BUSINESS ENVIRONMENT COUNCIL
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Smart and Sustainable City Development: Hong Kong and International Experiences

July 2022

Executive Summary

The concept of a Smart City lies at the intersection of urban planning, technological innovation and government policy. Locally, the launch of the Smart City Blueprint in 2017 marks the HKSAR government's intention to pursue Smart City initiatives. At its core, it aims to use technology for good, bringing greater efficiency to the operations of our cities and connectivity for its citizens. However, technology being a double-edged sword brings challenges in the areas of data privacy and digital inclusion. Moreover, the often-conflicting interests amongst government, businesses and citizens add a layer of complexity in identifying and executing initiatives that serve all three parties.

BEC sees the urgent need for society to recognise the business case of Smart City and remove silos to enable a truly integrated approach. Thus, BEC has conducted research with a focus on Smart City development towards a sustainable living environment (covering Smart Environment and Smart Mobility). Project activities included desktop research and 10 interviews with industry stakeholders. This report presents BEC's findings on the current state of Smart City initiatives in Hong Kong and high-level policy recommendations for the HKSAR government, as backed by local and international case studies.

Key findings include the need for government to support the property and construction sector to implement and fully reap the benefits of mature technologies, such as building management systems and modular integrated construction. Within the transport sector, smarter physical and digital infrastructure is needed to support the growing EV usage and the development of the Northern Metropolis area. Across the recommendations, the overarching considerations are data trust and digital inclusion. Government should strengthen mechanisms to protect users' data to build trust and promote usage in the long term, and guarantee that societal players such as SMEs or the elderly can access and contribute to Smart City initiatives.

Summary Table of Policy Recommendations

Scope	Policy Recommendations
Smart Buildings / Construction	<u>Building Management Systems (BMS)</u> • Encourage wider adoption of BMS particularly for SMEs through subsidies or green finance schemes • Work with relevant B/Ds to incorporate Smart Building considerations into industry standards or building codes, aligning with climate targets and COVID resilience • Demonstrate leadership by implementing Smart Building technologies in government buildings <u>Modular Integrated Construction (MiC)</u> • Foster greater regional collaboration with GBA on MiC projects to leverage talent and resources, and facilitate Smart Construction
Smart Waste Management	<u>Smart Bins</u> Coordinate with waste management contractors and encourage buy-in towards smart bin technology in public spaces.
Smart Mobility	<u>Smart EV Charging</u> Lead a consortium of public EV charging spot owners/operators to coordinate and establish a common portal for the sharing of real-time information, including the occupancy and charging status of charging spots.
Innovation	Be cognizant of the compatibility of existing regulations to emerging opportunities and facilitate technology trials by shortening approval process and de-regulating where necessary.
Data Use and Digital Considerations	<u>Data Trust</u> • Maintain a high level of transparency with end-users on data use and analytics mechanism, e.g., whether data is collated on an aggregate or personal level, whether raw data will be destroyed after analysis, and whether (personal) data will be used for revenue creation • Communicate the business case and value of centralised data to obtain buy-in from business sector and the wider community, such as the possibility to improve traffic, or cost savings from smarter energy use • Improve upon data standards and regulations, by continuously benchmarking against international and industry best practices <u>Digital Inclusion</u> • Improve digital accessibility by reviewing the needs of vulnerable groups and working with NGOs or local communities to provide tailored support. • Improve digital literacy by hosting workshops at community centres and encourage digital participation through posters, social media, etc.

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1. Introduction

1.1 Cities' Urgent Need for a Holistic, Post-COVID Recovery Strategy

For most cities, the COVID-19 pandemic began as an unknown battle. While Hong Kong has been able to draw some parallels from the painful 2003 SARS pandemic, for example in enforcing facial mask protection, we were still far from equipped in managing the pandemic. As we embark on the road towards recovery, it is important to identify lessons learnt and advocate for improvements towards greater resilience.

The deadliest pandemic in history was the Black Death which began in 1347 CE and lasted until the 17th century, wiping out a quarter of the world's population then. In 1348 CE, believing that the plague was introduced by merchant ships infested with rats and fleas, the city-state of Venice adopted a 40-day detention period for entering vessels[1]. This gave rise to the now-familiar term 'quarantine', which in Italian means 'forty days'. In addition to more advanced disease control measures, this period brought about the most drastic transformation for cities in Europe: improvements in ventilation, drainage, water and waste management, greatly improved the well-being of citizens.

Figure 1. The 40-day detention period of merchant ships is the origin of the term 'quarantine'

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If we were to identify the key transformation that the world has undergone during the COVID-19 pandemic, is it undoubtedly the greater adoption of technologies whether in the context of Smart Cities for governments, or digital transformation for businesses. The mounting death tolls became the strongest ever incentive to push for wider use of technologies, which enabled essential activities to be carried out while adhering to social distancing rules and guaranteeing public safety. While most of the recent initiatives can be seen as emergency responses – in time, they will evolve into more mature technologies and prepare society for the new normal.

1.2 Hierarchy of Smart City Needs

As illustrated by this hierarchy diagram adapted from Maslow's Hierarchy of Needs, public security including housing, food and hygiene factors will remain the foundation for cities. Only when these factors are satisfied can a city progress to meet its higher needs, including socio-economic factors (employment opportunities, social inclusion, quality of life) and city-wide factors (resilience towards pandemics and climate change, and preparing the city to cope with population growth and ageing). This diagram should therefore act as a reminder for government and businesses alike to prioritise meeting foundational needs prior to pursuing higher needs.

Figure 2. Hierarchy of Smart City Needs

As the HKSAR Government draws close to the third year of a budget deficit, and many businesses struggling to meet the bottom line, it is more important than ever to strategically determine the best use of funds in the coming years. The ideal approach would be holistic and can target more than one level of the hierarchy. Therefore, it is

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reasonable to revisit the concept of a Smart City and examine whether it has the potential to bring about rapid change that is urgently needed across government, businesses, and citizens.

1.3 Overview of the Smart City Concept

Predecessors of Smart Cities

In defining the term 'Smart City', two common features are observed in various literature:

i. Being a city that leverages the information and communication technology infrastructure and uses innovative solutions to address urban issues;
ii. Aiming at improving the quality of life of the citizens and enhancing the sustainable growth and competitiveness of the city through the Smart City initiatives[2].

The development of smart cities across the world has always been driven by the need to address urbanisation challenges. In 1974, the city of Los Angeles carried out the 'Cluster Analysis of Los Angeles'[3] project, aiming to improve housing quality and tackle poverty by utilising technology. In the time when the world was transitioning from analogue to digital, the then-responsible Community Analysis Bureau digitalised and centralised city-wide datasets from various departments such as the US census and LA police into one database. This enabled the Bureau to perform high-level analysis and draw useful insights. It is also worth noting that the project deployed infrared aerial photography to map land uses – an example of 'Warfare to Welfare', where technologies previously developed for military use found uses in the civilian setting. It is interesting to note that the challenges in standardising data and deploying technologies across industries are still prevalent in the recent context.

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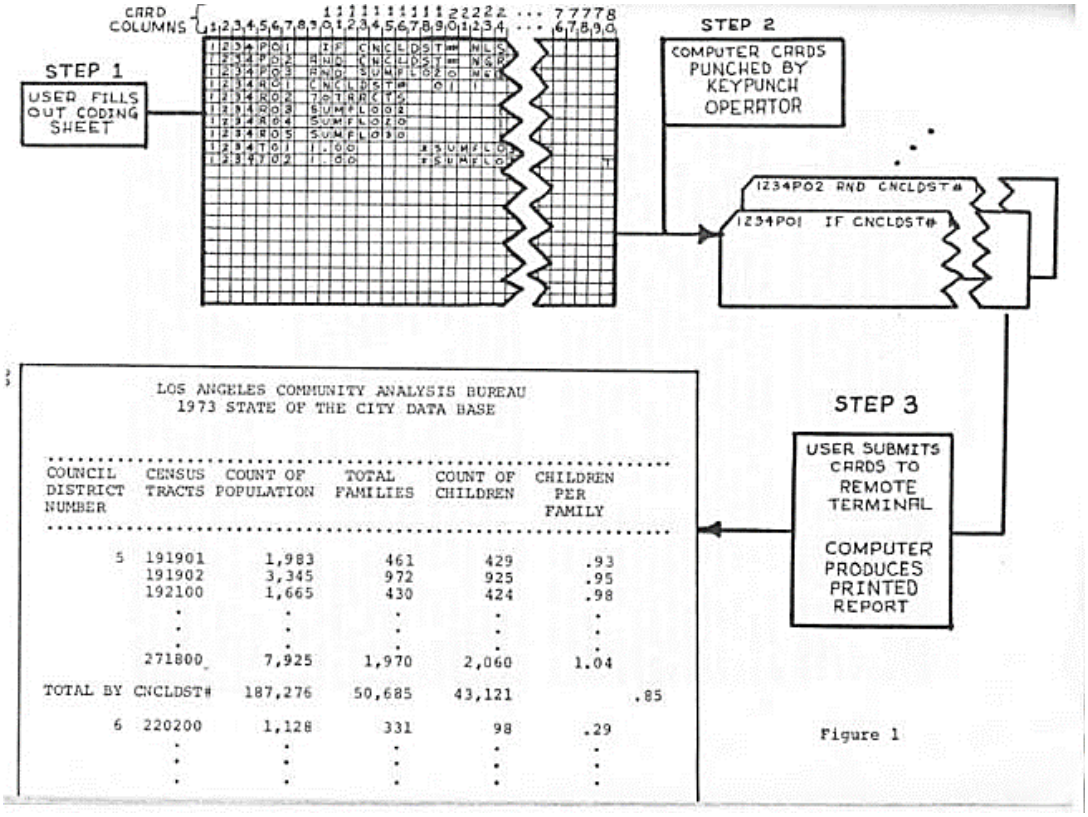

Figure 3. Flowchart on the procedure to digitalise analogue city-level datasets. 1974.

While the example of Los Angeles illustrated how city planners combined technology with urban planning, the 1970s still lacked the means to involve its citizens to become a comprehensive Smart City initiative. It is during the 1990s boom of the world wide web when extensive public involvement became feasible. In 1994, the city of Amsterdam created 'De Digital Stad (DDS)'[4], which in Dutch means 'the Digital City'. For the first time, internet access was available for a large group of citizens in Amsterdam: 100,000 users were noted in the first half-year alone. It had a striking resemblance to the 'Metaverse' that we know now, where the virtual space was equipped with post offices, cafes and houses, allowing for participants to exchange ideas using a bulletin-board style interface. Rightly so, it is recently nominated for the UNESCO Memory of the World list.

Our expectation of a Smart City in recent years has drastically evolved since these cases, with a heavy focus on using data analysis to improve our living environment, enabled by sensors in buildings, infrastructure, transportation and power grids. However, these two cases remind us of the core purpose of Smart Cities, which is identifying appropriate use cases of technologies to improve the livelihood and connectivity of citizens.

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Development of Smart City in Hong Kong

In 2017, the HKSAR Government has commissioned PwC to perform a consultancy study on Smart City[5]. The study adopted the Smart City Framework introduced by American social and urban strategist Boyd Cohen, which set out the six key areas of Smart Cities as Smart Mobility, Smart Living, Smart Environment, Smart People, Smart Government and Smart Economy. In the same year, the Government published the first Smart City Blueprint (Hong Kong Smart City Blueprint 1.0), aligning with the six Smart Cities areas and setting out 70+ initiatives. In light of the pandemic and other emerging technological trends, the government followed with the second Smart City Blueprint (Hong Kong Smart City Blueprint 2.0) in 2020, extending to 140+ initiatives. Of which, 13 initiatives are particularly targeted to combat the pandemic, such as promoting the use of contactless payments in public markets and expanding functions of the Hospital Authority's 'HA Go' mobile app.

Figure 4. Six Smart City Areas as laid out in Smart City Blueprint

Building on the blueprints, various industry-driven initiatives are actively pushing for greater investment and adoption of Smart City technologies. Below are notable examples:

- The ET Net Smart Living Partnerships Award[6], comprising of 12 award categories such as Property Technology (Prop Tech), Education Technology (Ed Tech) and Health Technology (Health Tech), acknowledges the most innovative and disruptive players in the market.
- The Hong Kong PropTech Association (HKPTA)[7], an independent, membership-based organisation that aims to convene property developers, investors and PropTech start-ups.
- The Community Lab[8], a joint initiative by property group Hysan and Hong Kong Science and Technology Parks Corporation (HKSTP), aims to incubate local start-

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ups with the 'Last Mile Testing Programme' as the backbone with real-life application to test drive their concepts in the Heart of Hong Kong. The initiative aims to manifest start-up potential and contribute towards a Smart City.

1.4 Project Objective and Activities

Earlier in November 2017, BEC organised an EnviroSeries Conference on Smart Sustainable Cities. This research serves as a continuation of that discussion to further explore how the government can work with the wider community to accelerate the adoption of smart city initiatives. From March 2021 to March 2022, BEC conducted project activities such as desktop research, and interviews with 10 stakeholders across industries such as utilities, properties, mobility, building services, professional services, IT and networks.

Out of the six smart city areas, the stakeholders view Smart Environment and Smart Mobility as areas that have seen the most changes and opportunities in recent years. They also agreed that data is a key enabler for most initiatives and highlighted the challenges that come with digitalisation. As such, the report will centre around these topics, evaluating their current state and gaps, identifying business opportunities and providing high-level policy recommendations for the HKSAR government, as backed by local and international case studies.

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2. Smart Environment

2.1 Upgrades to Building Systems for COVID-Resilience

Hong Kong is at a critical turning point with the new administration under John Lee – with his election manifesto promising to tackle the long-standing issue of housing, it is reasonable to assume that interest in buildings and construction will only climb in the coming years. Coupled with more stringent public hygiene requirements in public spaces, industry players such as hotels or shopping malls may have to look beyond prevention measures such as plastic dividers, air purifiers or even sanitation robots – to upgrades that require substantial investments such as modifications to the heating, ventilation and air conditioning (HVAC) system or Building Management System (BMS). In May 2020, Siemens published a report[9] that provided recommendations on disease prevention measures within buildings. The table below highlights some of the mentioned mechanisms:

Table 1. Covid Prevention Mechanisms for Buildings – Recommendations by Siemens

Objective	Mechanism
Prevention of contaminated air circulating to uncontaminated areas	Close all air circulation dampers / Operate Heat Recovery Wheel (HRW) / Correct pressure difference
Dilution, extraction of viral particles from the air	Operate on higher ventilation levels / install higher density filters or UV sanitation
Prevention of contaminated air moving outside the toilet areas	Separate extraction from toilets always on
Avoiding physical presence at locations while having full 24/7 control of the building's HVAC systems	Enable remote connectivity for building management staff / outsource professional remote service and maintenance staff

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Figure 5. Smart HVAC solutions in a negative pressure patient isolation room (Johnson Controls)[10]

While not all commercial buildings require HVAC features as stringent as those in medical facilities, COVID-resilience is a strong driver for businesses to improve indoor air quality by upgrading their HVAC systems. While upgrades are capital intensive in the short term, they could potentially provide energy savings in the long term. Businesses should therefore carefully review market offerings to identify future-proof solutions.

2.2 Smart Building – Removing Pain-points in Building Management Systems (BMS) Implementation

Technologies that are adopted in the property management and construction sector have made steep progress in their scope and functionalities in recent years. For example, Building Information Modelling (BIM) has matured to incorporate AI prediction and forecasting functions along the building life cycle, sometimes even through a Digital Building Twin model. However, stakeholders have expressed that given the property and construction sectors are traditionally risk-averse, some players have yet to catch on with more basic offerings such as Building Management Systems (BMS) and thus delay the process towards Smart City implementation. These gaps need to be addressed by better financial incentives, supplemented by industry standards or guidelines.

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BMS requires both software and hardware to achieve its primary purpose to automate and optimise energy usage, which associates with large upfront capital costs in its implementation and maintenance. While larger players could benefit from economies of scale, small and medium enterprises (SMEs) will find it difficult to justify such investments. This area is where government or industry support in the form of subsidies or green finance schemes would be able to bridge such financial gaps.

Stakeholders also identified pain points in the procurement and implementation of such systems, such as difficulty in identifying proven and mature systems, and the potential disconnect between front-end and back-end systems when they are managed by different contractors, preventing the ultimate user from yielding insightful data for optimisation purposes. In this aspect, better industry guidance in the form of building standards or procurement guidelines is needed. As such, BEC proposes the following recommendations:

Key recommendations for BMS implementation

- The government should encourage wider adoption of BMS, particularly for SMEs by consulting industries to devise relevant incentive mechanisms, including subsidies or green finance schemes
- The government should work with relevant B/Ds (e.g., Electrical and Mechanical Services Department) to incorporate Smart Building considerations into industry standards or building codes, aligning with climate targets and COVID resilience requirements
- The government should demonstrate leadership by implementing Smart

BEC has previously published two reports[11] relating to smart buildings – 'Investing in Buildings Energy Efficiency – How to Enhance Hong Kong's Policy' Framework in January 2019 and 'Improving Data Transparency in Building Energy Performance' in March 2020. Key policy recommendations in these reports can also be referenced.

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2.3 Smart Construction – Potential of Modular Integrated Construction (MiC) and Collaboration with GBA Construction Businesses

New buildings are expected to account for 20% of the building electricity demand in Hong Kong by 2030[12]. With new town development projects such as the Northern Metropolis, carbon emissions from the construction of new buildings will continue their upward trend. In the Climate Action Plan 2050[13] published in October 2021, the Government set out to achieve the interim target of 50% carbon emission reduction by 2035 against 2005 baseline, and the long-term carbon neutrality target by 2050. The construction sector has a crucial part to play for Hong Kong to achieve these ambitious targets, it must adopt more sustainable building practices which target the blind spot of embodied carbon.

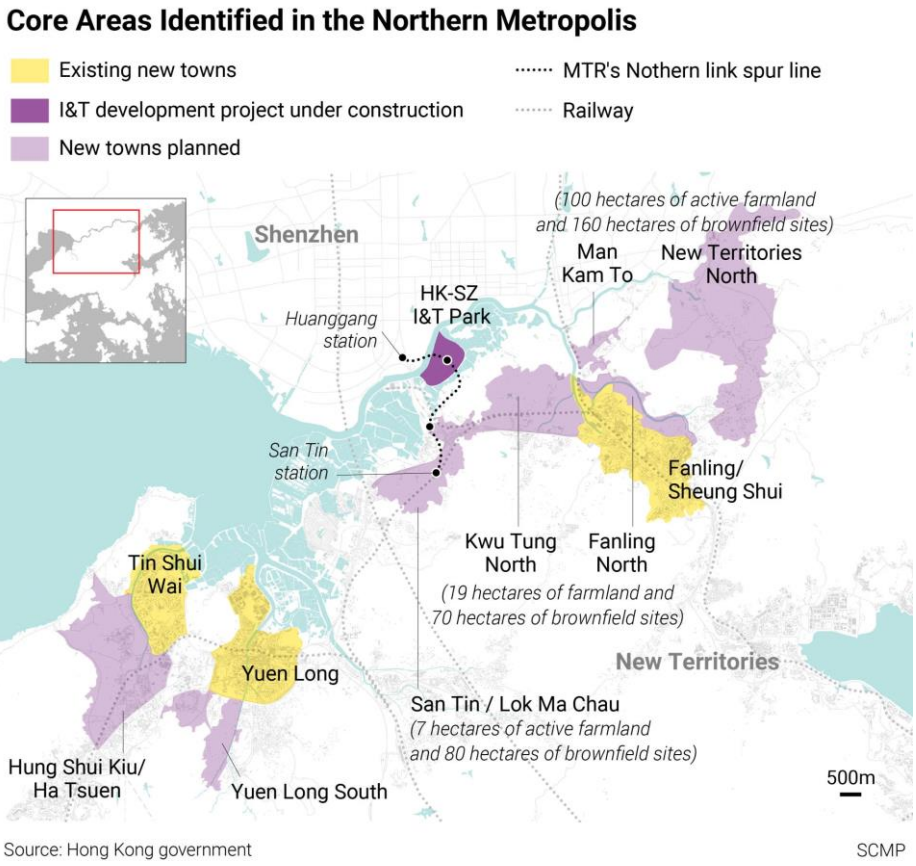

Figure 6. Planned Northern Metropolis Development[14]

The development of modular integrated construction (MiC) technology worldwide represents an opportunity to enhance sustainability in the construction sector. The technology enables free-standing integrated modules to be prefabricated off-site and then transported to the construction site for assembly to improve efficiency in the construction process. Based on a Korean study[15], MiC buildings can achieve a 36%

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reduction in carbon emissions and a 15% reduction in material waste compared with conventional reinforced concrete building methods. Furthermore, pre-assembly work done off-site means that on-site noise disruption to neighbouring buildings can be minimised and workers' time could be prioritised for essential on-site assembly, thus reducing staff costs.

In recent years, the Government has proactively adopted MiC in various public pilot projects including public housing projects, and the construction of quarantine facilities to cope with the pandemic. The Government also took the lead and issued a technical circular in 2020 mandating the adoption of MiC for designated government buildings such as schools, dormitories, hospitals and office buildings under the Government's Capital Works Programme. Other efforts could be seen with the setup of a steering committee led by the Development Bureau which formulate policies such as the concession policy in May 2019 which allows partial floor area of the modules to be disregarded from the gross floor area, giving the sector more flexibility in adopting MiC. The Development Bureau also introduced various measures to encourage greater adoption of MiC, including setting up the Construction Innovation and Technology Fund.

Figure 7. First Concrete MiC Construction in Hong Kong (2020) – Married quarters for the Fire Services Department at Pak Shing Kok, Tseung Kwan O Construction site (left) and Building Interior (right)[16]

Embodied carbon is an alarming issue in China, accounting for roughly one-half of the total annual building sector carbon emissions in China[17]. Hence, China has also made rapid advances with MiC technology in Zhaoqing, the largest Greater Bay Area city being transformed into a key supplier of prefabricated building parts. Given Hong Kong's labour

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shortage and high labour costs, Hong Kong's construction industry can partner with Greater Bay Area cities like Zhaoqing which is well-positioned to support our smart construction with the latest technologies. For example, more MiC building parts can be manufactured in Greater Bay Area cities to meet Hong Kong's demand for enhanced efficiency and sustainability in the construction sector. Regarding MiC, BEC proposes the following recommendation:

Key recommendations for MiC

Foster greater regional collaboration with GBA on MiC projects to leverage talent and resources and facilitate Smart Construction.

However, regional collaboration usually comes with concerns of incompatibility in regulations or standards. This would mean that operations are complicated by having to harmonise such differences prior to commencing relevant projects. Businesses need to assess whether the benefits of regional collaboration will outweigh the cost of additional resources required to involve compliance expertise from both regions. This applies to physical operations such as construction but also intangible operations that involve data and transactions.

2.4 Smart Waste Management – Smart Bins to Reduce Logistic Costs

Waste management is another area that can benefit from innovation. Smart bin technologies are maturing and available at different scales and could greatly reduce operating costs surrounding logistics, complement the government's waste sorting program and provide education for private premises users.

Government initiatives regarding waste management have seen great success in engaging the public in recent years. This could be attributed to the high-profile passing of the Municipal Solid Waste Charging Bill in August 2021 and coming into effect in 2023. The Green@Community[18] (綠在區區) collection points have expanded rapidly. In 2021 alone, over 9,000 tonnes of recyclables are received, representing a four-fold increase from 2020.[19]

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While these recycling initiatives are effective to encourage the recycling of household waste, there are still gaps in managing general waste within commercial buildings or public areas. Existing vendors include Guardforce, originally a secure logistics provider which leveraged its know-how in logistics and technology to offer both smart bin and food waste recycling bin solutions. An existing initiative that can be scaled up includes the BEC Jockey Club – Intelligent Resource Management Programme[20], targeting users such as commercial buildings and schools. This programme combines the hardware (smart bin scale) with software (data platform) which allows the participant to gain better visibility into their waste generation and to better strategise for waste reduction and upcycling opportunities.

Regarding general waste in public areas, the challenge of effectively managing waste becomes greater due to the lack of monitoring and timely collection. A case study that features the use of smart bins is explained below.

International Case Study

Use of Smart Bins in the Melbourne Metropolitan Area[21]

Each year Melbourne's street bins collect 4800 tonnes of waste, and the related waste services cost around 9.8 million Australian dollars. With the number of residents and visitors increasing daily, the City of Melbourne is adopting new ways to reduce waste, such as introducing smart bins. A smart bin includes the following features:

- A communication module allows notifications to be sent when the bin is ready to be emptied, or if there are any issues
- Compactor to hold rubbish with enclosed design to prevent pests from gaining access to the waste, and to slow down decomposition
- A solar panel top to provide a sustainable energy source for the bin

The smart bin functions as follows: first, the rubbish is placed into the container, and the sensor measures its capacity. The compactor then compresses the rubbish and measures the compacted trash resistance. Finally, notifications are sent via e-mail or SMS when the bin is full and ready to be emptied. This operation allows for greater

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bin capacity at a time, thus reducing the frequency of collection visits, and in turn lowering the emissions from the collection procedure.

Figure 8. Smart bins that compact waste and hold seven times more than a standard bin have been tested in the innovation district of Melbourne[22]

The smart bin mechanism could see successful adoption in public areas of Hong Kong for the following reasons:

- With the high population density in Hong Kong, a high volume of waste generated in a small area is expected
- Waste overfill at bins is a common issue, leading to a hygiene hazard to both pedestrians and waste collection personnel, particularly during the pandemic
- Analytics data helps manage collection routes and more effective placement of bins, a critical consideration in many narrow streets of Hong Kong

Based on this, BEC proposes the following recommendation:

Key recommendations for Smart Bins

Government can coordinate with waste management contractors and encourage buy-in towards smart bin technologies in public spaces.

Ideally, all recyclables should be recovered even in public areas, but Smart Bins could act as a transitionary technology while better recycling infrastructure becomes commonplace.

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2.5 Smart Meter – To Improve Accuracy, Timeliness and Accessibility of Energy Data Reporting

Traditionally, meter readings need to be manually recorded by a person every two months. This tedious procedure not only makes it hard for both the user and utility to track energy use, but it is also subject to inaccuracies which have wider implications in the energy planning and energy projection for decarbonisation plans.

New smart meters will be able to read and send meter readings automatically through the internet. A complimentary mobile application will give consumers insights into their consumption patterns, while more timely outage notifications can assist utility companies in providing more reliable energy. China Light and Power Company (CLP) and Hong Kong Electric Company (HKE) are currently rolling out this device for new customers over the course of 2018 to 2025[23].

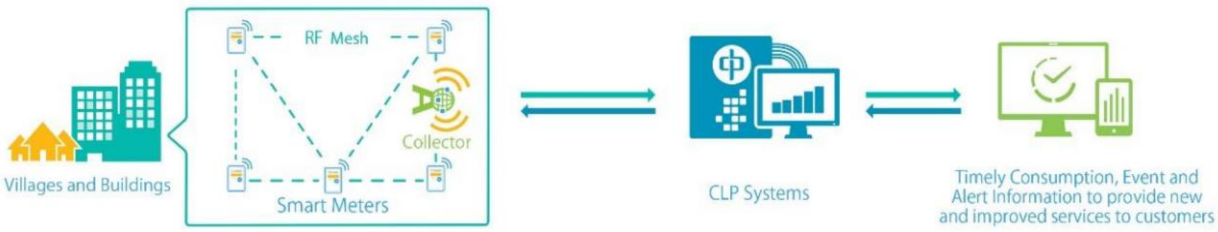

Figure 9. An advanced metering system is a key component of the wider smart grid infrastructure[23]

Figure 10. The Smart meter (right) with an associated communication system can collect near real-time electricity usage information[23]

A notable mention is that Towngas prioritises their smart meter installation for visually impaired and wheelchair users, targeting social inclusion and empowerment as users no

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longer have to rely on others to report readings. The service and smart meters are provided for free once users are referred to the programme which is supported by organisations such as the Hong Kong Council of Social Service (HKCSS) and Hong Kong Society for the Blind (HKSB).

Figure 11. Representatives from HKCSS, Towngas and HKSB at the launch of the 'Easy Metering service' programme (left); Beneficiary of the programme expressing that the Smart Meter brought greater convenience in reporting readings (middle and right)[24]

It is noted by stakeholders that smart meter technology also has the potential to serve smart city initiatives beyond the scope of energy. For example, it can be harnessed to detect water leaks, or smart transformers can host air quality sensors and can be extended to smart home or building systems. While substantial investments are required to upgrade existing metering systems, public education and its importance within the wider Smart Grid infrastructure provide a strong incentive for utility companies to push for its adoption.

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3. Smart Mobility

The pandemic has brought on substantial challenges for the mobility industry, but it has also accelerated many technological changes such as going cashless / e-payment on taxis and tolls, monitoring passenger flow on MTR and familiarising a greater portion of the public with the concept of demand-responsive transport (via Uber/taxi-hailing apps). It can also be assumed that private-car usage has increased due to public hygiene concerns.

With the increasing electric vehicle (EV) ownership in Hong Kong, an area that needs to be carefully considered is the capacity of EV-charging facilities. The issue of insufficient EV charging stations has caused long-wait times at stations to the extent that it becomes a deterrent for citizens to adopt private EVs. In the HK Roadmap for EV Popularisation [25] ('EV roadmap'), the government demonstrated that they are cognizant of the issue by introducing the HKD 2 billion subsidy scheme for private/residential buildings and mandating a certain number of EV charging spaces for new buildings. In the context of a sustainable city, the issue translates to reducing avoidable carbon emissions arising from vehicles searching and queuing for charging spots.

However, there are still gaps surrounding EV charging, such as energy use optimisation and the logistics of locating and timing a charge session. The two technologies below are not new but should be explored for greater adoption in view of the increasing EV ownership, as well as increasing electric public transportation. While electric minibuses have been in operation, the government has approved for electronic taxi (e-taxi) trials to commence in mid-2022.

3.1 Optimising Electricity Output through Smart Load Management System

By monitoring the real-time power usage of EV chargers through the Internet of Things (IoT), a smart load management system can regulate the charging current of EV charging facilities based on the overall demand. For example, when more than one EV is connected, the system can reduce the power output of some chargers to allocate additional power to the just-arrived vehicles. Hence, more EV chargers can be installed in old or existing

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buildings without the need to increase electricity load while fully utilising car park electricity capacity.

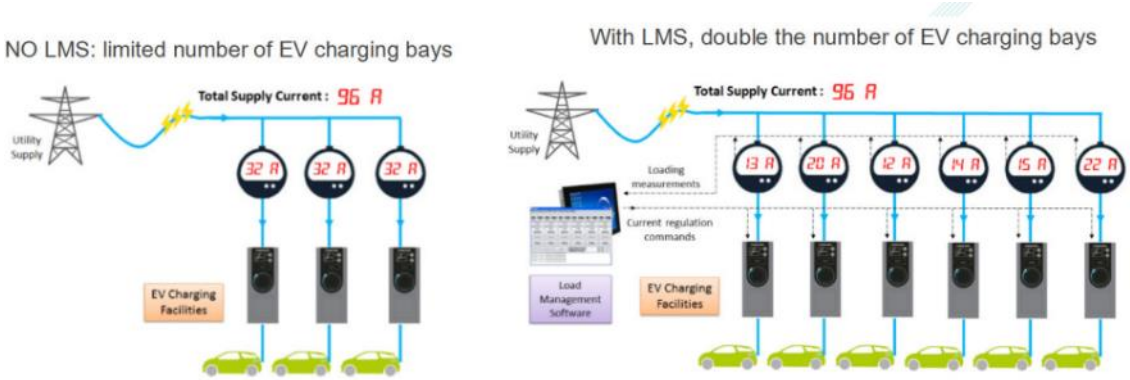

Figure 12. Smart Load Management System for EV charging (Hong Kong Productivity Council-owned technology)[26]

Although its application is currently limited to car parks catering to private EVs, its technology can inform urban planning strategies for the construction of large-scale charging stations for electric public transport modes. As its application expands, it can be viewed as a component of the wider Smart Grid concept.

3.2 Connecting Drivers to EV Charging Stations via Real-time Data Sharing

Also outlined in the EV roadmap to be a priority is to provide real-time vacancy of public EV chargers to users. The function has been co-developed by Environmental Protection Department and HKE and is currently featured as a function within the general HKE app instead of a standalone app. Its features a map view of charging stations supported by HKE on Hong Kong Island, with green labels signalling stations available, and red labels signalling stations in use. Users can also filter by charger types.

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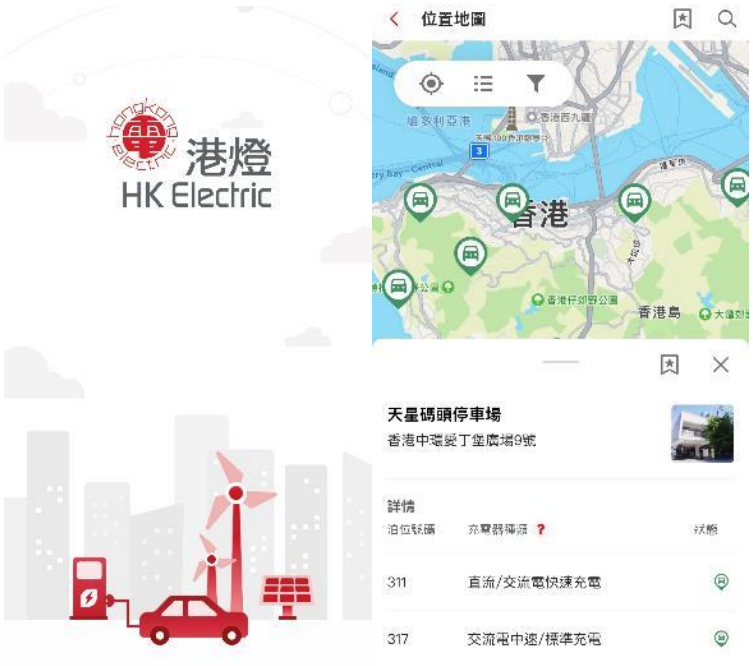

Figure 13. The interface of the HKE App – EV Charging Station Search Function[27]

However, an obvious limitation is that the app will only show charging stations within Hong Kong Island where HKE supplies the electricity. Similarly, a local company (Bolt) has attempted to actualise this mechanism. However, the app has not seen wide adoption as the booking was limited to EV stations that were also installed by this company as they were not able to access utilisation status from other EV-charging providers.

This is an example of how silos within the sectors and a lack of a common data-sharing platform inhibit smart city initiatives in bringing significant benefits to the general public. Regarding this opportunity, BEC proposes the following recommendation:

Key recommendations for EV-charging

Government should lead a consortium of public EV charging spot owners / operators to coordinate and establish a common portal for the sharing of real-time information, including the occupancy and charging status of charging spots.

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Another consideration is whether such apps need to be equipped with an advanced booking and payment function. The HKE app did not include these functionalities, likely due to complications in setting up a secure booking or even payment system, and users must operate on a first-come, first-served basis. In theory, one could view this case as an under-utilisation of existing technologies. However, fully incorporating every feasible technological feature might not be ideal in practice as this usually demands a greater digital literacy from users. If a partial group of users are unable to access these technology offerings, such a system fails to account for digital inclusion. This concern is largely relevant for many use cases and will be explored in the following sections.

3.3 Regulatory Sandboxes – To Foster Experimentation and Technology Trials

> *One of the challenges we face with smart cities is that technology is outpacing policy…On one hand, advancement and adoption may be stifled by concerns about murky policy or a lack of accepted technological standards. On the other, innovation without thoughtful oversight raises the spectre of security, privacy and ethical breaches.*
>
> *John Hayduk (Chief COO, Tata Communications) on balancing regulatory oversight with innovation* [28]

During the stakeholder interviews, there is a consensus that the Hong Kong transport system is currently over-regulated. There are two main consequences of such a phenomenon, 1) high barriers of entry shield existing players and cause the lack of incentive to optimise operations and the market to lose competitiveness; 2) market entrants face high risk and lack the freedom to engage in more experimental smart sustainable city initiatives (such as demand-responsive, or ride-sharing transport platforms).

A local example demonstrating this phenomenon is the case of Green Minibuses or Public Light Buses. The operations of these two types of services are regulated through conditions imposed by the Commissioner for Transport under the passenger service

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licenses, which limits the flexibility in licensing and route planning. During the pandemic, the inability to divert from planned routes means operators miss out on potential riders amidst an overall reduction in traffic demand. As a result, vehicles reminded idle, and drivers struggled to maintain their livelihood[29].

This incident signifies the need for greater adoption of demand-responsive transport (DRT), which also falls within the scope of the wider concept of Mobility-as-a-Service (MaaS). MaaS has seen global success in improving mobility in suburban areas and solving the 'first-mile, last-mile' issue – which is the distance a commuter needs to travel from a transit stop to their destination, or vice versa. New towns such as Tung Chung sees the greatest potential in such urban planning explorations, as transport infrastructures are still in development. Given that prevalent challenges in the local transport system include improving accessibility for elderly or physically disabled persons and addressing the skewed employment densities such as in the Central area – a thorough exploration of transport solutions is critical for Hong Kong in becoming a connected city and promote greater economic and social inclusion. For this reason, BEC proposes the following recommendation:

Key recommendations for Technology Trials

Government should be cognizant of the compatibility of existing regulations to emerging opportunities and facilitate technology trials by shortening approval process and de-regulating where necessary.

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Presented below is a case study of deregulation adopted by Korea in smart city development.

International Case Study

Korea eliminates all relevant regulations relating to the implementation of smart city projects[30]

In Korea, the government has significantly reduced regulations to promote smart city development. It has created two pilot smart cities in Sejong and Busan, to act as testing grounds for new technologies, such as artificial intelligence, 5G and blockchain, to develop new industries, including autonomous vehicles, drones and renewable energy.

The government has also introduced what it describes as 'drastic deregulation' to encourage participation in smart city development from the private sector. It has set up a smart city regulatory sandbox that eliminates all relevant regulations relating to the implementation of smart city projects. To encourage collaboration, a series of 'Living labs' have also been established where citizens and businesses can come together to identify urban problems and find solutions to them.

Figure 14. Sejong, South Korea's central administrative city, will carry out smart city trials, with emphasis on healthcare and environment in its 2.74 million sqm district

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Locally, while there are technology trials (such as autonomous vehicle drive testing at Hong Kong Science Park and Hong Kong Air Cargo Terminals[31]), experimentation at the level of deregulated 'sandboxes' is not common in Hong Kong. One example is the Fintech Supervisory Sandbox[32], which is driven by the Hong Kong Monetary Authority in September 2016 to allow banks and partnering technology firms to conduct pilot trials of their fintech initiatives involving a limited number of participating customers without the need to achieve full compliance with the HKMA's supervisory requirements. This approach produces more timely user feedback, reduces development costs, and accelerates refinements and the launch of new technology products. This concept has also been proposed by the Hong Kong General Chamber of Commerce[33] in 2020 (titled 'Smart City Fast-Pass Programme'). However, whether such deregulation to facilitate technology trials is appropriate ultimately depends on the nature of the issue. This market-driven approach might not be appropriate for the provision of critical services such as electricity distribution and management.

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4. Data Use and Digital Considerations

Data is a key enabler of the development of smart cities. However, for a society to fully reap the benefits of its usage, we must acknowledge its complex nature and the urgency of addressing digital concerns. The hierarchy diagram below is a useful visualisation, while industry experts focus a lot on building data trust, the reality is that there are still gaps in the society that prevents a greater level of inclusion from SMEs, or groups such as the elderly or disabled. Without addressing the foundation of digital accessibility and literacy, Hong Kong cannot progress towards a truly inclusive Smart City ecosystem. This section will further discuss the two-pronged approach required in the Smart City vision, pursuing both data trust and digital inclusion.

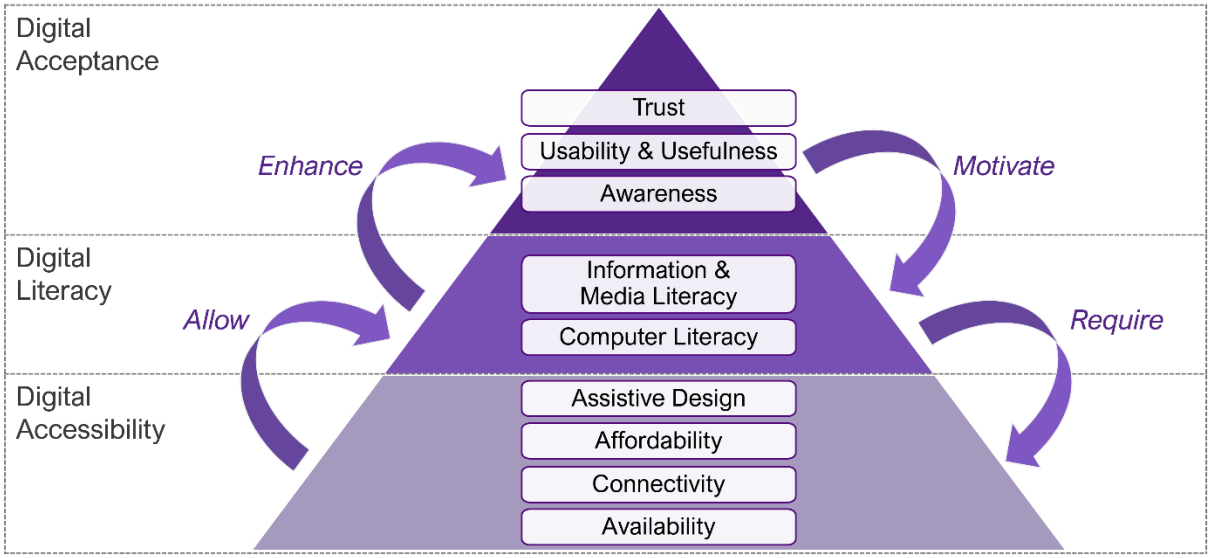

Figure 15. Hierarchy toward Digital inclusion[34]

4.1 Overview of Data Types and Data Privacy Regulations

We must first understand the types of data and their nature to understand their relevant implications. The table below illustrates the five main different types of data and the respective sensitivity around data use. Key insights are that personal data will have a high level of sensitivity around data sharing; and human behavioural data should be treated with special caution due to its haphazard nature, such as the need for a tailored approach in data analytics.

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Table 2. Five main types of data and sensitivity around data use

Data Sensitivity	Types of Data	Examples
High ↕ Low	Personal data	Personally identifiable information (e.g., name, age, ID)
	Aggregate data	Aggregate and anonymized data (e.g., passenger flow, utilization rate)
	Environmental data	Greenhouse gas emissions, air pollution, water, waste data
	Infrastructure data	Transport system data, Utility data (water pipes and electricity grids)
	Geospatial data	Vector maps, Satellite imaging (i.e., Common Spatial Data Infrastructure (CSDI) in HK)

This allows us to understand the public sentiments towards data sharing. Research by Hong Kong Baptist University revealed that Hong Kong residents are simultaneously ultra-connected and adept at technology, yet mistrusting towards government applications, even to improve the delivery of its services.

Public controversy in providing personal data to the government could be seen through the resistance and slow adaptation of the contact-tracing app 'Leave Home Safe', where the public feared that instalment of the app would jeopardise personal data on the smartphone. Another example is the tearing down of smart lampposts in Kowloon Bay in 2019, where the public feared that cameras or sensors could capture facial data used for surveillance purposes.

The private sector is also reluctant to share data with both the government and other industry players for reasons around privacy, interoperability, and perceived/real competition. For example, public transit operators and the private sector view data about their customers as a source of differentiation and value creation, and do not want to provide full access owing to concerns about losing the ownership of passengers or undercutting fares. Furthermore, their obligation to protect customers' data from malicious use puts a layer of additional concern around cybersecurity.

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By definition, data privacy indicates who has access to data, while data security provides tools and policies to restrict access to the data. In theory, any personal data that is shared must comply with Hong Kong's Personal Data (Privacy) Ordinance[35], which covers both the private and public sectors. Under the regulation, data can only be collected on a fully informed basis, must be stored securely, cannot be held for longer than needed and cannot be used outside of the original purpose for which it was collected.

The Privacy Commissioner for Personal Data (PCPD) is committing to ensuring best practices in data privacy and governance. Acknowledging that utility companies handle vast amounts of customers' personal data but are prone to malicious hacking for political and criminal reasons similar to financial institutions, the PCPD has inspected the data governance of the two local utility companies (CLP and HKE) [36] in August 2021. Areas of inspection include data governance structure, staff work-from-home IT arrangements, data inventory and retention policy, etc. The inspection concluded that their customer personal data management practices are aligned with industry best practices and provided nine recommendations for managing customer data.

In addition, PCPD published a personal data privacy guidance specific for the property management sector[37] (residential and commercial) in June 2022. The guidance covers nine areas, including personal data collection of residents or visitors, recording of HKID card numbers, and transparency on CCTV usage and collection, etc.

Figure 16. The Privacy Commissioner team provided concise and practical guidance on personal data privacy for residential and commercial property management firms

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4.2 Building Data Trust by Transparent Disclosure on Data Use and Governance

One way for the government to build public trust and ensure transparency and integrity of its data governance is to engage in third-party audits. A best practice is presented below, demonstrating Amsterdam's approach to data governance:

International Case Study

Amsterdam's Government Address Data Concerns through Data Audits[38]

With a growing part of its economy moving onto digital platforms including its government, the city of Amsterdam has developed a digital agenda along with a standard for auditing algorithms together with universities and industry. Amsterdam is assessing 25 of its own algorithms to ensure the methodology is suitable to apply in permits, concessions or contracts with private-sector parties. In the near future, the city will also ask companies that operate in Amsterdam to submit algorithms for auditing. Parameters are categorized as honesty, safety, inclusivity and privacy.

Amsterdam also partnered with Barcelona, New York and the UN-Habitat programme under the United Nations to launch the 'Cities Coalition for Digital Rights'[39] in 2018. The algorithms and standards used for auditing are shared and expected to be scaled up for use in the other membership 50 cities in the coalition.

Figure 17. Amsterdam, a city that is renowned for its successful and cutting-edge urban planning now extends to safeguarding their digital platforms

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One of the most high-profile attempts in building a Smart City was the 'Sidewalks Toronto' project – but it was also a poignant case to illustrate the controversy around personal data as a form of revenue creation; and how the lack of transparency on data use could result in public mistrust and eventually the failure of the project.

International Case Study

Google's Sidewalks Lab Project in Toronto[40]

Sidewalks Toronto was a project first initiated by the Toronto government to revitalise its waterfront area. The project tender was won by Sidewalks Lab which is a subsidiary of Google/Alphabet. In October 2017, development plans are revealed to citizens as 'a neighbourhood that will be built from the internet up', including features such as self-driving public transit vehicles, housing and commercial buildings built by timber, all backed by a network of sensors to optimise operations and minimise carbon emission.

This utopian vision was met with distrust from the general public, fearing that the government is becoming increasingly reliant on tech companies and adapting their business model to profit off personal data. Even after renouncing data ownership and claiming that data will be anonymised, critics have managed to unravel more concerns. This spurred a #BlockSidewalk movement and also a lawsuit by the Canadian Civil Liberties Association, accusing the project of 'surveillance capitalism'. In May 2020, Sidewalks Lab announced the cancellation of the project in view of the economic uncertainty brought by COVID-19.

Given that the project was likely overseen by top industry experts, it was not the mechanism that was flawed but the way it failed to build trust by maintaining an open dialogue with the public that led to its downfall. Micah Lasher, spokesperson for Sidewalk Labs, acknowledged this by saying, "*If you share data management strategies too early, they seem half-baked and you might move away from them later; if you share them too late, you are subject to criticism for not being transparent.*"[41].

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Figure 18. Sidewalks Toronto – a utopian city vision by Google halted by public mistrust in data usage

Drawing from the two case studies above, and echoing the PCPD's two guidance on data privacy, the government should consider the following aspects to build trust over data use from individuals and the private sector:

Key recommendations for Building Data Trust

- Maintain a high level of transparency with end-users on data use and analytics mechanism, e.g., whether data is collated on an aggregate or personal level, whether raw data will be destroyed after analysis, and whether (personal) data will be used for revenue creation
- Communicate the business case and value of centralised data to obtain buy-in from business sector and the wider community, such as the possibility to improve traffic, or cost savings from smarter energy use
- Improve upon data standards and regulations, by continuously benchmarking against international and industry best practices

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4.2 Promoting Digital Inclusion by Improving Digital Accessibility and Literacy

The pandemic highlighted the polarising nature of technology – widening the economic gap between early adopters and laggards, as well as the social gap between those who are tech-savvy, and those who are less adept.

For larger businesses, they will have the financial means to pursue the adoption of most technologies mentioned in this report. In fact, the pitfall for larger businesses lies in hastily adopting emerging technologies for the sake of staying relevant, rather than adopting tested and mature technologies that bring tangible benefits. But for most SMEs, technological adoption is limited to essential operational systems, such as providing more electronic payment methods in support of the recent consumption voucher scheme.

Given that the 340,000 SMEs in Hong Kong constitute more than 98% of our business establishments and employ about 45% of our workforce in the private sector[42], their ability to thrive is key to our economy. Hong Kong Telecom has demonstrated its acute awareness of this by rolling out complimentary relief measures totalling HKD 32 million[43], to supply SMEs with digital marketing and payment solutions. But ultimately, the government has the responsibility to ensure SMEs have the means to access technologies that allow them to be a part of the wider Smart City vision.

For citizens, this digital gap lies more in the difference in the level of digital literacy. Younger generations are more capable of making the most out of technology solutions offered by the government; while older generations could be left behind and with no alternatives to these solutions, for example with the mandatory use of the 'Leave Home Safe' app to enter public venues.

As of 2021, smartphone ownership for persons over 65 is at 73%, compared to overall ownership of 99%[44]. This demonstrates the need for a two-fold approach to increase ownership for those with less financial means and improve digital literacy for those already with a smartphone. On the financial side, the Hong Kong Jockey Club has partnered with 4 local telecom companies in the programme 'Digital Support Project for the Elderly'[45] to provide 'Leave Home Safe' compatible smartphones with free 12-month internet service

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to around 20,000 underprivileged elderlies with the aim to bridge this digital divide. On the digital literacy side, the government has demonstrated some initiatives such as the 'Leave Home Safe' support hotline[46] introduced in May 2022; and the Enriched ICT Training Programme for the Elderly, running between 2021-2023[47].

Figure 19. HKJC programme provides the elderly with smartphones to bridge the digital gap

Currently, the government is heavily reliant on NGOs, charities, or businesses with relevant stakes as drivers to promote digital inclusivity. It should be acknowledged that this cause has an impact beyond convenience, as it enables greater participation of elderly in the society, which in turn combats loneliness and promote health. In addition to the elderly, groups such as the mentally or physically disabled also have the right to fully participate in digital initiatives. Given that part of the government's Smart City goals is to digitalise public and health services, the government must pursue digital inclusion in parallel, to ensure all citizens who are both drivers and users of Smart Cities initiatives can fully contribute and benefit.

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Drawing from 2017 research by the Information Services Division of the Legislative Council, BEC proposes the following recommendation:

Key recommendations for Digital Inclusion

- Governments should improve digital accessibility by reviewing the needs of vulnerable groups and working with NGOs or local communities to provide tailored support.
- Government should improve digital literacy by hosting workshops at community centres, and encouraging digital participation (including but not limited to Smart City initiatives) through posters and social media, etc.

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5. Conclusion

To accelerate the development of a Smart City, stakeholders must gain buy-in by understanding its business case. While the business case for a Smart City is vastly different to a commercial project, parallels can be drawn between them.

The Five Elements of a Business Case, proposed by the Association for Project Management[48], is a framework commonly used by businesses to evaluate the feasibility of a commercial project. The five elements are translated into the context of a Smart City within Hong Kong and are summarised in the table below to conclude the points mentioned in this report.

Table 3. The Business Case of a Smart City for Government and Private Sector

Elements	Description	In the context of a Smart City
Strategic	The compelling case for change	Smart City outcomes align with wider Digitalisation and Decarbonisation targets, as well as potential to demonstrate Corporate Social Responsibility for businesses
Commercial	Derived from the sourcing strategy and procurement strategy	IoT applications are becoming mature and commercially viable at different scales, potential for SMEs to expand adoption
Financial	Affordability to the organisation in the time frame	Intersectoral nature of Smart City initiatives gives rise to flexibility in financing and funding options
Economic	Return on investment based on investment appraisal of options	Investment/capital cost is high (5G network, building management systems) but return/revenue is continual and generate intangible benefits for society
Management	Roles, governance structure, etc.	Right mix of internal and external ecosystem of suppliers and partners (cross-border, academic and private-public partnerships)

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Given Smart City's alignment with other strategic drivers such as decarbonisation or digitalisation, it is no longer enough for technology firms to be the sole players. Much like how climate strategy now requires board oversight, top-decision makers within a government and business must now be involved to shape a truly holistic Smart City strategy. They have a responsibility to citizens to formulate initiatives that are inclusive, ethical and generate societal benefits.

The inter-sectoral nature of Smart City initiatives also means that government and businesses enjoy flexibility in a wider range of funding or financing options. For more experimental and capital-intensive initiatives, the model of private-public partnerships should be explored. The private sector's higher risk tolerance will help spread the risk and rewards, and their market insights will guide government initiatives to better address industry and public needs.

Beyond the scope of Smart Environment and Smart Mobility covered by this report, aspects within Smart Living such as education, housing and health urgently require more progress as they are the key to generating long-term and sustained progress in society, as illustrated by the Hierarchy of Smart City Needs.

The pandemic has accelerated the adoption of many smart city initiatives. The coming years will therefore be a critical time for government and businesses to continue using digital initiatives as a tool for economic recovery and to improve the livelihood of citizens.

> *Pandemics are both catastrophes and opportunities, in the wake of even the most devastating public health disasters, human social life and creativity have re-emerged in new and unexpected ways.*
>
> *Mark Bailey (Historian and Author)*
> *for an article in New York Times*[49]

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6. Glossary

BMS	Building Management System
CSDI	Common Spatial Data Infrastructure
DRT	Demand-Responsive Transport
EV	Electric Vehicle
GBA	Greater Bay Area
HVAC	Heating, Ventilation and Air Conditioning
IoT	Internet of Things
MaaS	Mobility-as-a-Service
MiC	Modular Integrated Construction
PCPD	Privacy Commissioner for Personal Data
SMEs	Small and Medium Enterprises

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KPMG
Siemens Mobility Limited
Smart Charge (HK) Limited
Swire Properties Limited
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