. 'engage' enables local government to deliver on recognised priority outcomes such as greater citizen participation, liveability and economic growth, by combining sector-leading expertise with technological innovation.
- UK Government runs an on-line portal (www.gov.uk) which has merged the websites of all government departments and many other agencies and public bodies.

[113] http://www.edb.gov.hk/attachment/en/curriculum-development/renewal/STEM%20Education%20Report_Eng.pdf
[114] https://www.ieconomysummit.hk/wp-content/uploads/2017/05/Michael-Chui.pdf, presentation by McKinsey Global Institute in the Internet Economy Summit on 12 April 2017
[115] https://www.cityofchicago.org/city/en/narr/foia/key_performance_indicatorso.html
[116] https://www.tech.gov.sg/en/Programmes-Partnerships/Programmes-Partnerships/Initiatives/M-Government
[117] https://www.elpasotexas.gov/planning-and-inspections/one-stop-shop

Gov.UK provides information on all policies, announcements, publications, statistics and consultations[118].

- New Zealand Government is piloting an initiative to develop an ecosystem where government provides data, content, transaction services and business rules for not just improving its own service delivery, but also enabling others to build on top[119].

The leading practices on facilitating lifelong learning about technology include the following:

- New York University School of Engineering hosts STEM participants events where the university students inspire middle and high-school students to learn more about creating a smarter city using computer programming[120].
- US2020 is a platform that supports city-based coalition in United States to foster STEM mentoring movements to scale the number of STEM mentors[121].
- Northwestern University and UC Berkeley offer specific programmes for data science with the Master of Science in Analytics degree and the Master of Information and Data Science degree respectively[122,123].
- Data science boot camp programmes such as Metis Data Science Bootcamp are also provided by both start-ups and large corporations, and on-line courses provided by companies such as Udacity for additional credential supplementation[124] .
- On smart education, the Guangzhou Municipal Government will create an education cloud public services platform so as to consolidate and share city-wide information on quality education. Construction of a smart university city and a digital education city will be accelerated, and the building of a smart campus will be explored. On smart culture, the Guangzhou Municipal Government will be creating a cultural industry network trading platform and a number of high-quality cultural information database. Other areas of work on smart culture include: promoting self-service books borrowing/returning terminals and encouraging the transformation of the print media to a whole media or omnimedia.

3.4.4. Description of Potential Scene/Outcome

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
Citizens	• Become better aware of the importance of incorporating STEM subjects into Hong	• Access to multi-channel and single points of contact to receive most public	• Experience seamless multichannel interactions with relation to public and

[118] https://www.gov.uk/
[119] http://www.opengovasia.com/articles/7606-exclusive---the-new-zealand-governments-lab-experiment---testing-a-fundamental-change-in-the-service-delivery-model#.WRuJ1nXWBp0.linkedin
[120] http://engineering.nyu.edu/k12stem/stemnow/category/science-of-smart-cities/
[121] https://us2020.org/front
[122] http://datasmart.ash.harvard.edu/news/article/the-rise-of-the-data-scientists-611
[123] http://data.berkeley.edu/data-science-smart-cities-civeng-88
[124] http://datasmart.ash.harvard.edu/news/article/the-rise-of-the-data-scientists-611

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	Kong's education policy and school curricula • Become aware of increasing career opportunities for data scientists and strengthening university education curriculum • Aware of the potential prospects of entrepreneurship • Access to more STEM education and creative innovation in Hong Kong school curricula • Access to continuous learning programmes and more forms of eLearning • Easily find relevant Government information and access Government e-services though a centralised One-Stop Shop	services and selected private sector services ● Increased access and variety of curriculum, programmes, and eLearning for data science ● Aware of partnerships between private sector and public organisations that provide job and internship opportunities in ICT fields such as data science ● An increasingly adaptive and innovative population ● Easily find relevant public and private sector service information on the Government One-Stop Shop ● Be able to complete selected on-line public and private e-service tasks via the One-Stop Shop ● Experience proactive Government e-services and push of information in accordance with a life event	selected private sector services ● Access to various channels, such as school, continuous learning programmes, and eLearning, to develop relevant STEM and creative skills ● Access to a wide range of jobs in data science ● A highly adaptive and innovative population
Businesses	• Through exercises such as hackathon, stimulate and support enterprises and start-ups to leverage real-world commercial data to make service innovation and improve people's lives • Easily access and complete Government e-services relevant to the business, such as applying for permits	• Have the ability to provide personalised and bundled services based on insights into user preference • Higher integration of private sector services through integration of city data and provisioning of services through One-Stop Shop	
Government	• Better provide public	• Transform access and	• Better management

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	e-services for citizens to complete on-line tasks in a consolidated One-Stop Shop • Better integration and provisioning of citizen services especially those requiring data and processing of multiple B/Ds • Provide more self-service platforms through kiosks and applications for faster service delivery for high volume transactions	provision of public and private services to create a citizen-centric, smart, and fully digital experience • Provide higher quality and efficient public services by better coordinating across B/Ds accountable for offering services • Tracking of real-time feedback on citizen services and continuously improving service delivery	of B/Ds e-services • More shared e-service offerings relevant to citizens' needs • Quick and efficient deployment and updates to public services

3.4.5. Proposed Initiatives

The following are potential projects and initiatives that may be considered to achieve the objectives under this theme.

Description of Potential Projects

- Cultivate Data Science Expertise:

  This project aims to improve the landscape for cultivating data science expertise, and other smart city and ICT related expertise, in the city. The Government can do so through the promotion of school curricula, learning programmes, a variety of eLearning, and facilities that aim to teach the necessary data science skills to those interested, and in the long run, result in a business environment where job opportunities in data science develop and flourish in Hong Kong. Having regard to the global trend in big data analytics, development of data science expertise is important in Hong Kong and partnerships with the academia and industries should be considered - similar to the one between the city of Chicago and Code for America. These programmes aim to train individuals in data science in-house, and then provide them with job opportunities to exercise and enhance their skills. Such job opportunities might include positions in developing apps which incorporate open data, for example. In Hong Kong, these partnerships can be formed between the private sector and tertiary institutions.

- One-Stop Shop:

  This project involves providing a One-Stop Shop for the people of Hong Kong and travellers to Hong Kong to allow for simple and easy access to multiple public and private

services in one on-line location. The One-Stop Shop project can also involve integrating multiple interaction channels and can also move to integrating a user's digital persona as an ID and password.

- Use of On-line Applications and Social Media for Stakeholder Engagement:

  Following global trends, public engagement is becoming pre-requisite for public policy and services. In particular, smart city initiatives and solutions are aimed to be people-centred. Vide the consultancy study, a crowdsourcing portal was set up to gauge the view of the public. It has proved to be an effective additive to conventional engagement activities like meetings, workshops, focus group discussion, opinion surveys, etc.

  Some cities have chosen to set up a dedicated public engagement portal. This should be premised upon both the Government structure and the prevalent culture of public engagements in individual cities. We recommend B/Ds to make better use of Internet-based tools and social media in future public engagement on major policy issues. Examples are Barcelona, Amsterdam, Tampa and Austin.

- Technology Education:

  This project aims to promote and support technical skills and creative thinking through education to foster Hong Kong people's entrepreneurial and innovative appetite. The education will focus on three main groups, namely, those in the education sector, the private sector, and the public sector.

  The project includes assessing and revising of existing curricula based on global practices, and providing channels for innovative and creative ideas to be showcased in Hong Kong. Continuous learning programmes and eLearning for individuals in the private and the public sectors workforce can also be assessed and considered to promote more technical awareness and increase the appetite for innovation. Existing regular trainings and workshops for those working in the private and the public sectors can be assessed and re-designed to reorient employees' mindset towards embracing the latest technology and leveraging innovative process, and retool them with relevant skills to manage a smart city. Specific sector academies can be set up to train up professional expertise in managing certain smart city services, not just for Hong Kong, but for other cities who may adopt a Hong Kong model. The MTR Academy is a good example.

- Education and Skill Retooling:

  This project will involve running relevant trainings and learning seminars, and publishing new training material, to help educate those in the public sector and private sector, as well as the general public on the latest challenges, opportunities and trends brought about by innovation and how to plan for change. The Government can facilitate partnerships between the private sectors and innovation centres, such as Hong Kong Science Park and Cyberport, Hong Kong Productivity Council (HKPC) to instil innovation in business

operations and product/services offerings. The aim is to increase confidence in managing transitions in the fast evolving living and working environment and embrace the new practices that come with smart city development.

Proposed Initiatives to Meet the Objectives

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
1. Enable people to interact with service providers and participate in civil society with ease and confidence	<u>One-Stop Shop</u> • Identify more e-services to expand www.gov.hk as the One-Stop Shop • Organise the services of the One-Stop Shop by themes or life events such as grouping the services into sector-specific thematic clusters to facilitate access • Assess the feasibility of integrating 1823 with www.gov.hk • Use of digital persona for government e-services • Explore the feasibility of including private sector services in the One-Stop Shop • Develop an engagement model to enable the private sector to plug into portal to provide e-services • Consider piloting walk-in centres (particularly for the elderly)	<u>One-Stop Shop</u> • Use of digital persona for e-services involving the public and private service providers • Pilot the use of automated analytics tools that can respond to citizen queries and produce content from integration of predictive analytics • Evaluate the pilot for walk-in centres and consider extending the service scope	<u>One-Stop Shop</u> • Review the delivery model of e-services to the community • Evaluate the service provider engagement model and identify potential areas for improvement • Adopt the use of automated analytics tools and AI chatbots that can respond to citizen queries and produce content from integration of predictive analytics and machine learning
	<u>Stakeholder Engagement Portal</u> • Refine functionalities of the Ideas Crowdsourcing Portal, and promote the portal as a Stakeholder Engagement Platform for actions that		<u>Stakeholder Engagement Portal</u> • Continue to assess and adopt the best practices for the Stakeholder Engagement Platform

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	require citizen advocacy • Create mechanisms to integrate the Stakeholder Engagement Platform across popular social media, to improve citizen participation and engagement with the Hong Kong community and Government		
2. Facilitate lifelong learning for individuals in the public and private sector, youth to elderly, about science, technology, engineering, and mathematics (STEM) leading to a fluency in the development of innovation and information technologies	<u>Technology Education</u> • Assess and evaluate current Hong Kong school curricula and policy in the area of STEM and data science against global leading practices • Assess and evaluate existing continuous learning programmes and eLearning for individuals in STEM • Assess and evaluate existing regular training and workshops for civil servants for technical and creative thinking • Design and implement relevant training programmes for civil servants • Establish an on-line platform that supports the sharing of innovative, creative and user generated content, to showcase Hong Kong's people's creativity and talent, and new innovative ideas to reinforce the creative culture and value of STEM education in Hong Kong	<u>Technology Education</u> • Design and implement continuous learning programmes for individuals in STEM and innovation • Continue to assess training programmes for civil servants	<u>Technology Education</u> • Continue to assess the education policies that support STEM education and creative innovation in Hong Kong school curricula • Continue to assess continuous learning programmes and eLearning in STEM for individuals • Continue to assess training programmes for civil servants

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	• Implement new policies that support STEM education and creative innovation in Hong Kong school curricula		
	<u>Cultivating Data Science Expertise</u> • Promote curricula that include the necessary data science skills (data scientist should have an effective command over statistical software, big data analytics tools, machine learning, programming, database management, and recommender systems[125]) that allow them to: - Design and develop tools for data re-usage - Identify, extract and format data - Design data models - Integrate data from various services - Derive insights from data • Encourage corporations and start-ups to provide boot camps, on-line courses, internships or programmes that foster data science expertise • Promote technology curricula to include designing and managing applications and	<u>Cultivating Data Science Expertise</u> • Assess the possibility of working with higher education institutions in developing curricula focusing on data science, AI and machine learning, visualisation and business intelligence • Assess the possibility of partnering with the private sector and public institutions (such as HKSTP, Cyberport) to promote and cultivate job and internship opportunities for university graduates and data science talents in ICT fields • Provide incentives to promote the study of ICT related fields, for instance, consider conditional scholarship programmes that aid students to pursue higher education at prestigious universities, requiring a commitment to serve the community upon returning to Hong Kong	<u>Cultivating Data Science Expertise</u> • Continue to assess and evaluate curricula based on their effectiveness in developing talent necessary for smart city development • Continue to grow and strengthen partnerships with the private sector and public institutions to promote and cultivate job and internship opportunities for university graduates in ICT fields such as data science

[125] http://smartcities.ieee.org/images/files/pdf/dav_datascientist_v12_final_tjc-eln.pdf

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	solutions in the areas of IoT, M2M, sensor networks, data warehouse and management, and software development such as GIS		
3. Nurture a highly adaptive population that readily embraces changes	<u>Education and Skill Retooling</u> • Design and run awareness programmes for the public/private sector and citizens on the latest challenges, opportunities and trends brought about from innovation and how to plan for change • Facilitate partnership between the private sector and innovation centres to adopt innovation in business operations and product/service offerings		

3.4.6. Benefits

The following are the key benefits the citizens, the city, and businesses will be able to take advantage of:

	Benefits
Citizen	• Enhanced adaptiveness to changes brought about by innovation and technologies • Improved service at all levels by providing feedback from captured transaction sentiment index • Easy to access one-stop shop for on-line city services and links to other government/3rd party sites that offer citizen services
City	• Provides a medium for increasing collaboration between citizens and the government • Promotes broader city government engagement with citizens by improved service delivery • Creates value for various entities through the medium of communicating with the entire citizenry through a unified access to target audience

Business	• Lower transaction / customer service costs • No need to maintain individual service points • Opportunity to act as integrated service provider • Business opportunities brought about by new technological products / services

3.4.7. Major Stakeholders

3.4.7.1. Bureaux/Departments (B/Ds)

- Education Bureau
- Innovation and Technology Bureau
- 1823 Hotline, Efficiency Unit

3.4.7.2. Public Bodies

- Public education sector
- Research and development institutions, e.g. universities
- HKSTP, Cyberport, and other public institutions that support technological innovation, jobs in ICT and data science

3.4.7.3. Private Sector

- Private sector that provide services to the community
- Private education sector
- Private research and development institutions
- Private businesses or institutions that support technological innovation, jobs in ICT and data science

3.4.7.4. Other Key Stakeholders

- Legislators and district councillors

3.4.8. Legal and Regulatory Matters

There are no major legal or regulatory matters identified for attention under this theme.

3.5. Smart Government

"Smart Government" changes how the Government manages the city and serves its stakeholders through the deployment of supporting infrastructures that collect, collate, analyse and present city data in the ways that can best support the stakeholders, leading to a more vibrant, dynamic and safe community. Various Smart Government projects are enabled by a city-wide digital framework and infrastructure which facilitates use of data collected from the city and spatial-related data to support city management or planning/visualisation. Overall, the Smart Government projects, and related activities, will strengthen connections across government, citizens, businesses, and with academics and other organisations to improve accountability, transparency, engagement and responsiveness in the provision of public services and information.

The Government has set up $500 million (TechConnect fund) for the Innovation and Technology Bureau (ITB) to provide funding support to government departments for implementing projects which improve quality, efficiency or effectiveness of public service delivery by the adoption of technology or to make use of technology to improve operations that will bring benefits to members of public.

3.5.1. Policy Objectives

To achieve a smarter Government for Hong Kong, the Government should aim to:

1. Promote a data-driven approach to further promote development of e-government and related public services;
2. Deploy appropriate infrastructure to support Smart Government; and
3. Facilitate easy access to government services for transacting with the Government.

3.5.2. Key Issues and Challenges in Hong Kong

The following are observations on the need for a data-driven approach to managing city operations and services:

- There is lack of a complete digital perspective on city assets and infrastructure.
- While Hong Kong offers many e-Government services, only 58.2% of people in Hong Kong were aware of GovHK, and 58.5% of people had used on-line Government services, according to the Thematic Household Survey Report on Information Technology Usage and Penetration survey in 2016[126].

[126] http://www.statistics.gov.hk/pub/B11302622017XXXXB0100.pdf

- Hong Kong ranks 29th in "Government success in ICT promotion" in the Global Information Technology Report 2016[127].
- Insufficient coordination to transform e-Government services from a department-based / sector specific approach into a more citizen-centric service model.
- Hong Kong e-Government services may be "more convenient, more integrated, highly personalised, and location sensitive"[128].

It has been observed that there is insufficient collaboration in public infrastructure across B/Ds. Key observations include:

- Limited real estate space in dense city surroundings for utility, telecommunications companies, standalone sensors.
- A need to deploy edge devices for smart city initiatives, including Wi-Fi, power management, traffic management, parking management, power meter reading, vehicle surveillance, pedestrian flow, waste management, weather detection, air pollution detection, etc.
- Multiple B/Ds have their respective infrastructures for their edge devices.
- The city of Hong Kong is built upon a complex network of underground utility pipes and cables. These underground pipes are owned by different agencies and utility companies.
- Frequent pipe bursts, and the repair work, often disrupts traffic in the city.

3.5.3. Overseas and China Leading Practices

The leading practices of data-driven approach to managing city operations include the following:

- Virtual Singapore is an inflight initiative of the National Research Foundation of Singapore that consists of a dynamic 3D city model and collaborative data platform, including the 3D maps of Singapore to help public, private, people and research sectors for testing concepts and services, planning and decision making.
- Virtual Brisbane is an innovative dynamic 3D city model that is used by city officials to visualise and analyse city development in relation to the existing urban environment[129].
- "Tianditu" (天地圖), the national spatial data information sharing and service portal, was launched by the China's State Bureau of Surveying and Mapping (SBSM). It has integrated different sources of public services of geographic information from surveying and mapping departments of the national, provincial and municipal governments as well as relevant government departments, enterprises,

[127] http://www3.weforum.org/docs/GITR2016/WEF_GITR_Full_Report.pdf
[128] http://www.legco.gov.hk/yr13-14/english/panels/itb/papers/itb1209cb4-196-7-e.pdf
[129] https://www.brisbane.qld.gov.au/planning-building/planning-guidelines-tools/online-tools/virtual-brisbane

organisations and the public. It provides authoritative, standardised, one-stop on-line geographic information integrated services to the public[130].

- Virtual Beijing - there are a number of smart applications developed for Beijing city. Diciti.com presents a Virtual Beijing with a 3D city modelling. With applications of virtual reality (VR) and augmented reality (AR) technologies, the relic of Yuanmingyuan documentary can be seen now. Smart Zhongguancun has introduced geographical information service platform with VR technology, which allows enterprises and the public anytime anywhere to visualise and understand the new products and services in Zhongguancun under a virtual reality environment[131, 132].
- Shenzhen's Geospatial information sharing aims to build a unified "geospatial government services information sharing window"[133] to facilitate on-line geospatial information sharing amongst government departments, businesses and the public, leveraging "3S", i.e. remote sensing, GIS and Global Navigation Satellite Systems (GNSS), and other technologies as foundation for this development. Other areas of related work include: to further improve the application of the "Digital Shenzhen Geospatial Platform" (szgeoinfo.com); to hasten digitalisation of internal structure of construction works; to innovate the model for planning, building and maintaining public pipelines; and to develop the overall underground pipeline information system that includes water, electricity, natural gas, information and subway amongst others. All of which will help realise the digitalisation and 3D management of underground pipelines, better support decision-making of relevant government departments and facilitate answering of queries from relevant enterprises[134].

The leading examples of building infrastructure that support Smart Government include the following:

- Pennsylvania Avenue 2040 project deploys a sensory lighting platform on a road stretch in Washington DC that combines Wi-Fi, sensor-based LED streetlights with options to include parking, surveillance, environmental sensors, Wi-Fi roaming service and interactive kiosks with an aim to collect real-time data to create applications that will improve city operations while reducing operation and maintenance (O&M) costs[135].
- The city of San Jose is piloting smart light pole initiatives that embeds radio units, antennas inside the pole and transmission units, power, batteries and other

[130] http://www.tianditu.com/index/contact.html?type=1
[131] http://bjrb.bjd.com.cn/html/2016-10/13/content_73303.htm
[132] http://www.diciti.com/zh-cn/about/city.html
[133]智慧深圳規劃綱要（2011-2020 年）, http://www.szjmxxw.gov.cn/Upload/admin/20120521/17/2012052101.doc
[134] Shenzhen Planning Bureau, 數字深圳空間基礎信息平臺, http://www.szpl.gov.cn/xxgk/ztzl/kjxxpt/01.html
[135] http://octo.dc.gov/page/pa2040-project

equipment underground. It also allows for monetisation by providing additional usages right on the pole for advertisements, stations, parking meters, maps, etc.[136] .

- Underground combined utility tunnels has been implemented for many decades in Europe (e.g. Berlin, Stockholm, Madrid and Barcelona), and more recently in North America and Asia[137].
- Singapore is building a Common Services Tunnel (CST) which is an underground tunnel network, houses utilities for distribution to all developments in Marina Bay. The completed system will be a 20 km long network of purpose-built tunnels[138].
- The Azabu-Hibiya Common Utility Duct in Tokyo, Japan, collects various utility lines into a single underground tunnel to reduce the number of overhead wires and decrease damage due to earthquake susceptibility[139].
- Prague, Czech Republic, has installed extensive underground utility tunnels, to allow installation and maintenance of utility lines and equipment without disrupting the historic streets above. Their construction began in the 1970s, but sections of the tunnel were built as early as the 1920s. Utilidors 20m in depth, with a total length of 90km[140]. Images show that some utility tunnels in Prague are equipped with tracks for maintenance vehicles[141].
- The Utility Tunnels in Qatar built on the Lusail, 15 km north of Doha, aims to allow for tighter and more coordinated construction and maintenance work schedules[142].
- Utility tunnels were pioneered in Taipei, Taiwan in the mid-1990s when they were collocated with the city's rapid-transit line. One utilidor project cut typical construction time by six months, and saved NT $44.64 million for the Taipei city government through its single, spatially efficient, coordinated construction[143].
- Helsinki, Finland, has an underground master plan (UMP) for its whole municipal area, including a 60 km utility tunnel with district cooling and heating, electrical and telecommunications cables, and water[144].
- Utility ducts can be found in the new Poundbury Village settlement, United Kingdom and in Bremen, Germany[145].

[136] http://www.sanjoseca.gov/index.aspx?NID=4688
[137] http://www.worldurbancampaign.org/underground-utility-tunnels-integrated-urban-underground-space-development-planning
[138] http://www.building.com.hk/forum/2007_0309marinabay.pdf, https://www.ura.gov.sg/skyline/skyline06/skyline06-04/text/pg6.html
[139] http://www.bigempire.com/sake/underground_tokyo.html
[140] http://www.prague.eu/file/edee/universal/maps/pruvodce_prum-tech_stavby_en_2015-7-03_nahled.pdf
[141] https://en.wikipedia.org/wiki/Utility_tunnel
[142] http://www.lusail.com/the-project/infrastructure-of-the-future/infrastructure/
[143] Pg 20, *Next Generation Infrastructure: Principles for Post-Industrial Public works*, Hillary Brown. https://books.google.com.hk/books?id=nc-4AwAAQBAJ&pg=PA19&lpg=PA19&dq=common+utility+duct+germany&source=bl&ots=E44dpBMQA5&sig=QW5eVH9zVDP1a3Hs7GUQNq6CZz8&hl=en&sa=X&ved=0ahUKEwiE6PyWuofUAhUMmZQKHUcHALsQ6AEITzAK#v=onepage&q=common%20utility%20duct%20germany&f=false
[144] http://www.sciencedirect.com/science/article/pii/S1674775514000699
[145] Pg 19, *Next Generation Infrastructure: Principles for Post-Industrial Public works*, Hillary Brown.

3.5.4. *Description of Potential Scene/Outcome*

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
Citizens	• Access more free Wi-Fi hotspots and wider bandwidth across Hong Kong offered by the city • Access some city services at smart intelligent and integrated poles	• Navigate city and its sights virtually • Individuals who live and work in New Development Areas and Lok Ma Chau Loop will experience less road disruptions due to more coordinated excavations and underground maintenance works	• Experience e-Government services that more proactively and pre-emptively push services to individuals; this is made possible by a new generation of e-Government services
Tourists	• Access more free Wi-Fi services across Hong Kong offered by city	• Access specific city services for tourists at smart poles • Navigate city and its sights virtually	
Businesses (including Academia and Professional Institutions)	• Easily deploy and install their devices on smart poles allowing them to provide their services to the public	• Join the digital transformation based on government set standards in Common Spatial Data Infrastructure, building information modelling (BIM), etc. • Participate and provide additional services to the smart intelligent and integrated poles, generating new revenue streams and operational efficiencies • Make better investment and location decisions based on simulations run on the 3D virtual map of Hong Kong, as well as information gathered from their sensors on the smart intelligent and integrated poles • Utility companies with operations in New Development Areas and Lok Ma Chau Loop will be able to service and maintain their underground infrastructure with ease	• Achieve energy and operational efficiency by deploying multiple coordinated services, lower O&M costs and faster turnaround

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
Government	• Achieve better coordination and communication across multiple B/Ds assigned to deliver public services • Continue to leverage smarter and more efficient e-Government services to improve day-to-day work streams • Establish a centralised system in sharing of real-time emergency information among various works departments and other relevant departments	• Able to anticipate better future needs of Hong Kong citizens through big data analytics • Roll out Common Spatial Data Infrastructure (CSDI) policy, standard and sharing platform for B/Ds to adopt • View a singular, uniform, and overarching view of the city and its assets on a common base map, which will be helpful for any city decision making, in crisis and in an on-going basis • Experience higher visibility into city operations • Efficiently leverage common and shared public infrastructure to optimise and offer services • Share and lower the city O&M costs through the use of BIM • Effectively deploy utility ducts for multiple uses by minimising land/access requirements for offering utility services • Prepare models and simulations to analyse and plan impacts of changes from future city initiatives with the 3D city mapping tool	

3.5.5. Proposed Initiatives

The following are potential projects and initiatives that may be considered to achieve the objectives under this theme.

Some of these potential projects can be considered for pilot, as indicated by a  .

Description of Potential Projects

- 5G:
  The 5G project involves setting venues as testbeds for 5G and ensuring all future investments are 5G compatible. 5G will support a broad array of innovative services and applications which are characterised by high speed mobile transmission, high speed mobility, extreme low-latency, real time communications and massive Internet of Things (IoT) connections. Therefore, 5G will be the key enabler of the smart city to provide next generation services such as pervasive video-centric applications, latency-sensitive autonomous driving, collaborative robots and massive sensor networks.

- Building Information Modelling (BIM):

  This project involves expanding the adoption of BIM to provide better insight for planning building construction, safety measures, cost estimation and asset management. BIM is the process of generating a 3D digital representation of building data, capturing information throughout the building's life cycle for design analysis. BIM incorporates various types of information, including building design, lighting, ventilation, enabling either a comprehensive picture or deep dive of a single attribute of a building, allowing for easy sharing between government and developers, consultants, contractors, suppliers, architects, engineers and surveyors. BIM can be leveraged as a technology tool in the construction industry, allowing those involved in various processes in a buildings' lifecycle to design, build and operate buildings with the aid of a virtual environment, which helps minimise change and reduce project risk. Example applications of BIM include clash detection, cost estimation, fabrication and shop drawings, asset and facilities management, and to plan construction sequencing. BIM may be used in conjunction with GIS for more sophisticated analysis. With the onset of virtual reality, augmented reality, and IoT, BIM may be used to conduct rehearsal and training, facilitate review and approval, and bring virtual data to life, easing decision making and resolution of problems.

  BIM can be used as a project management tool to help avoid changes in the construction process as far as possible, reduce risks and render clarity to project costs in various stages. The Government is identifying applications of BIM for adoption. Currently, there is an on-going initiative to study the administrative and technical issues to integrate BIM data and SD spatial data and to propose a way forwards towards establishing a framework and data specifications when implementing integration of BIM data and 3D spatial data.

- Smart Intelligent and Integrated Poles (Smart Poles):

  A Smart Poles project will involve integrating sensors and other hardware into the poles infrastructure across the city to provide multidisciplinary functionalities, benefiting those managing and living in the city. Smart Poles have been designed to be multifunctional. When fitted with prioritised hardware and supporting software, Smart Poles will help Government agencies to monitor the city's environment, strengthen the city's services and operations, and increase the efficiency and environmental friendliness of the city's street furniture:

On the topic of monitoring, environmental data - such as air quality index and temperature captured from sensors and other monitoring devices on Smart Poles - may be transmitted to the relevant Government agencies for monitoring. Streamed and analysed live, the data can serve to identify long term trends, as well as detect immediate changes to the environment that may serve as a signal for emergency service deployment to a site, for example. The same environment related information may also be displayed to passer-bys. Smart Poles may also be fitted with CCTV as well as other security equipment to increase the safety of the city.

On strengthening the city's services, Smart Poles may be equipped with wireless telecommunications small cell antennas to enhance city-wide Wi-Fi services. With the rise of connected vehicles, Smart Poles can house the necessary sensors and transponders to allow for data sharing between vehicles and infrastructures.

As a piece of street furniture, Smart Poles may adopt energy efficient means (e.g. LED) to provide better lighting to the surrounding areas with less energy, lowering the city's overall carbon footprint. With smarter materials, the Smart Poles itself are often made with materials that are fully recyclable.

In the long run and with the onset of 5G adoption, Smart Poles may be fitted with the relevant technology to support further IoT and edge devices to advance smart city development. In addition, Smart Poles hardware, when combined with the right software, enables Government agencies to leverage data to make more informed city management decisions. The benefits to citizens are two fold; firstly, they will benefit from the immediate services on the Smart Poles, and more importantly, experience improved quality of living.

The project will require an assessment of priority locations for deployment as well as ongoing maintenance roles and cost allocation.

- Virtual Hong Kong:

  A Virtual Hong Kong project will involve development of a virtual 3D simulated platform that will allow departments to perform interactive visualisations and performance analysis with spatial data of various nature of the built environment[146], environment data and social events etc; building data generated by Building Information Modelling (BIM) and Internet of Things (IoT) data (data integrated from various sensor and sources); and of different resolutions and dimensions.

  Currently most spatial data available in Hong Kong are mostly designed in 2D. However, 2D maps are inadequate to meet needs of strata (layering) land development and smart city applications, hence the emergency need of 3D digital spatial data. In particular, 3D Framework data (e.g. base map, land status information and planning control) should be

[146] Built environment is defined as everything manmade to modify the spaces in which we live and work, including buildings of all types, roads, parks, landscaping etc. (Source: Energy Saving Plan for Hong Kong's Built Environment 2015~2025+)

established for a complicated multi-dimensional city with high-rise infrastructures, mixed land use and underground space/utilities like Hong Kong.

To make a Smart Map for the community, the Lands Department has commenced the development of a 3D digital map with buildings, infrastructure, and terrain models; and would further enhance the 3D digital map models and enrich the map data contents. The Virtual Hong Kong platform, leveraging the Common Spatial Data Infrastructure, can assess and utilise the 3D geospatial data generated by the 3D digital map models developed by the Lands Department as well as other building data and real-time data from sensors, to significantly improve city management and the city's understanding of space, environment, and population dynamics. Additionally, this platform facilitates decision making by city officials to support the city master planning, land administration, the supply of housing, building of a better environment to improve the quality of living, and disaster management. With the help of a new Electronic Submission Hub to handle the submission and approval process of private building developments using BIM, it will accelerate the establishment of the 3D digital map of Hong Kong.

The 3D spatial data, integrated with BIM, will allow developers and city planners, such as those in lands and works related departments, and other map data providers and users, to explore ways to enrich and update the 3D map objects and to leverage BIM functions such as extracting, simplifying and manipulating 3D floor and Unit information to support smart city development. Integration between BIM and 3D Spatial Data will facilitate and ease processes between works agents and related lands/city management departments, and provide a base for linking spatial data of various natures (e.g. land, building, environment data, social events) for analysis and decision making in a spatially-referenced 3D view.

- Underground Integrated Ducts:

  Also known as a utility tunnel, utility corridor, or utilidor, an underground integrated duct project will involve designing and building an underground passage that carries utility lines such as electricity, water supply pipes, and sewer pipes. The tunnels may also carry communications utilities like fibre optics, cable television, and telephone cables.

  In comparison to direct burial or a trench, an utilitdor will coordinate the pipes underground in a collinear manner. By collocating the ducts, this will reduce the overall encumbrance on surrounding development by providing common access points and reducing the number of excavations.

- e-Government Services:

  The e-Government project continues with the Government's journey of offering citizen-centric e-services with a view to improving user experience and ease of access and

interaction with the Government on a continuous basis[147], reflecting the changing expectations of Hong Kong's citizens and the business community. This is to ensure that the e-Government services offered by the Government remain relevant and convenient for its stakeholders, with a particular focus on transforming e-Government services from information integration to more sophisticated service integration.

With the rising public expectation and changing business requirements, it is necessary for the Government to deliver e-Government services in a more agile manner than ever before to better meet the public demands and business needs. In order to support the agile development of a new generation of e-Government services, a new application architecture framework is required, covering the prevailing best practices in application development and operation. The framework should aim to bring about the following benefits:

- Expedite responses to requirement changes in both functionality and service demand
- Shorten time-to-launch, through reuse of components and more streamlined testing and deployment processes
- Facilitate resources scale-out for performance and utilisation improvement
- Facilitate better collaboration between development and operation
- Reduce scheduled and unscheduled application downtime.

All these will translate into more efficient and effective provision of e-Government services that better meet the changing public demands and business needs.

The Government should also develop a central platform, which conforms to the new application architecture framework, for shared use by Government B/Ds to develop a new generation of e-Government services. The central platform will achieve economy of scale and better utilisation of overall Government resources, while realising the above mentioned benefits.

- Data-analytics-as-a-Service for Government Departments:

With the advancement of information technology in big data analytics and applications, data is becoming the core in driving strategic operations, service and business innovation in both public and private sectors. It also underpins smart city development. Big data analytics has become an effective means for cities globally to assist in city management. It is therefore quintessential for the Government to take early steps to build up its own capability on big data analytics with respect to technical infrastructure and expertise in

[147] In the Finance Committee meeting of the Legislative Council held in Mar 2006, OGCIO reported that "In the absence of comprehensive citizen-centric government service portal, users need a good understanding of the Government's departmental structure in order to make effective use of these on-line services." The Government Chief Information Officer secured a commitment to support the development of a government-branded One-Stop Access Portal (OSP) and enhancement of the central infrastructure for delivery of citizen-centric e-government services.

developing big data analytics. It is also useful for the Government to invest resources in kick-starting implementation of some use cases of big data applications which will have direct impact on quality of e-government services. Through early success in these use cases of big data applications, it will facilitate adoption of new technologies and applications in big data analytics and artificial intelligence as a strategic and continual work within the Government.

A centralised cloud-based big data infrastructure for shared use by government departments should enable the Government to support effectively smart city applications. The big data infrastructure will support flexible expansion of massive compute resources and data storage for government departments to develop and execute big data analytics models/applications and artificial intelligence applications. The big data infrastructure will also provide a high-performance data interconnection message bus ("Digital Highway") for fast data sharing (including near-to-real time data, e.g. IoT/sensor data) in application-level between government departments for big data analytics and dissemination of data to the PSI Portal, which will be core requirements for smart city development.

The centralised big data infrastructure will facilitate secure and effective sharing of necessary data analytics and data warehouse tools, common service modules (including artificial intelligence and social media analytics) and massive compute/storage resources for developing and executing big data analytics models for smart city applications. Through this centralised and shared infrastructure, cost-effective implementation of future smart city applications will be achieved through economy of scale and by avoiding the need for building duplicated complicated big data infrastructures by B/Ds separately. Moreover, without a centralised data interconnection message bus, it will not be feasible for multiple B/Ds to effectively and securely share data for implementing big data analytics applications.

Smart city development, in particular big data analytics, will involve new expertise with multi-disciplinary skillsets including computer science, mathematics, statistics and data science. The Government should progressively build up in-house capability and expertise in view of substantial knowledge of government services and operations required and for strategic and continual need for smart city development and big data analytics.

Big data analytics applications have been spanning a wide variety of public service domains and livelihood matters. With reference to successful cases in other economies, the Government can consider kick-starting big data use cases/applications which can induce more direct benefits to the public and improvement in people's livelihood. Some examples for consideration include:

- **Food safety inspection -** In the U.S.[148], a data-driven approach was adopted in domestic food inspection, allowing the authority to prioritise inspection of food that is more likely to suffer from contamination through big data analytics on historical inspection data, food information and historical data on food incidents. With more effective and targeted food safety inspection, the limited food inspection resources could be deployed in a more cost-effective way. Early actions could be taken by the government to alert the public and reduce the risk of foodborne illnesses that results in better food safety.

- **Fire safety inspection -** New York City (NYC)[149] uses big data analytics on data related to buildings (e.g. building age, previous inspection result, reported cases of illegally converted apartments, etc.) to predict buildings at risk of serious fires and accords priority to inspect those buildings. With early inspection on the most at-risk buildings, fire hazards and accidents would be minimised and hence better protection of life and property of the public from fire.

- **Healthcare demand prediction -** Changes in temperature, rainfall patterns, heat waves and cold spells could affect the spread of some communicable diseases (e.g. influenza, dengue fever) while the occurrence of extreme weather events could bring acute challenges to healthcare preparedness. There are many local and overseas research evidences suggesting that meteorological factors play an instrumental role in public health. With big data analytics, healthcare demand (e.g. A&E attendance, hospital admission) could be predicted based on meteorological (e.g. weather, humidity) and socio-demographical factors (e.g. population, income, age, gender). Healthcare providers can better manage their manpower and resources for the demand surge. This will in turn benefit citizens in shortening the queuing time of hospital admission and A&E admission, resulting in better public healthcare services. A similar study can be found in the journal paper "*Big data as a new approach in emergency medicine research*"[150].

- **Safety inspection on electrical and mechanical (E&M) facilities –** The impact of incidents of E&M facilities (e.g. elevator and escalator) can be large. It is critical to keep E&M facilities running smoothly in order to maximise their utilisation and performance as well as to minimise the potential big impact on unscheduled downtime and accidents. This challenge can be addressed by early identification of potential failure with big data analytics on data related to the facilities' status and its environment such as temperature. With the adoption of

[148] http://www.fsis.usda.gov/wps/portal/informational/aboutfsis/strategic-planning
[149] http://www1.nyc.gov/office-of-the-mayor/news/163-13/mayor-bloomberg-fire-commissioner-cassano-new-risk-based-fire-inspections-citywide
[150] https://www.researchgate.net/publication/282539457_Big_data_as_a_new_approach_in_emergency_medicine_research

predictive maintenance of E&M facilities, operational risk can be reduced and rate of return on assets can be increased by early identifying potential failures of the facilities before they occur. With more accurate predictive maintenance of E&M facilities, number of incidents due to unexpected failure of such facilities will be minimised. This will lead to more reliable and safe services to the public when using the facilities. A similar case can be found in Microsoft's Cortana Intelligence Solution Template Playbook[151].

- **Social listening -** The Internet and social media platforms have become the new space for the public to voice their opinion, communicate and interact. On top of the traditional methods of collecting public feedback, analysis on data gathered from social and news media websites/channels (e.g. Twitter, Facebook and on-line forums, etc.) can provide a better understanding of public views, attitudes, inclination and sentiment. Social media analytics has been widely used by the U.S. government in the recent years [152]. Continuous analysis on the latest data from social media platform and on-line news can facilitate governments to master the latest public views and sentiment and make instant responses. Insights generated from social media can support better and more informed government planning / decision in areas such as policy formation, campaign organisation, law and order enforcement, etc.

Proposed Initiatives to Meet the Objectives

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
1. Promote a data-driven approach to further promote development of e-government and related public services	<u>Virtual Hong Kong</u> • To pave the way for establishing CSDI for Hong Kong, to create 3D digital map of Hong Kong with enriched spatial data	<u>Virtual Hong Kong</u> • Integrate 3D topographic map data with the Common Spatial Data Infrastructure • Establish a unified visualisation and modelling of existing urban environment with provision for inputs from planned changes across: - City Master Planning - Mobility- visual representation of road and transportation networks and impact on infrastructure from new development/retrofits	<u>Virtual Hong Kong</u> • Fully integrate all department information, and fully utilise the virtual 3D (including underground utility data) platform by the city to perform interactive visualisation, performance and operational analysis on city data • Upon the full implementation of the Electronic Submission

[151] https://docs.microsoft.com/en-us/azure/machine-learning/cortana-analytics-playbook-predictive-maintenance
[152] https://www.brandwatch.com/2015/01/understanding-sentiment-analysis/

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
		- Utility routing - Archaeological preservation/new places to explore - Built Environment Management - Culture and Entertainment- visual representation and location of these facilities and nearby transportation, restaurants, and parking to enhance city brand globally - Decision Support System - Disaster Management- by simulating location of damage or impacted locations and nearby utilities and built infrastructure; location of hospitals and shelters; ingress and egress routes	System, • consider mandatory submission building plans of large scale private development projects in BIM through the Electronic Submission Hub • allow the public to retrieve the record plans in BIM
	<u>BIM</u> • Consider adoption of Building Information Modelling (BIM) in new developments to pave the way for future integration of BIM information with Virtual HK and other government planning processes, such as planned Electronic Submission System of Building Department • Develop an Electronic Submission Hub to handle the submission and approval of building plans for private development projects to replace paper-based centralised	<u>BIM</u> • Launch the Electronic Submission Hub for building plans of pilot private development projects in BIM	<u>BIM</u> • Upon the full implementation of the Electronic Submission System , - consider mandatory submission building plans of large scale private development projects in BIM through the Electronic Submission Hub - allow the public to retrieve the record plans in BIM

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	plan processing system involving various government departments • Actively seek to require consultants and contractors to use BIM technology when undertaking design of major government capital works projects and encourage adoption of BIM for private construction projects		
	<u>Data-analytics-as-a-Service for Government Departments</u> • Implement a centralised big data infrastructure with common service modules (including artificial intelligence and social media analytics) for developing and executing big data analytics models for smart city applications • Set up the central big data office with expertise to facilitate big data analytics applications across the Government	<u>Data-analytics-as-a-Service for Government Departments</u> • Kick-start big data analytics use cases that have direct impact on quality of e-government services and people's livelihood	
2. Deploy appropriate infrastructure to support Smart Government	<u>Smart Intelligent and Integrated Poles</u> • Assess priority locations and deployment of integrated poles • Assess on-going maintenance roles and responsibilities, and recurrent cost	<u>Smart Intelligent and Integrated Poles</u> • Evaluate and review pilot integrated poles, and develop city-wide implementation strategy • Expand Smart Telephone Booth project to other	<u>Smart Intelligent and Integrated Poles</u> • Deploy integrated pole city-wide

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	allocation • Develop pilot Smart Intelligent and Integrated Poles with the following features: - Integrated sensors into the poles to demonstrate multi-functionalities - Provision of 3rd party hardware (telecom equipment, cell sites, electricity charger, etc.) - ICT enablement for data collection and sharing - Display of information, such as air quality index, time and temperature • Assess the use of telephone booths to pilot integration of sensors and other technologies to provision new services to users	locations across the city	
	<u>5G</u> • Ensure all investments are 5G compatible • Allow certain venues (e.g. HK Science Park, Cyberport) to be testbed for 5G technology		
	<u>Underground Integrated Ducts</u> • Assess the feasibility of deploying utilidors in the planned NDAs	<u>Underground Integrated Ducts</u> • Deploy utilidors in the planned NDAs where	<u>Underground Integrated Ducts</u> • Assess the feasibility of deploying utilidors in the developed areas of

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	and consider the operational requirements (e.g. implementation timeframe, funding, operation model) for utilitdor implementation in these NDAs (pilot areas may include Lok Ma Chau Loop)	feasible	Hong Kong
3. Facilitate easy access to government services for transacting with the Government	<u>e-Government Services</u> • Develop a new application architecture framework and implement a central platform for agile development of new generation of e-Government services • Start delivering e-Government services in a more agile, efficient and effective manner that better meets the changing public demands and business needs, by leveraging on the new application architecture framework and the central platform.	<u>e-Government Services</u> • Implement a central platform, which conforms to the new application architecture framework, for shared used by Government B/Ds	

3.5.6. Benefits

The following are the key benefits that the citizens, the city, and businesses will be able to take advantage of:

	Benefits
Citizen	• Insights and improved response time for service requests to real time data • Improved citizen experience and convenience

	• Access to a digital representation of Hong Kong • Better e-Government services for meeting citizen expectation and needs
City	• Improved speed to deploy services • Better management of infrastructure and issues (illegal parking, breakdowns, water logging, etc.) • Facilitate data exchange within and outside city departments to foster innovation and improve service delivery • Optimal use of valuable and sparse real estate by sharing infrastructure • Virtual integration across city functions • Leverage 5G to support real-time data exchange and smart city services city-wide • Lower energy usage for distributed ICT infrastructure • New tool for performing visualisation and analysis for planned and future city initiatives • Integrated asset management for multiple B/Ds • Improved operational Energy and Operational Efficiency • Reduced O&M costs • Standardisation and interoperability • Converge with open and industry standards
Business	• Decreased impacts to business operations • Access to city data to foster innovation • Additional investment opportunities and revenue streams • New revenue streams by mining into extensive data • Access to mineable data and information for analytics to co-create and drive innovation to improve city experience • New revenue streams • Reduced outlays for O&M • Greater access to deploy hardware in dense areas

3.5.7. Major Stakeholders

3.5.7.1. Bureaux/Departments (B/Ds)

- Innovation and Technology Bureau (ITB) and OGCIO
- Development Bureau (DEVB(W) and DEVB(PL)) and its group of departments

3.5.7.2. Public Bodies

- Construction Industry Council
- Housing Authority
- Urban Renewal Authority
- Public utilities

3.5.7.3. Private Sector

- Telecommunication and network providers
- Construction industry
- Systems and product (devices and sensors) manufacturers

- Building owners/occupants
- Land developers/real estate agencies
- AI and machine learning solution providers
- Electronic-city-map providers
- Other citizen service providers

3.5.7.4. Other Key Stakeholders

- Legislators and district councillors

3.5.8. Legal and Regulatory Matters

	Short-term (2017 – 2020)	**Medium term (2021 – 2025)**	**Long term (2026 – 2030+)**
Smart Government	Balance privacy protection and wider use of data generated from city-wide sensors (including CCTVs): • Guidance on CCTV Surveillance and Use of Drones (issued by the Office of the Privacy Commissioner)		Provide the legal basis for mandatory submission of building plans of large scale private development projects in BIM through the Electronic Submission Hub: • Buildings Ordinance, Cap.123

3.6. Smart Economy

"Smart Economy" intends to transform and strengthen Hong Kong's economy by improving the overall business climate, city attractiveness for start-ups, investors and growing the economy in a sustainable manner. The combination of a city rebranding effort, and the Smart Economy initiative will help position Hong Kong as a leading investment destination, attract talent to the city, and establish itself as the investment gateway to China and other eastern markets. Smart Economy will improve Hong Kong's productivity and competitiveness by fostering an environment of greater collaboration among government, citizens, businesses, academia, and NGOs to spur innovation in new high technology products and services. In addition, Smart Economy seeks to increase the attractiveness of Hong Kong as a tourist destination through leveraging innovative and creative measures to facilitate tourists' interactions with the city.

3.6.1. Policy Objectives

To move towards a smart economy, Government should aim to:

1. Improve and promote the overall business climate, the advancement of Fintech and re-industrialisation, and city attractiveness for start-ups and investors; and
2. Attract leading talent and investments globally to increase the city's economic vibrancy through established smart city brand.

3.6.2. Key issues and challenges in Hong Kong

It is observed that there is a need for city brand realignment to attract leading talent and investments globally. Key observations include:

- Relatively low global rankings in the areas of innovation cities index when compared with the 30 of the world's leading business cities[153].
- The weakening of the yuan against the Hong Kong dollar, combined with changing retail preferences, have resulted in a weaker retail market in Hong Kong.
- Increasing competition from overseas cities for talent expected to be long-term.
- Reduced container throughput and logistics performance for cargo[154].

Additionally, there is a need for improvement in business climate and city attractiveness for start-ups and investors, as seen in the following:

- Inadequate public and private funding to support entrepreneurship.
- Increased competition from other cities in the region as an entrepreneurial and liveable destination[155].

[153] PwC Cities of Opportunity https://www.pwc.com/us/en/cities-of-opportunity/2016/cities-of-opportunity-7-report.pdf
[154] http://hkma.org.hk/pdf/2016pya/PYA-2016.pdf
[155] http://www.citylab.com/tech/2015/07/the-worlds-leading-startup-cities/399623/

- Time-consuming to secure start-up funding coupled with low-risk appetite for providing start-up finance.
- Adoption of ICT in particular cloud services is low among local SMEs.

3.6.3. Overseas and China leading practices

The leading practices in city branding to attract leading talents and investments globally include the following:

- Barcelona is commonly recognised as the leader in smart city branding. The city promotes events such as the Mobile World Congress and Smart City Expo World Congress while also establishing initiatives such as the Activa programme which mentors and guides entrepreneurs and residents[156].
- Cork Ireland leveraged social media, consulted with business leaders, and performed a detailed assessment of the city to revamp through roundtables and workshops in order to create their brand[157].
- Mississuaga (Canada) recognised their brand was outdated; they surveyed residents, small businesses, and city officials, conducted brand workshops, and transformed their brand[158].
- In Shenzhen Smart e-commerce has been promoted to accelerate the development of professional markets for e-commerce, cultivate e-commerce enterprises, develop third party e-commerce transaction platforms and expedite promotion of e-commerce services. Beyond this, other measures include: To develop various forms of secured on-line payment; to establish an e-commerce credit system; to promote e-commerce security certification; to improve the modern logistics and distribution system; to optimise e-commerce communication environment; and to enhance the e-commerce trading environment[159].

The leading examples on creating an attractive business climate and city for start-ups and investors include the following:

- Tech London is an on-line platform connecting and supporting London's expanding entrepreneurship ecosystem. It includes information and resources that people in London may need to access opportunities in the tech sector, connect with each other, and grow their businesses. This collaboration between Mayor of London, Gust (a funding platform), and partners from London's tech community highlights the city's commitment to increase jobs, retool the city's workforce, support new business, ensure London continues to lead technology innovation[160].

[156] http://www.barcelonactiva.cat/barcelonactiva/en/all-about-barcelona-activa/who-we-are/index.jsp
[157] http://strengtheningbrandamerica.com/blog/2014/12/the-brand-and-marketing-strategy-for-the-cork-city-region-ireland/
[158] http://mississaugabrand.ca/
[159] Shenzhen Municipal Government, 智慧深圳規劃綱要（2011-2020 年）, http://www.szjmxxw.gov.cn/Upload/admin/20120521/17/2012052101.doc
[160] http://www.tech.london/about

- SPRING Singapore is the agency under the Ministry of Trade and Industry responsible for helping Singapore enterprises grow and building trust in Singapore products and services. SPRING runs Start-up SG, which provides entrepreneurs with a launch pad for their development and serves as a platform of connectivity to the global stage. Start-up SG Schemes include Start-up SG Equity, which aims to catalyse equity investment for start-ups by increasing government co-investment funding to stimulate more private sector investments in deep-technology[161,162].
- Canada offers a range of incentives to foster an attractive business climate and city for start-ups and investors. Revenue Agency runs a Scientific Research and Experimental Development Tax Incentive Program to provide support, in the form of tax credits and/or refunds, to corporations, partnerships or individuals who conduct scientific research or experimental development in Canada. The Ontario Interactive Digital Media Tax Credit (OIDMTC) encourages the development of interactive digital media in Ontario. Eligible products could include educational software, informational websites and video games[163,164].
- The Massachusetts Global Entrepreneur in Residence (GEIR) Program was established in 2014 to attract and retain qualified entrepreneurs and their growing companies in Massachusetts[165].
- Barcelona has positioned itself as a world leading smart city, in part by holding the annual Mobile World Congress and Smart City Expo World Congress event to showcase industry leading technology in the mobile and consumer technology space[166].
- The City of Copenhagen has launched a market place for public and private data known as the City Data Exchange (CDE). It is the first data exchange platform to monetise data. The project is a key initiative of the City of Copenhagen and the Capital Region of Denmark[167,168].
- Beijing planned to invest RMB 100 billion to build a city-wide high-speed information network. In the 12th Five-Year Plan, Beijing would expedite operation of cloud computing and Internet of Things to achieve economies of scale. Beijing would foster 10 world-class information technology companies with global influence and operating income exceeding RMB 10 billion.
- In Hangzhou, projects such as citizens-focused WeChat services, public services, internet financing are developed with citizen cards being used as the carrier. By using citizen cards, citizens can go about their daily life make payments and WeChat without any concern.

[161] https://www.spring.gov.sg/About-Us/Pages/spring-singapore.aspx
[162] https://www.spring.gov.sg/Nurturing-Startups/Pages/nurturing-startups-overview.aspx
[163] http://www.cra-arc.gc.ca/txcrdt/sred-rsde/menu-eng.html
[164] https://www.marsdd.com/mars-library/tax-credits-rd-ontario-startups/
[165] http://masstech.org/innovation-institute/projects-and-initiatives/global-entrepreneur-residence-pilot-program
[166] https://www.mobileworldcongress.com/
[167] http://cphpost.dk/news/copenhagen-launches-worlds-first-city-data-marketplace.html
[168] https://stateofgreen.com/en/news/city-of-copenhagen-launches-the-world-s-first-big-data-platform-for-cities

3.6.4. *Description of Potential Scene/Outcome*

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
Innovators (such as *Professionals, Students, Academia)*	• Position Hong Kong as a viable location to fully develop innovative business ideas from ideation to commercialisation • Consider Hong Kong as an attractive test-bed for developing and testing innovative ideas for real urban challenges • Receive support and assistance from the Government, public organisations, and private organisations to build and promote innovative and technology solutions for consumption within Hong Kong, and making them viable for export • Have more access to financing from public and private platforms • Encounter reduced regulatory bottlenecks in starting and scaling operations • Easily access, and be able to develop skilled labour in areas with innovation potential	• Easily access funding and resources as a result of Hong Kong's growing international presence for investors (especially outside China) • Consider Hong Kong as a centre of innovation and technology, and recognise an increasing level of attractiveness of local universities to local and foreign talent • Recognise an increasing level of collaboration between universities, industry and the Government • Receive more forms of university scholarships and partnerships with leading overseas universities and businesses to develop local talent • Receive awards and scholarships such as Student Entrepreneur of the Year Award • Access to further enhanced entrepreneurship and ICT (Information and Communications Technology) programmes	• Consider Hong Kong as an international centre of excellence and leading example of shared economy and cashless society • Adopt the viewpoint that entrepreneurship is a viable employment opportunity for young students/graduates
Talents	• Position Hong Kong as a viable location to fully develop innovative business ideas from ideation to commercialisation • Position Hong Kong as an opportunistic location in area of Fintech, Smart	• Consider Hong Kong as a centre of innovation and technology, and recognise an increasing level of attractiveness of local universities • Consider various industries in Hong	• Consider Hong Kong as an international centre of excellence and leading example of shared economy and cashless society • Adopt the viewpoint that entrepreneurship is a viable employment opportunity for young

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	Manufacturing and all other industries with potential for digital transformation • Receive support and assistance from the Government, public organisations, and private organisations to build and promote innovative and technology solutions across all industries, such as Fintech and Smart Manufacturing for consumption within Hong Kong, and making them viable for export • Have more access to financing from public and private platforms • Encounter reduced regulatory bottlenecks in starting and scaling operations • Easily access to Hong Kong market to start business or take key positions in companies in areas with innovation potential	Kong in tune with the digital landscape • Easily access funding and resources as a result of Hong Kong's growing international presence for investors (especially outside China) • Receive more forms of university scholarships and partnerships with leading overseas universities and businesses to develop local talent • Receive awards and scholarships such as Student Entrepreneur of the Year Award • Access to further enhanced entrepreneurship and ICT (Information and Communications Technology) programmes • Increasing opportunities from companies to build and promote innovative and digital strategies across all industries, such as Fintech and Smart Manufacturing	students/graduates • Consider Hong Kong as one of the most attractive location to work in executive level roles
Investors and Businesses	• View Hong Kong as one of the most conducive and viable locations to conduct business attributable to its business-friendly regulations, fairness in resolving disputes, incentives, for example. • Easily access, and be able to develop skilled labour in areas with innovation potential,	• Assist in rebranding of Hong Kong as a centre of innovation and technology, increasing attractiveness to foreign investors and international businesses • Always place Hong Kong in the initial list of locations for consideration for technology	• View Hong Kong as the hub and leading example for development and application of Fintech technologies, such as cybersecurity • Consider Hong Kong as the top choice for technology related investments across multiple industries, such as Fintech and high value added

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	especially in Fintech and high value added manufacturing • Easily access air and port logistics for movement of economic products • Easily access and integrate trade and efficient cross-boundary financial transactions with China	investment • Assess to digitally advanced and adaptive infrastructure at high value added manufacturing locations • Aid the establishment of Hong Kong through their strong presence as a desirable retail destination for tourists • Leverage Hong Kong as the premier gateway and hub into Asia markets	manufacturing • Strengthening brand of Hong Kong as a leader in innovation through further strategic partnerships to set up and host events
Government	• Enhance Hong Kong's competitiveness to improve business and tourism attractiveness • Attract high value tourists and innovators to visit and participate in economic development of the city • Experience continued growth and development of Hong Kong International Airport into the leading passenger hub into Asia, outshining competition from Beijing, Singapore, and Shanghai • Enhance economic integration with China through joint infrastructure projects • Support high-value manufacturing through increased accessibility to next generation technology for research and development and production • Improve Hong Kong's	• Lead by example to procure local innovative products for use in Hong Kong by ensuring procurement guidelines that facilitate new entrants to compete and offer products and services to the Government • Improve the positioning of Hong Kong as a trade hub through increased accessibility and connectivity of the city • Implement annual events on next generation technology (e.g. Internet of Things (IoTs), Artificial Intelligence (AI), Virtual Reality (VR)) • See an increase of high value add manufacturing businesses through the promotion to utilise industrial estates, sites	• Lead Hong Kong to be the international centre of excellence and leading example of shared economy and cashless society • Establish Hong Kong as the leading location for Fintech development and Fintech companies • Establish Hong Kong as a leading choice of location for high value added manufacturing • Establish Hong Kong as a desirable tourist location due to revival of retail industry coupled with branding of Hong Kong as a centre of technology and innovation

Impacted stakeholders	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	position as the desired location for Fintech research and development and establishment for Fintech companies • Encourage local SMEs to adopt cloud computing services	designated for innovation and technology development • Rebrand and market of Hong Kong as a desirable retail destination for tourists • Establish Hong Kong as a smart city and also the premier gateway/hub into Asia • Expand the number of Partner State Key Laboratories in Hong Kong	
Tourists	• Feel and perceive that Hong Kong is an attractive, innovative, and technologically advanced tourist destination	• Feel that: - they can use technology to more easily navigate the city's tourist attractions - they can more easily personalise and plan their trip to Hong Kong with new web and mobile apps - their experience in Hong Kong is much more interactive, personalised and enhanced - their trip was enhanced due to technological innovation and smart tourism	• Feel that: - their visit to Hong Kong is exciting, innovative, interactive and immersive - Hong Kong is a Smart Tourism destination

3.6.5. Proposed Initiatives

The following are potential projects and initiatives that may be considered to achieve the objectives under this theme.

Description of Potential Projects

- FinTech:

By taking proactive steps, Hong Kong could become the leading FinTech centre within the region and one of the leading centres in the world. In recognition of the need to develop FinTech in Hong Kong, a Government-appointed FinTech Steering Committee delivered its report in early 2016, and the Financial Secretary's 2016/17 Budget restated a commitment to further develop FinTech in Hong Kong.

FinTech may dramatically alter today's financial services delivery model. Financial services contribute 18% of Hong Kong's GDP and 6% of its employment, thus Fintech's impact will be considerable. Hong Kong's large financial industry, links to the East and the West, and its trusted institutions and respected regulatory standards are its strengths in FinTech development. Moreover, as Hong Kong continues to invest in its ICT infrastructure and data science education, Hong Kong possesses the strong foundational capabilities to support the data-heavy activities that will help to further FinTech development in the city.

Hong Kong's FinTech development faces a number of challenges. From the standpoint of consumer opportunities, Hong Kong is a small market, and already heavily served by principal incumbents. Other issues include little tradition of technological innovation, and high cost. From a long-term developmental standpoint, Hong Kong is very strong in 'Fin', but not strong in 'Tech'. There is competition as other centres move rapidly ahead with their own FinTech initiatives such as Singapore.

FinTech may be considered as a subset of the start-up ecosystem. FinTech development will address the city's future needs in the already-established finance sector, and also ride on the efforts established in the start-up ecosystem.

Hong Kong can take advantage of its large financial sector and leverage on the fact that it houses many regional headquarters, and act as a landing pad for FinTech eyeing regional opportunities and market for FinTech providing business-to-business (B2B) services. The city should also aim to act as a launch pad for Mainland FinTech seeking international expansion.

The Hong Kong Monetary Authority (HKMA) established the Fintech Facilitation Office in March 2016. Since then, the HKMA launched the Cybersecurity Fortification Initiative to strengthen the banking sector's cyber resilience, the Fintech Supervisory Sandbox to shorten Fintech's time-to-market, the HKMA-Applied Science and Technology Research Institute (ASTRI) Innovation Hub for brainstorming/testing solutions by the industry, the Distributed Ledger Technology research to explore the technology, the Central bank Digital Currency to understand its implications, the Fintech Career Accelerator Scheme for student internship, and the Haccelerator for facilitating competitions.

- Smart Manufacturing:

  The project focuses on facilitating re-industrialisation in Hong Kong. Specifically, emerging technologies such as robotics, IoT, drones, 3D printing, AI and analytics, will be

used to deliver high value added manufacturing. It involves building advanced manufacturing centres and data centres at industrial estates in Tseung Kwan O, Tai Po, Liangtang. Expansion of industrial estates will continuously support innovation in manufacturing.

- Foreign Investments:

  This project involves implementing policies and strategies that will allow Hong Kong to serve as a melting pot of knowledge and experience. This will attract foreign investors and international businesses to the city. The project aims to create programmes to engage innovators and host events that broadcast Hong Kong's smart city initiatives.

  This project would advocate and run, for example, start up support programmes, and a portfolio of programmes that will showcase Hong Kong's creativity, innovative spirit and human capital. Moreover, local innovations, technologies, and business solutions which have been showcased successfully in Hong Kong may be promoted and exported to other parts of the world, in a coordinated manner. The goal is to establish a conducive business environment to attract the global investor community, sign post Hong Kong as a forward thinking city and to export Hong Kong's innovative solutions.

  The Financial Secretary in the 2017-18 Budget Speech proposed to set up a tax policy unit under the Financial Services and the Treasury Bureau to comprehensively examine the tax issues from a macro perspective to ensure Hong Kong's competitiveness and to address the problem of a narrow tax base.

- Start-up Ecosystem:

  This project will involve the development of Hong Kong's start-up ecosystem to accelerate the deployment of innovative product and services. This project should include establishing funds and pilot programmes to test new products and services from its ideation, research, and design stages to its production and eventual commercialisation. A robust start-up ecosystem will also expand incubator programmes and support start-ups.

- Research and Development Platform

  This project involves the establishment of a platform dedicated to research and development at the Hong Kong – Shenzhen Innovation and Technology Park to be developed in the Lok Ma Chau Loop, complementing the existing innovation hubs at Hong Kong Science Park, Cyberport, research centres (e.g. ASTRI) and universities.

- Smart Tourism:

  This project aims to enhance and reinforce the attractiveness of Hong Kong as a travel destination. Smart tourism leverages smart and innovative technologies, to ease visitor's interactions with the city, navigate and find services, plan their trip, and enhance the overall tourists' experience. A pilot is recommended to explore the best technologies and approaches to enhance the digital experience to tourists.

Proposed Initiatives to Meet the Objectives

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
1. Improve and promote the overall business climate, the advancement of Fintech and re-industrialisation, and city attractiveness for start-ups and investors	<u>Fintech</u> • Enhance transaction security through biometric authentication options • Encourage usage of Fintech Supervisory Sandbox to test and deliver on products and services using newer financial technology • Continue to consider technologies to improve transactions and financial management • Explore feasibility of Distributed Ledger Technology (Blockchain) on trade financing, insurance claims, cross-boundary remittance to reduce costs and fraud risk, and enhance transparency • Assess the feasibility of Hong Kong becoming a cashless economy and using digital currencies • Assess the feasibility for leveraging technology in relation to regulatory monitoring, reporting and compliance in the financial industry	<u>Fintech</u> • Continue to encourage development of blockchain and cybersecurity within Fintech and promote Hong Kong as a hub and leading example for the application of these technologies, leveraging Hong Kong as one of the leading international financial centres • Pilot selected projects to demonstrate the feasibility of cashless economy and use of digital currencies in Hong Kong	

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	(i.e., Regulatory Technology (RegTech)) in view of the heightened international regulatory environment (e.g. anti-money laundering, Common Reporting Standard)		
	<u>Smart Manufacturing</u> • Evaluate the prevailing industry landscape and regional collaboration opportunities in terms of product innovation and manufacturing, and formulate a policy to promote re-industrialisation for Hong Kong focusing on incorporating emerging technologies, such as robotics, IoT, 3D printing, into high value manufacturing processes • Continue to encourage and support collaboration between universities, industry and the Government/public organisations in support of re-industrialisation	<u>Smart Manufacturing</u> • Promote utilisation of sites set aside for innovation and technology sector to continue developing infrastructure including the development of the Hong Kong – Shenzhen Innovation and Technology Park at Lok Ma Chau Loop and industrial estates. Develop an action plan to support the implementation of Hong Kong's re-industrialisation	<u>Smart Manufacturing</u> • Review and refine policies related to re-industrialisation to reflect emerging industry development and technologies
	<u>Foreign Investments</u> • Continue to expand the number of	<u>Foreign Investments</u> • Design and implement a globally-targeted	

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	annual / biennial events which focus on next generation technology innovation (e.g. virtual reality, artificial intelligence) • Design and implement an Asia-targeted marketing campaign to position Hong Kong as a preferred investment destination for creative and innovative products and services	marketing campaign to position Hong Kong as a preferred investment destination for creative and innovative products and services • Establish large scale, international annual/biannual events to focus on next generation technology innovation attended by international innovators	
	<u>Start-Up Ecosystem</u> • Explore a procurement approach in Government that focuses on outcome and innovation • Develop policies to lower barriers to access funds for start-ups • Continue to expand incubation programmes run by public organisations such as HKSTP and Cyberport to assist with start-ups • Identify possible partners to establish a Student Entrepreneur of the year award to promote entrepreneurship and attract students from across the	<u>Start-Up Ecosystem</u> • Adopt a procurement approach in Government that focuses on outcome and innovation • Explore with other possible partners to further establish other student and business entrepreneur award and schemes to promote entrepreneurship and attract students and business globally • Partnerships between Hong Kong universities and overseas universities to establish internationally recognised innovation programmes / research and development (R&D) centres in Hong Kong • Work with the Mainland Government to continue supporting the Partner	

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	world to compete for the award • Provide more comprehensive and in-depth subject knowledge on ICT and practical skills to younger generation[169] • Expand scholarship's/ twinning programmes with leading universities across the world[170] • Enhance programmes that promote entrepreneurship as a strong career choice	State Key Laboratories and Hong Kong Branches of Chinese National Engineering Research Centres in Hong Kong	
	<u>Cross-Project Activities</u> • Assess the policies and initiatives that enable Hong Kong to participate in the sharing economy, including examples such as, sharing of consumer goods and cars.		
			<u>R&D Platform</u> • Develop the Hong Kong – Shenzhen Innovation and Technology Park as a key base on technology research in the region
2. Attract leading talent and	<u>Foreign Investments</u>	<u>Foreign Investments</u>	<u>Foreign Investments</u>

[169] http://www.edb.gov.hk/en/edu-system/primary-secondary/applicable-to-primary-secondary/it-in-edu/ite4.html
[170] Universities in HK are partnering with overseas universities, e.g. HKUST and University of Toronto established academic cooperation promote and enhance engineering teaching, learning and research (source: http://www.seng.ust.hk/web/eng/news_detail.php?id=744)

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
investment globally to increase the city's economic vibrancy through established smart city brand	• Attract foreign investment and technology for smart city Hong Kong via PPP • Work with relevant organisations such as the Hong Kong Economic and Trade Office (ETO), Hong Kong Trade Development Council (HKTDC), InvestHK, HKSTP, and Cyberport to further enhance their investor attraction programmes, in particular for innovation and technology sector • Encourage corporations to enhance their on-going efforts to create co-working spaces (such as Cyberport's Smart Space initiative, and HKSTP's Incubation Programmes) and other programmes targeted at start-ups and businesses to spur innovation • Consider tax incentives for research and development (R&D) • Attract talents by enhancing Quality Migrant Admission Scheme	• Attract foreign investment and technology for smart city Hong Kong via PPP • Execution of strategy to strengthen Hong Kong's ability to attract foreign direct investment and talents, such as to: - Stimulate/incentivise trade associations (e.g. GSM Association, a trade association representing mobile operators) to hold globally relevant events in the city - Continue to refine existing platforms such as "istartup.gov.hk", "Startmeup.hk", "hongkong-fintech.hk" and "fintechweek.hk" to increase global start-up exposure and increase overseas economic opportunities - Encourage entrepreneurs/ corporations to work with Hong Kong Economic and Trade Offices (ETOs), Hong Kong Trade Development Council (HKTDC), InvestHK, HKSTP, and Cyberport to showcase Hong Kong's innovation experience in order to expand business	• Attract foreign investment and technology for smart city Hong Kong via PPP • Continue to develop services for innovation centres across city creating a platform for future innovation • Hosting of global smart city related events and conferences similar to Smart City Expo World Congress and Smart Cities Asia in Hong Kong

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
		opportunities in a targeted manner (e.g. participate in world renowned city events and international conferences) • Develop/expand innovation centres and create programmes (e.g. hackathon) to engage youth and innovators, broadcast smart city initiatives and provide a platform for smart city innovation (e.g. new apps, portals) • Replicate smart city solutions, proven in Hong Kong, to other parts of the world, exporting technology and services, similar to MTR	
	<u>Smart Tourism</u> • Enhance the attractiveness of cultural and heritage tourism in Central District, including the projects on the revitalisation of Dr Sun Yat-sen Historical Trail and Old Town Central, with relevant smart technologies, and execute further promotional campaign and related activities • Assess and review the effectiveness of smart technologies implemented for	<u>Smart Tourism</u> • Identify and assess other tourism projects, initiatives, and tourist attractions that may be enhanced with proven smart technologies • Leverage data collected from smart tourism projects, and big data analytics, to generate valuable tourist behaviour and preferences	<u>Smart Tourism</u> • Design and implement the technologies to enhance specific tourism projects, initiatives, and tourist attractions that may be enhanced with proven smart technologies

Objectives	Short term (2017 – 2020)	Medium term (2021 – 2025)	Long term (2026 – 2030+)
	reference of possible projects in future		

3.6.6. *Benefits*

The following are the key benefits the citizens, the city, and businesses will be able to take advantage of:

	Benefits
Citizen	• Increased access to state of the art technology • Higher quality of life • Improved sense of community • Citizen participation • Greater opportunities for employment • Access to secondary sources of funds • Improved opportunities to participate in the sharing economy
City	• Healthier economic strategy • Improve business attractiveness • International recognition • Global conferences/events stimulate energy and innovation throughout city • Increased revenue from business taxes • Increased employment in high value, high technology fields • Increased city attractiveness for high-end businesses and talent • Increased tourist revenue
Business	• Increased access to world class businesses • Increased value generating partnerships through additional businesses • Increased access to world class talent, generating jobs and revenue in the city • Increased ability to scale businesses • Expanded sales through increased tourism and foot traffic • Improved access to start-up funding for entrepreneurial ventures

3.6.7. *Major Stakeholders*

3.6.7.1. Bureaux/Departments (B/Ds)

- Innovation and Technology Bureau (ITB) and its departments under ITB
- Commerce and Economic Development Bureau (CEDB) and its departments (e.g. Tourism Commission, Hong Kong Economic and Trade Office, Invest Hong Kong)
- Financial Services and the Treasury Bureau (FSTB)

3.6.7.2. Public Bodies

- Hong Kong Monetary Authority (HKMA)

- Securities and Futures Commission
- Insurance Authority
- Trade associations, e.g. Group Managed Service Account
- Hong Kong Trade Development Council (HKTDC)
- Public organisations that runs incubation programmes for innovation, e.g. Cyberport, HKSTP
- Hong Kong Tourism Board
- Education sector and related scholarship providers
- Research and development institutions – e.g. universities, R&D Centres
- Culture promotion and related public organisations

3.6.7.3. Private Sector

- Financial services industry
- Manufacturing industry
- Hospitality industry
- Mobile app developers
- Payment system and Stored Value facilities
- Fintech solution providers
- Telecom industry
- AV and VR developers, user experience specialists
- Retail industry
- Restaurant industry
- Art galleries

3.6.7.4. Other Key Stakeholders

- Legislators and district councillors

3.6.8. Legal and Regulatory Matters

	Short term (2017 – 2020)	**Medium term (2021 – 2025)**	**Long term (2026 – 2030+)**
Smart Economy	Enable innovative means of raising money or funding: • New legislation to be considered for enactment		Provide the legal basis for issuing digital currencies: • Legal Tender Notes Issue Ordinance, Cap.65 • Coinage Ordinance, Cap.454 • Payment Systems and Stored Value Facilities Ordinance (Cap. 584)

4. Governance Arrangements

4.1. Introduction

This section discusses a range of considerations for the appropriate governance structure for overseeing the rollout of the Smart City Blueprint to be formulated by ITB and implementing the various smart city programmes / projects suggested in this report, with reference to overseas practices and the experience of similar establishments in Hong Kong.

4.2. Selected Overseas Practices

Overseas practices suggest that successful implementation of smart city initiatives require a senior champion to provide top-down leadership and a centralised coordination and implementation body within the government to work with both internal and external stakeholders on multi-disciplinary and cross departmental issues.

4.2.1. Singapore

Singapore has been named a top global smart city in 2016[171]. Its Smart Nation strategy covers a wide range of smart city initiatives related to energy, transport, lighting, mobility and technology innovation. The success of Singapore in delivering these initiatives could be credited to the city state's leadership and effective delivery team.

The city state deploys a top-down approach to its Smart Nation strategy where the Prime Minister is the champion who provides high-level direction and coordination among a wide spectrum of policy matters. This arrangement also attaches great importance to the strategy and ensures cooperation from government agencies and departments.

The Smart Nation strategy involves substantial stakeholder inputs from industries, businesses and the general public. The Smart Nation Programme Office (SNPO) has been established to provide effective integration of stakeholder views and to coordinate activities across relevant government agencies and departments. Supported by a team of 12[172], the SNPO oversees development planning and implementation initiatives pertaining to Smart Nation and drives collaboration and engagement with citizens and industries[173].

4.2.2. Barcelona

The success of Barcelona's Smart Barcelona strategy relies on coordinated efforts among government agencies and departments, as well as an effective top-down approach.

[171] Juniper Research (https://www.juniperresearch.com/press/press-releases/singapore-named-global-smart-city-2016)
[172] Prime Minister's Office, Government Directory of Singapore (https://www.smartnation.sg)
[173] Singapore Prime Minister's Office (https://www.smartnation.sg).

Like Singapore, Barcelona also adopts a top-down approach in implementing its Smart Barcelona strategy, with dedicated leadership to spearhead policies and strategy. The City Council is responsible for developing and agreeing on Smart Barcelona's overall strategy and direction. One of the vice mayors has been delegated to be the driving force behind the strategy.

At implementation level, a Project Management Committee has been established to monitor the implementation of about 22 key programmes suggested under Smart Barcelona. On technical aspects of Smart Barcelona, a Project Management Office (the Office) has been established under the Municipal Institute of Information Technologies (MIIT), a department responsible for providing ICT solutions across Barcelona. The Office guides and coordinates all related projects in the city throughout their project lifecycle. The Office is also responsible for carrying out implementation duties that fall under the auspice of the MIIT. On initiatives related to urban planning, energy, environment and ICT infrastructure, the responsible department, the Urban Habitat, has also set up a Smart City Strategy and ICT International Office to coordinate and implement various initiatives[174].

4.3. Key Considerations for the Governance Structure

4.3.1. Need for a Champion

Smart city is a multi-disciplinary subject encompassing a wide range of policy matters and requires a highly coordinated approach to ensure the successful implementation of initiatives. Therefore, it is suggested that a champion with sufficient authority be identified to:

- Spearhead the policy making at the top level;
- Coordinate efforts amongst the B/Ds; and
- Demonstrate to external stakeholders (including the public and the private sector) that the Government attaches great importance to the subject.

A similar arrangement has been adopted by a number of cross-B/Ds initiatives in Hong Kong. Examples include the Commission on Strategic Development (chaired by the Chief Executive[175]), Commission on Poverty (chaired by the Chief Secretary for Administration[176]) and the Steering Committee on Housing and Land Supply (chaired by the Financial Secretary[177]).

[174] C40 Cities (http://www.c40.org/case_studies/barcelona-s-smart-city-strategy)
[175] Central Policy Unit (http://www.cpu.gov.hk/en/commission_strategic_development/2015_csd_introduction.html)
[176] Commission on Poverty (http://www.povertyrelief.gov.hk/eng/welcome.html)
[177] LCQ11: Steering Committee on Housing and Land Supply (http://www.info.gov.hk/gia/general/201312/18/P201312180405.htm)

This recommendation is also in alignment with leading practices whereby a senior government official acts as the champion of smart city initiatives. For instance, the Prime Minister of Singapore actively advocates and markets for Singapore being a Smart Nation[178].

4.3.2. Need for Better Coordination

International experience shows that often issues pertaining to innovation, technology and their applications do not fall neatly into a particular policy/programme area or follow government departmental boundaries – in fact, our experiences with most smart city initiatives are that they are cross-departmental in nature.

To enable smooth and effective coordination amongst B/Ds and to implement the Smart City Blueprint, a dedicated, one-stop office supported by a multi-disciplinary team with relevant programme / project management experience would be desirable for such a purpose.

4.4. Proposed Governance Structure

4.4.1. The Overall Governance Structure

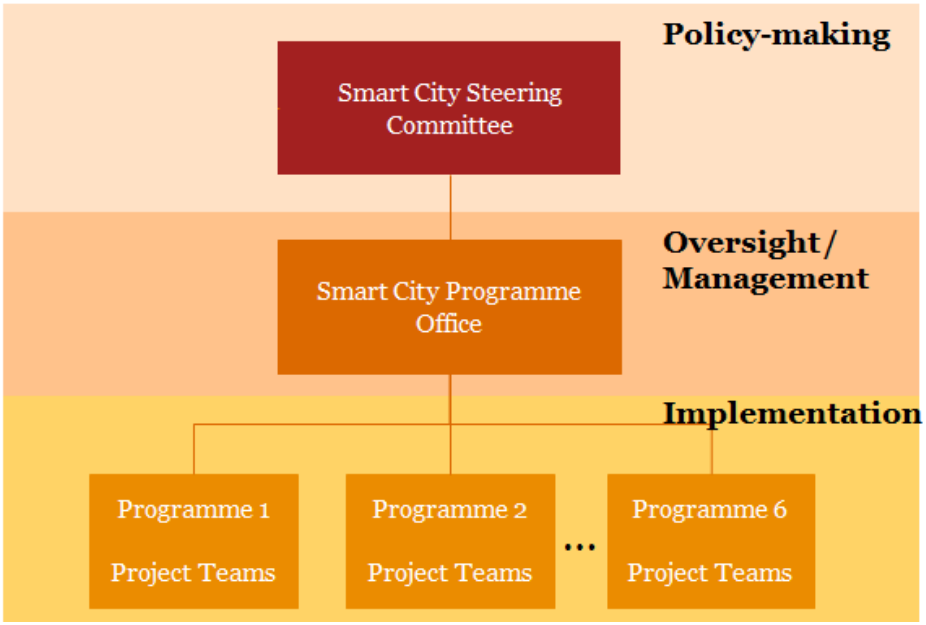
The proposed governance structure (as shown in Figure 4.1 below) aligns with leading practices and involves three layers: policy-making, oversight / management and implementation:

1. **Policy-making:** The Smart City Steering Committee (SCSC) is responsible for setting the strategic directions for the smart city implementation, determining the priority policy areas and smart city programmes, defining and monitoring KPIs.
2. **Oversight / Management:** In response to the strategic directions and policy programmes agreed by SCSC, the Smart City Programme Office (SCPO) focuses on coordinating the relevant efforts of B/Ds for implementation of smart city programmes, as well as managing risks. In addition, the SCPO is responsible for formulating individual smart city projects underpinning each programme and monitoring the implementation and outcome of these projects.
3. **Implementation:** This is the execution of smart city projects by individual Project Teams (PTs) under the direction of the SCPO.

This arrangement allows the appropriate division of work, eliminates redundancies and silos, and affords a robust "checks and balances" mechanism (refer to Annex 1 for the proposed Terms of Reference).

[178] Referencing the transcript of Prime Minister Lee Hsien Loong's speech at Smart Nation launch on 24 November 2014 (http://www.pmo.gov.sg/mediacentre/transcript-prime-minister-lee-hsien-loongs-speech-smart-nation-launch-24-november)

Figure 4.1 Overall Governance Structure



4.4.2. SCSC: Functions and Composition

The SCSC's primary mandate is to formulate the overall strategic direction of smart city development in Hong Kong, the priority areas and programmes for action. It is the body ultimately responsible for the successful implementation of smart city in Hong Kong. To this end, the SCSC receives reports from the SCPO concerning the effectiveness and progress of smart city programmes and projects.

As the SCSC is expected to provide high-level steering and coordination of relevant policy bureaux and that smart city initiatives are mostly cross-B/Ds in nature, it is advisable for the Chief Secretary for Administration (CS) or the Financial Secretary (FS) to chair the SCSC.

Members of the SCSC are made up of heads of bureaux who are anticipated to have extensive involvement in smart city initiatives, namely:

1. **Development Bureau (DEVB):** For matters related to the adaptation of smart city initiatives in land development, planning and infrastructure;
2. **Environment Bureau (ENB):** For matters related to the adaptation of smart city initiatives and the interface with green living concepts;
3. **Financial Services and the Treasury Bureau (FSTB):** For matters related to developing a Smart Economy including emerging areas of FinTech;
4. **Food and Health Bureau (FHB):** For matters related to the adaptation of smart city initiatives in health (especially in areas for elderly care);
5. **Innovation and Technology Bureau (ITB)**: For matters related to innovation and technology covering areas such as big data, data analytics and artificial intelligence, cyber and IoT security;

6. **Transport and Housing Bureau (THB):** For matters related to the adaptation of smart city initiatives in transport and housing-related matters;
7. **Commerce and Economic Development Bureau (CEDB):** For matters related to the regulation of public telecommunication services including emerging 5G services and for matters related to the making available of radio spectrum to underpin the development of 5G services as part of the smart city infrastructure;
8. **Efficiency Unit:** For matters related to change management, process re-engineering, organisation restructure, manpower planning, etc. in the Government; and
9. **Office of the Government Chief Information Officer (OGCIO):** For matters related to e-Government services and smart city digital framework.

In addition, the SCPO is suggested to act as the Secretariat to the SCSC and to provide necessary administrative and secretariat support.

As smart city is a dynamic concept and cuts through a wide range of policy areas, it is expected that the SCSC will, on an as-needed basis, invite other B/Ds to join and discuss matters related to their respective policy areas.

4.4.3. SCPO: Functions and Composition

The key mandates of the SCPO are to ensure the alignment of programmes and projects with policy objectives and optimise the effectiveness and impact of smart city projects individually and collectively.

To this end, the proposed SCPO is a dedicated team focusing on:

- Facilitating and coordinating the development of portfolios of projects underpinning the agreed smart city programmes;
- Providing oversight and management of the implementation of smart city programmes / projects at departmental level;
- Acting as the "one-stop shop" to facilitate cross-B/Ds smart city projects;
- Overseeing and promoting collaboration with private sector and academia on research relating to the provision of smart services in urban space[179]; and
- Providing secretariat support to the SCSC[180].

Having regard to the mission and modus operandi of the SCPO, the need for and importance of effective coordination amongst B/Ds in problem identification and solving, implementation of agreed policy initiatives and monitoring of progress, we consider that the SCPO be led by two directorate grade staff, one as Head and the other as Deputy Head (refer to Annex 2 for details). These posts will be responsible for the running of the SCPO.

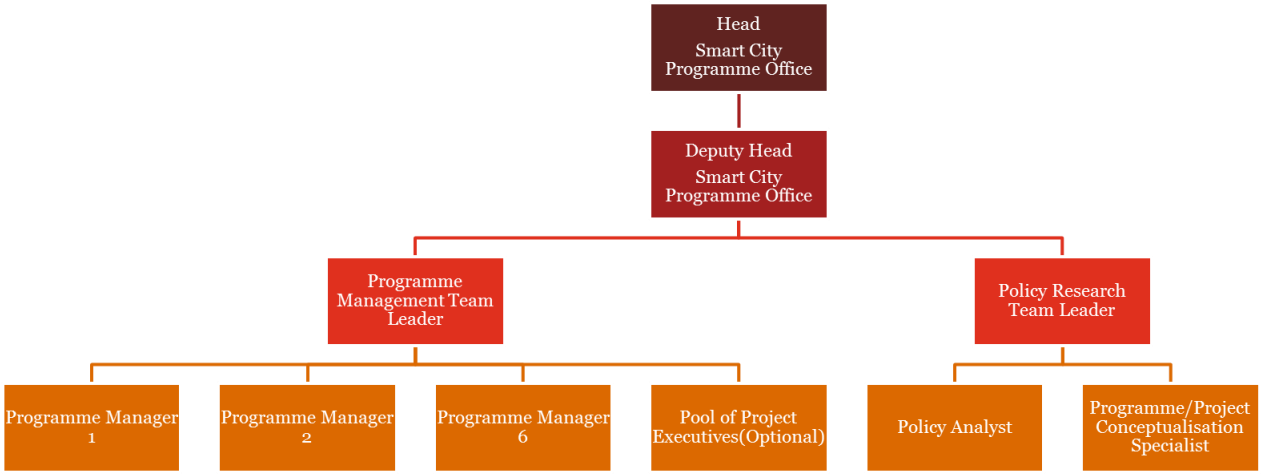
[179] Referencing the PMO established by the City Council of Barcelona to manage smart city projects
[180] Referencing the Policy and Project Co-ordination Unit under the Chief Secretary for Administration (http://www.legco.gov.hk/yr12-13/english/hc/papers/hc1123cb2-215-1-e.pdf)

The rest of the SCPO includes:

- Policy Research Team Leader supported by two individuals for policy research and implementation planning through conceptualisation of programmes and projects;
- Programme Management Team Leader supported by the following individuals:
  - Depending on the complexity of the programme, an individual of non-directorate grade with robust programme/portfolio management experience and technical specialities in each of the six smart city themes (i.e. Smart Mobility, Smart Living, Smart Environment, Smart People, Smart Government and Smart Economy) to assume the role of Programme Manager;
  - Depending on the number of projects that require project management support, a team of Project Executives who have experience in implementing cross-B/Ds projects would support the Programme Managers.

An indicative structure of the SCPO is shown in the figure (Figure 4.2) below.

Figure 4.2 An indicative structure of SCPO



The proposed SCPO may be established as a specialist unit directly under the oversight of the CS or FS. This has made reference to leading practices of having high level leadership – for instance, the Smart Nation Programme Office in Singapore is under the purview of the Prime Minster Office.

The manpower requirement for the "core team" (i.e. excluding the pool of Project Executives) is about 13, which is similar to the size of the Smart Nation Programme Office in Singapore. It should be noted that the proposed structure of the SCPO and the anticipated manpower level should be reviewed on a regular basis to ensure that the SCPO can continue to support the effective implementation of smart city in Hong Kong.

It is important for the SCPO to demonstrate leading programme and project management practices (refer to Annex 3 for details) to maximise the chance of success for the smart city initiative. This is particularly important for programmes of national importance where citizens' lives are impacted and reputational considerations are paramount.

4.4.4. *Project Teams*

Each smart city project has a responsible department (or leading department) owning the project with participation/support from other relevant departments. A project delivery team (i.e. PT) drawing resources from all relevant departments should be formed for each project. It is important that the PT possesses strong domain knowledge as well as good project management experience in cross-B/D projects.

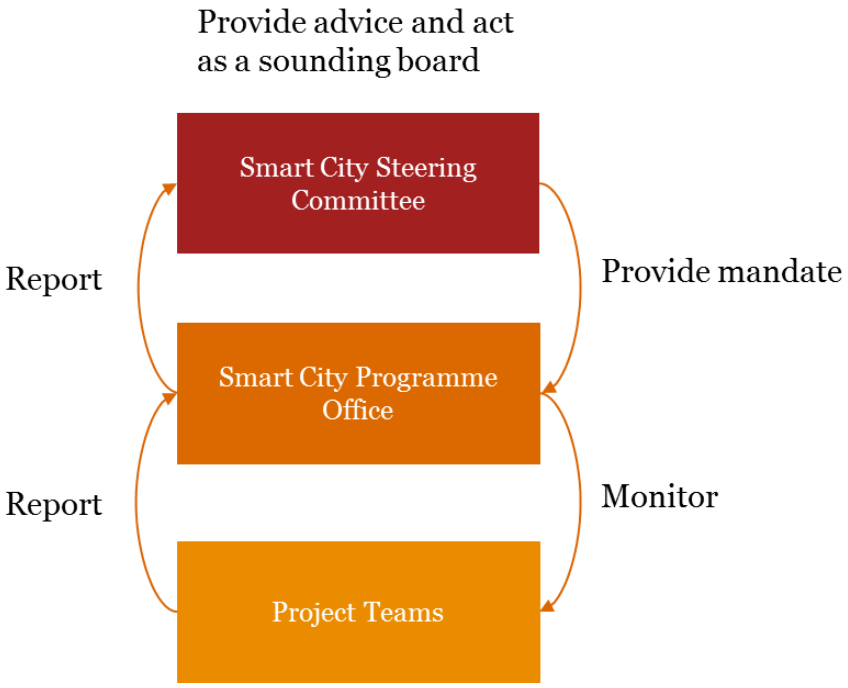
When requested by the leading department, Project Executives from the SCPO will provide necessary support for the implementation of smart city projects. In addition to being a project team member, departmental staff will serve as a conduit for the Programme Managers / Project Executives in navigating through departmental work streams and processes. External specialists can be used if resources or specialised skills not available in the Government are required. The PT will be responsible for:

- Day-to-day management of resources;
- Planning and execution of projects under individual programmes;
- Providing training and developing relevant capabilities of departmental staff as necessary;
- Quality control of outcome;
- Documentation and reporting of effectiveness and outcome; and
- Acting as the first contact point with external stakeholders affected by smart city projects.

4.4.5. *Monitoring and Reporting Arrangement*

A well-defined reporting line is crucial to the governance arrangement. Figure 4.3 illustrates the proposed reporting line.

Figure 4.3 Line of Reporting



The SCPO will seek the SCSC's advice for resolution of priorities and programme initiations and cancellations which would impact the overall smart city objectives. In addition, the SCPO will communicate to the SCSC when a consensus cannot be reached at the implementation level and seek governance decisions.

Any changes to programme/project timing and scope that may impact the overall smart city strategy and performance will be communicated to the PTs.

The PTs are expected to escalate project issues to the SCPO. These include any significant changes in plan or schedule, any material changes in the overall business case and any observations in relation to the effectiveness of individual projects.

5. Digital Framework

Purpose of a Digital Framework

The purpose of a digital framework for a smart city is to provide the foundational technical capability upon which smart city services will be built. Such a digital framework will ensure that there is a common platform to evaluate the required emerging technology for smart city development, and allows key stakeholders inside and outside the city to engage actively with the platform, and successfully build a smart city. As technology continues to advance and permeate into all facets of life, citizens expect the same quality and speed of service from their government as they do from private organisations; just as they can request a taxi on their mobile device, they increasingly want to be able to report city management issues through their mobile devices. Leading cities are continuously working on improving their service delivery mechanisms to ensure that citizen's needs are met in an efficient and timely manner. The following diagram depicts a generic digital framework for smart city development.

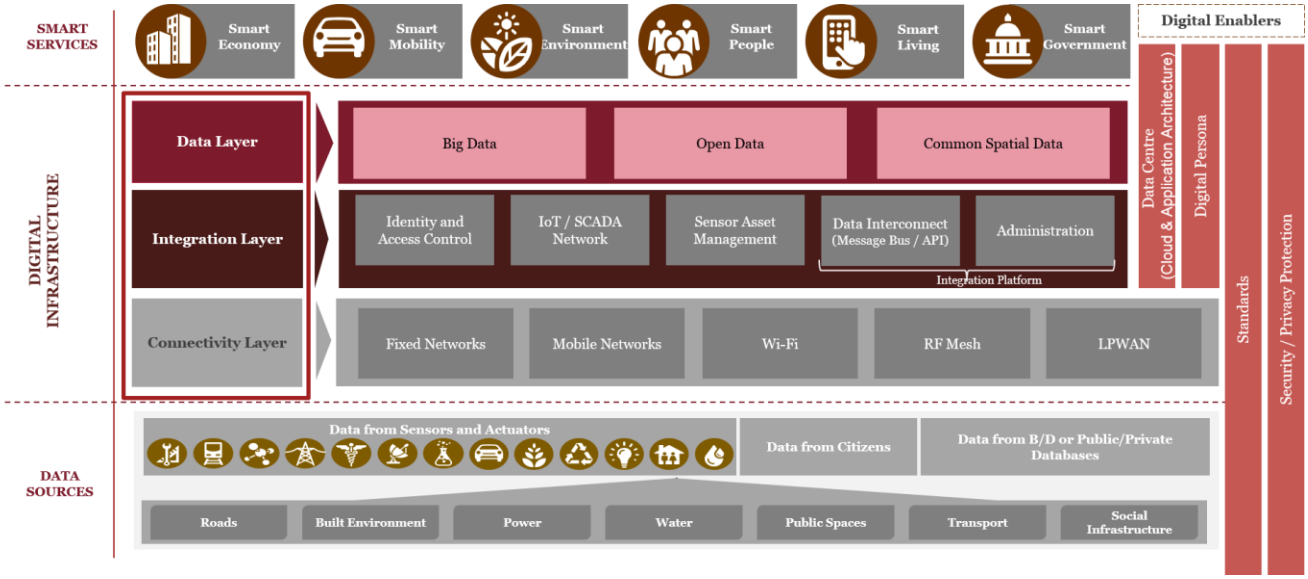


Figure 5.1 Generic Digital Framework for Smart City Development

The various components of the digital framework provide the foundational technical capabilities required to enable various smart city services. Notwithstanding the world-class ICT infrastructure possessed by Hong Kong, the Government should start the digital transformation to create the foundational capability to enable smart services. This ensures that past investments in technology are not lost, and that future capabilities are supported.

The delivery of holistic smart services will position Hong Kong as a global leader and next generation city metropolis. A robust digital framework will mark Hong Kong as a leader in the connected global marketplace, and allow the city to optimise its greatest assets.

The digital infrastructure layer will ensure quicker service deployment, enabled by the components in the integration layer. This will reduce silo investments and operational costs, and facilitate internal and external collaboration and innovation. Therefore, the digital infrastructure will encompass a variety of technology components that will work together to offer integrated service.

To provide this level of service, it is crucial to understand and build foundational service delivery capabilities that can adapt to anticipated and future technologies quickly. In order to achieve this vision, Hong Kong must embark on an evolutionary path that will incrementally increase the city's technology capabilities to support the concurrent smart city progressive developments. A robust, flexible, adaptable, scalable common city-wide foundational digital infrastructure will be conducive to the development of smart city services.

A digital framework will:

1. Provide a foundational reference model of technical capability to enable smart services;
2. Provide a sustainable and secure technology landscape on which smart services can be rapidly deployed with confidence;
3. Establish resilience to withstand physical and cyberattacks and quickly recover and reconstitute;
4. Significantly improve automation across various functions responsible for delivering city services by reducing manual mediation;
5. Ensure interoperability across heterogeneous data sources, information systems, networks, disparate vendor systems and applications;
6. Design, construct and implement disparate devices which are used for sensing, storing, and analysing data from multiple data sources;
7. Aggregate data among different parties to support existing and new smart city services; and
8. Present data in interoperable formats that can be easily utilised for analysis and decision-making.

The generic digital framework is divided into five distinct layers:

1. Data Layer: Digital components for the provision of data and insights necessary for various smart city services enablement

2. Integration Layer: Digital components to support the exchange and aggregation of data from and among various sources
3. Connectivity Layer: Telecommunications connectivity provided by telecommunications/network service providers for connecting different infrastructure components and data sources for the development of smart services
4. Data Sources: Sensor data collected by devices deployed across city infrastructure, as well as operational data provided by government, the public and private sector, and citizens
5. Digital Enablers: Digital technologies, mechanism, protocols, security, standards and enabling infrastructures to support secure and innovative smart city service development

Data Layer

Big Data

Description and Relevance

Building Big Data for Hong Kong will involve data science, technology, and government policies to ensure effective delivery of services to citizens, and provide better insights to the community. Big Data drives the city towards becoming a knowledge economy by being able to transform massive volumes of data into variable information for business development and policy making.

Hong Kong will need to combine data collected from legacy systems and smart city services to generate meaningful insights. Big Data for Hong Kong will encompass structured, semi-structured and unstructured data, created inside the city or from third party aggregators, and may contain historical, demographic, psychographic information, sentiment, transactional and situational data streamed 24/7 from devices, sensors and other data sources.

Current Capabilities within Hong Kong

The objective of leveraging big data analytics in the Government is to improve operational efficiency and public services delivery, and improving public services. The OGCIO has started to facilitate adoption of big data analytics since mid-2016. As the applications of Big Data are relatively new, most B/Ds may not be familiar with Big Data technology. With that, OGCIO is piloting big data analytics in some departments (e.g. Transport Department, Hong Kong Observatory) to develop useful cases for leveraging Big Data to produce meaningful value to citizens.

Facilitating the implementation of big data analytics applications involving data from multiple B/Ds will be a key consideration in smart city development. The OGCIO will implement a cloud-based pilot platform to facilitate the development of big data analytics models by OGCIO

and B/Ds. The need will be explored for such centralised platform to further provide big data analytics tools to facilitate big data applications for B/Ds.

To enable implementation of big data analytics applications by B/Ds, the Government needs to ensure that the following two key elements are in place:

- Infrastructure, which will include big data software and hardware platform; and
- Skilled data science expertise. Colleagues at OGCIO have started to develop in-house capability in big data analytics. However, with the large scales of data generated in a smart city, more comprehensive training internally and externally are necessary.

Common Spatial Data

Description and Relevance

Formulating an effective Common Spatial Data Infrastructure (CSDI) framework should cover policy and institutional framework, data governance model, data and technical standards, data technologies and applications, and a sustainable resource model based on overseas best practices with reference to the experience learned from the existing established data sharing and alignment mechanisms. This is particularly relevant to a high-rise city like Hong Kong.

Spatial data, defined in its broadest sense, includes maps, land status information, land-related attributes and other data that could be geo-referenced in 2D and 3D. It is a valuable asset that will transform Hong Kong into a knowledge-based, service-oriented smart city. Digital maps and framework spatial data are foundational for drawing connections between large amounts of social, economic, environment and real-time sensor data. Specifically, a 3D digital map enriched with timely updates for multi-purpose applications is essential for smart city development.

Augmenting the enormous volume of IoT data with spatial data would bring considerable benefits to the Government and potentially other spatial data users such as utility providers. It will allow the Government to leverage the integrated data set to make better and more informed decisions in areas such as land administration, city planning and management, housing supply, facility and utility management, and innovative applications.

To this end, a CSDI will help achieve this goal. It comprises the policy, institutional and technical framework for the application and sharing of spatial data among users in the Government, the business sector, the academia and the society. A CSDI will provide not only a common technical platform for the collation and dissemination of spatial data, but also the related technologies, policies, applications, standards and human resources, to construct, preserve, manipulate, distribute and utilise spatial data, which are typically located in individual data silos, among different data contributors and users.

In the context of the digital infrastructure, the CSDI is an essential component because there is a need to identify and associate the locations of various entities given that most of the digital

applications in/across B/Ds and other organisations/institutions are location based. Location will be a common key in providing cross B/Ds and other organisations/institutions applications, services and in analysing social phenomena, and therefore, sustainable, compatible, interoperable, shareable and reliable spatial data, including associated map locations on a common map base, are important for smart city development.

Current Capabilities within Hong Kong

Over the years, the Government has taken initiatives to improve its spatial data management. For example, the data alignment measure (DAM) was implemented in 2004 to align the five common spatial units among the 15 participating departments with a view to addressing data exchange problems at a technical level. The common spatial units include slope, building, land lot, road centreline, and tertiary planning unit/street blocks.

Many government B/Ds and private sector entities use spatial data to support their daily business. They have over the years implemented different mechanisms for managing spatial data. Some have developed their own geographic information systems (GIS). These GIS often store spatial data in different standards, definitions, formats with different updating cycles and/or with different levels of completeness and precision. There is currently no comprehensive policy, governance arrangement and common platform for effective sharing of spatial data for reference, analysis and application purposes. The existing situation has created much hurdle for B/Ds and the private sector in acquiring, discovering and using the spatial data required to support their businesses, resulting in duplication of efforts and costs in spatial data collection, processing, consolidation and dissemination. This issue is more prominent for planning, land administration and infrastructure development and city management.

The major components of a CSDI include the policy framework, governance structure, technical standards and necessary information infrastructure for manipulation, generation, compilation, storage, retrieval, dissemination, management and application of spatial data. It is expected that a CSDI will enhance the overall policy framework management and applications related to spatial data and enable cost-effective and efficient use of spatial data.

There are a number of challenges to be addressed before the full potential of spatial data can be realised:

- No explicit policy at present to require or facilitate spatial data and API sharing;
- Individual B/Ds collect spatial data and develop GIS or separate spatial applications according to their business needs without sharing. Data standards and management policies may not be standardised, which hinders wider exchange of spatial data among departments;
- No standard channel at present for spatial data exchange or spatial application interaction;

- Data collected falls into information silos. Data managed by individual B/Ds become trapped within silos making it difficult or impossible to access, moving data across data silos is expensive and requires lots of resources;
- Centralised storage of spatial data is limited. Only a handful of departments store digital geospatial data into the metadata catalogue system under the custody of Lands Department. Spatial data owned by other departments are not captured and documented for easy reference;
- Cross-departmental application of GIS platform is limited due to different operating systems, data formats and knowledge of data owned by different departments;
- Private sector has limited access to government spatial data for application development;
- Current GIS platforms available for public access are limited in functions. They mainly provide functions for users to visualise and to perform basic search of data or information. Other interactive functions like allowing users to overlay/import their own data for analysis are not common;
- Most spatial data currently available in different B/Ds are basically designed in 2D. The need of 3D or even 4D (including time stamped) digital spatial data is emerging. 3D Framework data (e.g. base map, land status information and planning control) should be needed especially for such a complicated multi-dimensional city with high rise infrastructures, mixed land use and underground space/utilities like Hong Kong;
- Data sharing culture (within and outside public sector) needs to be nourished;
- Different B/Ds have different paces in spatial data technology and applications. "Legacy" problem needs to be addressed; and
- Change in ICT and spatial data technology is rapid.

Open Data

Description and Relevance

Open Data is the timely, relevant and standardised release of Government and other public and private companies' data on an accessible platform prescribed by appropriate structures to ensure usability and utility of the data.

Globally, the degree of open data has increasingly become an indication of a city's performance in smart city and innovation and technology deployment.

This often calls for a common shared data management strategy and infrastructure that empowers B/Ds to share data between them and externally.

Current Capabilities within Hong Kong

OGCIO launched the revamped Public Sector Information (PSI) portal (*data.gov.hk*) in March 2015 for opening up PSIs for free-of-charge re-use by the community to facilitate public innovation and drive the digital economy. As of March 2017, the *data.gov.hk* portal houses nearly 7 000 datasets in 18 categories, provided by 48 B/Ds. The portal also makes available data collected and managed by other public and private organisations, such as Mass Transit Railway Corporation, China Light and Power, HK Electric, Centaline Property Agency, Hong Kong Society for Rehabilitation, etc.

As announced in the 2014-2015 Budget, the Government would make all information released for public consumption available in machine-readable format from 2015 onwards. Under this initiative, departments are requested to release datasets in digital formats for all information released on-line and free of charge for public consumption starting from 2015.

The OGCIO has defined the following PSI dissemination processes for data providers to follow (e.g. Government departments, public organisations):

- Dataset Identification – Data providers should review their existing websites and identify PSI that is suitable for dissemination through *data.gov.hk* as far as practicable.
- Dataset Preparation – Data providers should convert all datasets to machine-readable and preferably with open formats and equipped with Application Programming Interfaces (APIs) where applicable.
- Dataset Publishing – *data.gov.hk* serves as a one-stop portal for all PSI datasets and ensures that they are searchable and discoverable by the general public. Data providers should publish information of all their PSI datasets in *data.gov.hk*. To achieve this, data providers publish metadata files, and *data.gov.hk* will periodically harvest the latest version of these files from each data provider to update the dataset catalogue accordingly. Data providers should host their datasets in Internet facing servers and allow public access through the Internet.
- Data Ownership – All data and datasets remain the property of B/Ds or the public bodies providing the data through *data.gov.hk*. The respective B/Ds and public bodies that own the datasets are responsible for all aspects of quality, integrity, and security of the datasets.

The OGCIO continues to work with B/Ds and public/private organisations to release more PSIs useful to the community. It should be noted that some private companies are reluctant to release their datasets on commercial consideration.

Integration Layer

Integration Platform (Data Interconnect and Administration)

Description and Relevance

The integration layer will facilitate horizontal interconnections between various B/Ds' IoT platforms/Supervisory Control And Data Acquisition (SCADA) systems in order to send and receive data and information required for enabling the various smart services. This requires complex integration across IoT platforms, sensor networks and SCADA systems implemented across Hong Kong. This will also need to ascertain the needs, values, technical feasibilities and implementation approaches, etc. of building an integration platform to collect data and for the services - including Big Data, Open Data and Common Spatial Data - by drawing on leading practices and experiences.

The set of capabilities include:

- **Administration**: This is the ability to configure and update the connection settings of various IoT platforms and SCADA systems that will be connected to the platform including the ability to provide logs that contains information on activity.
- **Data Interconnect**: The Interconnect feature allows for the connection of data across various types of individual technologies deployed across the B/Ds and/or other stakeholders. This feature is a combination of tools that help manage the interconnection necessary across the various IoT platforms, SCADA and sensor networks, including:
    - Messaging Bus: The sensor message bus provides a communications protocol, in which the sender and receiver of the data and information do not need to interact simultaneously. Data and information placed onto the bus is cached for facilitating the recipients to retrieve it at different connection speeds. Message buses also provide Application Programming Interfaces (APIs) that enable connection to various data sources (e.g. IoT / SCADA platforms).
    - API layer: API layer provides a set of routines, protocols, and tools for building software applications, defining how software should interact. In the Integration layer, the architecture should have a robust API layer to integrate across various data sources (various IoT platforms, SCADA and sensor networks) and edge devices or services for data interchange.

With the rapid increase in network connected devices and sensors, rising demand for new services, and an increasing number of data sources, there is a need for a shared stable platform that manages devices and moves data to support vertical services. There is a need for standardised and speedy deployment of services and edge devices.

Current Capabilities within Hong Kong

At present, departmental data - such as sensor data, geographic spatial data - are owned, stored, managed and maintained by the respective departmental IT systems.

OGCIO has developed an Interoperability Framework (IF) which defines the set of specifications to facilitate Government systems to communicate and interoperate with other systems, both within and external to Government (i.e. Government to Government, and

Government to Public). The IF is a collection of guidance documents, standards, and specifications that help B/Ds define the interface between interacting applications. The IF promotes and fosters the adoption of eXtensible Markup Language (XML) to enable the exchange of data between applications.

Identity and Access Control

Description and Relevance

Current Identity and Access Control components will be extended to include various smart city applications and services. This component will grant access to different user groups including government users, citizens, businesses and third party service providers, to various systems and applications. The Identity and Access Control service will ensure that user groups have the right level of access according to their role, provide and revoke access rights as required, and allow single sign-on to different smart city applications.

Current Capabilities within Hong Kong

MyGovHK provides single sign-on service for citizens to access e-government services of multiple B/Ds with just one single login to the MyGovHK Portal. User login is based on username and password but users with Recognised Digital Certificate can use the certificate to login to provide higher user authentication assurance level to B/Ds.

Currently, citizens access e-services provided by the government or the public / private organisations using individual user IDs for individual services, except MyGovHK which citizens can access e-government services of multiple B/Ds after single sign-on to MyGovHK portal. Besides Recognised Digital Certificates, there is yet to be a single e-identity for accessing e-services.

IoT/SCADA Network

Description and Relevance

IoT platforms and SCADA networks are used to manage and control various B/D assets as well as collect data required for operations and service delivery by individual B/D. They are responsible for the sensors and devices applied across the city infrastructure for city functions. They ensure that B/Ds are able to sense and facilitate situation assessment, relay situational awareness, perform automated or informed actions based incidents and manage operations and services.

Current Capabilities within Hong Kong

Various B/Ds currently have IoT platforms and SCADA systems deployed for their own usage. The data managed by individual B/Ds through their own IoT platforms and SCADA systems is working in silos. The opportunities for sharing of the data amongst B/Ds are limited.

Sensor Asset Management

Description and Relevance

The purpose of the sensor asset management system is to ensure planning, maintain inventory and locations, manage service contracts, and enable asset maintenance throughout the lifecycle of all IoT/Edge devices that are part of the Hong Kong smart city programme.

As Hong Kong develops into a smart city, there will inevitably be a significant increase in the use of sensors, devices and other technology assets. These assets need to be effectively managed to ensure that ownership, ongoing maintenance, and refresh arrangements are properly recorded and maintained. The asset management system allows tracking and management of all city assets throughout their entire lifecycle.

Current Capabilities within Hong Kong

Various B/Ds currently use asset management systems to manage their individual assets.

Connectivity Layer

Description and Relevance

Telecommunications for enabling the various smart city services will require a combination of different network connectivity and edge processing technologies, including fixed networks, mobile networks, Wi-Fi, RF mesh, LPWAN, etc. to collect raw data from different data sources, such as sensors, citizens, B/Ds and public/private databases for further processing.

Current Capabilities within Hong Kong

Fixed Networks

- The local fixed carrier services market in Hong Kong is fully liberalised. There is no pre-set limit on the number of licenses issued, no specific requirement on network rollout or investment, and no foreign ownership restriction. The level of investment is determined by the market. The government's objectives are to provide a level playing field in the telecommunications markets. As of November 2016, 25[181]

[181] Fact sheet: Telecommunications. Retrieved from http://www.ofca.gov.hk/en/media_focus/fact_sheets/index.html (as at December 2016)

licensees were granted and permitted to local fixed carriers competitively to provide services for both residential and business segments.

- Hong Kong's fixed broadband penetration rate and average broadband speed are among the highest in the world. Hong Kong household broadband penetration rate is of 93.1%[182] and the average peak connection speed in Hong Kong is 116.2Mbp[183]. As of March 2017, there were 228 Internet Service Providers (ISPs) licensed to provide broadband services in Hong Kong[184]. As of September 2016, there were about 2.42 million registered customers using broadband services, and the current available speed is up to 10Gbps[185].
- Hong Kong has a robust telecommunications network[186]. As of April 2017, Hong Kong has eight submarine cable landing stations connecting to ten regional and trans-Pacific submarine cable systems Hong Kong is also connected to China via a number of overland cables. As of December 2016, the total equipped capacity of external telecommunications facilities was over 45 Tbps, Facebook and Google are building the fastest trans-pacific cable (bandwidth of 120 Tbps) connecting Hong Kong and Los Angeles which will come on-line in 2018. Together with other submarine cable systems being constructed, the total capacity will approach 200 Tbps by the end of 2018. Hong Kong has a very high level of reliability of worldwide interconnectivity.
- More than 98% of intra-HK Internet traffic stays within Hong Kong. Hong Kong's average Internet connection speed at 21.9 Mbps (4th Quarter, 2016) is among the fastest in the world.

Mobile Networks

- As of November 2016, there are four mobile network operators providing a wide range of public mobile services. In September 2016, the number of mobile service subscribers was 17.06 million, representing one of the highest penetration rates in the world at about 232.2 percent. Among these subscribers, 15.33 million were 3G/4G service customers. In addition to 3G services, all four mobile network operators have deployed 4G services utilising Long Term Evolution (LTE) technology. This has enabled mobile service subscribers to enjoy data downlink speeds of up to 450Mbps. With a wide range of high-speed mobile data services available in the market, subscribers are able to download and upload large files via the Internet and enjoy good quality of video streaming and web-browsing on mobile devices.[187]

[182] Fact sheet: Hong Kong — An ICT Hub. Retrieved from http://www.ogcio.gov.hk/en/facts (as at April 2017)
[183] Fact sheet: Telecommunications. Retrieved from http://www.ofca.gov.hk/en/media_focus/fact_sheets/index.html (as at December 2016)
[184] Fact sheet: Hong Kong – The Prime Location for Data Centres. Retrieved from http://www.datacentre.gov.hk/en/home.html (as at May 2017)
[185] Fact sheet: Telecommunications. Retrieved from http://www.ofca.gov.hk/en/media_focus/fact_sheets/index.html (as at December 2016)
[186] Fact sheet: Office of the Government Chief Information Office. Retrieved from http://www.ogcio.gov.hk/en/facts/ (as at April 2017)
[187] Fact sheet: Telecommunications. Retrieved from http://www.ofca.gov.hk/en/media_focus/fact_sheets/index.html (as at December 2016)

- With the launch of the CDMA2000 service in November 2008, visitors can enjoy roaming services through the CDMA2000 network, in addition to the GSM900/1800, W-CDMA and LTE networks.[188]
- Upcoming 5G will be the core element for smart city development due to its unique advantages which are characterised by high speed mobile transmission, high speed mobility, extreme low-latency real time communications and massive Internet of Things (IoT) connections. Therefore, 5G will be the key enabler of smart city to provide next generation services such as pervasive video-centric applications, latency-sensitive autonomous driving, collaborative robots and massive sensor networks.
- 5G is a system of systems. 5G is not merely an evolution of 4G with the pure objective to increase the mobile transmission speed, but rather a step change in technologies and standards to enable new innovative services in different aspects: As said, 5G is not only about eMBB (enhance Mobile Broadband) for the continuous evolution of 4G to support high mobile data rate transmission. 5G is about mMTC (massive Machine-Type Communications) to support wider and deeper penetration for massive IoT connections, and URLLC (Ultra-Reliable and Low Latency Communications) to support near real-time and ultra-reliable connections in the use of autonomous driving. Different frequency bands will serve different purposes. High frequency bands can provide ultra-fast data speed but the effective range of coverage is limited. Low frequency bands can reach far remote areas but low data rate. On the one hand, mmWave (Millimetre Wave) bands above 24GHz are potential candidate frequencies to support ultra-high speed mobile application. On the other hand, low frequency of sub-1GHz is suitable for wide coverage.
- To support the implementation of 5G in Hong Kong, an additional new spectrum for 5G service is one of the key elements to address. The Government needs to continue to make available the frequency bands for 5G services as identified by the International Telecommunication Union (ITU) as early as possible to facilitate the local industry to launch 5G services and products. The Government will continue to adopt a market-based approach in the management and assignment of frequency spectrum with competing demand and technology-neutral approach to allow operators to select the technology choices and standards.
- Another key factor to consider with regard to 5G deployment is the huge number of small cells required. In order to increase the data capacity for the users, very low power small cell mobile radio stations with small covered areas will be the major deployment approach under the 5G network which would be enabled by more street furniture. With the small cell mobile radio station approach, it is anticipated by the industry that there will be an increase of about 10-20 times more cell stations. The latest Government initiative to expand the provision of Wi-Fi hotspots in the city

[188] Fact sheet: Telecommunications. Retrieved from http://www.ofca.gov.hk/en/media_focus/fact_sheets/index.html (as at December 2016)

has helped facilitate the transition required for an effective 5G network using small cells.

Wi-Fi

- Hong Kong has launched the Wi-Fi connected city programme with extensive coverage providing Wi-Fi access points at Mass Transit Railway (MTR) stations, Airport Express stations and trains, offices, major tourist attractions, shopping malls, coffee shops, restaurants, hospitals, public libraries, parks, etc. The penetration of public Wi-Fi is among the highest in the world with more than 43 500 wireless hotspots installed by the Government and the private sector as of September 2016[189]. The widespread deployment of free Wi-Fi service in Hong Kong provides a unique convenience to tourists visiting Hong Kong.
- The Government has been providing free wireless Internet access services to all citizen and visitors by installing Wi-Fi facilities at designated Government premises with high public patronage. Besides providing convenience to citizens and visitors, the service also stimulates development of other Wi-Fi initiatives by the private sector to drive more development of Wi-Fi hotspots in Hong Kong.
- In 2014, the Government collaborated with the industry to launch the common brand "*Wi-Fi.HK*" to promote Wi-Fi service offered by the public and private sectors completely free, or free for a certain period of time in Hong Kong. As of April 2017, there were about 19 000 hotspots under the "*Wi-Fi.HK*" brand.
- Under the "Wi-Fi Connected City" programme which commenced in May 2016 with an aim to progressively expand the *Wi-Fi.HK* coverage to 34 000 hotspots in 2019, the Government has adopted a multi-pronged approach - continuing the effort to encourage more public and private sector organisations to join the *Wi-Fi.HK* brand, opening up government venues to the private sector for provision of free Wi-Fi service under the public-private collaboration arrangement, and promotion of digital inclusion by subsidising NGOs to provide Wi-Fi service in study rooms and youth service centres. The Government will also continue to provide Wi-Fi services for those government departments' venues which have lower commercial value to the private service providers. Amidst the launch of 5G service in 2020, the Government should review the provision of free public services and its major target groups in future, e.g. to bridge the digital divide for underprivileged group and to address tourist needs.

RF Mesh

- RF Mesh is commonly used by the government, service providers and public utilities to provide connectivity of their network via microwave transmission/radio communications technology in remote areas where fixed line broadband connections are normally inaccessible.

[189] Office of the Government Chief Information Office, Hong Kong Special Administrative Region. (2017). Fact Sheet. Retrieved from http://www.ogcio.gov.hk

Low Power WAN (LPWAN)

- With the raising demand of connecting devices for smart city development, LPWAN is racing against LTE-based technologies to capture an emerging wide-area IoT connectivity market. LPWAN technologies promise to open new market opportunities by providing power-optimised, on-demand spot-connectivity for IoT devices.
- LPWAN technologies are the most suitable for digital on/off applications with a few messages per hour. The linchpin of 3rd Generation Partnership Project (3GPP) strategy is the development of LTE Category M1 (LTE Cat-m1) and Narrowband-IoT (NB-IoT) technologies, both defined in 3GPP Release 13 with anticipated commercial availability in early and late 2018 respectively.
- LPWAN technologies are more advantageous in comparison with 3GPP technologies. For example, LPWAN is 2-3 years ahead in development in comparison to 3GPP, operates on unlicensed spectrum, and has a cheaper device cost.
- Internationally, there is growing interest in wireless IoT solutions for smart city applications. For example, SK Telecom has been trialling wireless connectivity using LoRa (Low Power Radio Access) technologies.
- In Hong Kong, promoting LPWAN solutions is important to drive the adoption of IoT in the context of smart city applications and services development. Given that LPWAN operates on unlicensed spectrum, interference may arise when the mass network is rolled out. Therefore, the industry should conduct a technical study on the coverage and performance of various LPWAN technologies in unlicensed spectrum to identify any issues and resolution approaches. The Government should also address the compatibilities of different LPWAN technologies and should consider to issue guidelines or specifications to ensure the LPWAN devices can co-exist or will interfere with each other.

Data Sources

Description and Relevance

Data sources include data from various edge devices, comprising of sensors and actuators, data provided by citizens, as well as transactional data required for providing various smart services. The type of data gathered include:

- Data from Sensors: Data generated by a variety of sensors, for example on traffic, weather, and water levels.
- Data from Citizens: Data from citizens may include wearables, complaints, service requests, and situations through multiple channels including mobile apps, citizen portals, digital kiosks, live chats, call centers, social media and in-person.

- Data from B/Ds or Public/Private Databases: Transactional data from various B/Ds or may include public/private organisations that offer smart services.

In this layer, data is collected from different data sources for the purposes of smart city development and will eventually become big data, open data and/or common spatial data.

Digital Enablers

Data Centre (Cloud & Application Architecture)

Description and Relevance

Data Centres, which support computing and storage capabilities, give the flexibility to use on and off-premise hosted environments for computing needs.

As technology advances, the effective and efficient use of data centres, and cloud computing technology will positively enable smart city initiatives. With the rapid changes in technology landscape and security risks, there is a need to keep up and adapt to technology changes.

Current Capabilities within Hong Kong

Hong Kong is a prime location for data centres in Asia Pacific. Secure and high-end data centres, as well as cloud computing operations in Hong Kong, will enable Hong Kong to be the regional hub for multi-national enterprises in Asia, and continue to support the digital needs of the regional offices and headquarters in the finance, logistics, trading and professional services industries located in the city. Furthermore, the proliferation of cloud computing, the rise of smartphones and tablets, and the growing popularity of digital media will continue to accelerate the demands for network bandwidth and computing power. This in turn drives the demand for data centre space. The ability to provide robust and ample data centre facilities becomes an important component in Hong Kong smart city development.

For global enterprises, Hong Kong is an ideal location for developing data centres, with its:

- Robust telecommunication infrastructure (for example, household broadband penetration rate of over 230% is among the highest in the world).
- Reliable power supply with comparatively tariff (for example, reliability exceeding 99.999%).
- Pro-business environment (for example, free trade, free market, predictable tax regime, low tax rate).
- Proximity to China market.
- Effective protection of data privacy and security (for example, Personal Data (Privacy) Ordinance has been in force since 1996).
- Knowledgeable professionals and support in the world.

Against this background, the Hong Kong Government has implemented several initiatives to accelerate the development of data centre facilities. The Government has introduced facilitation measures to encourage the conversion of eligible industrial buildings into data centres. These measures include:

- Exemption of waiver fee for changing eligible industrial buildings into data centre use.
- Assessment of the premium for lease modification of industrial lots for development of high-tier data centres on the basis of actual development intensity and high-tier data centre use.

In addition, the Government has set aside about three hectares of land in Tseung Kwan O for high-tier data centre development. In addition, about 19 hectares of land in the industrial estates have been granted for data centre development. At present, the Tseung Kwan O Industrial Estate houses a cluster of 11 high-tier data centres, which is the largest data centre cluster in Asia Pacific[190].

The Government has been adopting cloud computing technology to support e-government services. The Government Cloud environment includes:

- An "In-house Private Cloud" owned and operated by the Government for providing computing resources for e-Government services with classified data.
- An "Outsourced Private Cloud" operated by a third party provider to provide dedicated computing resources to the Government for e-Government services with classified data.
- A list of Government Public Cloud Service (GPCS) Providers, through which B/Ds can acquire public cloud services from over 40 GPCS providers with over 300 cloud service options is maintained by the Government. The GPCS providers offer cloud services under four categories: Productivity Applications, Business Applications, Cloud IT Services and Social Media Applications.

The Government has also been adopting a traditional application architecture for building applications in a single, autonomous (monolithic) manner. These monolithic applications are increasingly difficult to maintain, modify and enhance as they become more complex. This type of applications makes new services difficult to launch.

Digital Persona

Description and Relevance

Digital Persona Infrastructure enables secure and convenient authentication and authorisation to access and use public and private services by individuals. A holistic secure infrastructure design can assure trustworthy smart services.

[190] Fact sheet: Office of the Government Chief Information Office. Retrieved from http://www.ogcio.gov.hk/en/facts/ (as at April 2017)

Current Capabilities within Hong Kong

Citizen's digital identity by means of using legal-right digital certificate can be traced back to 2000, when the Electronic Transactions Ordinance (Cap. 553) (ETO) was enacted. The ETO legal framework gives electronic records and signatures the same legal status as their paper counterparts. The Hong Kong Postmaster General was designated as a recognised Certification Authority (CA) to offer e-Cert (a product name) services to the public. At present, apart from Hong Kong Postmaster General, Digi-Sign Certification Services Limited is the other recognised CA in the private sector and its product name is ID-Cert. There are nine types of e-Cert and 10 types of ID-Cert available for subscription by individuals and organisations. E-Certs can be carried in a number of storage means, e.g. Hong Kong Smart ID card, contact smart card, USB file card and USB secure token. All these require reading by smart card readers or USB-enable reading devices.

Technically speaking, digital certificate is a mature and advanced technology providing individuals and businesses with an electronic identity. Currently, Hong Kong adopts PKI (Public Key Infrastructure) technical framework for digital certificate to safeguard confidentiality and integrity of data, authenticity of identity and non-repudiation of transaction. This infrastructure is proven to be secure and mature for the authentication of users' identities for many on-line and mobile services such as on-line banking, electronic payment, and remote access to organisation's systems.

Though digital certificates can be a viable option to provide highly secured authentication, the current mode of issuance, deployment and usage of digital certificates in Hong Kong has not changed over the years. Adoption rate has remained low, mostly attributed to "ease of use" issues. Therefore, a separate consultancy study has been commissioned by the OGCIO in 2016/2017 (undergoing) to review the current arrangement against the background of technology advancement, in particular the trends towards mobile and wireless access technology. The objective of the study is to review the development and usage of digital certificate in Hong Kong, with particular focus on:

- Identifying opportunities to boost demand of digital certificates (usage in financial services, healthcare services, cross-boundary transactions with the Mainland, e-payment services, smart city services, government services, etc.).
- Recommending possible models with financial implications to position digital certificate as part of the wider e-identity infrastructure in Hong Kong.
- Reviewing the institutional arrangement and the respective roles of public CA.
- Proposing implementation options and carrying devices to enhance user experience (including less technically savvy users such as elderly people) so as to widen the adoption of digital certificates.

With rising threats in cybersecurity, innovative authentication technologies (e.g. biometrics) should be adopted to safeguard the trustworthiness of e-services to protect both the customers and the service providers.

Security / Privacy Protection

Description and Relevance

Security and privacy protection is a suite of services that is integral and embedded into the technology landscape in Hong Kong to ensure the trust of citizens in their digital interaction with the City, and includes security, privacy, transparency, reliability and remediation.

Cybersecurity is a necessary pillar of Smart Cities. Every new technology and innovation brings new challenges and risks. Today, developed cities around the world face similar cybersecurity threats when their business and services would be conducted on the one and only connected network, the Internet. These potential risks and cyber threats could have a direct impact on governments, businesses and citizens. Hong Kong, as a global financial centre and regional hub for many industries involving large amounts of personal and transactional data, is at especially high risk of cyberattacks.

The IoT and Industrial IoT (IIoT) is a technological opportunity for the interconnectedness of computing devices, heterogeneous networks, and people. These devices could expose users to new threat vectors from digital control to physical threats. To address the core opportunities and security issues, the existing IT security practices are important but insufficient. It is essential for the original equipment manufacturers (OEMs) to design and develop secure and interoperable IoT and IIoT devices to ensuring device security with proper authentication and authorisation processes to join the networks as well as to securing data within the devices with reference to industrial best practices and international standards.

Cybersecurity is extremely important and cybersecurity strategies for the various Smart initiatives should be secure, vigilant and resilient. The interconnected nature of Industry 4.0 drives the integration of operational technology (OT) and information technology (IT). That also brings unprecedented risks and challenges in cyber-physical world. All smart city initiatives need to adopt adequate information security and personal data privacy protection measures in their design, implementation and operation.

Current Capabilities within Hong Kong

On a regular basis, the Government reviews the relevant data security and privacy requirements in order to increase the confidentiality requirements for storage of sensitive information, strengthen departmental management capability for information security incident response, and enhance the capabilities of information security and detection of emerging cyberattacks. Independent information security compliance monitoring and audits for all B/Ds are carried out regularly. The Government has also established stringent requirements on data protection with the use of encryption when storing and transmitting sensitive data.

The Government has been closely monitoring the trend of cyber-attacks and related security threats. Against this, the Government has implemented multiple layers of security measures internally. The Government has formed the Computer Emergency Response Team Hong Kong (GovCERT.HK) which is responsible for coordinating incident response for the Government by disseminating security alerts and reminders to the B/Ds. The GovCERT.HK works closely with the Hong Kong Computer Emergency Response Team Coordination Centre (HKCERT) to share threat information and to organise public awareness activities. GovCERT.HK organises regular seminars and trainings for staff to strengthen their knowledge on cyber-attacks. To support the public in tackling malware, the Government organises cybersecurity seminars regularly and disseminates information on ransomware attacks to SMEs and the general public through the Cyber Security Information Portal (*www.cybersecurity.hk*), newspapers and electronic media.

Apart from the Government, in 2016, the Hong Kong Monetary Authority (HKMA) launched its Cybersecurity Fortification Initiative (CFI) by establishing a Cyber Resilience Assessment Framework for banks to assess their risk profiles against a common scale to evaluate their cyber defence needs and a Professional Development Programme to train cybersecurity professionals, thus deepening Hong Kong's talent pool, and providing a Cyber Intelligence Sharing Platform to facilitate the sharing of cyber threat intelligence among banks to enhance collaboration and raise the overall level of cyber resilience in the region.

Standards

Many standardisation development organisations (SDOs) have initiated standardisation work for Smart Cities. They can be grouped into global, regional and country-specific SDOs. The commonly known SDOs are: the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), the International Telecommunication Union – Telecommunication Standardization Sector (ITU-T), the European Telecommunications Standards Institute (ETSI), the British Standards Institution (BSI), the Institute of Electrical and Electronics Engineers (IEEE), and the American National Standards Institute (ANSI). Various SDOs have published their standards which are at different stages of development and for different scopes of work. In China, the national standards are called "GuoBiao (GB)" which are issued by the Standardisation Administration of China (SAC).

Leading global SDOs are collaborating, and working towards strengthening and advancing the voluntary consensus-based international standards for Smart Cities. The following is a list of relevant technology standards for reference.

Digital Framework Standards
Data Source Layer

Sensors

The ISO/IEC 29182 series focuses on a generic architecture for sensor networks. It can be used by sensor network designers, software developers, system integrators, and service providers to meet customer requirements, including any applicable interoperability requirements. The seven parts of the 29182 series are described below:

- ISO/IEC 29182 Information Technology – Sensor networks: Sensor Network Reference Architecture (SNRA)
- ISO/IEC 29182-1:2013 SNRA – Part 1: General overview and requirements
- ISO/IEC 29182-2:2013 SNRA – Part 2: Vocabulary and terminology
- ISO/IEC 29182-3:2014 SNRA – Part 3: Reference architecture views
- ISO/IEC 29182-4:2013 SNRA – Part 4: Entity models
- ISO/IEC 29182-5:2013 SNRA – Part 5: Interface definitions
- ISO/IEC 29182-6:2014 SNRA – Part 6: Applications
- ISO/IEC 29182-7:2015 SNRA – Part 7: Interoperability guidelines

ISO/IEC 30101:2014 Information technology – Sensor networks; Sensor network and its interfaces for smart grid system: This standard describes the requirements needed to support interfaces between sensor networks and smart grid technologies

IEEE 2700-2014: IEEE standard for Sensor Performance Parameter Definitions: The purpose of this standard is to define parameters for sensor performance

ETSI TS 102 690: Machine-to-Machine communications (M2M); Functional Architecture. The specification describes the end-to-end M2M functional architecture, including the description of the functional entities and associated reference points.

Connectivity Layer

Mobile Networks

IMT-Advanced is the fourth generation (4G) system for mobile communications. Long Term Evolution (LTE), the standards developed by 3GPP, is a successor of UMTS networks and cdma2000 network. LTE defines the specifications of high speed wireless communications for mobile phone, and data terminals based on the GSM/EDGE and UMTS/HSPA technologies. There are two mobile data transmission technologies of the LTE: LTE-TDD is a 4G telecommunications technology advocated by China and the other being LTE-FDD. LTE Advanced Pro (LTE-A Pro), also known as 4.5G is a marker of the 3GPP release 13, completed in 2016.

The 3rd Generation Partnership Project (3GPP) is a collective of global telecommunications standard organisations. This collaboration has worked to create and organise the standards for a number of mobile communications systems including 2G, 3G, HSPA and LTE.

5G standards are still under development at the time of writing. 3GPP Rel-14 and Rel-15 represent the first phase of work in 3GPP towards 5G standards.

Wide Area IoT

There are a number of competing standards and vendors in the Low Power Wide Area Network (LPWAN) space, the most common of which include: LoRa, SigFox, LTE-MTC, NB-IoT, Weightless-N, 6LoWPAN, RPMA.

The Wi-Fi Alliance, Bluetooth Special Interest Group, and the Zigbee Alliance are three organisations responsible for ensuring interoperability of devices with wireless connectivity

Additionally, **IEEE 802** is a family of standards dealing with local area networks and metropolitan area networks. With relevant standards including:

IEEE 802:11: Wireless LANs: Communication standard serves as a basis for WLANs or Wi-Fi

IEEE 802:15:3: IEEE Standard for High Data Rate Wireless Multi-Media Networks: Communication standard serves as a basis for ultra-wideband (UWB) technologies

IEEE 802:15:4: IEEE Standard for Low-Rate Wireless Networks: Standard for low-data rate WPANs and was a basis for Zigbee and can be used with 6LoWPAN

GB/T 15629.15 – 2010 Information Technology - Telecommunication and information exchange between systems local and metropolitan area networks. Specific requirements Part 15 – Wireless Medium Access Control (MAC) and Physical Layer (PHY) specification for low rate wireless personal area networks

GB 15629.1101-2006 - Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: High-Speed Physical Layer in the 5.8 GHz Band

GB 15629.1103-2006 - Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Specification for operation in additional regulatory domains

Network Communications

ISO/IEC 17568:2013 Information technology -- Telecommunications and information exchange between systems – Close proximity electric induction wireless communications

ISO/IEC 18450:2013 Information technology -- Telecommunications and information exchange between systems – Web Service Description Language (QSDL) for CSTA Phase III

ISO/IEC/IEEE 18880:2015 Information technology – Ubiquitous green community control network protocol

ISO/IEC/IEEE 18881:2016 Information technology – Ubiquitous green community control network – Control and management

ISO/IEC/IEEE 18883:2016 Information technology – Ubiquitous green community control network - Security

ISO/IEC 29180:2012 Information technology – Telecommunications and information exchange between systems – Security framework for ubiquitous sensor networks

ISO/IEC TR 29181-1:2012 Information technology – Future Network – Problem statement and requirements – Part 1: Overall aspects

ISO/IEC TR 29181-4:2013 Information technology – Future Network – Problem statement and requirements – Part 4: Mobility

GB/T 16651-1996 - Message handling systems--Electronic data interchange messaging system

GB/T 18903-2002 - Information technology--Quality of service: Framework

UNE 178101-4:2015 - Smart Cities Infrastructures Public Service Networks, Part 4: Telecommunications Networks

Integration Layer

Integration Platform

ITU-T Recommendations

- **ITU-T Y.2060:2012** – Overview of the Internet of things
- **ITU-T Y.2069:2012** – Terms and definitions for the Internet of things
- **ITU-T Y.2061:2012** – Requirements for the support of machine-oriented communication applications in the next generation network environment
- **ITU-T Y.2080:2012** – Functional architecture for distributed service networking
- **ITU-T Y.2027:2012** – Functional architecture of multi-connection
- **ITU-T Y.2063:2012** – Framework of the web of things

IEEE P2413: Standard for an Architectural Framework for the IoT. This standard defines an architectural framework for the IoT, including descriptions of various IoT domains, definitions of IoT domain abstractions, and identification of commonalities between different IoT domains.

Data Layer

Big Data

ITU-T Y.3600 – [*Reference Guide*] Big data- Cloud computing based requirements and capabilities

Open Data

UNE 178301:2015 - Smart Cities. Open Data

Creative Commons licenses – Licenses that enable companies and institutions to share content that can be copied, distributed, edited, and updated within the copyright law

Open Government License - A set of terms and conditions to facilitate the use and reuse of public sector information free of charge mandated by the UK Government

5 Star Open Data – Provides a deployment guide and framework for an organisation opening of data from 1 star rating to a 5 star rating, while highlighting the differences of each step on the way

Common Spatial Data Infrastructure

NGA - World Geodetic System 1984 (WGS84) – A reference coordinate system of the Global Position System and standard US Department of Defense definition of a global reference system

SMO - Hong Kong 1980 Grid and Hong Kong Principal Datum (HKPD)–Local geodetic reference coordinate system commonly adopted for horizontal positions and vertical levels suitable for use in Hong Kong onshore and offshore for geodetic survey, topographic and engineering survey, and cadastral survey

OGC® Standards - interface standards that support interoperable solutions that "geo-enable" the Web, wireless and location-based services and mainstream IT

Digital Enablers

Digital Persona

ISO/IEC 24760-1:2011 Information technology and security techniques - A framework for identity management – Part 1: Terminology and concepts

ISO/IEC 24760-2:2015 Information technology and security techniques – A framework for identity management - Part 2: Reference architecture and requirements

Cloud Computing

ISO/IEC 17788:2014 – Information technology – Cloud computing – Overview and vocabulary, defines Cloud computing as "Paradigm for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on-demand"

ISO/IEC 17789:2014 – Information technology – Cloud computing – Reference architecture

ISO/IEC 19086:2016 – Information technology – Cloud Computing – Service Level Agreement (SLA) framework

Security/Privacy

ISO/IEC 27002:2013 - Security techniques – Code of practice for information security controls

ISO/IEC 29100:2011 - Security techniques – Privacy framework

ISO/IEC 15408 - Security techniques – Evaluation criteria for IT security

ISO/IEC TR 15446:2009 - Security techniques – Guide for the production of Protection Profiles and Security Targets

ISO/IEC 15944-8:2012 – Information technology – Business operational view – Part 8: Identification of privacy protection requirements as external constraints on business transactions

GB/T 17901.1-1999 - Information technology – Security techniques – Key management – Part 1:Framework

GB/T 17710-2008 - Information technology – Security technique - Check character systems

GB/T 19715.1-2005 - Information technology – Guidelines for the management of IT Security – Part 1:Concepts and models of IT Security

GB/T 19715.2-2005 - Information technology – Guidelines for the management of IT Security – Part 2:Managing and planning IT Security

GB/T 22080-2008 - Information technology - Security techniques - Information security management systems - Requirements

GB/T 22081-2008 - Information technology - Security techniques - Code of practice for information security management

Technical standards are changing from time to time. In the event of application involving more than one devices or even technologies, it is imperative for the Government and regulatory agencies to ensure optimal benefits from appropriate choice of standards.

5.1. Potential Digital Infrastructure Development

The digital infrastructure of smart city supports the technology infrastructure requirements, and enables the development and deployment of relevant initiatives under the Development Plans of the six smart city themes for Hong Kong:

- Smart Mobility is enabled by integrated multimodal transportation which combines the city's current multiple modes of public and private transport to create a seamless and customer-centric travel experience. The digital infrastructure will help facilitate data sharing for transportation services and provide traffic information for dissemination via a central platform. Additionally, this information can be analysed to provide insights about traffic conditions to enable efficient and integrated multimodal transportation, alleviate traffic congestion problems, and in turn reduce the overall environmental impact due to traffic issues. It is envisaged that the emerging IoT advancement and the upcoming 5G technologies will become the key enabler to support the development and deployment of connected/autonomous vehicles.

- Smart Living enhances the overall living experience of the people of Hong Kong by improving individual's ability to interact with electronic services, and on improving general wellbeing and health with the aim to create a safer, more secure, accessible, and happier society. The digital infrastructure will help facilitate the use of technologies and infrastructure to support the development of projects such as digital persona, which will in turn facilitate the delivery of public and private services to citizens, for example, the provision of health monitoring, telehealth and smart hospital in the healthcare sector.

- Smart Environment aims to promote a more sustainable environment for the citizens and optimise the use of city resources by using technology, sensors, awareness campaigns, conservation programmes and goal setting which will help drive systemic and cultural changes in city-wide pollution and waste management, as well as regulatory changes that will encourage the incorporation of more sustainable design, standards, and management of buildings. The digital infrastructure will help provide monitoring and measurement of environment data, made possible by the use and deployment of city-wide IoT devices. This live stream data can be used for data analytics which in turn will help to produce insights on effective pollution management, waste management and further the city's green

initiatives. While enjoying the benefits from the use of IoT for smart services, the wider adoption of IoT devices also suggests that adequate security measures on IoT deployment increasingly becomes a critical factor. IoT devices are often small in size and require low power consumption – these physical and electrical characteristics tend to imply that only relatively simple encryption measures could be built in an IoT device. To address this issue, IoT security guidelines and practices should be implemented to enforce the key tenets of information security such as confidentiality, integrity, availability, non-repudiation and authentication.

- Smart People aims to enable people to interact with service providers and participate in civil society with ease and confidence. The digital infrastructure will help facilitate data collection from different sources, enable analytics to provide better insights about citizen's preferences, and allow the Government to develop and provide citizen-centric services.

- Smart Government aims to promote a data-driven approach to further promote development of e-Government and related public services. The digital infrastructure will help support new city planning and operation tools by collecting relevant city-data. The digital infrastructure will be able to support the manipulation, generation, compilation, storage, retrieval, dissemination, management and application of spatial data by leveraging a Common Spatial Data Infrastructure (CSDI). In addition, the digital framework will help promote the development of e-Government and related public services by leveraging the robust, secure and innovative infrastructure.

- Smart Economy intends to transform and strengthen Hong Kong's economy by improving the overall business climate, increasing the city's attractiveness for start-ups and investors, and growing the economy in a sustainable manner. The digital infrastructure will help optimise the use of the data collected and enable data analytics for supporting the initiatives for economy development, such as tourism services for promoting unique tourist experience. In response to demands of content-rich, social-oriented and responsive applications, there will be growing demands for secured, reliable, cost efficient, scalable, and high performance computing and storage data centre facilities for commercial activities. The adoption of internationally recognised technical standards will facilitate product / system compatibility and market competition. Furthermore, a robust and advanced digital infrastructure in place will attract innovators and entrepreneurs to invest in Hong Kong.

The infrastructure will ensure efficient and quick service deployment by providing a common platform for all B/Ds, thereby reducing silo investments and operational costs, and facilitating internal and external collaboration and innovation. With reference to the generic digital

framework, the development of Hong Kong's smart city digital framework will comprise four distinct categories including Data Sources and Data Layer, Integration Layer, Connectivity Layer and Digital Enablers:

5.1.1.Data Sources and Data Layer

The Data Sources and Data Layer comprises Big Data, Common Spatial Data, and Open Data.

5.1.1.1. Big Data

Hong Kong should continue to expand its Big Data capabilities to help better decision making across B/Ds to provide improved services to its citizens. The proposed activities are listed below:

- Continue to monitor, review and revise, if necessary, guidelines on Big Data security and privacy leveraging global best practices;
- Increase in-house Big Data technical resources and capabilities through training, collaboration with external academia and institutes;
- Increase the level of data scientist supply in Hong Kong through academic education programmes, in-service training provided by industries, and policies to attract global expertise working in Hong Kong;
- Develop pilots and use cases that can quickly demonstrate the potential value of Big Data to B/Ds which can quickly benefit from analysing large volume of operational data
- Implement Big Data development platform for big data analytics development, testing, maintenance of data analytics models for B/Ds; and
- Define Big Data service catalogue and capabilities offering to B/Ds.

5.1.1.2.Common Spatial Data

Hong Kong is embarking on developing a CSDI and recommendations are proposed for the development of a common shared spatial data infrastructure across B/Ds. The proposed activities are listed below:

- Perform current baseline of spatial data standards, definition, format, and costs associated with collection and processing;
- Implement an effective SDI institutional structure to be the leading authority;
- Evaluate and finalise the type of model for possible technical architectures;
- Design a unified user-friendly platform to enable effective contribution, conversion and retrieval of spatial data among B/Ds;
- Establish common data standards, and consistent data quality level among the B/Ds;

- Develop APIs and interfaces for various B/Ds to access the spatial data on the common platform;
- Establish clear roles and responsibilities, security/restrictions of map areas and sharing of dataset policies from various B/Ds to reduce duplication efforts and cost;
- Define ongoing operating model and SLA's that B/Ds should adhere to;
- Develop a development strategy plan;
- Set up governance structure for institutional arrangement;
- Promote awareness of CSDI within the Government and externally;
- Propose and carry out suitable quick wins or pilots which can serve as catalytic building blocks of the CSDI so as to speed up the development (e.g. transforming 2D base map to 3D, construction of 3D pedestrian and road network, open up more spatial data/services whenever available; negotiate a better deal with spatial technology vendors on the whole-government, rather than individual B/Ds, basis); and
- In the longer term, extend platform to support different sources from public and private sectors and establish a clearinghouse process for geospatial data to create continuously uniform, consistent, and accurate information.

5.1.1.3. Open Data

Hong Kong is recommended to transform its Open Data capabilities to help foster innovation, and better decision making across B/Ds to provide improved services to its citizens. The proposed activities are listed below:

- Create policy to require B/Ds to open up more PSIs as appropriate with reference to principles and guidelines in Section 5.2;
- Monitor statistics of open data demand and usage, and understand demand from the community with a view to opening up more useful PSIs;
- Continue to develop more APIs for data dissemination;
- Establish process to support data release, sharing and publication;
- Benchmark with industry-wide available open data maturity models to assess the effectiveness in publishing and consuming open data and to identity areas for improvement based on industry best practices. For example, the Government should aim at least level 3 of the 5 Star Open Data Scheme; in the longer term, the Government should keep in view of global development to explore the feasibility of adopting a higher target of level 4 or 5;
- Identify and implement areas to enhance open data quality and usefulness, for example, the inclusion of geospatial data parameter into the datasets and adding visualisation wherever possible;
- Develop geo-spatial map function on the existing PSI portal for better presentation of data in order to simplify data extraction method by developers and provide better graphical visualisation to users;

- Develop mechanisms to enable a greater degree of open data publication and consumption by the public. (e.g. providing easy-to-use map interface for the public to extract data);
- Solicit feedback on the published PSIs; and
- Promote the use of PSIs to develop new applications (like hackathons).

5.1.2. Integration Layer

5.1.2.1. Integration Platform (Data Interconnect and Administration)

Hong Kong needs to plan for a platform to manage and allow interconnection of data from various data sources, to efficiently deploy services that rely on shared data.

Data Digitalisation in Policy-making and Public Services

In order to fully leverage a digital framework, there is a need to enable digitalisation and geo-enablement of various B/Ds' internal operation and management information and data, with an objective to achieve smart government by facilitating a holistic view of operation through management dashboard by leveraging the benefits of big data analytics. The ultimate objective is to facilitate data sharing and analytics systems linking up all B/Ds for smart city development. Three building blocks to achieve this goal are:

- To implement full digitalisation of existing government data and statistics to enhance coordination and integration in policy programmes and monitoring of public services. Deliverables will be city-based / sector-based data and statistics dashboards, such as advanced decision support tools, for top government officials, bureau heads and heads of departments.
- To explore inter-departmental collaboration in data integration and big data analytics, with a view to enhancing policy making, and applications to improve existing and develop new public services.
- To conduct a feasibility study on the wider use of sensors by different B/Ds in data collection and subsequent use of such data across B/Ds.

The long-term goal is to establish a data sharing and analytics system for the Government for smart city development.

5.1.2.2. Identity and Access Control

The OGCIO has established policy, procedures and solutions to support identity and access control to enable Government users to securely access G2G and G2E services. On an ongoing basis, the Government should continue to review and update the policy, process, standards and architecture with respect to identity and access control in accordance with the changing technology landscape and industry leading practices.

5.1.3. *Connectivity Layer*

To maintain Hong Kong as a well-connected city, the following recommendations are proposed:

- Review the effectiveness, service performance of Wi-Fi services and sustainability, under the current Public-Private Partnership model;
- Review the Public Wi-Fi objectives to address tourism and digital inclusion;
- Assess need to incorporate newer technologies such as 5G mobile network, high speed fixed networks, Wi-Fi expansion, RF Mesh, and LPWAN;
- Ensure relevant investments are 5G compatible and allow certain venues (e.g. Science Park, Cyberport) to be testbed for 5G technology; and
- Ensure the 5G network coverage and interface support future smart city solution devices and applications.

5.1.4. *Digital Enablers*

The Digital Enablers comprises Data Centres (Cloud & Application Architecture), Digital Persona, and Security/ Privacy Protection.

5.1.4.1. Data Centres (Cloud & Application Architecture)

The Government has established and offered cloud computing for B/Ds to use. In addition to supporting operation of various e-government applications of B/Ds, planning for implementation of new functionalities in a new integrated cloud infrastructure to support digital government services delivery in the coming years is necessary to support the development of smart city initiatives.

Enabling Digital Government Services Delivery

Besides basic demand for robustness, reliability, resilience and scalability, enabling digital government services delivery will have the following extra constituents that impose new demands on supporting infrastructure. The new infrastructure will:

1. Provide shared services (API) and data, platforms and hosting leveraging in-house/private cloud as well as public cloud with interconnections and networking agility to ease building of digital government services;
2. Support new application architecture and provide infrastructure support for agile development and continuous delivery of digital government services; and
3. Have sufficient capacity and scalability to support B/Ds on data capture from processes and devices for use on developing computational and data intensive big data analytics models/applications and artificial intelligence applications and other data centric digital government services and digital transformation.

5.1.4.2. Digital Persona

To transform the current infrastructure and enable acceptance of Digital Persona to authenticate digital identity of individuals and authorise them to use on-line services, the following plan is suggested:

- Design and implement the Digital Persona Infrastructure, its governance framework and financial model;
- Review the current digital persona infrastructure and evaluate the feasibility and cost-effectiveness of retrofitting and transforming into the Digital Persona Infrastructure;
- Establish service model for Digital Persona in end-to-end manner;
- Design common standards and methods for public/private service providers to adopt Digital Persona easily;
- Identify and engage public/private service providers to implement pilot projects; and
- Rollout Digital Persona Infrastructure and the pilot projects.

5.1.4.3. Security / Privacy Protection

The OGCIO has established a Government-wide IT security policy and related guidelines for Government B/Ds with respect to the protection of Government information systems, as well as establishing government-wide IT security framework. These security policy and guidelines have been developed by making reference to international recognised standards, namely ISO/IEC 27001 for standards on information security management system, and ISO/IEC 27002 for standards on information security controls.

The OGCIO also supports the operation of the Government central management and coordination framework to oversee and steer the implementation of the IT security standards and measures of B/Ds. Moreover, the OGCIO has taken proactive steps in combating cyber threats by continuously monitoring IT security related to vulnerabilities and threats, providing alerts and technical assistance to B/Ds to handle information security and cyberattacks.

The Government should continue to review and update current policies, processes, standards, guidelines and governance models with respect to security, privacy, cyber protection; conduct reviews and adopt best practices and appropriate systems and technology infrastructure; devise programmes to raise awareness and educate users on security risks and best practices specific to smart services; and closely monitor the development of IoT security and develop appropriate IoT security guidelines and practices in due course.

Cybersecurity on IoT Applications

Challenges and Vulnerabilities across IoT deployments in Smart Cities

IoT security is increasingly becoming a critical factor for consideration in smart city development as smart city services become reliant on a complex network of IoT devices. Unlike

traditional servers, databases, communications and applications, IoT hardware and networks introduce a number of unique security challenges that should be addressed.

There is a challenge associated with the management of a complex fleet of IoT devices. IoT devices are often physically small, with low power consumption and intermittent connectivity. This limits the use of encryption and other measures to ensure the devices' security. Moreover, IoT devices often lack a human user to directly input authentication credentials. With that, there is a requirement of remote monitoring during and after on-boarding the device and the capability of managing thousands of devices and users which may be scaled even further.

Although there is still a significant gap between different countries and individual networks for the IPv6 readiness, it is vital for all stakeholders to continue to adopt IPv6 or other future internet standards for continued global connectivity and long-term growth. IoT deployment will increase the number of devices connected to the Internet and each of which will require unique IP addresses to operate properly. IoT devices that are intended to be connected directly to the Internet will require end-to-end connectivity with a unique IP address which cannot be relied on using IPv4.

There will be a mix of IoT protocols and technologies, resulting in an IoT heterogeneous system, which increases the complexity of the IoT devices network and can complicate security vulnerabilities. Hence, there is a need for management techniques to enhance end-to-end security implementation. An example of a management technique would be to incorporate a centralised federated management authority to generate, distribute, and manage the credentials across the IoT layers. Using different network technologies will require gateways for connection, resulting in increased cost and complexity.

Given this, there will be a need for device and system management systems. Using device and management systems will help to monitor, update devices and reduce the overall operational complexity. Such systems will enhance the security of the data being transferred. The system will ensure that connectivity between devices are monitored and managed, and that problems are detected. The system will assist in device data aggregation and analysis.

Privacy and information sharing management will also be crucial. Sensors deployed in an IoT platform will be collecting data from various sources. Some of the data can include personal information leading to privacy issues. If the data is not secured, hackers can view and collect personal user data. Privacy protection measures need to be implemented also to promote citizen's trust. Incorporating privacy by design into the initial design phase will assist in alleviating privacy issues.

To address IoT security, there are also four main security vulnerabilities to consider:

1. **Device Vulnerability:** This includes connecting to or physically tampering with devices to retrieve and/or destroy data or perform any malicious action. Attackers have

to connect to or physically tamper with the device. An example is extracting security credentials by connecting to the device can cause the network to be compromised.

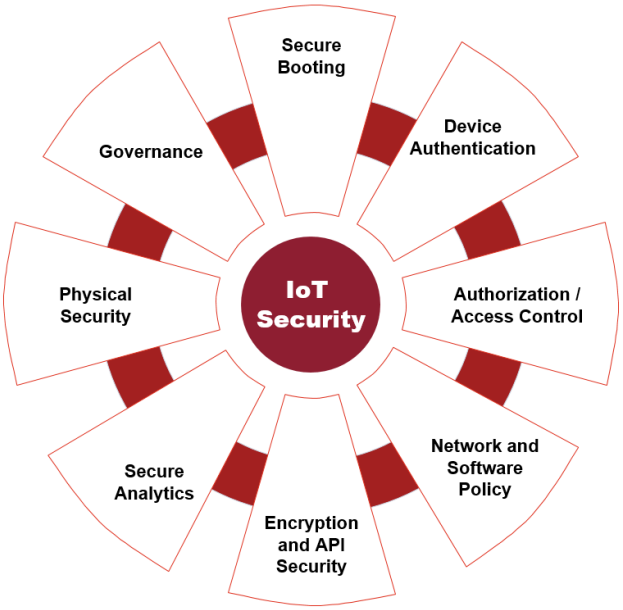
2. **Protocol Vulnerability:** This includes sending malicious requests through unsecured communication protocol to initiate and perform a malicious action. To exploit this vulnerability, attackers use weak credentials to access the protocol. The impact can result in destroying data, denial of service, and can lead to complete device takeover.
3. **Transmission Vulnerability**: This includes blocking, capturing, and/or mimicking the signal of devices to capture data or send malicious signals to the platform. In this type of vulnerability, attackers use vulnerable signals from the sensors and eavesdropping to attack the device. As a result, attackers use the compromised devices to facilitate attacks on other devices such as DoS attacks.
4. **Physical Vulnerability:** This includes the protection of physical IoT devices hardware and associated software from events that can cause loss or damage. Attackers can exploit this vulnerability through physical attack such as knockoff devices, compromised hardware installation or repair, and firmware replacement attack.

Therefore, implementation of appropriate physical and virtual security measures and setting IoT security policies are important.

Proposed IoT Security Framework for Hong Kong Smart City

To address these IoT challenges and vulnerabilities, it is imperative that security controls are embedded in both the network itself and the entire lifecycle of the device. Specifically with devices, security should be an integral part of the device's functionality. Devices should not only be able to deliver on specific tasks, but also be able to recognise errors and threats automatically. No single control will adequately protect all IoT devices, but a holistic IoT security framework of leading practices that can address security through devices and networks should be applied to IoT in Hong Kong. Cybersecurity and related information management measures are important and IoT implementation should consider and select the appropriate security measures to be suggested in the IoT security framework based on the security assessment of the IoT systems.

Figure 5.2 IoT Security Framework



The objective of the IoT security framework is to securely deliver superior services to the beneficiaries and users. Every city that has successfully implemented IoT security framework has a similar structure outlined below.

The IoT security framework comprises the following eight components (see **figure 5.2**):

1. **Secure Booting:** When power is initially supplied to load a device, the authenticity and integrity of the device software should be verified through cryptographic digital signatures. Through this, only the software authorised to run on the device will be loaded.
2. **Device Authentication:** When a device is introduced into the network, the devices identity should be verified, before data can be generated, received or transmitted. Similar to a user name and password, a similar set of credentials or identifiers should be applied to allow a device access to the network. PKI is a market ready solution that can be embedded into devices when manufactured to deliver key authentication capabilities that have applications in wearables, smart grids, connected cars and medical devices.
3. **Authorisation/Access Control:** Once a device is authenticated, mandatory and role-based access controls should be built in to limit the privileges of the device components to only the resources needed to complete the designated job. Solutions should also be created to allow users to create, modify, and manage the devices directly or through a web interface.
4. **Network and Software:** Firewalls or Intrusion Prevention Systems are needed to control data traffic to terminate at a device for network intrusion prevention. During device operation, software updates and security patches that need to be delivered should be done so in a way that limits bandwidth use and does not compromise the functional safety of the device.
5. **Encryption and API Security:** The sensitivity of data generated and transmitted should be considered. Sensitive data should be encrypted on the device as well as in transit. PKI

usage has been fairly reliable in securing connected devices on smaller scales. With the significantly large number of IoT deployments in cities, solid credential generation mechanisms, and rapid key generation for large scale IoT deployments that can leverage crypto algorithms designed for low power - low latency devices, could be adopted.

6. **Secure Analytics**: Data from devices should be analysed to identify potential IoT attacks and intrusions. There should also be an increased processing bandwidth in the IoT edge network to detect abnormalities and prevent outages.
7. **Physical Security**: Physical security that assures devices and associated hardware and software infrastructure from natural and man-made calamities is extremely important. Secure and stable physical infrastructure, enclosure with proper IP ratings, access controls, physical monitoring/security patrols and in some cases, video surveillance of assets will be required to ensure physical assets that are deployed remain secure and available.
8. **Governance**: A governance structure responsible for the IoT Security of the entire city should be enforced. The organisation should conduct risk assessments frequently for vulnerabilities and gaps, educate stakeholders through security awareness programs to increase understanding and facilitate adoption of security friendly behaviours, and build additional resilience through mitigation plans for disaster recovery and incidence response. Guidelines and practices should be set by this centralised unit to enforce the key tenets of information security including confidentiality, integrity, availability, non-repudiation and authentication. Additional guidelines and practices can be set to minimise disruption to critical infrastructure and require audit logs for access trails and breach notifications. Processes should then be in place to detect and mitigate unauthorised access or breaches. By implementing these recommendations along with the proposed IoT security framework, Hong Kong can adopt an effective end-to-end security solution.

Requirements to Implement, Manage, and Maintain the IoT Security Framework Components

As for the security guidelines, practices, processes and procedures around implementation and ongoing management of the IoT security framework components, B/Ds may need to perform risk assessments during the design phase of an IoT system development project. B/Ds could adopt a risk based assessment methodology that is consistently repeatable and adequately covers the threats. The processes and procedures will define the operating requirements to observe the guidelines through sound operating practices. The processes and procedures should include independent audit of the security programme and measures along with relevant information security trainings for the individuals who are responsible for IoT security. On the technological solutions for the implementation of IoT security framework components, non-proprietary solutions are preferred.

With regard to the alignment of proposed IoT security framework with international security standards such as ISO 27000, the proposed IoT security framework is compatible with security standards along with IoT standards for deployment and security. For example, an

implementation similar to NIST Cybersecurity for IoT programme is built upon international standards published by ISO, IEEE, and IEC. By adopting these published standards will embed system security engineering methods, practices, and techniques into the IoT security framework.

5.1.4.4. Standards

Hong Kong will require a unique mix of technology solutions to enable current and future smart services delivery. This situation is complicated by the addition of emerging technology. The required technology could originate from a variety of international and local providers, requiring them to work with each other. This complex task can be greatly simplified by adopting the right mix standards to ensure a stable and resilient digital infrastructure. Standards facilitate the assurance of broader and quality solutions, ensures competitive and transparent procurement, and provides a choice of compatibility, interoperability, with expected performance levels from technology investments. Technology is omnipresent across all smart city systems, and it is important to adopt appropriate standards suitable for Hong Kong. These standards should be open and interoperable to maintain Hong Kong's leading position in global competitiveness and technology innovation.

5.2. Open Data Policy

5.2.1. *Government policy and strategy for facilitating the release of more open datasets*

5.2.1.1. Definition, Purpose and Objectives of Open Data Policy

Definition

Open Data represents the timely and relevant release of government and other public and private company's data with the legal and technical characteristics for it to be accessible and usable by anyone.

Purpose

The purpose of Open Data for a city is to share anonymised data with the public to stimulate new applications and innovation for improving city services. Taking reference of the open data principles promulgated by The Open Data Charter[191] and considering the specific practice and maturity of Hong Kong, a set of open data principles for Hong Kong are proposed, as follows.

Principles

1. Data should be open as far as practicable, with exceptions made for legal, privacy, security, commercial sensitivity, competition and operational concerns

[191] http://opendatacharter.net/principles/

2. Data is timely and comprehensive. The data should be consistently updated, and real-time if available and feasible, to ensure not only quantity but also the quality of data.
3. Data is accessible and usable, provisioned in a way that allows for easy retrieving, downloading, and searching.
4. Data is comparable and interoperable, provisioned in standard formatting for ease of use by different stakeholders.
5. Open data is used to stimulate creativity, innovation, and collaboration.

B/Ds are encouraged to use machine-readable format for data released where appropriate, as being adopted in the Public Sector Information mechanism launched by the Government in 2011.

5.2.1.2. Guidelines on Open Data Policy

Various organisations and groups, such as the Sunlight Foundation, Open Knowledge International, and Open Data Charter, have prescribed various, common steps and guidelines to serve as a model for cities in the creation of their Open Data Policy[192][193][194]. The common guidelines noted are synthesised into three sections.

When deciding on what data is to be made public:

1. **Proactively open government data on-line**: Most government disclosure policies take on a reactive approach, where data is public, but at the same time, it is only provided when requested through methods such as Code on Access to Information. Open data policy presents an opportunity for a transition to a more proactive approach where data is automatically provided before any requests are made.

2. **Specify methods for prioritising the data to be posted**: Governments should put in place a mechanism which allows prioritisation of data to be released to facilitate big data applications. One such way is to provide information in which stakeholders have already demonstrated an interest through formal and informal requests. Identifying goals is vital when gathering stakeholders' support. For example, a goal would be to release data for improving citizens' access to services or to spur economic development.

3. **Safeguard sensitive information**: Exempt data includes data that should not be made public due to security, privilege limitations, legal, commercial sensitivity, competition (data the release of which would undermine an entity's competitiveness), operational and privacy concerns. Data that has financial, technological, or contractual barriers should also be considered exempt data. For example, data that cannot be published include addresses due to personal privacy concerns. Safeguarding sensitive information can only be done

[192] https://sunlightfoundation.com/opendataguidelines/#build-on-precedent
[193] http://opendatacharter.net/principles/
[194] http://opendefinition.org/od/2.0/en/

appropriately with a balance test that asks whether the potential harm from releasing the information outweighs the public interest in accessing the information. For example, the Health Insurance Portability and Accountability Act (HIPAA) in the US has exact requirements for determining whether data have been sufficiently de-identified so as to not to compromise individual privacy. Personal Identifiable Information (PII) in datasets should not be published.

When addressing how to pursue open data initiatives:

1. **Standardise data formats**: Data should be released in machine-readable formats that are easy to reuse. Formats should be based on open standards defined by standards organisations that can be used by at least free and open-source software tool.

2. **Remove access restrictions**: Data should be accessible with minimal registration requirements, fees, and usage limitations to any person without need for justification.

3. **Mandate license-free data usage**: For Open Data to be usable to its maximum potential, there should not be license barriers to data usage, redistribution, and modification.

4. **Recommend use of appropriate citations**: Datasets should note the original data source through citations, so that users can trace back possible quality problems.

5. **Publish metadata**: Standardised metadata schemes and other forms of documentation should be provided along with datasets to provide sufficient information on the context of the datasets creation and usage.

6. **Create central data portal**: User-friendly and well managed portals or similar websites facilitate dataset usage, but allowing users easy access and search mechanics for data. Features such as a link to a data inventory or a mechanism for feedback should also be included.

7. **Create public APIs**: APIs allow third parties to search and retrieve information directly and automatically from datasets in the portal.

8. **Mandate ongoing data publications and updates**: Data available should be as close to real-time as possible. To maximise usefulness and accuracy, data should be released early and updated often.

9. **Create lasting access to data**: Portals and websites can serve as stable locations for data perpetually, but the datasets themselves should also be permanently available.

When assessing how to implement Open Data Policy, consideration should be given to:

1. **Appoint an oversight authority or position**: A single authority should be appointed to oversee Open Data polices, review practices, and resolve conflicts.

2. **Incorporate public perspective**: Data should be released to address public demands as far as possible. As such public stakeholders should be involved in the ongoing review of the Open Data initiative.

3. **Set timeline and funding**: Set timelines will allow for accountability. The timeline should allow for enough time for stakeholders to implement change, but be firm in order to strengthen commitment, provide motivation, and allow for benchmarks on progress. Funding should be set aside for new staffing and software.

4. **Explore partnerships**: Partnerships with think tanks, academia, and non-profits can provide a variety of benefits and identify gaps in service delivery.

5. **Set mechanisms and cadence for future review**: Open Data practices are rapidly changing so the Open Data Policy should enforce future review of the policy itself to stay current with best practices.

5.2.1.3. Leading Practices and Common Themes

Strong Executive Support - Chicago, Los Angeles, and New York

Clear and vocal support from the executive sponsor in parallel with effective top-down governance structure can help in overcoming a number of internal and external barriers. In Chicago, strong support from the Mayor's Office sped up the implementation process by employing policies that mandated for government agencies to participate in the initiative and proactively open their datasets. Chicago, Los Angeles, and New York also all had very similar and successful governance structures. Each of the cities appointed a Chief Officer to oversee the initiative as well as Open Data Coordinators in each department to manage data dissemination processes. In Los Angeles, the Information Technology Agency additionally took the lead in managing the portal, providing policies and procedures and further improving on the initiative[195].

Partnership with NGOs - Chicago and Austin

Cities such as Chicago and Austin successfully utilised various partnerships with NGOs to further the success of their Open Data policies. In Chicago, the John D. and Catherine T. MacArthur Foundation funded three thematic competitions to encourage businesses and

[195] http://datala.github.io/od-policy/

software engineers to use City of Chicago and Cook County open data in 2011[196]. Chicago partnered with Code for America to host programmes that train data skills and place data specialists in positions where they can create applications enabled by open data. Chicago's robust stakeholder involvement fosters partnerships with The Sunlight Foundation, Smart Chicago Collaborative and University of Chicago, all of which helped with Open Data expertise, services, and applications. The city of Austin in partnership with St. Edward's University held a Hack-a-thon event that was very effective in engaging the community to use Open Data to create applications. Following the success of the Hack-a-thon, the city then hosted a Data Jam workshop.

Common Standards - Houston and Berlin

In cities like Houston and Berlin, common standards were created to ensure consistent release and quality of datasets. Houston specifically engages the various departments through the Enterprise Data Officer and Open Data Advisory Board to develop its dataset inventory, data quality requirements as well as guidelines to identify high priority data, ensure data quality, and recommended timeframes to release data among the departments.

Prioritisation of Dataset Release - Chicago

Chicago's prioritising methodology for the release of current datasets is based on perceived value to users as well as the expected ease and speed of which the data can be released. To do so, Chicago with its robust stakeholder engagement, gathered feedback on the most desirable datasets. Crime data was amongst the most demanded datasets and Chicago released all its crime data dating back to 2001. Presently, the City of Chicago has the largest automatically updating set of incident-level crime data ever released by pulling data from police warehouse to city's data portal via Socrata's API[197].

Performance Management - San Francisco

Open Data benefits are difficult to quantify and not much guidance is provided on the method or KPIs used to measure progress. The City of San Francisco uses results based accountability model to track quality and impact on the open data against its objectives of an innovative economy, increase engagement, etc. Rather than simply using the number of datasets released as a success metric, the city focuses on its performance against the target, timeliness of publishing, and documentation and usability. The city identifies its target number of datasets to publish every six months and tracks performance against that number. The city also focuses on the frequency of data updates and percentage of datasets with documentation[198].

[196] http://www.urban.org/sites/default/files/publication/22671/413154-Case-Study-Open-Data-in-Chicago.PDF
[197] http://beyondtransparency.org/chapters/part-1/open-data-in-chicago-game-on/
[198] https://datasf.org/blog/how-to-measure-open-data/

5.2.1.4. Benefits

Across cities, an effective implementation of Open Data Policies leads to benefits for a variety of stakeholders[199][200]. Open data allows governments, businesses, and communities to:

1. Opens up avenues for commercialisation of data
2. Create economic benefits for the city
3. Promote transparency, accountability, and good governance
4. Make better informed decisions with more timely information
5. Develop new insights and innovative ideas for services and applications
6. Compare and combine different datasets to uncover trends
7. Identify social challenges and inequities and benchmark progress
8. Increase citizen engagement and communication

Louisville, Kentucky's air quality poses a problem to residents to asthma. In response, the city designed a programme called AIR Louisville to produce sensors for integration with inhalers to track when and where citizens experienced asthma symptoms. In combination with released weather and traffic data, this information made it possible to identify problem areas within the city to improve air quality.

Parking has been a major issue in Milton Keynes, England. However, rather than spending large amounts on new spaces, the city utilised sensor data published through the city's Data Hub that matched drivers with open spaces to park. This saved the city capital expense to build new parking spaces while reducing fuel usage and vehicle emissions.

In the city of Seattle, citizen engagement with the open data programme is increasing. As citizens explore the portal and provide feedback on additional datasets desired through a mechanism provided on the portal, the portal had grown from the initial 50 datasets to now over 700[201].

In Chicago, the press, with examples such as the Chicago Tribune and Sun Times, are taking advantage of open data to move from traditional print media to new digital ways of presenting news. They have used the open data to create infographics and other visuals in parallel with articles they write. Reduced administrative burden was another benefit in Chicago. Due to increased availability of datasets, the city recorded a 50% decrease in public requests for access to information.

In Amsterdam, the open data initiative drove collaboration across the city's fifty departments. Additionally, through the data portal, over 100 applications were developed.

[199] http://opendatahandbook.org/guide/en/why-open-data/
[200] http://opendatacharter.net/principles/
[201] https://data.seattle.gov/browse?limitTo=datasets

5.2.1.5. *Known Issues and Challenges*

With open data programmes there are sizable upfront costs associated with paying for staff, contractors, and training. The difficulty in assessing quantifiable benefits of open data also makes initial stakeholder engagement difficult to capture. Moreover, confidence needs to be built in stakeholders that the government will continue to deliver the data perpetually. In case there is a budget shortfall, businesses that built their business model around open data need to be able to trust that the data will continue to be provided[202].

In the UK, over 8,300 datasets have been released to its Open Data portal, data.gov.uk, making it possibly the largest government-owned open data site. Despite this, key issues have been plaguing UK's Open Data programme. Although the government is spending upwards of £500,000 a year on Open Data staffing, the website's low traffic figures show that not many people are actually using the portal.

In 2010, Seattle created an open data initiative and did not initially have a promotional budget assigned to the initiative. The city relied on word of mouth to notify users of the datasets available. As a result, stakeholder engagement in Seattle was not very strong until in 2014, when Seattle partnered with Code for Seattle to promote the usage of open data.

In Chicago, one of the main challenges is simply managing the large size of the open data initiative. Numerous existing datasets have already been published; the difficulty lies in providing timely release of new datasets, while also updating existing ones. The consistent updating of the data portal has already become integral to the development of various new services.

In Hong Kong, the private sector plays an important part in providing essential service to the public and competition among businesses is keen. Businesses may have a tendency to guard their data most cautiously. For example, the majority of privately-operated car parks that offer hourly parking have not responded positively to the Transport Department's initiative of providing real-time parking vacancy information in the Department's mobile application HKeRouting. To date, less than 2% of privately-operated car parks offering hourly parking are feeding real-time vacancy information to the mobile application.

Another example is franchised bus companies' operational data. Unlike most local governments overseas which own their public bus fleet, the Hong Kong Government does not own the public bus fleet in Hong Kong. The public bus service is operated by private companies with the franchises granted by the Hong Kong Government and these companies invest in and own their assets without any government subsidies. While the opening of public bus operation data is a relatively simple matter for most overseas governments, it has not been that simple in Hong Kong despite calls from some quarters of the public for opening such data. For franchised bus companies, these data are their private property and these have been developed

[202] http://www.govtech.com/data/How-Government-Can-Unlock-Economic-Benefits-from-Open-Data-Part-I.html

with their own resources, and are commercially sensitive. Further, it is viewed that these franchised bus companies should have already fulfilled their obligations under the franchises by providing and continuously enhancing the provision of service-related information to passengers and to the Government for service-monitoring purposes. Although they have been granted franchises to operate public bus service, they are not competition-free. There is a limited degree of competition among the major franchised bus companies. They also see themselves as competing with other public transport modes including the MTR, public light buses, trams and taxis. They see the release of operational data as potentially damaging to their competitiveness.

There may well be other businesses which are reluctant to open data for similar or different reasons in Hong Kong.

5.2.1.6. Key Stakeholders

Certain stakeholders play key roles in the success of Open Data in these cities as well as all other Open Data initiatives.

Role of Citizens

The opening of data directly improves citizen lives in possible ways such as the development of services tailored for citizens' needs. Citizens may also contribute to open data, for instance, the government can consider placing forums or other mechanisms to engage citizens on their personal insights such as which streets need reparation. In fact, citizen data in itself can be valuable as open data provided that privacy issues are appropriately addressed (through measures such data aggregation and anonymisation). For example, aggregated information gathered from medical wearables can improve health education and formulation of health-related policy.

Role of Businesses

Open data can become truly valuable when the private sector buy in and becomes a participant. This value is created largely in two major ways.

Businesses can provide and have access to data from Government departments, citizens, and other businesses to draw insights from, bridge information gaps, and collaborate on. The restaurant review platform, Yelp now offers restaurant health inspection information for open data available in San Francisco and New York City. As more private sector datasets are opened, a networking effect is created, generating exponentially more impact[203].

Open data can enable businesses to identify opportunities, create new products and services, and develop new business models. Geospatial data has been a key to successful start-ups such as Zillow. Zillow, a US real estate company, takes data from multiple data sources such as

[203] https://www.codeforamerica.org/featured-stories/san-francisco-puts-restaurant-safety-data-on-yelp

county land records, satellite imagery, and listing services that advertise homes. Visitors of the website are able to view images of the entire neighbourhood when assessing properties to purchase[204].

Similar to government provided data, data from businesses have significant potential to provide benefits. Governments can encourage private sectors to open data for public usage. For example, governments can enforce businesses that work with government departments to publish their data that they provide as part of the contract. Additionally, governments can create APIs to business platforms like Twitter and Facebook, to make them available as part of the government's open data platform[205]. To incentivise businesses to open data, government can institute regulations that limit liability regarding risks to avoid criticism. Businesses are often hesitant to open their data to avoid loss of competitive advantage. Governments can help businesses to promote innovation by intellectual property rules that are transparent and fair for determining if the data can be redistributed or combined with any other data. As an example, Yale University Open Data Access (YODA) provides an open data platform for healthcare and pharmaceuticals businesses to release clinic trail information[206]. Users need to submit a proposal, take a course on responsible conduct, and share research findings with others to access the open data. As a final step, government can setup regulations to make businesses open their data. For example, in the United States, the Securities and Exchange Commission requires financial businesses to collect and submit certain financial documents and publishes certain documents in the Electronic Data Gathering, Analysis, and Retrieval (EDGAR) portal[207].

It should be pointed out, however, that although public stakeholders may have good reasons for seeing certain data as valuable, consideration should be given to justifications advanced in support of the data being exempted. The importance of safeguarding sensitive information cannot be over-emphasized and a balance test that weights the potential harm from opening the data and the public interest to be gained by opening the data should be properly conducted.

Taking the examples of privately-operated car parks and franchised bus companies as examples, if after careful weighing the balance tilts towards public stakeholders, a number of options may be explored in the Hong Kong context to incentivise or make businesses open their data. The Government and the community may consider mandating the release of data through legislation (and/or compensation). This however will have to be carefully considered, including whether it is proportionate to do so.

Role of NGOs and Non-Profits

NGOs including universities, advocacy groups, and think tanks are some of the most active collectors, disseminators, users, and proponents of open data. Organisations such as the World

[204] http://www.esa.doc.gov/under-secretary-blog/open-data-impact-how-zillow-uses-open-data-level-playing-field-consumers
[205] https://www.opengovpartnership.org/blog/martin-tisne/2014/03/19/missing-link-how-engage-private-sector-ogp
[206] http://yoda.yale.edu/
[207] https://www.sec.gov/edgar/searchedgar/webusers.htm

Bank Group have massive databanks that are publicly shared for analysis and creation of new products. NGOs, therefore, are capable of assisting governments with developing guidelines and standards to improve availability and use of open data. As done in Chicago and Austin, NGOs can also assist through partnerships with city governments to create events that better engage the public with Open Data.[208]

NGOs also draw value from using the open data themselves. An example is Aidspan, an NGO that utilises open data from Global Fund to fight AIDS, Tuberculosis, and Malaria. Non-profit organisations such as GreatSchools utilise open data from the US Department of Education's Civil Rights database to provide parents with information on STEM courses offered in schools. Fair Health, a non-profit organisation, uses open data for medical and dental services to enable citizens to estimate and plan medical and dental expenditures.

5.2.1.7. Recommendations for Hong Kong to Consider in Drafting and Adopting an Open Data policy

Hong Kong has already adopted much of the necessary infrastructure for open data. A Public Sector Information (PSI) portal – "*data.gov.hk*" – has already been released on-line, and CKAN[209], which is also used by various EU cities such as Berlin and Amsterdam, has been employed as the technical platform. At present, the *data.gov.hk* portal houses close to 7,000 datasets in 18 categories, provided by 48 B/Ds as well as other public and private organisations, such as MTRC, CLP, HK Electric, Centaline Property Agency and Hong Kong Society for Rehabilitation, etc. The Government is also working towards enhancing access to these datasets (for example, using Application Programming Interfaces (APIs))) and preferably in open formats where appropriate. To continue the implementation and adoption of open data, based on existing guidelines and leading practices of other cities, Hong Kong should consider the following:

Establish governance structure and appoint a central coordination party

A common theme across almost all the cities analysed was a strong top down governance model that allowed for the mandating of data release in the various government departments. Cities such as Austin, where the initiative began bottom-up as a grassroots movement, found slower development. Chicago on the other side saw huge success due largely to the strong and vocal support of the mayor and appointment of a Chief Data Officer (CDO). For reference, in Chicago the CDO reports to the Acting Commissioner & CIO; in Los Angeles to the Mayor; in New York to the Mayor. Similar to the models of Chicago, Los Angeles, and New York, Hong Kong may consider appointing an individual such as a CDO to champion the cause and serve as an evangelist of open data in the community. The CDO should be overseeing the formulation of a formal Open Data Policy for the Government having due regard to data privacy and facilitating the adoption of such policy by B/Ds, as well as be responsible for

[208] Chui, Michael, Diana Farrell, and Kate Jackson. How Government Can Promote Open Data and Help Unleash Over $3 Trillion in Economic Value. Tech. N.p.: n.p., n.d. Print.
[209] https://ckan.org/

monitoring the implementation. An Open Data Coordinator (ODC) should also be placed in each B/D to enforce data quality, timeline of release and updates, and maintenance of data inventory. OGCIO can in turn be responsible for the data portal, looking for innovations and optimisations for the initiative.

Conduct current inventory of existing datasets, prioritise their release, and monitor data statistics and feedback to ensure relevance and usefulness

As Hong Kong continues to release datasets to the public, a valuable project the city should undertake is to baseline the inventory of existing data that the government currently holds. With a clear understanding of what data sets are held, like Chicago, Hong Kong can then develop a methodology to assess which datasets to be released and in what priorities. The Open Data Policy in Hong Kong should specify that a phased approach to opening data be adopted. This Policy can be implemented through: first, taking reference to international practices to assess which datasets should be opened initially (i.e. the base datasets) in Hong Kong; then, formulating a mechanism by which the city can "listen to" and engage with stakeholders to assess and prioirtise the most appropriate datasets to open after the base datasets, based on a combination of factors such as community requests and input, perceived impact of data, effort and cost to release and whether its proportionate, and ease of release due to privacy and also security concerns.

Regarding data user input, Hong Kong should also monitor the data usage statistics and embed feedback mechanisms directly on its portal to ensure data relevance and usefulness. Stale data should be refreshed and a feedback mechanism can also allow data users to notify Hong Kong on specific datasets that need updating.

In addition, there are agencies in some EU countries including meteorological agencies and business registers that continue to charge for data. However, several studies show that these cost-based models do not generate additional revenue in the long run, while free data is more beneficial in value creation. Given this and existing difficulties across Open Data initiative to generate stakeholder engagement, Hong Kong should look to providing data with minimised costs and restrictions on usage[210].

Establish common practices and formats for data release and usage

The US open data policy considers ISO, ANSI, INCITIS, FGDC, and other standards whenever relevant for best practices with dealing with data[211]. Hong Kong can also refer to these organisations for overall data practices. In addition, as with other cities like Houston, Hong Kong should continue to develop more specific open data practices to be adopted across B/Ds and private organisations. These practices should include common formats, terms of use for open data, and updating to be applied to Hong Kong's dissemination process.

[210] http://www.odbms.org/2016/02/stop-charging-for-open-data/
[211] https://project-open-data.cio.gov/open-standards/

Establish KPIs that can effectively assess open data effectiveness and then market milestones to the community

A limitation found in many city open data policies was a lack of a method of evaluation on the initiative success. Some B/Ds and private organisations may be more resistant towards a shift towards open data unless benefits are clearly seen. Benefits associated with open data are best measured in terms of its usefulness; therefore process and output-based metrics such as frequency of updating, percentage of datasets with metadata, or number of new businesses or applications created through open data, together with outcome-based metrics such as potential impacts to the society and environment as a consequence of data published, are a better measure of success and impact. Another issue, noted from analysis of Seattle, showed lack of a promotional budget, leading to slow adoption. Hong Kong should dedicate funds to the promotion of the initiative and key milestones to elevate community participation and approval.

Improve on Hong Kong's existing *data.gov.hk* portal by automating release of datasets and implementing APIs

In the city of Chicago, an OpenData ETL Utility Kit was created to allow for a large portion of the datasets to be automatically pulled from the source, transformed, and loaded onto common data storage[212]. Hong Kong should assess the need for developing similar tools that are applicable to individual B/Ds' systems allowing for the automated release and publishing of datasets and help provide users with more timely data. In addition, the Government should consider extending the current provision of APIs to cover more open data in PSI Portal.

5.2.2. *Potential Priority list of public and private datasets*

Since 2010, OGCIO has been promoting the concept of "open data" and facilitating B/Ds to release Public Sector Information (PSI) to the public in machine readable formats for free use by the public. At present, the PSI portal provides nearly 7,000 datasets from B/Ds and public/private organisations grouping in 18 categories as follows:

- City management
- Climate and weather
- Commerce and industry
- Development
- Education
- Employment and Labour
- Environment
- Finance
- Food
- Health

[212] http://www.pentaho.com/city-chicago-embeds-pentaho-build-open-data-portal

- Housing
- IT and Broadcasting
- Law and Security
- Population
- Recreation and Culture
- Social Welfare
- Transport
- Miscellaneous.

OGCIO is currently working to improve the usability of the PSI and the PSI portal. Since March 2017, historical data is made available in the portal, facilitating the public to conduct big data analysis of past trends. OGCIO has also started to roll out Application Programming Interfaces (APIs). As of April 2017, there are some 730 APIs in the portal. OGCIO will continue to roll out progressively more APIs, targeting to achieve around 1,000 APIs by mid-2017. OGCIO will also enhance the PSI portal in 2017 by way of reorganising datasets of different data formats; improving the search function of the portal to make it easier for users to find the required datasets, and providing geo-tagged information (to present PSI that carry geographical information on map).

Potential List for Opening up More Datasets

To open up more datasets for reuse by the public, a potential priority list of public and private datasets in addition to those already open in the PSI Portal has been developed based on the following:

- Desktop research results on popular data types viewed / downloaded in open data portals of overseas smart cities, including UK (Central Government, London) and US (Federal Government, New York City and Los Angeles);
- The results of a survey namely "Innovation with Data – Tell us what you want!" conducted in January 2017 by the HKSTP with its tenants on suggestions of new government data; and
- Other suggestions including feedback received from the stakeholders and the public.

While the list is by no means exhaustive, the sharing of it is intended to help stimulate creativity, innovation and collaboration as well as to enhance governance and civic engagement.

- Climate and weather
  - Temperature and sea surface temperature
  - Maximum and minimum temperatures (over a pre-defined period)
  - Relative humidity

- Wind
- Visibility
- Lightning locations
- Rainfall distribution
- Times of sunrise, sun transit, sunset, moonrise, moon transit, moonset and tidal predictions
- Tropical cyclone-related information
- Ultra violet (UV) index

- Commerce and industry
  - Company register-related information
  - Name of company
  - Unique identifier of the company
  - Company address

- Development
  - Hong Kong map and land-related/geospatial information
  - Stock of lands and related land status information
  - Base map of appropriate scale including administrative areas and zones (2D and 3D)
  - Markings of public/private buildings, roads, tunnels, railways, street lighting
  - Markings of natural features (e.g. streams, rivers, mountains)
  - Markings of trees
  - Land boundary records

- Education
  - Individual primary/secondary/international school
  - Number and statistics of students
  - Number of classes
  - Number of teachers (including academic qualifications and years of tenure)
  - Subjects taught (and language used)
  - Public examination results
  - Facilities
  - Extra-curricular activities
  - Awards
  - Association with religious body
  - Tertiary and higher-education institutions, e.g.:
  - Number and statistics of students including international students

- Details about teaching staff (including number, expertise/specialism, academic qualifications and years of tenure)
- Number of administrative staff
- Number of intellectual properties (IPs) and academic publications
- Amount of research grants
- Statistics on the degree/diploma awarded (e.g. average GPA)
- Facilities
- Awards
- Association with religious body

- Environment
  - Volume of waste generated by categories (e.g. domestic vs non-domestic, food waste, construction waste)
  - Air quality (e.g. particulate matter levels, sulphur oxides, nitrogen oxides, volatile organic compounds, carbon monoxide)
  - Noise level
  - Utilities consumption, e.g. water
  - Data on water and air quality in detail
  - Statistics on energy consumption, e.g. percentage of renewables / non-renewable, peak usage and time

- Finance
  - Information on investment loss/gain of MPF

- Food
  - Hygiene information after inspection of food premises

- Health
  - Usage of public hospitals, clinics and other healthcare facilities
  - Supply of practitioners in public hospitals, clinics and other healthcare facilities
  - Data on patients (e.g. prescribing rates, treatment options and mortality rates by disease group)
  - Statistics and trends on disease incidence rate, mortality rate, and cost of treatment for different types of diseases
  - Information on expenditure of the Government on healthcare

- Housing
  - Property-related information

- Stock of flats (by type, age, district)
- Building information (e.g. land lease expiry, use, inclusion of public open space)
- Usable floor areas of new buildings completed and of new building projects for which consent to commence work has been given
- Property rental and sale transaction including property address, transaction date, price, period of the lease, areas of the property
- Housing price to income distribution

- IT and Broadcasting
  - Information on number of mobile device in usage, bandwidth consumption

- Law and Security
  - Data related to law enforcement
  - Crime map

- Recreation and Culture
  - Public facilities and services:
  - Sports and recreational facilities (e.g. availability, booking)
  - Libraries (e.g. usage)
  - Museums and performance venues (e.g. visits)
  - Parks, zoos and gardens (e.g. locations)

- Social Welfare
  - Usage and provision of selected social services

- Transport
  - Traffic flow (e.g. roads, highways, tunnels, real time bus services, real-time traffic status, cargo flow)
  - Availability of parking lots and charge stations
  - Usage of curbside loading/unloading bay
  - Deployment status of emergency vehicles
  - Data on public transportation (e.g. journey time, schedules and passenger capacity of buses and trains in operation)
  - Travel related statistics in city (e.g. number of passenger enter / exit in each MTR exit, using Octopus card for MTR travel, which can help predict mobility bottlenecks and travel time)

- Miscellaneous

- Government budget and spending-related information
- Budget and variations by B/Ds
- Tenders and awards aggregated by office
    - Tenders (tender name, tender description, tender status)
    - Awards (award title, award description, value of the award, suppliers name)
- Transactions
    - Individual record of transactions
    - Date of the transactions
    - B/D which had the transaction
    - Description of the transaction
    - Name of vendor
    - Amount of the transaction

Continuous Review of Public Sector Information Datasets

It is suggested that the Government should continue offering other additional datasets, which are currently in high demand in the PSI Portal, and ensure that these datasets are updated on a regular basis in alignment with stakeholders' expectations.

The Government should also regularly review the datasets offered in the PSI portal, taking into account the main objectives to be achieved through formulating and implementing the Government's Open Data Policy.

5.3. Privacy Issues in Smart Cities

The right of individuals to privacy, though not an absolute right, must be duly protected in any modern city, including smart cities[213].

Privacy and data protection policies are essential for the protection of data that includes personally identifiable information (PII). The United States Department of Labor (USDOL) defines Personal Identifiable Information as "any representation of information that permits the identity of an individual to be reasonably inferred by either direct or indirect means." This includes[214]:

1. Information that directly identifies an individual (name, address, telephone, email address)
2. Information, that when combined with other data elements allow for indirect identification (Birth date, gender, race).

Within the PII data category, data with sensitive personal information (SPI) is to be treated with even greater care, as it is deemed more private and can potentially be used in a

213 http://www.cmab.gov.hk/doc/en/documents/policy_responsibilities/iccpr_booklet_web.pdf
214 https://www.dol.gov/general/ppii

discriminatory way. The United Kingdom's Information Commissioner's Office (ICO) defines SPI as information on[215]:

1. Racial or ethnic origin
2. Political opinions
3. Religious beliefs
4. Membership in a labour union
5. Physical or mental health
6. Sexual life
7. Offences committed or alleged offences or proceedings for any offence.

Misuse or accidental release of any PII can lead to negative consequences for individuals. Therefore, governments and other organisations in different jurisdictions have created various privacy principles regarding the collection and usage of PII.

5.3.1. Existing Privacy Principles

In 1980, due to the proliferation of computerised systems, there was a need for protection of personal information privacy. As a result, the Organisation for Economic Co-operation and Development (OECD) adopted core privacy principles to form the basis of privacy principles in member countries[216]. Since then, the EU's Article 29 Working Party, UK's ICO, and organisations like Electronic Privacy Information Center (EPIC) have made some adjustments, but by and large have adopted the same principles. In Hong Kong, the Personal Data (Privacy) Ordinance also laid down Six Data Protection Principles, which are very similar to the principles of the aforesaid organisations[217]. Across jurisdictions with such privacy principles, the following key requirements are usually included[218,219,220].

1. **Lawfulness:** The data must be collected in a fair way for a purpose directly related to the function/activity of the data user
2. **Consent:** The data subject must give specific, informed, and explicit consent to the data collection
3. **Purposeful:** The purpose of collecting and using the data must be specified prior to collection
4. **Necessity:** The concept of data minimisation should apply with data to be used only for the specified purpose and not be kept longer than necessary
5. **Accuracy:** Steps should be taken to ensure collected data is accurate
6. **Transparency:** Policies and processes regarding personal data collection and usage should be made known and clear

[215] https://ico.org.uk/for-organisations/guide-to-data-protection/key-definitions/
[216] http://www.mccarthy.ca/pubs/share2.htm
[217] https://www.pcpd.org.hk/english/data_privacy_law/6_data_protection_principles/principles.html
[218] https://secure.edps.europa.eu/EDPSWEB/edps/site/mySite/Art29
[219] https://ico.org.uk/for-organisations/guide-to-data-protection/data-protection-principles/
[220] https://epic.org/privacy/consumer/code_fair_info.html

7. **Accessible:** A data subject should have access to his/her own data and be able to rectify, update, or erase it
8. **Security:** Though data should be accessible to the subject, data should be securely safeguarded from unauthorised or accidental access

These requirements were developed with traditional modes of data collection and usage in mind prior to the rise of IoT solutions, Big Data, Open Data and other new technological capabilities to be implemented in smart cities. Whether and how they should be modified for enabling new ways of collecting and using data are important questions which will require careful deliberations involving different stakeholders.

5.3.2. Privacy Concerns for Smart Cities

IoT Platform

Devices and sensors connected through IoT systems are designed to provide users with an unobtrusive and seamless user experience. This very design also creates a huge privacy concern in that these devices are capable of continuously collecting data of the user's personal daily activities, while remaining almost invisible or seemingly innocuous. As more and more devices are connected, there are increasing possibilities of for example wearables directly revealing health issues or cars directly revealing people's whereabouts and driving behaviour. Users will start to view an integrated device and sensor platform as a method of surveillance rather than a service enabler[221].

This continuous, unobtrusive collection of data also makes consent difficult. In contrast to sharing personal data on-line where users are provided at least once the opportunity to withhold consent for data collection, sensors and devices often only provide notes with privacy policies that most users will gloss over.

Big Data

Big Data is an essential component providing Smart Cities the capability of processing large volumes of real-time and historic data in structured, semi-structured, and unstructured forms for various uses and reuses to draw applicable insights. It is this high volume and velocity of data collection and usage that brings up notable privacy concerns, such as:

1. The trend in big data for maximised collection of all data
2. The reuse of data for new or additional purposes without an individual's consent
3. The lack of transparency on the processes behind big data analytics, which may potentially be used to produce differential treatment.

[221] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2711290

Open Data

Open Data represents the timely and relevant release of government and other public and private company's data with the legal and technical characteristics for it to be accessible, usable, and distributable by anyone. Normally it does involve personal data. As cities release more datasets to the public, a number of privacy concerns could arise, namely:

1. The possibility of identifying individuals through connections found between multiple open datasets
2. The lack of control how the above is handled
3. The possibilities of inaccurate data being published.

In addition to an integrated platform, big data, and open data, various other smart city capabilities bring forth similar concerns. Leaving privacy concerns inadequately addressed can be very damaging in terms of ensuring ethical practices as well as building public trust. This said, privacy policies should not simply denounce the capabilities of smart city technologies. An effective balance of the two can maximise smart city benefits and citizen approval.

5.3.3. Privacy by Design Framework

Organisations such as EPIC recommend the Privacy by Design (PbD) framework to augment existing privacy principles, and it has already been adopted by organisations such as FTC and ICO[222][223]. PbD provides specifics on how PII is to be used and can serve as an answer to ongoing smart city privacy concerns.

PbD is an internationally recognised framework where privacy should be embedded into the design, operation, and management of technology networks and infrastructure. The PbD methodology can be applied to smart cities through examples such as restricting the amount of data collected by applications and devices to the amount necessary to fulfill its purpose, encrypting data as a default, de-identifying personal data, embedding menus of privacy settings and notices in user-friendly ways, and reducing the data retention times. The following are the seven tenets of PbD[224]:

1. **Proactive not Reactive:** PbD approach is characterised by proactive rather than reactive measures. It anticipates and prevents privacy invasive events before they happen. PbD does not wait for privacy risks to materialise, nor does it offer remedies for resolving privacy infractions once they have occurred — it aims to prevent them from occurring. In short, PbD comes before-the-fact, not after.

[222] https://epic.org/privacy/ftc/EPIC-FTC-IoT-Cmts.pdf
[223] https://www.insideprivacy.com/uncategorized/big-data-analysis-is-possible-without-infringing-key-privacy-principles-says-international-working-group/
[224] https://www.iab.org/wp-content/IAB-uploads/2011/03/fred_carter.pdf

2. **Privacy as a Default Setting:** PbD seeks to deliver the maximum degree of privacy by ensuring that personal data are automatically protected in any given IT system or business practice. If an individual does nothing, their privacy still remains intact. No action is required on the part of the individual to protect their privacy — it is built into the system, by default.

3. **Privacy Embedded into Design:** PbD is embedded into the design and architecture of IT systems and business practices. It is not bolted on as an add-on, after the fact. The result is that privacy becomes an essential component of the core functionality being delivered. Privacy is integral to the system, without diminishing functionality.

4. **Full Functionality:** PbD seeks to accommodate all legitimate interests and objectives in a positive-sum "win-win" manner, not through a dated, zero-sum approach, where unnecessary trade-offs are made. PbD avoids the pretense of false dichotomies, such as privacy vs. security, demonstrating that it is possible to have both.

5. **End-to-End Security:** PbD, having been embedded into the system prior to the first element of information being collected, extends securely throughout the entire lifecycle of the data involved — strong security measures are essential to privacy, from start to finish. This ensures that all data are securely retained, and then securely destroyed at the end of the process, in a timely fashion. Thus, PbD ensures cradle to grave, secure lifecycle management of information.

6. **Visibility and Transparency:** PbD seeks to assure all stakeholders that whatever the business practice or technology involved, it is in fact, operating according to the stated promises and objectives, subject to independent verification. Its component parts and operations remain visible and transparent, to users and providers alike.

7. **Respect for User Privacy:** PbD requires architects and operators to keep the interests of the individual uppermost by offering such measures as strong privacy defaults, appropriate notice, and empowering user-friendly options.

Adoption of PbD will provide clarity to data controllers on how specifically to handle PII data for new ICT technologies and ensure individuals that effective processes are in place for privacy protection. In addition, specific solutions should be implemented in smart cities to help with risk assessment and increased use and release of data.

5.3.4. Specific Solutions

Privacy Impact Assessment (PIA)

Privacy Impact Assessment aims to identify and mitigate privacy risks in the implementation of new projects. A PIA should identify what, why, and how personally identifiable information

(PII) is being collected, used, accessed, shared, safeguarded and stored. A PIA should also carefully assess the possible consequences for individuals that have shared PII[225].

Expanded Consent

Traditional consent involves "notice and choice." The individual should be notified of data collection, and then provided a choice on whether or not consent is given. Smart city applications necessitate new strategies and integrating technology to obtain consent in the context of smart devices; examples include[226]:

1. Utilising management dashboards for individuals to review the data they have chosen to share through various devices and applications.
2. QR codes can be placed on IoT devices to be scanned by individuals to allow mobile access to privacy policies and ability to consent
3. Utilising set-up wizards to assist individuals in setting up data collection choices

UK's ICO has also set new requirements on consent. Vague and binary consent forms are not enough. ICO has required consent to be very specific and granular[227]. This allows individuals to clearly specify which data they will allow to be collected, rather than accepting, rejecting data collection entirely.

Additional methods of pre-collection are being looked into for allowing individuals to set data collection preferences for future collection. There will undoubtedly be challenges in obtaining consent in all circumstances, but diminishing the consent requirement would threaten an individual's control on their data. Implementing these expanded consent forms can provide some ways to allow for increased transparency to citizens and expanded data usage. In cases where consent is vague, the data controller should be accountable for processing the data within carefully balanced limits, where the data controller's interests do not override the data subject's interests.

De-Identification

Data collected should be de-identified whenever feasible. Total anonymisation is near impossible, but there should be considerations on what method of de-identification should be used based on the nature of the data. Organisations such as Internet Engineering Task Force (IETF) have set standards on anonymity, pseudonymity, and identity confidentiality[228].

[225] http://searchcompliance.techtarget.com/definition/Privacy-impact-assessment-PIA
[226] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2711290
[227] https://ico.org.uk/media/about-the-ico/consultations/2013551/draft-gdpr-consent-guidance-for-consultation-201703.pdf
[228] https://tools.ietf.org/html/rfc6973#section-6.1.1

5.3.5. *Global Leading Practices*

In 1995, in the EU, the Data Protection Directive 95/46/EC, based on the OECD privacy principles, was adopted and to be advised by the Article 29 Working Party[229][230]. However, with the rapidly changing ICT landscape, the EU has moved to make another update on privacy. The EU General Data Protection Regulation (GDPR) was adopted in 2016 and will effectively replace the Data Protection Directive 95/46/EC. Additionally, as a regulation rather than a directive, the GDPR will become an enforceable law in all cities, governments and organisations within the EU member states by 2018[231].

Whilst the GDPR still reflects the key principles specified in the Data Protection Directive, it has proposed key changes in regulatory policies to protect citizens from privacy breaches even in increasingly data-driven environments. Key changes include making PbD a legal requirement, introducing penalties for infringement on PbD concepts, requiring the right for individuals to access data freely and in electronic format, requiring consent forms be easily readable, accessible, and capable of being withdrawn, and others[232]. Although the GDPR has not yet been enforced, some cities have already implemented some of these changes.

Vienna clearly provides information on the type, scope, and purpose of collecting, processing, and using data. The data is deleted after use unless there is expressed consent to further usage, and the city also provides easy mechanisms for citizens to opt-out of data collection[233].

London generates massive amounts of data through sources such as website, smartphone apps, CCTV, and payments systems. The city places emphasis on ensuring transparency to its citizens about data privacy with regard to data collected on individuals; this is reflected, for example, in the clear language (in layman terms) used to describe user-data collection, use, and storage, and other related notices and information about the dissemination of personal data[234].

In Berlin, the International Working Group on Data Protection in Telecommunications (IWGDPT) was established to assist with data protection and privacy[235]. The group brings together data protection authorities and telecommunication experts to adopt resolutions that increase attention to data protection. Included in these resolutions are specific recommendations on adopting PbD and increasing transparency, awareness, accountability, and consent in data usage in big data and open data[236]. Although the resolutions are not

[229] http://theprivacyprojects.org/wp-content/uploads/2009/08/FINAL-OECD-PRIVACY-GUIDELINES-PUBLIC-SECTOR.pdf
[230] http://www.eugdpr.org/how-did-we-get-here-.html
[231] http://www.eugdpr.org/eugdpr.org.html
[232] http://www.eugdpr.org/the-regulation.html
[233] https://www.virtualvienna.net/privacy-policy/
[234] https://www.london.gov.uk/about-us/privacy-policy
[235] https://www.privacycommission.be/en/berlin-group
[236] https://www.insideprivacy.com/uncategorized/big-data-analysis-is-possible-without-infringing-key-privacy-principles-says-international-working-group/

binding, they have encouraged and inspired other data protection authorities like the Article 29 Working Party of the EU.

In Japan, with regards to big data and other ICT technologies, the Act on the Protection of Personal Information introduces two new categories of information, namely sensitive information and anonymised information[237]. Sensitive information has greater restrictions on transmission of data while anonymised information can be transmitted with certain restrictions without the express consent of the individual.

Cities in the US have also begun to implement solutions based on or similar to PbD tenets.

Seattle controls the way it collects, uses, and deletes data across departments closely along the PbD framework. The city's CTO has created an interdepartmental team to liaise departmental efforts and a privacy committee composed of privacy experts to recommend best practices. The city's CTO has also created an ethical framework to unite the departments under a shared commitment to processes and procedures. In addition, departments receive a "privacy toolkit". As part of the toolkit, the city will require departments to complete annual on-line privacy and security awareness classes on privacy best practices. It will also provide PIA protocol for departments collecting new types of data, embarking on new programs or introducing new technologies to go through a process to self-assess any privacy risk that innovation may entail. The PIA assessments are then made available on a public portal to inform citizens of the privacy measures to alleviate concerns on the use of their data[238].

To improve transparency and gain public trust, Chicago released a dataset on 100 million taxi trips, but publishing also a report to describe how the data was prepared and altered to protect privacy[239]. In addition, Chicago finalised a privacy policy on how data collected from cameras on city streets will be used. New York City similarly published its citywide IoT guidelines for privacy, transparency, and data management[240].

5.3.6. Recommendations for Hong Kong

In Hong Kong, the Office of the Privacy Commissioner for Personal Data (PCPD) is responsible for overseeing the enforcement of the Personal Data (Privacy) Ordinance. Moving forward, Hong Kong may consider improvements in the privacy protection regime vis-a-vis new trends and demands in smart city development.

Work jointly with the PCPD to adapt privacy principles based on PbD for smart city capabilities

[237] https://www.dlapiper.com/en/japan/insights/publications/2015/09/new-amendments-to-japanese-privacy-law/
[238] http://datasmart.ash.harvard.edu/news/article/protecting-big-data-742
[239] https://www.citylab.com/tech/2017/02/how-cities-handle-open-data-protection-privacy-harvard-research/517566/
[240] http://datasmart.ash.harvard.edu/news/article/datasmart-resources-internet-of-things-856

The Government and PCPD may work together in consultation with stakeholders to refine the existing privacy principles based on PbD that commit the B/Ds, public and private organisations to policies that keep data private and processes transparent.

Implement additional privacy measures

Like Seattle, Hong Kong may look to implementing privacy techniques and assessments, especially for planned pilot projects, to identify possible gaps and risks early. The UK ICO, in their data protection principles, touched on possible compensations, but mentioned that agreement is left for the affected parties to decide[241]. Hong Kong may explore how the data controllers are held accountable.

Set policies and specify practices around consent, transparency, and de-identification

In line with Berlin's IWGDPT recommendations, policies to provide clarity in the area of consent are especially important. The policies should clearly define the responsibilities and limitations of data controllers as they collect and use data. Hong Kong can also explore the possibility of policies that enable expanded forms of consent to be incorporated depending on the situation.

To increase public trust, Hong Kong may adopt practices similar to Chicago and London in the area of transparency. With devices that make explicit consent difficult to capture such as cameras, phones, and payment systems, Hong Kong may provide easy to find and read information on how that data is handled, secured and deleted.

Data controllers often have to decide which de-identification technique is best suited for the data used and the purpose it is used for. Additionally, data controllers have to determine at what point the de-identification of a dataset is robust enough for the data to be shared. The PCPD has already published guidance materials on data erasure and anonymisation[242].

Further work

Hong Kong has established its own privacy protection framework for many years and there is growing public awareness of privacy issues. On the other hand, there is a rising community aspiration for more smart city solutions and applications. In addition to having an overarching privacy protection framework that balances the need of protecting personal data and use of such data (in various forms) for smart city implementation, some projects proposed in the Development Plans require specific consideration of legislative amendments (e.g. Electronic Road Pricing Scheme may require a new legislation). Alternatively, sector-specific industry

[241] https://ico.org.uk/for-organisations/guide-to-data-protection/principle-6-rights/compensation/
[242] https://www.pcpd.org.hk/english/resources_centre/publications/files/erasure_e.pdf

guidelines or practices could be published to provide greater flexibility for adapting to advancement in technologies. The potential legislative changes required for each theme have been discussed in Section 3 Smart City Development Plans.

6. Public-Private Partnership

6.1. Introduction

Smart city calls for close collaboration among the public sector, private sector, academia and citizens over the whole cycle of smart city implementation: from identification of city challenges, formulation of policy and strategy, research and development, conceptualisation of potential projects, feasibility assessment, proof of concept through pilot projects to city-wide implementation. Therefore, Public-Private Partnership (PPP or P3) in smart city is a broad concept, this section focuses on possible PPP models that can be considered for pilot projects and city-wide implementation.

Considerations for the appropriate PPP model for individual smart city projects

Whilst PPP models can generally be applied to smart city initiatives across different themes, a detailed assessment would be required in order to determine the appropriate PPP model(s) for smart city projects on a case-by-case basis, taking into account factors such as:

- Risk allocation (risk appetite of the Government, the level of risk transfer);
- Procurement time;
- Evolution and changing pace of the proposed solutions and services;
- Total lifecycle cost/Transaction costs;
- Price and delivery certainty;
- Project tax burden;
- Accelerated construction;
- Government involvement and the extent of control in operations;
- Government's capability and skills;
- Market readiness; and
- Public acceptance.

An important element to determining the appropriate PPP model(s) are inputs from the private sector. Therefore, the Government could promulgate its intention of leveraging PPP for smart city implementation during the public consultation expected to be conducted after this study. This would allow the private sector to consider and propose the preferred PPP models, which could then be reflected in the Smart City Blueprint.

6.2. PPP Model

The range of PPP models set out in the table below are not exclusive – for instance, the pilot for a smart city project could be funded by government research grant while the city wide implementation of the same project could be supported by PPP.

- **Purchaser / Provider Agreements** – The Government has extensive experience of involving the private sector in delivering services through purchaser/provider agreement. This arrangement can be implemented in a variety of forms, for instance, using private sector staff or expertise under in-house management (i.e. contracting in); contracting with an external party to provide specified services over an agreed timeframe (i.e. outsourcing or contracting out). In addition, the Government can also provide grants or subventions in the form of payment of a one-off sum or renewable lump sum to a private sector organisation or NGO to provide a service or to undertake a pilot project.
- **Private Sector Involvement** – Private sector involvement in smart city projects can take a number of implementation variations:
  - **Design Bid Build (DBB)**: Typical procurement method for the public sector, where the agency produces design documents and requests proposals from qualified vendors to execute the work.
  - **Design Build (DB)**: Procurement method by public agencies, where the contractor delivers both the design and construction (build) of a project. The public sector maintains ownership and operations and maintenance. A DB structure has generally been adopted for smaller projects and projects in which the public sector has familiarity and a clearly defined outcome and objective.
  - **Design Build Operate Maintain (DBOM):** The private sector provides these services under a single contract, with financing secured by the public sector. The public sector maintains ownership and retains a significant level of oversight of the operations through the terms defined in the contract. Often used for existing projects where upgrades and improved operational efficiencies are needed to reduce costs (wastewater treatment plants, energy facilities, etc.).
  - **Design Build Finance (DBF):** The private sector provides these services under a single contract. Operations and maintenance responsibilities are handed to the public sector upon completion. Often used for accommodation-type projects (schools, etc.) where the public agency 'leases' the asset.
  - **Design Build Finance Operate Maintain (DBFOM):** All services provided under a single long-term lease agreement. DBFOMs can be utilised for projects with a degree of complexity, transferable risk, and a significant operational period. DBFOM structures are often used for transport projects and defense

housing projects, where user charges (fares, tolls, rents, etc.) are paid to the public sector.

- **Concession (Build Own Operate (BOO), Build Operate Transfer (BOT, Build Own Operate Transfer (BOOT)):** A concession gives an operator the long term right to use all assets, including responsibility for all operation and investment. Asset ownership remains with the public sector. Assets can revert to the public sector at the end of the concession period, including assets purchased by the operator. In a concession the operator typically obtains its revenues directly from the consumer.
- **Privatisation:** Ownership of the asset is transferred to the private sector. Privatisation is usually employed for existing assets and services when the public sector is no longer in need of a particular asset or able to provide services in an economic manner. Oversight of the private sector's operations can be provided through regulatory bodies.

Some newer models for PPP have evolved recently to adapt to changing economic, environmental and social factors like rapid urbanisation, technology innovation, the growth of ageing populations, high-tech talent shortages, and the global economic downturn. Many aspiring smart cities and regional organisations, in particular, have responded to these complex challenges with new PPP designs. Some leading examples include:

European Union (EU) P3 for Innovation

The EU has launched an initiative called Horizon 2020 (H2020) to address the underinvestment in R&D from the private sector and further drive research collaboration across Europe. This research and innovation programme is focused on improving the environment for innovation with funding from fundamental research through market introduction. The objective is to foster research in the European Research Area (ERA) by coordinating national research policies and pooling research funding strategically in order to avoid duplication. With a total investment of around 80B EUR over 7 years, H2020 intends to drive a knowledge economy that will in turn spur additional private investment for large-scale, longer-term, and risky research and innovation initiatives in strategic, globally competitive technology sectors.

Success will translate into developing technology applied to lowering carbon emissions, finding alternatives to fossil fuels, discovering new treatments for poverty related diseases and threats from antimicrobial resistance[243]. H2020 is designed to enable innovative technologies to enter the market faster by allowing companies to accelerate the learning process through increased collaboration and information sharing, driving the creation of more jobs and expanding the economy. Contractual PPP under H2020 are being used to set objectives,

[243] https://ec.europa.eu/programmes/horizon2020/

commitments between the partners, key performance indicators, and outputs to be delivered. Contractual PPP include these areas:

1. Factories of the future;
2. Energy efficient buildings;
3. Green vehicles;
4. Future internet;
5. Sustainable process industry;
6. Robotics;
7. Photonics; and
8. High-performance computing.

Knowledge and Innovation Communities were also established under H2020 bringing together education, research and business sectors in long-term research efforts[244].

In the energy efficient buildings area, as of March 2016, the results achieved across all projects (127 total through 2014) produced[245]:

1. 30.5% CO2 reduction;
2. Generated 0.9 average patents per project;
3. 305 average people trained per project;
4. 34.8% average energy reduction per project; and
5. Participation of SMEs of 31%

Amsterdam

Amsterdam Smart City (ASC) is a partnership between businesses, governments, knowledge institutes, and citizens of Amsterdam. Collaboration among multiple stakeholders is key in the development of innovative technology-driven solutions for sustainability in cities. Currently, Amsterdam Smart City has a platform of around 100 partners working on more than 90 innovative projects. It focuses mainly on Smart Mobility, Smart Living, Smart Society, Smart Areas and Smart Economy[246] .

The aim of the ASC platform is to develop Amsterdam into a smart city, with an enhanced quality of life where living and working is pleasant. ASC serves as a project accelerator in Amsterdam's innovation ecosystem. Within this ecosystem, the platform ASC boosts the transition towards a smart city in three steps[247]:

[244] https://eit.europa.eu/activities/innovation-communities
[245] http://ectp.org/fileadmin/user_upload/documents/E2B/EeB_PPP_Project_Review_2016.pdf
[246] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/organisation/amsterdam-smart-city
[247] https://amsterdamsmartcity.com/

1. **Connecting**: Challenging different parties to come with innovative solutions and ideas for major city-related problems and connecting these parties.
2. **Accelerating:** Accelerating the movement towards a smart city via the use of the platform.
3. **Strengthening**: Stimulating the development of new markets and business models and investigating if it is possible to replicate projects in different parts of the city.

The ecosystem consists of key players, as well as relevant policies/ambitions, legal frameworks, network organisations, connectors, and funding sources. Unlike traditional PPP, the design of the ASC platform allows for experimentation and piloting of new technologies and methods. Ideas for projects can come from various sources such as the city administration, large corporations, SME's, start-ups, NGOs or citizens. Open innovation, collaboration, and communication are promoted by ASC, which hosts a website where any member of the smart city community can add a project. The platform is organised by two categories of partners: strategic programme level partners and project level partners. There are eight strategic partners (2015)[248]: the City of Amsterdam, the Amsterdam Economic Board, Alliander (energy grid company), KPN (telecom/ICT), Arcadis (natural and built asset design and consultancy firm), PostNL (logistics), Amsterdam ArenA (stadium) and Amsterdam University of Applied Sciences. Each core partner pays an annual fee and commits human resources to the organisation. They have a dedicated officer at ASC and have a three-year renewable commitment. They meet every two weeks to discuss the latest developments and any new innovation focus area requests for their consideration. ASC acts as a broker for new private and public partnerships and connector between multiple urban stakeholders. Its staff also organises many local and international venues where members can meet each other and form joint partnerships on initiatives and exchange ideas and lessons learned. A recent study[249] examined current practices and lessons learned across a broad range of smart city projects in Amsterdam in three key themes in urban sustainability: energy, mobility, and circular economy. Eight key insights were garnered for initiating, developing and executing smart city projects[250]:

1. The partnership should fit the project scope and must be open to new input;
2. Project scope and focus should be clear and shared by all partners involved;
3. Projects benefit from clear ownership and committed project leadership;
4. User engagement is a multi-layered and ongoing process;
5. Value of the project needs careful consideration and evaluation;
6. Development of a viable business model is key to continuation and upscaling of the project;
7. Technology does not need to be new to produce innovation, instead, it is the way it is used and integrated; and

[248] https://amsterdamsmartcity.com/
[249] http://www.iamsterdam.com/en/business/news/2016/amsterdam-leading-the-way-in-smart-city-projects
[250] Winden, W. van, Oskam, I., Buuse, D. van den, Schrama, W., Dijck, E. van (2016). Organising Smart City Projects: Lessons from Amsterdam. Amsterdam: Hogeschool van Amsterdam

8. Upscaling is a multi-layered process and cannot prosper without sharing knowledge

Copenhagen

Internationally recognised as a green growth economy leader, Denmark has been ranked in the top 2 of the Global Green Economy index multiple times in recent years for medium-sized cities.[251] Copenhagen's State of Green consortium is a public-private partnership between government, academia, and industries. The State of Green consortium unites leading players in energy, climate, water, environment to move towards making Denmark the first carbon neutral country by 2050. Innovation platforms are important for the collaboration that shapes the solution. The platforms also inform the necessary changes to the government procurement process in order to facilitate more small and medium enterprises (SMEs) to participate in the competition. Copenhagen has organised the innovation platform into clusters that attractive for international companies, investors, and talents. One of the most successful is the Cleantech cluster.

Copenhagen Cleantech Cluster (CCC)[252] functions as a platform where industry and the public sector can meet and innovate solutions to advance towards the common goal of carbon neutrality. Some key facts about CCC include:

1. Copenhagen Cleantech Cluster (CCC) had 12 partners and a total budget of DKK 142 million.
2. The project created 1096 jobs and supported 126 start-up companies.
3. The project was financed by EU funds and support from the Capital Region of Denmark and Region Zealand.
4. In 2014, CCC merged with Lean Energy Cluster, resulting in the national cluster CLEAN[253].
5. CLEAN is Denmark's green cluster with more than 170 members from the public and private sector and knowledge institutions.
6. The cluster works with energy, environment, smart city, and internationalisation.

The main functions of CCC are:

1. Facilitation: coordination of cluster activities and communications about projects, news and events in the cleantech industry;
2. Matchmaking: making connections between organisations and people;
3. Test and demonstration: provides access to research and full-scale demonstration facilities;
4. Innovation and entrepreneurship: start-up support from concept through success businesses; and
5. International outreach: connects CCC with other clusters around the world for knowledge transfer and exchange of ideas.

[251] www.smart-cities.eu
[252] https://stateofgreen.com/files/download/442
[253] http://cleancluster.dk/en/

Since the public sector owns the majority of city infrastructure, which generates tons of data, foreign, and domestic private sector firms seek these PPP relationships to grow their businesses, leverage the branding opportunity, and produce smart solutions.

Copenhagen's partnership with other cities also helps multiply the business opportunities from co-branding. If a smart solution is deployed in Copenhagen, other Danish cities can rapidly access the solution for assessment of its fit in that city and possibly more rapid deployment than by conventional procurement activities.

Spain-PPIPs for Healthcare

Plagued by rising costs, growing ageing populations, impacts from the global financial crisis, and shrinking health system budgets over the last two decades, governments are struggling to provide adequate healthcare facilities and services. The Valencia region in Spain has pioneered a new approach to funding and building new hospitals called the public-private investment partnership (PPIP). This PPP model goes well beyond the established PPP models commonly seen in other countries in that the PPIP in Spain engages the private partner to finance, build and operate the hospital as well as provide clinically and support services; this is in contrast to the commonly established PPP models where the private sector finances the building of hospitals, which are then run by the public authority. These services are broad in scope and can run the range from ambulance transport through immunisations and surgery. The region's health providers enjoy a 91% citizen satisfaction rating for services. Tight cost controls are reflected in spending that is 20-25% less than comparable publicly managed hospitals[254]. The four key principles that form the foundation for the Valencia PPIPs are[255]:

1. DBOD (design-build-operate-deliver): Private partners or consortia provide financing, design, build and operate healthcare facilities and a broad range of clinical and non-clinical services.
2. The government retains full ownership of assets at the end of the long-term (15+ years) contract.
3. Long term, shared investment: public and private partners commit to providing health services for predefined populations. If a patient is forced to see an out of network provider, the hospital has a contractual agreement to pay for the out of network services. The contract stipulates a set profit ceiling and anything earned above the ceiling is used to improve services or facilities (e.g. digitisation of healthcare records, competitive sourcing of supplies)
4. Risk transfer: Private partners are responsible for meeting service quality benchmarks, construction cost overruns, and managing human resource challenges. The public partner is responsible for ensuring quality service delivery through regulation, contract oversight, and management.

[254] http://www.who.int/bulletin/volumes/87/12/09-031209/en/
[255] The Global Health Group (2009) and PwC, Public-Private Investment Partnerships: https://globalhealthsciences.ucsf.edu/sites/globalhealthsciences.ucsf.edu/files/pub//hsi-ppip-atlas.pdf

The model for the PPIP can be summarised as below[256]:

Public funding	Private investment and management
Payment per capita: fixed budget (risk transfer)	Investment in infrastructure
Freedom of choice: money follows patients	Management Innovation
	Client orientated healthcare
	Integrated healthcare (including preventive and community care)
Public property	**Public guarantee**
Reversion to the government at the end of the contract	Equal access and services for everybody
Integrated into the NHS	Government: Inspection and control, through the commissioner working in the hospital

The United States of America – Energy Savings Performance Contract

The Department of Energy (DOE) of the US Government claims a "robust data center program" which aims to partner government agencies and energy service companies to save energy costs at data centres by implementing various energy saving measures. More than 550 facility-related Energy Savings Performance Contract (ESPC) projects worth $3.6 billion were awarded to 25 federal agencies and organisations in 49 states and D.C. as of March 2010, according to DOE's Federal Energy Management Program. The result being $11 billion savings in energy costs[257].

Simply put, an ESPC is a partnership between a government agency and an energy service company (ESCO). The ESCO conducts a comprehensive energy audit for the federal facility, identifies areas of improvements, designs and constructs a project that meets the agency's needs and arranges the necessary funding. A third-party financier provides the up-front capital for the project and as energy savings accrue, those savings are paid to the financier until the financing agreement is complete. The ESCO guarantees energy cost savings sufficient to

[256] http://www.reform.uk/wp-content/uploads/2014/11/Healthcare_in_Spain.pdf
[257] Schneider, The Case for Energy Savings Performance Contracts in Your Data Center (http://blog.schneider-electric.com/government/2015/12/18/the-case-for-energy-savings-performance-contracts-in-your-data-center/)

pay for the project over the term of the contract. Other funding sources could include savings from reduced operational and maintenance costs or utility incentives and tax incentives.

A variation to the ESPC model is Total Facility Asset Management Contract (TFAM). It is an innovative business solution that combines facility management, lifecycle, management, energy management and buildings technology convergence into a single, long-term, fixed-price contract for both new and existing facilities.

Ontario - Green Bonds

Green bonds are financial instruments that cities may utilise to attract private finance (usually from institutional investments) for smart city projects. Green bonds are fixed-income securities issued to raise capital for a project that contributes to a low-carbon, climate-resilient economy or measure for climate change mitigation.

For instance, Ontario is the first Canadian province to issue Green Bonds, leading the way to establish and develop a Canadian dollar Green Bond market with investor participation from around the world[258]. It serves as an important tool to help Ontario finance transit and other environmentally friendly projects across the Province. On 2 October 2014, Ontario successfully launched a Green Bond programme, with an inaugural global Canadian dollar bond of $500 million. On 22 January 2016, Ontario launched a second global Canadian dollar bond of $750 million.

Peterborough - Social Impact Bonds

Social Impact Bonds can be defined as a contractual arrangement whereby the public sector commits to pay the private sector for improved outcomes of privately-delivered social services. The necessary investment is typically raised from socially-motivated investors or trusts. Investors will receive payments from the government that cover the initial investment plus a financial return that links with the resulting outcomes. The investors bear the financial risk of paying for services.

An example is Peterborough Social Impact Bond[259]. A non-profit organisation designed and manages a £5m Social Impact Bond to reduce re-offending among short-sentenced male prisoners leaving Peterborough prison. A consortium of six organisations under the auspices of the One*Service offer a tailored service that focuses on the immediate needs such as accommodation, medical services, family support, employment and training, benefits and financial advice. This is to provide stability and support for the prisoners.

Australia/ Sweden – PPP for Automated Waste Collection System

[258] Ontario Financing Authority, Province of Ontario Green Bonds (http://www.ofina.on.ca/greenbonds/)
[259] Social Finance Limited, Peterborough Social Impact Bond (http://www.socialfinance.org.uk/impact/criminal-justice/#sthash.gvsydV9v.dpuf)

The Automated Waste Collection System in Maroochydore, Queensland, Australia, successfully leverages a PPP model in which 50% of the AUD 21 million development cost is funded by developers, while the remaining 50% is expected to be fully recovered from occupants of the development over the life cycle of the system. The waste collection system is a 6.5 km network of pipes covering over 52 hectares of land in Maroochydore, a town in Queensland, Australia which the Government is redeveloping into a central business district (CBD). The system is being designed and delivered by SunCentral Maroochydore Pty Ltd, an agency established by the Sunshine Coast Council. The Sunshine Coast Council, in turn, partnered with a private environment technology company in Sweden to install the waste collection system[260,261,262,263].

Similarly, four automated vacuum waste collection systems installed in Hammarby Sjöstad, Sweden were implemented with PPP. This automated trash system is part of the district's sustainability programme[264]. Here, as with many other places in Sweden, the property owners in Hammarby Sjöstad jointly own the network of automated waste collection systems through a joint-property association. The City of Stockholm compensates the property owners by charging a greatly reduced rate for waste collection (due to the fact that there is an overall reduction in waste collection costs). A private sector provider is commissioned by the joint-property associations to operate and maintain the automated waste collection facilities. The higher investment cost is offset by the significantly lower operating and maintenance costs, and the considerable space savings[265]. This system has resulted in a 60% reduction of heavy-waste-collection vehicles on the road[266].

Based on these two examples, some common areas of consideration for PPP to develop, build, and operate Automated Waste Collection Systems emerge. It is important to note that local context considerations, such as local legislation and regulation, should also be taken into consideration when designing the appropriate PPP model. The key considerations are as follows:

- Design and Build
  - Who will design and build the system

- Operating and maintenance agents
  - Who will operate the system
  - Who will maintain the system

[260] http://www.tiq.qld.gov.au/wp-content/uploads/2015/05/TIQ-15-271-Maroochydore.pdf
[261] https://www.sunshinecoast.qld.gov.au/Council/Planning-and-Projects/Major-Regional-Projects/Maroochydore-City-Centre/Maroochydore-City-Centre-PDA
[262] http://www.news.com.au/finance/real-estate/brisbane-qld/you-dont-have-to-worry-about-missing-the-garbage-truck-in-this-new-community--there-are-none/news-story/3475d6612007cb0a6970d9e053c98dc0
[263] http://www.abc.net.au/news/2016-09-21/maroochydore-rubbish-revolution-envac-underground/7864272
[264] http://www.envacgroup.com/projects/europe/hammarby_sjostad
[265] http://docplayer.net/37309820-Hammarby-sjostad-a-beacon-of-sustainable-urban-development.html
[266] http://www.envacgroup.com/projects/europe/hammarby_sjostad

- Asset ownership
  - Who will own the assets

- Funding processes and agents
  - Who will provide funding for building the system
  - Who will provide funding for operation and maintenance of the system
  - How will it be funded/ what is the financing model
  - How will the capital expenditure and recurrent expenditure be recovered

- Governance
  - Who will make and approve decisions at stages different stages of the work flow.

Hong Kong – A model proposed by a local organisation

A non-profit industry consortium has suggested a multi-partite model to coordinate the inputs of the private sector technology vendors, industry bodies and academies for the pilot implementation of smart city projects in Hong Kong. Briefly, it involves:

- Government B/Ds as project owner
- OGCIO as ICT advisor
- A non-profit consortium as implementation coordinator to :
  - Engage the private sector technology vendors, other industry bodies and academies to participate and support the pilot implementation
  - Collect and consolidate ideas from the private sector technology vendors, other industry bodies and academies
  - Propose innovative ideas to the Government which can be readily implemented as pilot projects
  - Act as the coordinator and liaise between these stakeholders
- Private sector technology vendors.

This consortium/platform model requires the Government to fully fund the projects, which is similar to the traditional public-sector procurement approach save that an individual private consortium assumes the roles for problem identification, advisory and coordination. This model however does not incentivise the private sector in sharing the costs of investment and maintenance as well as the benefits and risks of the projects. Such a selection of non-profit consortium and Government's role in monitoring of service delivery and standard also present new challenges to current government policies and practices.

Supporting Local SMEs

It is important for the Government to seek to provide an enabling environment and facilitate participation of start-ups and SMEs in smart city initiatives. This can be achieved through the Government's procurement approach[267], payment scheme and advisory/assistance schemes.

- In relation to the procurement approach, the following are the overseas examples which facilitate the participation of local start-ups and SMEs:
  - The US SME procurement approach covers small business, small disadvantaged business (i.e. owned by historically disadvantaged individuals), veteran- and women-owned small business and other categories. The programme targets US-based individuals and enterprises that contribute to the US economy through payment of taxes and use of US materials, labour and services. At the federal level, annual targets are established in terms of percentage value of total contracts awarded to small businesses. Implementation is undertaken through federal procuring agencies and local and state authorities who collaborate with the US Small Business Administration (SBA). However, the SBA has overall regulatory authority. The scheme includes an exit strategy for SMEs after a specified period of time, assuming they do not grow sufficiently to encounter automatic exclusion[268].
  - The Singaporean Government announced that local start-ups accredited by the government are getting a "green lane" to sell to the government. Of the S$2.4 billion of spending by the Singaporean Government on ICT in FY18, these accredited companies will get a preference on some of the deals. Government agencies, if they are looking for solutions that these accredited companies can provide, must procure from these companies first[269].

- The Republic of Korea provides an example of an integrated approach to promoting SME growth using a procurement platform. Unlike countries such as the US and South Africa, the Republic of Korea uses neither bid price preferences nor quotas to encourage SME participation in its public procurement market. The Korean Public Procurement Service Authority (PPS) has several initiatives to increase SME participation in government procurement used mostly within Korea's electronic procurement platform, Korea On-line E-Procurement System (KONEPS). PPS initiatives include advance payments to SMEs that qualify for an advance payment program for delivery of goods contracts, as much as 70% of the purchase price[270].

- On the internationalisation of smart city initiatives to other cities, the Hong Kong Government can consider assigning a specific agency with the task of promoting and exporting smart city solutions to other cities. One example is International

[267] https://www.wto.org/english/tratop_e/gproc_e/symp092015_e/S3-4Gordon.pdf
[268] https://www.adb.org/sites/default/files/publication/30070/sme-development.pdf
[269] https://govinsider.asia/innovation/singapore-changes-in-tech-procurement-govtech-jacqueline-poh/
[270] https://www.adb.org/sites/default/files/publication/30070/sme-development.pdf

Enterprise (IE) Singapore, which is a government agency responsible for promoting international trade, and supporting Singapore companies in global partnerships. In particular, IE Singapore focuses on identifying opportunities in specific sectors such as technology, media and telecommunications, aviation, land transportation and port services amongst others[271]. IE Singapore offers a suite of assistance schemes to local companies. Examples of financial assistance include tax incentives, e.g. Double Tax Deduction for Internationalisation (DTDi) which allows companies to enjoy a 200% tax deduction for eligible costs incurred from the company's internationalisation efforts, and grants, e.g. the Market Readiness Assistance (MRA) Grant that provides grants to SMEs to cover costs of activities such as overseas market set-up, identification of business partners and overseas market promotion[272]. Non-financial assistance such as knowledge resources, learning and networking is also available. An example of a success story is Sky Urban's export of its Sky Farm concept to other cities[273].

6.3. Benefits for PPP

Similar to the PPPs applied in the various locations mentioned, PPPs can tie into the economic development for Hong Kong through a number of ways such as infrastructure initiatives, public sector financing, and public service initiatives. When used effectively, PPPs can provide various benefits.

1. **Helps the public sector pay for services:** The public sector can turn to PPPs when it is recognised that additional investment may be needed. PPPs can create additional funds through user charges, effective revenue collection, or other alternative revenue funds.

2. **Requires the public sector to focus on project outcomes and benefits from the onset:** For the private sector to buy in to a PPP, the financial returns and benefits of the initiative must be well understood. This forces the public and private sector to go through an analysis process on perceived project benefits from the beginning of the initiative.

3. **Allows for quality to be maintained for life of the project:** A PPP contract can bundle the construction and maintenance sections of an initiative into a single contract. The private sector can then be incentivised to carry out maintenance regularly to attract users and increase user-fees.

4. **Encourages private sector to invest in public sector infrastructure projects and services:** PPPs provide opportunities for increased engagement and participation

[271] https://www.iesingapore.gov.sg/Venture-Overseas/Browse-By-Sector
[272] https://www.iesingapore.gov.sg/Assistance/Overview; https://www.iesingapore.gov.sg/Assistance/MRA
[273] https://www.iesingapore.gov.sg/Venture-Overseas/SgGoesGlobal/SkyUrban

from the private sector in various initiatives. The private sector is encouraged to invest in PPPs based on financial benefits, but also incentivised to ensure success.

5. **Maximises both public and private sector skill and expertise:** By working together, the public and private sector partners can develop projects jointly, pooling their skills, and sharing experience, knowledge, and resources. With a partnering relationship, it is not necessary to pass areas of public sector business wholly to a contractor. The private sector can be brought into activities where it has relative strengths, without displacing key public sector expertise.

6. **Allows for effective risk allocation:** An effective PPP structure focuses on achieving optimal risk allocation. A PPP allows for the passing of some risk from the public to the private sector and then emphasises the need for the partners to work together to deliver the project goals and objectives for mutual success.

7. **Deliver budgetary certainty for the public agency:** A PPP contract can impose budgetary certainty by setting present and future costs of projects at the beginning of the project. The private sector can then be put in charge of effectively managing constraints throughout the project

8. **Encourage private sector to develop and promote innovation in the industry:** PPP will involve and give opportunities to the private sector to deliver innovative solutions to city challenges. In particular, SMEs may benefit from partnerships with the Government in PPP in two ways: improving their profiles and enabling them to compete for business locally that may translate to further opportunities globally. In addition, the Government may showcase the innovative contributions of local start-ups and SMEs through PPP.

6.4. A PPP Model for Elderly Care Homes in Hong Kong

Hong Kong is facing an ageing demographic with over 35% of the population to be 65 years old and above by 2064, and about 10% of the population will be classified as old-old (age 85 or above)[274]. Furthermore, Hong Kong also has one of the longest life expectancy in the world with an average lifespan of 87 years old for women and 81 for men. Unfortunately, over 70% of the elderly suffer from one or more chronic disease(s)[275,276]. The growing size of the elderly population will therefore, inevitability give rise to the need for more effective care and chronic disease management at home, at the community level and at elderly homes.

[274] Census and Statistics Department, Baseline Population Projections up 2064
[275] http://www.elderlycommission.gov.hk/en/library/Ex-sum.htm
[276] http://www.hkmj.org/system/files/hkmj144326.pdf

As of March 2017, there are approximately 730 elderly homes providing around 74,000 residential care places, including around 27 000 subsidised places and around 47 000 non-subsidised places [277]. In addition, there are another some 36,000 elderly waiting for subsidised residential care home places [278]. Initiatives and solutions, which can provide support to address imminent operational needs and resources issues of the elderly home, could help improve the overall quality of care offered to the elderly and, in the longer term, make available more residential care places which have been in urgent need.

While Hong Kong has a public healthcare system which provides all-rounded medical care to the elderly at a highly subsidised cost, and many Government, non-profit and private efforts help to address basic service requirements of the elderly in the community, NGOs and other private service operators which provide care services and support to the elderly (e.g. elderly home, community day care centres, home care service providers) are facing the following issues:

- Increasing challenges due to growing population of elderly, increase in frailty, susceptibility to multiple chronic diseases and, in some cases, having no close family members or offspring to take care of their personal matters;
- Increasing need for innovative, technology driven and localised solutions to enable more personalised, effective and integrated care for seniors; and
- Shortage of healthcare workers in general.

In recent years, there are many local SME start-ups focusing on developing technology driven solutions to meet the needs of the elderly, the carers and family members at home and in residents' settings. There are a number of government initiatives that facilitate the development and pilot of those solutions through funding support, elderly focused conferences and co-ordinated research.

While non-profit and private service organisations can benefit from adopting or making references to proven, innovative and technology driven solutions from other frontier countries, Hong Kong may be considered too small a market for investment and product localisation. Some of the technology solutions which operators are actively looking for localisation includes monitoring devices (for elderly with Alzheimer's disease), mobility assistive solutions (for those who are extremely frail or disabled), hygiene and health related care monitoring system, cognitive stimulation games or devices, and assistive robots and technologies for physical and socio-emotional interaction.

One of the key challenges, therefore, is a lack of a centralised and sustainable platform in coordinating all these private and public efforts in addressing the needs of the elderly from a strategic and longer term perspective.

[277] Social Welfare Department, Government of the HKSAR
[278] Social Welfare Department, Government of the HKSAR

Setting up a centralised and sustainable platform with public-private partnership would bring forth benefits including:

- Enabling better understanding of the basic and auxiliary needs of the elderly from a holistic view (covering care needs of the elderly across different stages of their lives);
- Serving as a knowledge hub where local demand needs and user requirements could be expressed and shared with potential solutions and research providers;
- Localising the co-creation and development of personalised, effective and integrated care with the use of innovative solutions and technologies that address the diversified needs of the elderly at different stages of their life, their family members and carers at the institution in a sustainable manner;
- Facilitating the exchange of ideas between those who develop and supply and those who demand and consume these products and services;
- Knowledge sharing of success and failure, and most importantly, how to improve the solutions so that the wellbeing of the elderly is enhanced;
- Leveraging economies of scale and expertise (through mapping of business needs, user requirements; consolidating demand) in localising international best practice and solutions for the local environment in a cost effective manner; and
- Accelerating discussion, ideation, research, design, implementation and commercialisation for wider use of innovative and smart solutions.

The benefits of this localised process are threefold: it benefits SME solution providers by addressing a local market; the NGO and elderly home solution users by adopting available innovative product and service offerings; and the Hong Kong economy by promoting use of local innovative products.

A small number of elderly homes can be selected for pilot for the implementation of elderly care solutions through the collaborative platform where anticipated benefits of which can be exemplified and scalable for broader application on such solutions in a home and community setting.

An independent and non-profit public body (e.g. HKPC) be engaged to convene the collaborative platform involving:

- NGOs/associations (e.g. HKCSS), public and private elderly home service providers/associations, local smart solution providers;
- Academic and research institutions (e.g. Sau Po Centre on Ageing of The HKU, The CUHK Jockey Club Institute of Ageing); and
- Other relevant key players in the sector (e.g. HKSTP, LSCM, Housing Society).

The platform convener could participate in business matching, quality assurance, project management, system integration, etc. for implementation of solutions and technologies for pilot elderly homes. Examples of solutions and technologies include:

- Electronic nursing service management system;
- RFID-based drug management system;
- Elderly homes electronic management system, e.g. basic IT systems on cloud-based shared services for privately run elderly home operators[279]; and
- Care robots to reduce care taker's work load.

The Government and various public bodies and funding scheme should provide the initial funding required for launching this proposed platform.

In the longer term, financial sustainability of this collaborative platform could be achieved through provision of research services, project management support, quality assurance, service maintenance, and revenue generation through operational cost optimisation of elderly homes.

[279] Some elderly home that are smaller or family owned, are not equipped with basic IT systems to facilitate its operations, such as handling of patient-cases etc.

7. Proposed Pilot Projects

7.1. Methodology and Structure to Facilitate Continuous City Innovation

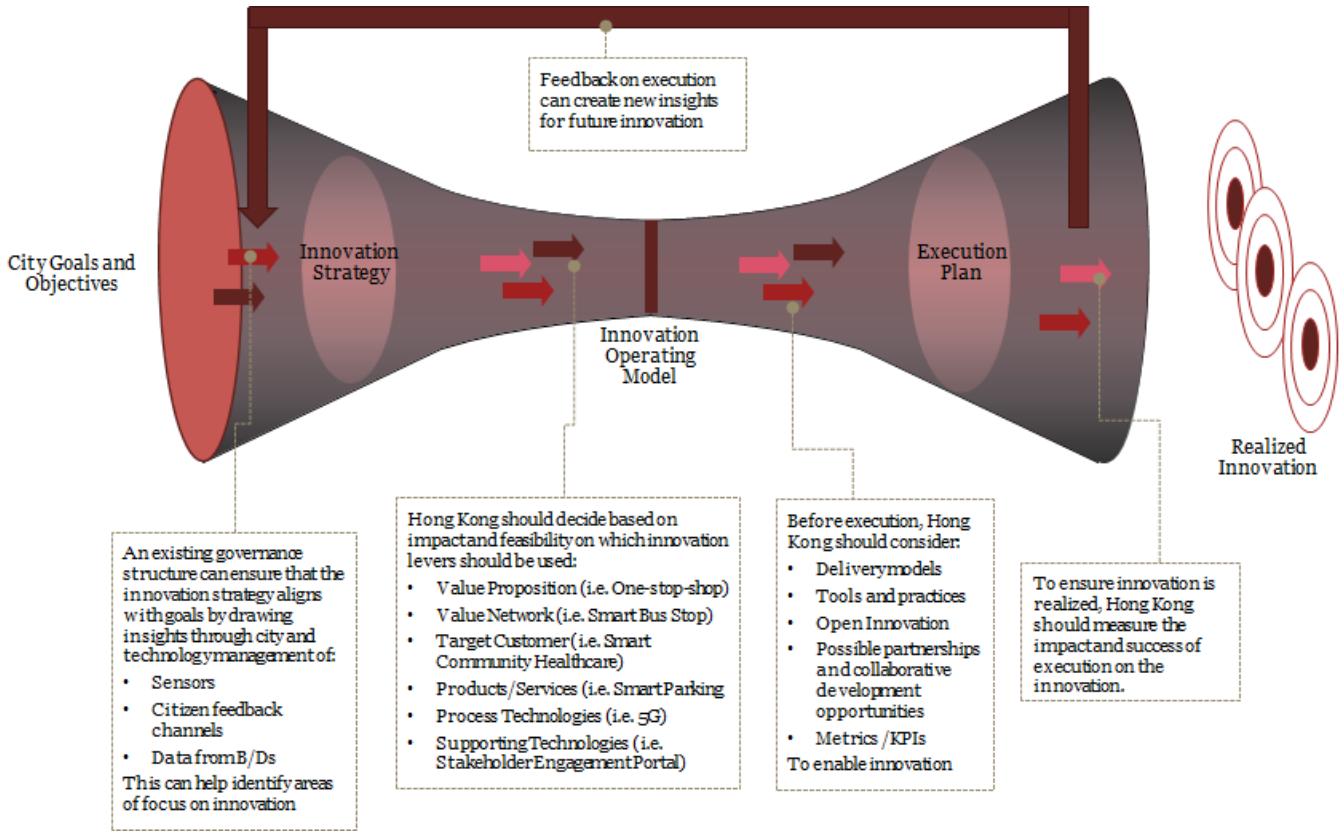


Figure 7.1 Framework for continuous innovation in Hong Kong

A city innovation framework should be adopted to facilitate continuous innovations in Hong Kong as a smart city even after initial pilot projects. To achieve innovation and growth, the city of Hong Kong should transition through five main phases, which are as follows:

A. City Goals and Objectives:

Innovation starts with the setting and revising the long-term city goals. Moving forward, Hong Kong should consistently baseline existing capabilities and technologies to adjust its city strategy based on its desires to achieve.

To transition to developing an innovation strategy, insights should first be drawn from the existing landscape. Specifically, Hong Kong should focus on capturing insights in five major areas:

1. Citizen: Identification of citizen's prioritised needs and prediction of possible future needs.

2. Channel: Identification of new ways to create/deliver services for citizens.

3. Product/Service: Identification of new smart services and products that could affect the future city landscape.

4. Policy: Identification of political shifts around privacy and other regulations.

5. Technology/Operations: Identification of technologies, processes, and techniques that are emerging and can potentially disrupt the current landscape and create new opportunities.

B. City Innovation Strategy:

The innovation strategy should clearly align and drive the city towards its goals. By focusing on the current city capabilities, Hong Kong should set a plan for how it should proceed with city innovation. Specifically, Hong Kong should look at which avenues, based on the current situation, have the most opportunities for improvement and are the most feasible. There are six major innovation levers or avenues that Hong Kong can consider including:

1. **Value Proposition:** This involves innovating the experience citizens and other stakeholders currently have with smart services. Examples are enhance drivers ability to head directly to the location with available parking through having access to real-time information on parking vacancy, digital persona used in financial services industry, empower users to assume the appropriate identity to perform and complete relevant financial e-services with ease, efficiency and without a middleman and using BIM in construction services from architect, developers and government agencies can experience more effective collaboration. Citizen's feedback can be analysed through conducting focus groups for Hong Kong to prioritise its needs.

2. **Value Network:** This involves optimising the supply and service chains and various distribution channels to deliver smart services.

3. **Target Customer:** This involves focusing innovations to tailor services specifically to target customer segments. An example includes the various projects Hong Kong is considering to improve living and healthcare for the elderly, frail, and disabled.

4. **Product/Services:** This involves considering new products and services that Hong Kong can feasibly deliver.

5. **Process Technologies:** This involves innovating on processes to reduce costs or improve quality in products and services that are being provided.

6. **Supporting Technologies:** This involves innovating in underlying technologies that may help with facilitating service provisioning.

C. Standards and Platform:

To maintain Hong Kong's leading position in global competitiveness and technology adoption, under the fast-changing technology environment, Hong Kong shall adopt the following principles when considering the selection of technology standards for the provision of smart city services.

- Adopt internationally recognised and mature technologies – By adopting internationally recognised or de facto standards that are mature and are widely used in the industry, it can facilitate market competitions and provide more choices to the wider general public. However, consideration should be given to the likely evolution of the mature standards, in the light of emerging standards and technologies, to minimise the likelihood of obsolescence of the mature standard.

- Ensure technology procurement is a non-proprietary solution – By promoting non-proprietary solutions on technology adoption, it help ensure that users have a wider choice of IT products and services, and a better performance of services that meet their needs, and offer the lowest total cost of ownership under a level-playing field environment.

- Promote market-led and interoperability – By promoting market-led approach to support wider choice for users, it can increase interoperability among products from different vendors and position Hong Kong as a test bed for different kinds of technology and acting as a gateway for international vendors considering to enter China market via Hong Kong.

- Promote the adoption of open standards – By promoting the adoption of open standards in favour of their proprietary alternatives, it can help facilitate interoperability, avoid technology lock-in and provide a level playing field to encourage market competitions.

- Adopt command and control manner if necessary – In the event that the application of the standard has implication to the safety and health of users, it is necessary to adopt a command and control manner to regulate the appropriate standards. On the other hand, given Hong Kong's proximity to Mainland China, the Government may consider to adapt and adopt standards of Mainland China to foster cross-boundary interactions.

To promote innovation, competition and a global marketplace for technology, it is important to consider an open approach for selecting the platforms/systems which support the following features:

- **Openness** – the source code has to be open and accessible according to the open standard principles;
- **Interfaces** – the interfaces between connecting different platforms and applications receiving/using data and sending commands have to be as simple as possible. As technology is moving to web services, the use of API is the simplest and most convenient way for implementation;
- **Performance** – the architecture of the platform has to be a simple and scalable, high capacity system to ensure performance in a data intensive and diverse city environment;
- **Resilience and service continuity** – the platform has to be built with resilience for scenarios of communication failure, system instability;
- **Security and privacy** – as cloud technology is becoming more prevalent, it is important to ensure that data security and privacy is strictly adhered. With that, the platforms should have equipped with an adequate level of security to avoid attack and ensure identification, authentication and authorisation measures are in place; and
- **Modularity** – The platform design should be based on the modular structure to allow flexibility for expansion.

It is also important that Hong Kong looks to leveraging innovation opportunities across various avenues rather than focusing on only one or two to maximise value creation.

D. Innovation Operating Model:

Hong Kong should consider the process frameworks, delivery models, practices, and tools needed to manage the innovation lifecycle.

More specifically, Hong Kong should consider possibilities of partnerships with a variety of organisations such as businesses and academia to deliver on innovation. Additionally, as Hong Kong has already shown, the Open Innovation paradigm should be adopted where Hong Kong utilises both local information, tools, and practices as well as external ones developed in other locations across the globe.

E. Execution Plan:

During the execution phase, Hong Kong should consistently review the level of success achieved from the innovation. Channels similar to a stakeholder engagement portal might be used to communicate with stakeholders to assess the value captured through the innovations and adjust the strategy as needed.

Through various channels, the feedback and communication received can feed into new insights that can catalyse future innovations as well.

7.2. Smart City Pilot Proposals

Pilot testing in the context of smart city is the conducting of small-scale trials in order to assess the practicality of the proposed solutions under the local environment and operational constraints, as well as the feasibility of implementing the proposed solutions on a territory-wide basis. This approach allows the Government to test innovative solutions in a managed and controlled manner so as to minimise unnecessary risks.

A list of criteria has been developed to help identify appropriate smart city pilot proposals with the following characteristics:

- Can be implemented in a relatively short timeframe;
- Are highly relevant to the community;
- Bring tangible benefits to the community;
- Have the potential for territory-wide implementation; and
- Are likely to be sustainable in the long term.

In total, there are six pilot areas suggested for the consideration of the Government.

1. Smart Public Transport Interchanges/Major Bus Stops	
Brief description of smart city pilot proposal	Selected current public transport interchanges (PTIs) or major bus stops will be transformed into smart PTIs/major bus stops with the following functions and features: • Integration of sensors into poles to demonstrate multi-functionalities (e.g. traffic detection, air quality) • ICT enablement for data collection • Provision of 3rd party hardware (telecom equipment, 5G, cell sites, electricity charger, etc.) • Provision of access of free Wi-Fi • Provision of multi-purpose touch screen offering a range of information (e.g. news, weather conditions, estimated time of arrival of the buses to the bus stops, the passenger's estimated time of arrival to the destination based on traffic, bus occupancy, bus options that passengers can opt for based on buses' arrival time, destinations and traffic, bus route/bus stop digital map) • LED lighting for enhanced energy efficiency • Digital signage for outdoor advertising • Other potential functions to consider include 999 Emergency Call button (which links to a video camera for capturing real-time situation when the

	button is pressed), broadcasting of emergency messages • Ideally at least some of the power requirements are provided by renewable energy
Smart theme	Smart Mobility
Proposed locations for pilot	At PTIs or at locations with less site constraints and where there is a concentration of passengers waiting for buses.
Implementation agents	• SCPO/OGCIO – coordinate with the relevant B/Ds on the implementation of this pilot (e.g. LandsD, TD) • CEDB/OFCA – approve installation of mobile communication equipment • Other relevant B/Ds involve in the implementation
Potential private sector involvement	Public Transport Operators
Timeframe	Technologies are readily available and the suggested pilot can be implemented within a short timeframe say two to three years. Services available at the booth can be offered in phases, with due consideration to availability of information, maturity of technologies, capacity of the infrastructure and demand of users amongst others.
Future expansion	An agreement should be in place between the Government and bus operators on the territory-wide rollout plan of Smart Bus Stops. The plan should cover all applicable bus stops in Hong Kong (i.e., those with shelter).

2. Smart Intelligent and Integrated Poles	
Brief description of smart city pilot proposal	Lampposts are important street furniture which have the potential to become wireless digital hubs. Upon resolving the ownership, management and maintenance responsibilities among the various stakeholders, it is anticipated that some selected lampposts at appropriate locations could be transformed into Smart Intelligent and Integrated Poles with the following features: • Integration of sensors/beacons into the poles to demonstrate multi-functionalities (e.g. air quality, parking, crowd control, traffic monitoring, positioning like Wi-Fi positioning) • ICT enablement for data collection

	• Provision of 3rd party hardware (telecom equipment, cell sites, electricity charger, etc.) • Provision of access to Wi-Fi connectivity • Display of information, such as air quality index, time and temperature • LED lighting for enhanced energy efficiency in conjunction with the LED installation programme under planning by HyD
Smart theme	Smart Government
Proposed locations for pilot	Selected developed areas (especially when there is a need to replace the existing lampposts)
Implementation agents	• SCPO/OGCIO – coordinate with the relevant B/Ds on the implementation of this pilot, including the resolving of the associated ownership, management, technical, maintenance and funding responsibilities • CEDB/OFCA - approve installation of mobile communication equipment • Other relevant B/Ds involve in the implementation
Private sector involvement	• A public-private partnership model similar to San Jose's SmartPoles pilot can be adopted. The private sector is requested to pilot 50 SmartPoles, which bring together energy efficient LED lighting and fully integrated 4G LTE wireless technology. The SmartPole is designed to house cutting edge small cell products. Mobile operators will be able to rent space in the poles. In this way, mobile network operators will be able to improve data coverage and capacity, resulting in enhanced mobile broadband services. • In exchange for the non-exclusive rights for SmartPole pilot, the private sector operator is required to replace (at no cost) existing streetlights in San Jose with new LED lightheads at a ratio of 15 LED lightheads (adjacent to SmartPole locations) per SmartPole installed.
Timeframe	Technologies are readily available and the suggested pilot can be implemented within a short timeframe say two to three years.
Future expansion	Upon successful conclusion of the pilot, the next phase should focus on expansion and implementation of Smart Poles in NDAs. Following this, on a progressive basis, Smart Poles should be used to replace existing "traditional" lamp posts. This will eventually result in Smart Poles being implemented city-wide.

3. Intelligent Signalised Junctions and Pedestrian Lights	
Brief description of smart city pilot proposal	Intelligent Signalised Junctions and Pedestrian Lights leverages the use of technology to improve traffic management for vehicles and pedestrian. The existing traffic signal system will be upgraded with the capability of interacting with the real-time demand of pedestrian and vehicles.
Smart theme	Smart Mobility
Proposed locations for pilot	Selected developed areas that cover different characteristics of traffic/pedestrian volume and pattern
Implementation agents	• SCPO/OGCIO – coordinate with the relevant B/Ds on the implementation of this pilot • TD – integrate the Intelligent Signalised Junctions and Pedestrian Lights with the wider signaling network • HKPF and FSD – arrange to install appropriate sensors in emergency vehicles • LandsD – provide pedestrian network
Private sector involvement	The private sector can support the development of technologies required for the Intelligent Signalised Junctions and Pedestrian Lights to interact collect real-time demand of pedestrian and vehicles.
Timeframe	Technologies are readily available and the suggested pilot can be implemented within a short timeframe say two to three years.
Future expansion	Upon successful conclusion of the pilot, the next phase should focus on expansion and implementation of Intelligent Signalised Junctions and Pedestrian Lights in NDAs. Following this, on a progressive basis, Intelligent Signalised Junctions and Pedestrian Lights should be used to replace existing "traditional" traffic lights. This will eventually result in Intelligent Signalised Junctions and Pedestrian Lights being implemented city-wide.

4. Smart Parking	
Brief description of smart city pilot proposal	Smart Parking provides guidance to drivers on available parking spaces (off-street) and pricing information (which may be dynamically adjusted). This helps reduce congestion and avoid having cars

	to make unnecessary journeys or queue around the car parking space and/or car park.
Smart theme	Smart Mobility
Proposed locations for pilot	• Selected car parks under the management of the Government • Selected car parks owned and managed by private operators who are prepared to share their data
Implementation agents	• SCPO/OGCIO – coordinate with the relevant B/Ds on the implementation of this pilot • TD – coordinate with the relevant car park operators on the implementation of this pilot
Private sector involvement	The private sector has the capability to develop applications as long as parking data are available and an appropriate commercial model is established.
Timeframe	Technologies are readily available for sensing the availability of parking space. The suggested pilot can be implemented within a short timeframe assuming data are available.
Future expansion	For the remaining car parks not covered in the pilot, such as those car parks owned and managed by private sector, to adopt Smart Parking on a progressive basis.

5. Science Park and The Chinese University of Hong Kong – Smart Region Living Lab for Smart City	
Brief description of smart city pilot proposal	To set up a living lab to support and pilot application of innovative solutions. The objectives are to accelerate the adoption of new technology; to enhance collaboration and knowledge sharing of solutions and projects in the region; to build a vibrant social community for cultural and technology exchange; and to highlight the research and development activities in the region. The first batch of pilot projects include a social culture platform, autonomous self-driving vehicles, smart building and facility management, and a cashless society. Depending on the timing, application of 5G communications technology will be incorporated.
Smart theme	Smart People, Smart Living, Smart Mobility, Smart Environment
Proposed locations for pilot	Hong Kong Science Park and The Chinese University of Hong Kong
Implementation agents	• SCPO/OGCIO – coordinate with the relevant B/Ds on the implementation of this pilot (e.g. ITC)

	• HKSTP – act as the lead agent in working with The Chinese University of Hong Kong and the tenants at Science Park • The Chinese University of Hong Kong
Private sector involvement	Local and overseas start-up companies to set up regional testing hub in the Smart Region. Investors or multi-national corporations from the innovation ecosystem can work with start-up companies in the Smart Region to develop and commercialise innovative services and products.
Timeframe	Technologies are readily available and the suggested pilot can be implemented in the coming years.
Future expansion	Upon successful conclusion of the pilot, the next phase should focus on expansion and implementation at other new region.

6. Cultural and Heritage Tourism in Central District	
Brief description of smart city pilot proposal	The Hong Kong Tourism Board (HKTB) recently launched the Old Town Central (OTC) as another major promotional campaign, covering various revitalised tourist attractions in Central and providing visitors with different routes for self-guided walk under different themes like historical architecture, art and culture, modern living, and dining and entertainment. Given the importance of the tourism industry in Hong Kong it is worthwhile to explore wider use of ICT to further enhance tourists' experiences by digital elements like interactive videos or photos, electronic coupons or discount offers at selected tourist spots, digital walking routes guide and on-line information on accessibility and other matters.
Smart theme	Smart Economy
Proposed locations for pilot	Central District
Implementation agents	• SCPO/OGCIO – coordinate with the relevant B/Ds on the implementation of this pilot • HKTB
Private sector involvement	Private sector may be involved in providing the services to support these applications, and related QR, sensor or smart ICT technologies. AR and VR developers and user experience specialists may also partner with the Government / HKTB to provide the suggested interactive content.

	The pursuit of technology-oriented projects will open opportunities for partnership in innovation and local app developer, local device and solution providers. Tailored coupons and increased marking will improve business to retailers, restaurants and other business operators in the Central District.
Timeframe	Technologies are readily available and the suggested pilot can be implemented within a short timeframe, say one to two years.
Future expansion	Upon successful conclusion of the pilot, the next phase should focus on expansion and implementation at other tourist spots, e.g. Wanchai.

While the Government would identify relevant parties and locations for implementing the above recommended pilot projects, the Government may wish to consider designating selected areas for implementing a collection of projects with "smart features", with due consideration of the result and outcome of the Kowloon East, smart city pilot area.

Needless to say, the New Development Areas (NDAs) (i.e. Tung Chung, Kwu Tung North / Fanling North, Hung Shui Kiu New Development Area, Yuen Long South Development, New Territories North) and probably the Anderson Road Quarry (ARQ) Development are ideal sites for implementing pilots or even scaled smart city solutions.

Details of these NDAs and preliminary smart city initiatives are at Appendix B. The Government should not overlook the window for these NDAs and ARQ Development in pursuing smart city development, as well as redevelopment areas under Urban Renewal Authority.

Appendix A. -

A.1. Profile and Sectoral Details of Hong Kong

Hong Kong has garnered international recognition in its efforts to position itself as "Asia's World City" as evidenced by recent rankings:

- 1st in IMD World Competitiveness Yearbook (2017) [280]
- 7th in World Digital Competitiveness Yearbook (2017) [281]
- 4th in Hot Spots (2025)[282]
- 9th in Cities of Opportunity (2016)[283]
- 4th in Digital Governance (15-16)[284]
- 1st in Cloud Readiness Index (2016)[285]
- 14th in Networked Society City Index (2016)[286]
- 35th Innovation Cities Index (2016-17)[287]
- 9th in Global Competitiveness Report (2016)
- 19th in Monocle's Quality of Life Survey (2015)
- 43rd in EIU's Global Livability Ranking (2016)
- 16th in Global Innovation Index (2017)[288]
- 70th in Mercer's Quality of Living Survey (2016) [289]
- 2nd in Global Opportunity Index (2015)
- 5th in Global Cities Index (2016)
- 37th in Global Open Data Index [290]

Hong Kong, however, must adapt to changing conditions in order to improve the quality of life for its citizens.

City Demographics[291]

Hong Kong is confronted by a growing population and a shrinking workforce, which are both exacerbated by the fact that the city as a whole is rapidly ageing.

[280] IMD (2017) World Competitiveness Yearbook
[281] IMD (2017) World Digital Competitiveness Yearbook
[282] EIU (2015) *Hot spots 2025 – Benchmarking the future competitiveness of cities*
[283] PwC (2016) *Cities of Opportunity 7*
[284] Rutgers (2016), *Digital Governance in Municipalities Worldwide 2015-16*
[285] Asia Cloud Computing Association, Cloud Readiness Index 2016 (Accessed on 11 December 2016)
[286] Ericsson (2016) *Networked Society Index*. This index focuses on both ITC maturity and the triple bottom line of society, economy and environment.
[287] 2thinknow (2016), *Innovation Cities Index 2016-17*
[288] INSEAD, Cornell University, WIPO (2017), The Global Innovation Index
[289] Mercer (2016) *Quality of Life Index 2016*
[290] Open Knowledge International, Global Open Data Index 2016 (Accessed on 11 December 2016)
[291] HK 2030+

- **Population Growth:** According to the Census and Statistics Department (C&SD), the current population of 7.24 million will grow to 8.22 million in 2043 before reaching 7.81 million in 2064. The number of domestic households will grow from its current level of 2.43 million in 2014 to 2.93 million in 2044, reaching 2.91 million in 2049. In addition, the average number of persons/household is expected to increase from 2.9 (current level, 2016) to 2.7 by 2044.
- **Population Ageing:** The population of Hong Kong is ageing rapidly, with citizens 65 and older to rise significantly from 15% in 2014 to 35% in 2064. The population of those citizens who fall under the category of "old-old" (85 or above) will rise from 2.2% (current level) to 10.1% (2064). This will reduce the labour force from 3.6 million (current level, 2016) to 3.11 million by 2064.

City Sectoral Details[292]

- **Area and Topography:** Hong Kong comprises approximately 1,106 square kilometers of land and roughly 1,649 square kilometers of sea. About 20% of Hong Kong land is steep slopes (>30 degrees)
- **Built Environment:** Built-up areas take up 24% of land which accommodates 27% of the total population. The average population density of built-up areas is about 27,330 persons per kilometers squared. The population in Hong Kong is 7.32 million; there are 3.75 million jobs, 3.91 million in the labor force, and 59.3 million annual visitor arrivals as of 2015. Employment is 76% in the metro area and 24% in new territories. There are 114 declared monuments and 1,027 historic buildings with confirmed grading.
- **Economy:** GDP in Hong Kong is approximately HKD $2,397 billion, with per capita GDP at HDK $.3 million, 93% of which comes from the services sector. The four pillar industries in Hong Kong are trading and logistics, professional and other producer services, financial services, and tourism. These four pillars comprise 58% of total GDP and 47% of total employment.
- **Natural Environment:** There are 443 square kilometers of Country Parks and Special Areas, 34 square kilometers of Marine Parks/Marine Reserve, and 77 square kilometers of areas zoned as Site of Special Scientific Interest, Conservation Area or Coastal Protection Area. 85% of the population lives within 3 kilometers of a country park, while 90% of the population lives within 400 meters from a park[293,294]. There are 57 species of terrestrial mammals, 236 species of butterflies, 198 species of freshwater fish, 540+ species of birds.
- **Climate Change:** Annual mean sea level has risen by 31 millimeters per decade on average (during the years 1954-2016).[295]. Annual mean temperature has risen

[292] HK 2030+
[293] http://www.news.gov.hk/en/record/html/2017/06/20170605_172521.shtml
[294] https://www.climateready.gov.hk/news_events.php?id=107&lang=1
[295] http://www.hko.gov.hk/climate_change/obs_hk_sea_level_e.htm (access on 20 June 2017)

0.15 degrees Celsius per decade on average (1987-2016). In 2014, the annual greenhouse gas emissions are 44.9 million tons, with 6.2 tons per capita. 70% of greenhouse gasses are from electricity generation, 92% of which is consumed in buildings. 16% of greenhouse gasses are from transportation, and 5% are from waste. [296,297]

- **Transport:** About 90% of passenger trips are made using public transport. These are roughly 12.6 million average daily passenger trips. Of these public transport trips, more than 40% are made using the railways. 77% of commercial offices are within 500 meters from a rail station, while 45% of living quarters are within 500 meters of a rail station.

[296] http://www.legco.gov.hk/research-publications/english/1617issh21-greenhouse-gas-emissions-of-hong-kong-20170314-e.pdf
[297] http://www.emsd.gov.hk/filemanager/en/content_762/HKEEUD2016.pdf

A.2. Analysis of PMO

Annex 1: Terms of Reference

Terms of Reference: Smart City Steering Committee (SCSC)

1. To assist the Government in setting a clear scope for smart city and steering the strategic direction and policy;

2. To identify and prioritise initiatives and programmes;

3. To secure funding for the implementation of initiatives and programmes;

4. To enlist commitment from, and ensure high-level coordination among relevant B/Ds on the implementation of smart city initiatives / programmes; and

5. To review the effectiveness and outcomes of smart city initiatives / programmes.

Terms of Reference: Smart City Programme Office (SCPO)

1. To oversee the implementation and manage risks of smart city programmes endorsed by the SCSC;

2. To formulate smart city projects supporting the relevant programmes;

3. To set financial guidelines and controls and manage scope change for the implantation of smart city initiatives / programmes;

4. To support relevant B/Ds implementing smart city projects through providing technical know-how and skillsets;

5. To manage quality and monitor the progress of implementing smart city programmes and projects, and recommend appropriate follow-up actions;

6. To develop business cases and justifications, and report the effectiveness and outcomes of smart city programmes and projects; and

7. To provide secretariat support to the SCSC.

Annex 2: Roles and Responsibilities of Head and Deputy Head

Head of the SCPO - Major Duties and Responsibilities

1. To provide support to the SCSC to enhance cross-B/D co-ordination in formulation of policies, strategies and measures, with particular reference to Smart City Blueprint of Hong Kong.

2. To provide support to the SCSC in monitoring the progress of cross-bureaux programmes to deliver policy pledges, in particular those relating to smart city implementation in Hong Kong, identify problems that may hinder their implementation and work out practical solutions.

3. To oversee the provision of secretariat support to the SCSC; and to co-ordinate follow-up actions by the relevant B/Ds.

4. To assist the SCSC in reviewing previous research and steering further studies; reviewing existing measures and devising new policy targets, programmes, measures and action plans for the short-term, medium-term and long-term.

5. To assist the SCSC in formulating strategies on public engagement and foster partnerships with stakeholders in the academic, business and community sectors; and maintaining liaison with other stakeholders including the Legislative Council, District Councils, non-governmental organisations, the media and the public.

6. To assist the SCSC in identifying scope for consolidation and better co-ordination of various smart city initiatives under the purview of different B/Ds to improve their effectiveness and create synergy.

7. To oversee the provision of one-stop consultation and co-ordination services to eligible non-government smart city projects that require cross-bureaux efforts and will contribute to achievement of Government's policy objectives; and to facilitate their early and successful implementation.

Deputy Head of the SCPO - Major Duties and Responsibilities

1. To co-ordinate and prepare policy papers for the SCSC, follow-up on their advice and recommendations, and prepare reports on their work.

2. To assist Head of the SCPO in monitoring progress in delivery of various policy initiatives by the relevant B/Ds relating to smart city implementation, and working out practical solutions to problems identified to ensure effective implementation of the measures.

3. To assist Head of the SCPO in reviewing various smart city initiatives within the Government related to smart city to identify scope for streamlining and rationalisation to enhance their efficiency in achieving Government's policy objectives.

4. To assist the SCSC in its public engagement work and foster partnership in liaison with the academia, business community, NGOs and other relevant parties.

5. To co-ordinate and monitor research, surveys and projects initiated by the SCSC; and to keep in view relevant local and overseas researches and policy development.

Annex 3: Effective Programme Management

The following 12 elements of programme excellence impact the success or failure of a project and distinguish those world class PMOs from less well developed, low value-add functions.

A brief description of each of the elements are set out below:

- **Clear scope:** The scope of the programme is defined, complete, communicated and agreed and it supports the objectives of the business strategy.
- **Engaged stakeholders:** Identifying and managing stakeholders so that they are committed, appropriately informed and contribute to the success of the programme.
- **Governance-enabling decision making:** Enabling leaders to govern with confidence, making timely decisions using high quality management information.
- **Focused benefits management:** Developing a realistic business case subjected to an appropriate level of challenge with benefits clearly defined, owned and tracked.
- **Managed risk and opportunities:** – Making certain that there are effective risk identification processes in place and that the key risks are mitigated and opportunities taken.
- **Smart financing:** Establishing the budget and associated policies, processes and reporting standards for effective cost estimation and programme financial management and reporting.
- **Delivery-enabling plans:** The plans in place must be realistic, achievable, understood and bought into by key stakeholders and suppliers.
- **Active quality management:** An agreed quality plan has been developed based on appropriate standards, it is communicated and the right behaviours are in place.

- **Agile change control:** A formal process is in place for controlling changes to programme scope according to the programme's principles and this has been communicated to the programme stakeholders.
- **Integrated suppliers:** An effective approach has been taken to engage with suppliers, including adequate governance of their activities.
- **High-performing teams**: The programme team is highly motivated, has the right blend of skills and personalities and the organisation supports the team to deliver.
- **Embedded lifecycle assurance and learning**: A clear assurance plan has been defined which outlines the nature, timing and extent of planned assurance, quality reviews and embeds learning.

Appendix B. -

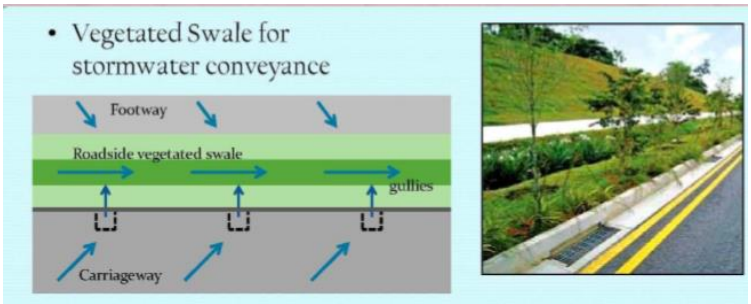
B.1. Anderson Road Quarry Development, Other New Development Areas and Lok Ma Chau Loop

The Anderson Road Quarry (ARQ) has started the infrastructure construction works in end 2016 with tentative population intake in 2023-24. This would be the first development area among the other New Development Areas. As a new development area, CEDD plans to build foundation infrastructure to facilitate the development of smart city development. The following initiatives are considered for inclusion in the provisional design for ARQ. (Items a to m in the following order refer.)

a. Sustainable Urban Drainage System

- Sustainable Urban Drainage System integrates blue-green infrastructures (i.e. a brief explanation of blue-green infrastructure) with recreational uses. Approaches to manage surface water that take account of water quantity (flooding), water quality (pollution), biodiversity (wildlife and plants) and amenity would be adopted in the design.
- The implementation will integrate with roadside vegetated swale; bioswale; public recreational facilities built adjacent to bodies of water or watercourses;

and natural, semi-natural, or planted space set aside for public enjoyment and recreation.



b. Permeable Pavements

- Permeable pavement made from recycled glass can be applied to footpaths to allow water to infiltrate through surfaces.
- Permeable pavements increase stormwater infiltration, improve groundwater recharge, reduce ponding from surface runoff and reduce heat island effect.

c. Underground Storage / Detention / Retention Basins

- In high flood risk area, flood control in drainage system will be substantially improved by employing underground stormwater retention tank and artificial attenuation lake to temporarily store stormwater runoff collected during heavy rainstorms and reduce the water flow to the downstream drainage system.

d. Rainwater Harvesting

- Rainwater from roofs, hard surfaces and/or artificial lake will be stored, and treated for non- potable uses, with appropriately designed rainwater collection and water treatment system.

e. Grey Water Reuse

- Grey water collected from bathroom wash basins, baths, shower, kitchen sinks, clothes washers, etc. can be treated and recycled at grey water treatment plant for reuse for flushing purpose.

f. Smart Water Network Management

- Both the fresh water and flushing water distribution networks can be monitored and managed with enhanced Water Intelligent Network (WIN) by dividing the whole development into District Metering Areas (DMAs) / Pressure Management Areas (PMAs) and using intensive monitoring and sensing equipment. It can facilitate earlier identification and more accurate location of leaks in the networks. With the Automatic Meter Reading (AMR) System installed, both customers and WSD can monitor the water consumption. There will also be beneficial in better management and operation of water supply system. Moreover, a trial of on-line water quality monitoring at the fresh water distribution network will be carried out to study the feasibility to strength the water quality monitoring near the customer side.

g. Walkable City

- Comprehensive pedestrian networks (footpaths, elevator systems, and footbridges will be built to cater for short trips and minimise driving.

- Incorporate features into the urban landscape that make walking a pleasant experience.

h. Comprehensive Cycle Network

- As an environmentally friendly, safe and convenient transport mode, cyclist strategy is formulated to map out the overall cycle track network. The cycle network will provide cycle parking facilities for connection with major residential, commercial and business nodes and public transport interchanges (PTIs). It will provide a pleasant cycling environment for cyclists and encourage people to use bicycles as a supplementary mode of transport.

i. Electric Vehicles Charging Infrastructure

- This project is to promote provision of charging stations for electric vehicles in location such as car park.

j. Integrating ICT with infrastructure systems and developing innovative applications such as e-platform / mobile Apps for citizens to enable smart information / resource management

- This project is to develop smart mobile App to facilitate visitors / citizens.
- The App can be used to collect / disseminate real-time city information from / to the public (e.g. real-time weather photos, public transit information, traffic conditions, parking spaces, etc.).
- The features include establishing a range of interesting destinations within walking distance of homes and workplaces, providing way-finding for points of interests and indoor navigation, and integrating the App with the 3D virtual map.

k. Free Wi-Fi access in town

- Both government and non-government venues on the Government, Institution and Community (GIC) sites will be provided with free public Wi-Fi access. Provision of basic infrastructure such as pre-built underground duct system for GIC sites will be explored to facilitate connection between the sites and the public telecommunications network (PTN). Public-private partnership is a preferred option to invite private Wi-Fi service providers to provide free public Wi-Fi service at the venues.

l. Smart parking (refer to #4 in list of pilots in Section 7)

m. Solar energy

- Solar PV panels can be adopted for infrastructure involving open spaces or surfaces with unshaded solar exposure area.

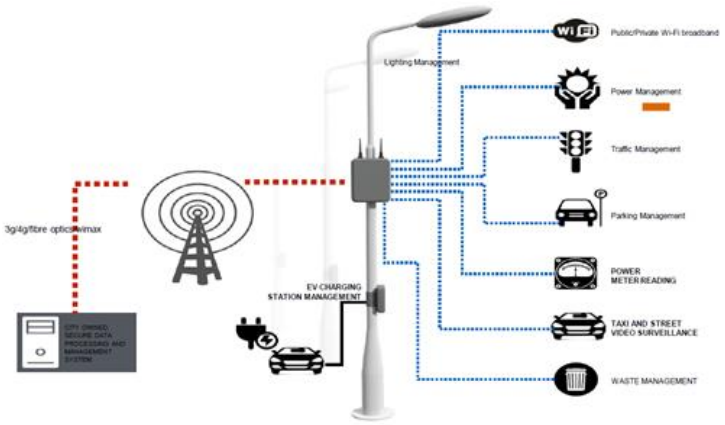
Other Areas to be Further Explored for ARQ (Items n to q in the following refer):

n. LED lighting

- LED lighting will be deployed to street lamps with features including automatic adjustment of light intensity and equipped with sensor to detect the need to switching on/off for energy saving.

o. Smart bus stops (refer to #1 in list of pilots in Section 7)

p. Smart intelligent and integrated poles (refer to #2 in list of pilots in Section 7)



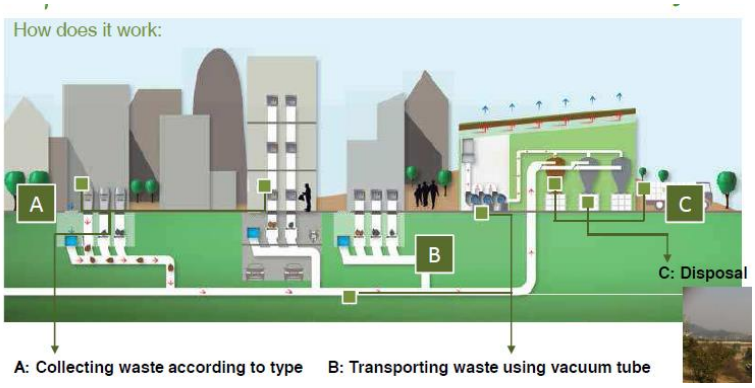
q. Intelligent Signalised Junctions and Pedestrian Lights (refer to #3 in list of pilots in Section 7)

Initiatives to be further explored in other new development areas (Items r to w in the following refer):

r. Automatic refuse collection system (ARCS)

The automatic collection system is to use pipes to collect the garbage within the building. The garbage standpipe is connected to a central refuse collection station that is away from the residents. All the garbage in the collection area will be entered by the throwing opening of each floor into automated refuse collection system, through a series of buried pipelines to the garbage collection station, with the use of vacuum or powerful fans to suck waste. Through the garbage separator and compressor, waste will be compressed to a refuse container which is transported to

the landfill or garbage incineration site for final disposal. The ARCS to be developed should be equipped with some smart charging feature that is compatible with the municipal solid waste charging regime to be introduced.



s. Energy from incineration of waste

- Conversion of non-recyclable waste materials into usable heat, electricity, or fuel.

t. Car sharing / car pooling

- Car sharing is a scheme where a single vehicle is shared and used jointly.
- Carpooling is a strategy where a driver picks up other passengers heading to the same general destination.

u. Pedestrian first, guiding system for visually impaired

v. Crowd Management

w. Underground Integrated Ducts (also known as a utility tunnel, utility corridor, or utilidor)

- An underground passage that carries utility lines such as electricity, water supply pipes, sewer pipes, communications utilities (e.g. fiber optics, cable television, and telephone cables).
- An utilitdor will coordinate the pipes underground in a collinear manner.
- This will reduce the overall encumbrance on surrounding development by providing common access points and reducing the number of excavations.

The above smart city features are largely showcased in the Kai Tak Development area, being part of the Kowloon East smart city pilot area. The experience gained in Kowloon East would serve as valuable experience to the overall smart city development for other projects.

Most smart city initiatives will similarly be explored and adopted, as far as possible, in other New Development Area Projects including Tung Chung, Kwu Tung North / Fanling North, Hung Shui Kiu New Development Area, Yuen Long South Development, New Territories North and Lok Ma Chau Loop.

Appendix C. -

Glossary

Advanced metering infrastructure (AMI): infrastructure that integrates the system of meters and sensors with communication networks and data management systems to enable communication between utilities and users

Biometric authentication: A security process to verify an individual based on unique biological characteristics. Biometric authentication technologies include fingerprint, iris scanning, facial recognition, and voice recognition to verify identity of an individual. This technology requires high-speed processing and precision to ensure genuine real-time authentication

Building Management Systems (BMS): Controls installed into buildings to allow for monitoring and managing building systems such as lighting, power, ventilation, and fire systems

Built Environment Management: Management of man-made infrastructure such as building, parks, and roads

City Master Planning: Comprehensive and long-term planning for city-wide developments

Combined Cooling, Heat, Power (CCHP): A system capable of production of electricity, heat, and cooling in a single process

Common Spatial Data Infrastructure (CSDI): A data infrastructure encompassing policy framework, governance structure, technical standards and necessary information infrastructure that fosters exchange of spatial data among different government departments and organisations, and enables efficient generation, compilation, storage, discovery, retrieval, dissemination, sharing, management and application of spatial data which are traditionally stored in individual data silos

Decision Support System: A set of tools and data used to improve on the decision making process

Differential Tolls: Tolls that can be adjusted based on different time of the day, for instance, different level of charge can be levied for peak and non-peak hours

Distributed Ledger Technology (Blockchain): Distributed ledger is a database that is shared across a network of organisations where each organisation has a copy of the ledger. Updates to the ledger are automatically synchronised and reflected to all participants. Blockchain is a peer-to-peer distributed ledger technology which records transactions, agreements, contracts, and sales

Energy Savings Performance Contracts: Contracts that allow building owners to finance building energy upgrades with future energy savings without use of capital budgets

EV Infrastructure: Refers to systems and infrastructure that enable and promote usage of electric vehicles, specifically electric vehicle charging stations

Green and Intelligent Buildings: Buildings that utilise technologies in construction and maintenance of buildings to efficiently manage resource and energy usage, which, in turn, produce benefits such as improved building performance, reduced environmental footprint, and increased comfort

Intelligent Waste Management: It involves the creation of various infrastructure and processes to maximise landfill diversion, increase recycling, and increasing efficiency in the overall waste management processes. For instance, this can include creation of waste sorting facilities that allow for single-stream recycling followed by sorting of the recyclables away from the source. Various waste-to-energy processes can also be implemented to transform non-recyclables into electricity or heat

Interaction Channels: Interaction channels refer to mechanisms for user communication and feedback. Channels can include mobile app, Stakeholder Engagement Portal, digital kiosks, live chat feature, call centers and walk in centres

Inter-Modal Transport Hubs: A single location where multiple modes of transportation meet to allow interchange for individuals

Journey Planning: By leveraging data from multiple transportation systems, real-time events, and traffic data, individuals should be provided the ability to comfortably, quickly, and effectively plan and use multiple transportation methods to get from point A to point B

LED Lighting: LED lighting is significantly more energy efficient than its fluorescent lighting. The use of low-to medium wattage LED lights can be used in the public lighting system as well as in commercial settings such as neon signs and illuminated signboards to improve on energy efficiency and create controls on electrical usage

Multi-Modal Transportation: Integration of transportation systems across the city and the data generated to allow for improved ability for individuals to use various means of transportation within a single journey

Pollution Management: Comprehensive activities to monitor and reduce pollution in Hong Kong

Smart Grid: Integration of ICT into an electrical network to create a grid that interconnects various sensors, meters, and appliances. This will allow for remote monitoring of energy usage and for users to manage their own energy demand and shift peak hours of energy usage

Telehealth: The enhancement of methods of healthcare service delivery through telecommunications technology

Waste-to-energy: The recovery of energy from treatment of waste for generation of electricity and/or heat