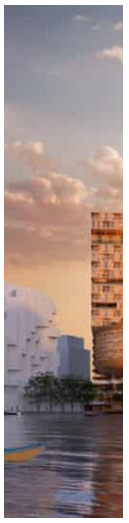
# Smart Cities - Overview, Open Data, Privacy and Management Issues, Standards and Solutions



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The definition of a Smart City by the Smart Cities Council is: “A smart city is one that uses technology and data to enhance its liveability, workability and sustainability. Or in short - tech and data for good.” Technology and data is understood as the use of digital technology and the exchange of data from the network of physical objects that are embedded with sensors, software and other technologies interconnected over the internet, also known as the “Internet of Things” (IoT). Importantly, it must be stressed that the ultimate goal is to achieve the improvement of the quality of life in cities (or more abstractly the built environment in which we live).

## How is Open Data published and used?

Open Data is the process of making datasets (information gathered by cities, public entities and private sector companies within the public domain) available to the public (citizens) to use and reuse. This data constantly gathered is considered “OPEN” (as defined by the World Bank) when it is available in a machine-readable standard format, being able to be retrieved and meaningfully processed by a computer application (Technically Open) and when the data is explicitly licensed so that commercial and non-commercial  use is permitted and is reusable without restrictions (Legally Open).

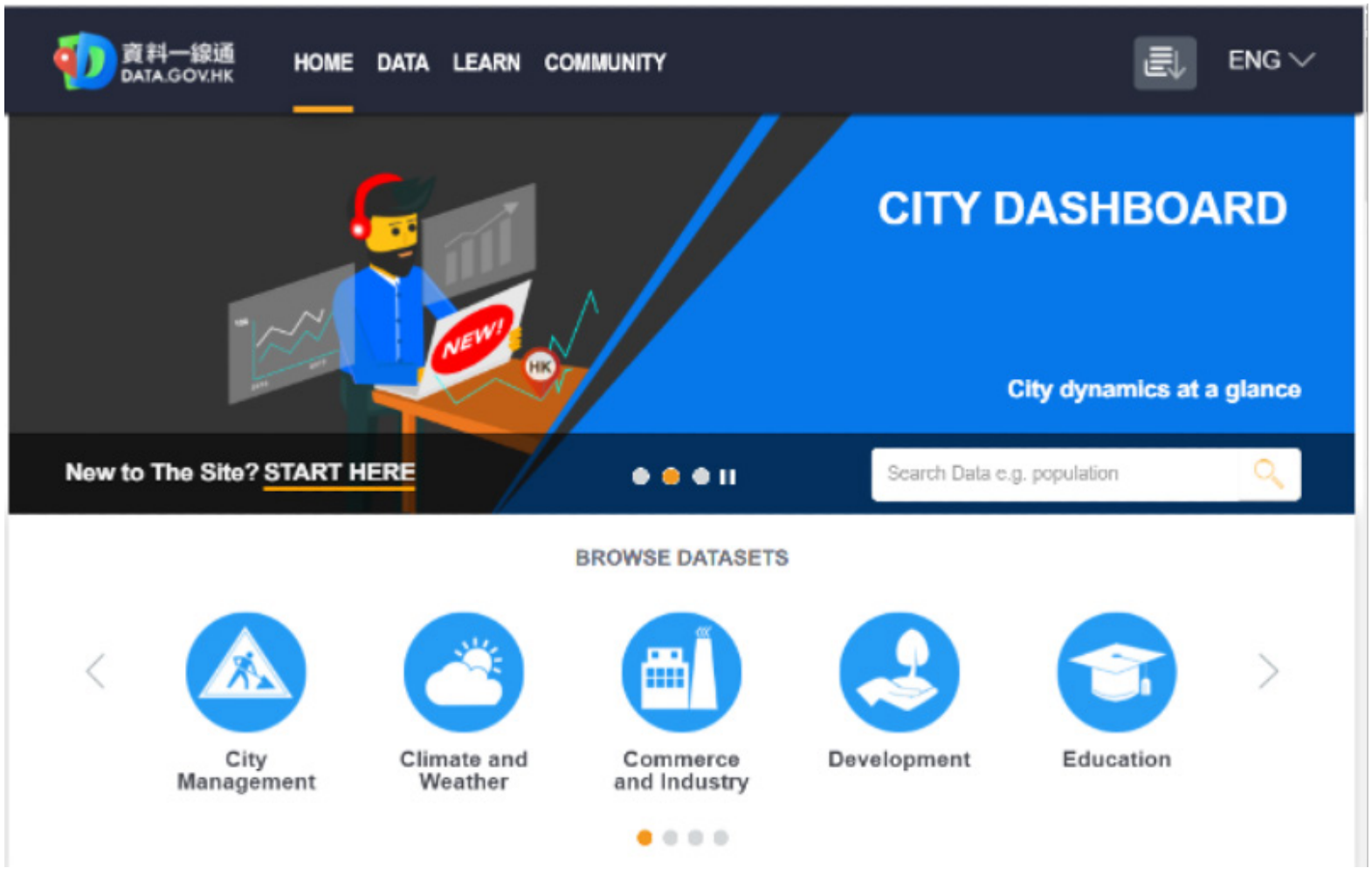


Figure 1. Screenshot of DATA.GOV.HK (Source: Internet screenshot by the author)

Governments typically coordinate and release data from multiple agencies through a central, secure, read-only location such as "data.gov" that facilitate users to find and use data. This location where data are published is called an open data portal. There are a range of platform options from cloud-based open sourced portals or built by their own cities. In Hong Kong, through the Public Section Information (PSI) Portal DATA.GOV.HK, anyone can access freely and harvest the datasets (covering from demographic, economic, geographical and meteorological data) through API for commercial and non-commercial purposes.

Priority of published data can be based on availability or by community feedback. Countries benefit from the release of government data in many ways, some common examples include:

**Promoting transparency and accountability**

When budget and expenditure data are released, designers often visualize them to make them understandable to the general public. Citizens can also see which programs, services and agencies are getting funding and how money is being spent.

**Releasing social and commercial value**

Geospatial, transport and weather data are often used by companies to build new services. These services benefit citizens and create economic value and often lead to more efficient ways of doing things.

**Increasing citizen participation and engagement**

Releasing data often opens the door to feedback and engagement – parents are interested in the performance of schools, citizens want to report issues with public services and governments can become more responsive to national needs.

## The Community factor and Data Privacy concern

There is a strong feeling of fear on the amount of data that citizens are giving away for the sake of making their cities more efficient. The decision to change in 2021 and back away from the original futuristic plan for Quayside, Toronto has become a landmark on how far citizens (and governments) want to go in the application of a "technology-based gated community, where everything was monitored behaviour, personal data is collected by thousands of cameras". Some even comment that this move reflects a growing skepticism over technology's role in urban planning decisions.

Further to the economic impact (and potential benefit) of open data and technology-enabled transparency, benefits for societies through increasing state or institutional responsiveness, reducing levels of corruption, building new democratic spaces for citizens, empowering local and disadvantaged voices or enhancing service delivery and effective service utilization. The study by the Sunlight Foundation: "In the Social Impact of Open Data" (by Julia Keseru, James

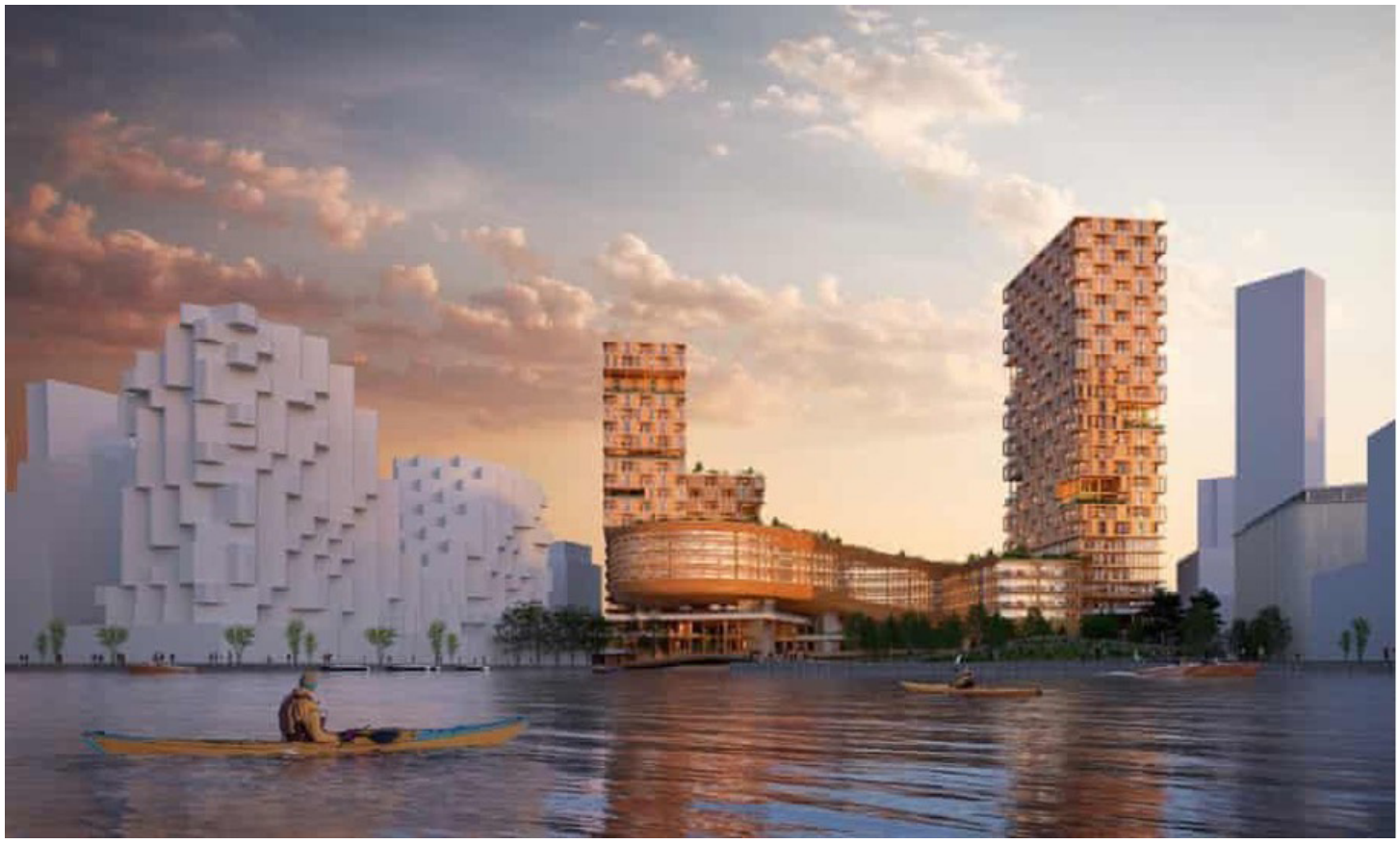

Figure 2. Rendering of proposed waterfront development for Quayside Toronto featuring a pair of futuristic high-rises linked by a curved structure. The overall planning of the project included state-of-the-art automation of many urban services and infrastructure, thus creating a very efficient built-environment. However the expected data that may be gathered from the users eventually created a backslash on how the project was received by the citizens and the local government. (Image Courtesy of Snøhetta.)

Kin-sing Chan, 2015), Open Data initiatives are defined as projects using data that can be freely used, reused and redistributed by anyone. The project collected more than 100 examples (outputs, outcomes and impact) of open data and digital technology projects.

Three case studies from the Global South were thoroughly assessed, considering theory of change for open data and digital transparency initiatives. As part of the conclusions, the research identified (potential benefit) categories for project outcome in open government space as the following:

1) Educate or inform citizens so that they can make more informed choices,

2) Promote direct vivid engagement and increase citizen participation in democratic processes

3) Gather feedback for policy-makers and/or the private sector, and

4) Monitor and hold officials and/or the private sector accountable

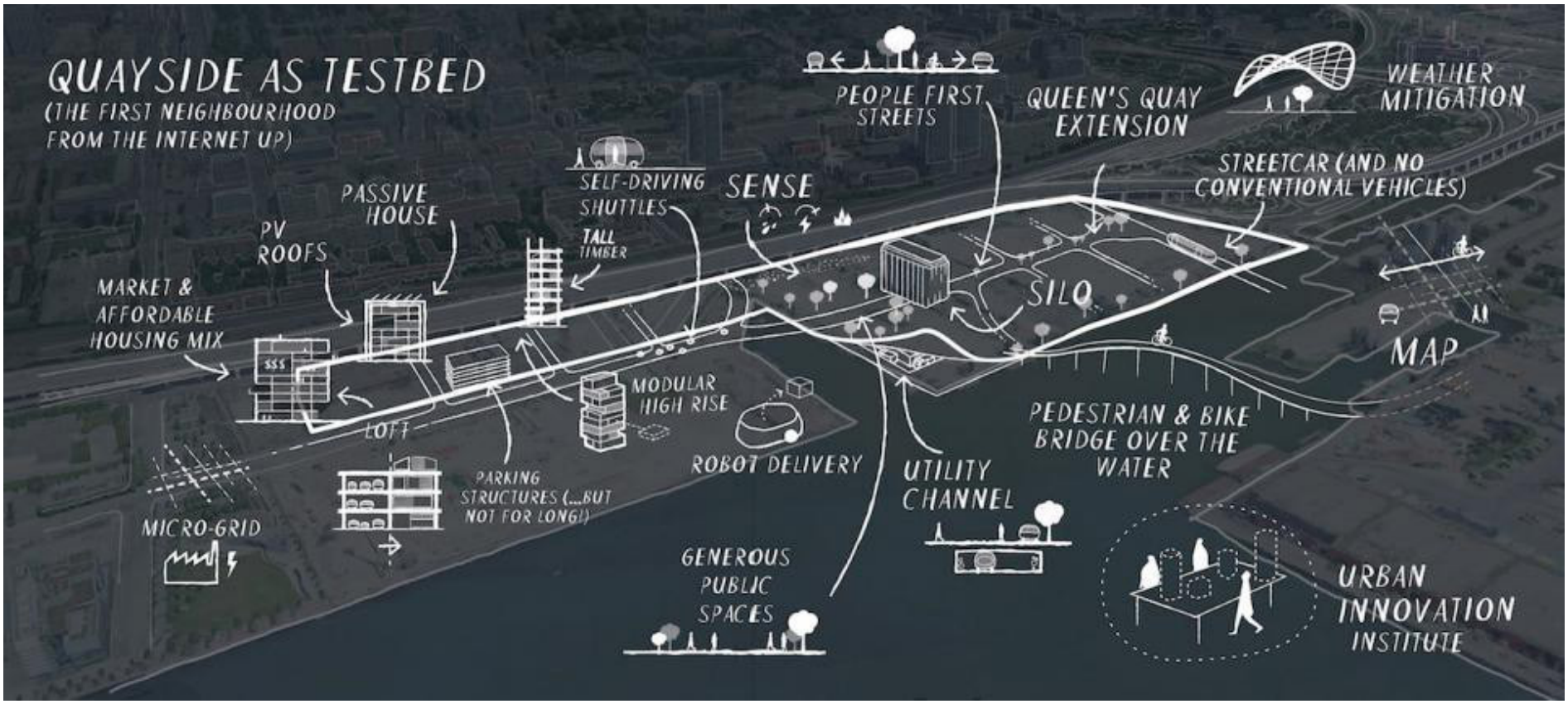


Figure 3. A conceptual sketch of Quayside showing all the Smart solutions proposed incorporating a lot of automation of many urban services and infrastructure. (Source: Planetizen - Smart Urbanism: The Potential and Criticism of Smart Cities, 2020)

Figure 4. Sketch of Quayside showing a cross section of the city showing the separation of systems which includes delivery and recycling systems underground separated from a cleaner and greener public realm. (Source: Planetizen - Smart Urbanism: The Potential and Criticism of Smart Cities, 2020)

## Smart City Development in Hong Kong - Common Spatial Data Infrastructure and the Built Environment Application Platform

As seen before, the trend of Smart City development is usually under the initiative of governments, finding that the benefits of better managed resources at the macro-urban level is achieved at quantitative and qualitative dimensions. Hong Kong is not an exception, and so far it has been at the top of its priorities to keep up with the technology for a constant improved management of its common services and resources (infrastructure, planning and utilities). In Hong Kong's 2030+ Smart, Green and Resilient City strategy. Looking to integrate the amount of information and data in between bureaus and departments for a seamless coordination under a core data management, a Common Spatial

Data Infrastructure (CSDI) was proposed. Under the strategy, it was defined that Users (planners, engineers, architects, surveyors, government, academia. business and general public) would cooperate, collaborate and co-create Applications to analise, visualise and get informed about Planning and Land use, Infrastructure and Engineering and Landscape, Environment and Conservation using data from the CSDI (consisting in 2D/3D data, images and real-time data), thus developing a Built Environment Application Platform (BEAP).

In the Feasibility Study carried out by ARUP for the Hong Kong Government's Planning Department in 2020, there is a thorough review of international cases, giving a comprehensive view and analysis of the systems in practise in Singapore (Virtual Singapore), Australia (AURIN) and the city of Portland (CGIS) in the United

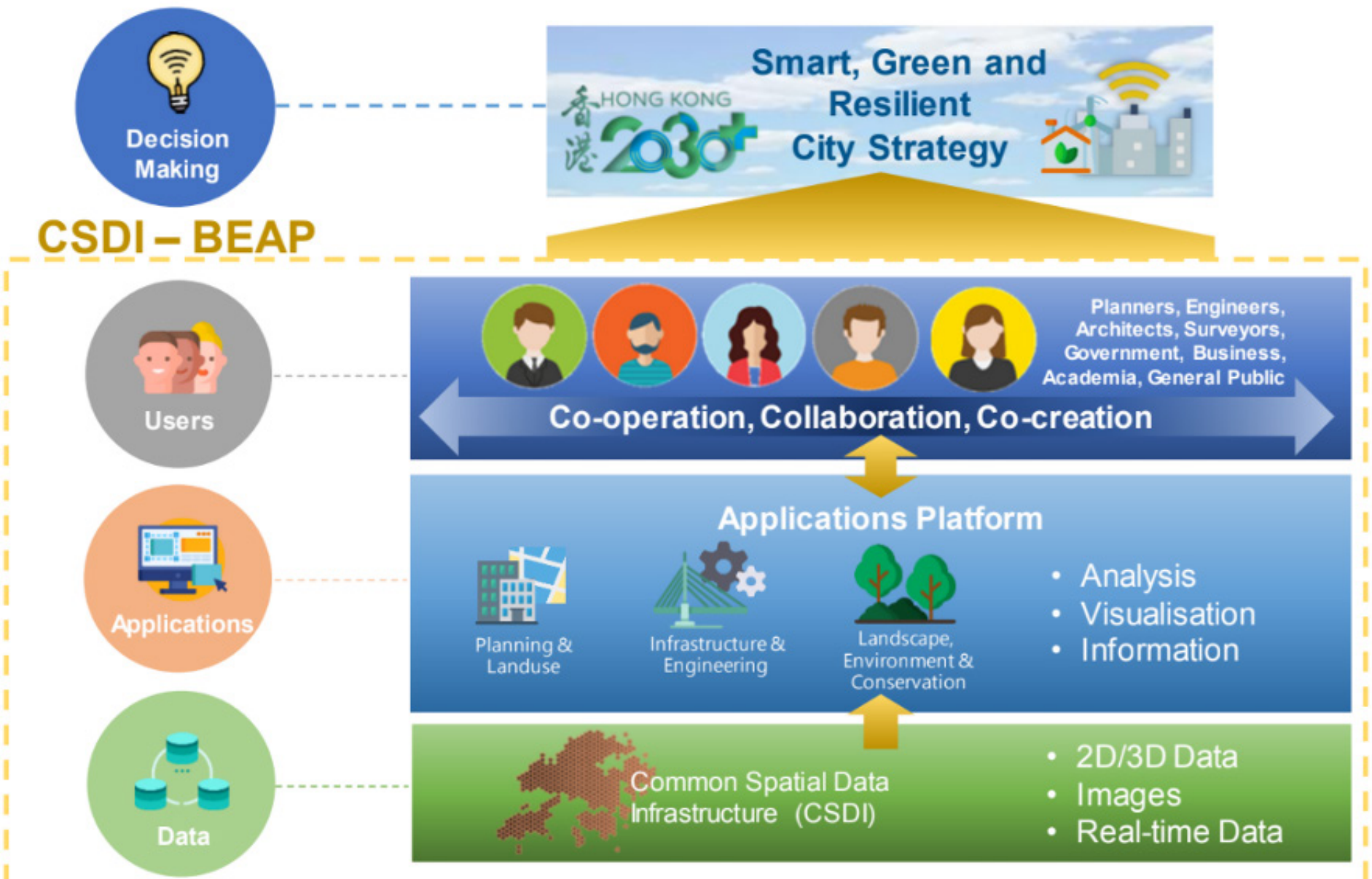


Figure 5. Common Spatial Data Infrastructure initiative - BEAP Study (Source: ARUP, Planning Department, 2020)

States. there were identified four Key Building Blocks needed to implement a successful Built Environment Application Platform:

**1) Applications Development** - This block refers to the web-based portal, its related applications tasked to address specific built environment requirements and Application Programming Interfaces (APIs) for applications

**2)"Actionable Data"** for Application Development - Data that is ready to be used, to be acted on, relevant to the query that is being made of. Actionable data is considered as a fundamental element of an application platform.

**3) Technology Infrastructure** - Hardware and softwares where the BEAP applications and data reside and operate and related Security Infrastructure.

**4) Business Architecture** - This comprises the services provided by the BEAP, basically the different applications provided to different user communities such as bureaus and departments, academia and the general public. It also requires a Governance and Operating Model which ensures the platform operates efficiently and effectively and devivers value.

The study not only presents the means to develop the BEAP but also includes proof of concept test cases for different scenarios on how the BEAP can be used, e.g.: Land use monitoring and analytics, Site Search, Scenario for Planning and Development, GIC Facilities and Open Space Analysis, Visualization and Analysis of underground space and utilities, etc.

Quoting the conclusion: "The BEAP has great potential to be further developed as the collaborative platform for Government, business, academia and research institutes to foster interdepartmental and multilateral co-operation, as well as to serve as a foundation of various types of spatially and digitally enabled built environment applications for planning and design formulation, decision making, resource management, statistical analysis as well as the delivery of high quality services to the public. Through the application development, the BEAP would also enhance innovation, knowledge and value creation for different segments of the populace starting from within the Government in the years to come."

The Built Environment Application Platform is a powerful tool for the city of Hong Kong, however it is clearly focused on its usability by highly specialized users (technical persons with specific skills to understand and manipulate the data available) which is good (but maybe not good enough), however it would be interesting to see the application of the available data for users a different levels, making it more user-friendly, practical (or commercial) and also there is the opportunity that it can become a strong and powerful educational tool for students, from simply creating thematic maps for assignments to looking for historical records and photos and understanding the complexity of the infrastructure and how the city works.

## Data movement through the Internet of Things

"Smart cities have numerous sustainable implications for advancing human development, improving societal processes, and reducing environmental costs. IoT technology merges interdisciplinary fields of technology, environmental resources and urban systems development to enhance human capital and create a sustainable future."(Drepaul, 2020) The implementation of IoT technology allows smart cities to link objects, information and people through intelligent computer networks. IoT technology allows the facilitation of data acquisition to guide future processes, improving the architectural sector by transferring data efficiently in order to improve decision-making on policies and projects related to housing, development, and the maintenance of public spaces. The sustainability implication is that, by improving our decision, IoT technology will lead to better housing and transportation designs, improved construction processes, and healthier lifestyles in cities.

Structural changes in policy and future governmental regulations can be enabled by the use of IoT technology. Within the multiple tiers of planning of smart cities, examination of IoT's structure and application, policy making, urban planning and sustainable practices can be improved. The first bottom tier is responsible for IoT sources, data generations and collections; the second intermediate tier consists of data management and processing; and the top tier is responsible for the application and usage of the aggregated data (Rathore, 2016) This tiered framework model supplements data aggregation, filtration and computing data which helps in future decision-making processes. IoT technology is implemented in three levels: the physical level which consists of data sets; the intermediate level which consists of statistical measurements or correlation chi-square, probability calculation and graphical analyses; and the upper level which relates to future planning derived from data collected. Its application has the capability of improving traffic, environmental pollution, surveillance, smart parking, weather tracking, water monitoring, and more.

## Towards a Standard for the ideal Smart City

As it is understood and as we can observe in the practice, the Smart Cities approach can be very helpful addressing issues at citywide level. In some cases the emphasis of the application of the use of technology as part of managing a "Smart City" becomes an efficient way of managing citizens behaviour within the public realm (e.g.: regulation of smoking in forbidden zones by the Singapore government, crowd densities and manage cleanliness); management of city services (e.g.: Dubai's internet application, Dubai Now which centralizes the information and payment of utilities, traffic speeding tickets handling, call taxi services, track deliveries, visa status, etc.); and efficient management of energy utilization (e.g.: Barcelona's use of smart street lamps, parking

sensors, garbage sensors and compacting system or the air quality and pollution management in Darmstadt, Germany).

Despite many cities becoming "smarter" in one way or the other, most solutions tend to deal with partial "smartification". The European Triangulum project (part of the European Community's Horizon 2020 framework programme) aims to transform urban planning into a multidisciplinary effort with the latest of the technology available. At the moment, three main cities: Eindhoven in the Netherlands, Stavanger in Norway and Manchester in the United Kingdom, are making use of smart city solutions which integrate energy, mobility and information & communication technologies (ICT) in their district.

The goal is to reduce energy use and carbon emissions, enhance quality of life and stimulate economic development. The project will demonstrate that this model, integrating existing technologies in the field of energy, transport and ICT can be replicated throughout Europe based on a compilation of best practice scenarios. This will be put on testing in Leipzig (Germany), Prague (Czech Republic) and Sabadell (Spain). Tianjin city acts as an observer and eventually will put the best practice scenarios into practice.

Since initial use of the term in the 1990s, the concept of Smart Cities has evolved into a truly interdisciplinary approach: one that not only smartens up the living conditions of its citizens but also the environment, the mobility, governance and the economy. This kind of city must be active and independent in its decisions made by well-informed residents, using resources at hand. Thus efficiency of urban and social infrastructure can be constantly improved by advanced technology.

The question and objectives are clear: the search for the "Smart City best practice scenarios across Europe", however in the practice, it can be noticed that cities tend to focus on issues that in many cases may be specific to their particular geographical or social setting.

In Eindhoven, the government collected frustrations and worries from their citizens, the focus was on public safety for one their busiest districts: Stratumseind, using smart lamp-posts fitted with Wi-Fi trackers, cameras and microphones. It also considered diffusing oranges smell into the air to create a calming effect. Eindhoven also addressed smart issues into smart mobility and traffic management and developed shared urban spaces, encouraging citizens towards healthier lifestyles and increased participation in governance.

Different drivers were the focus for Stavanger, Norway: the need for more sustainable business and its population's demographic change. Based on this premise, the city deployed technological solutions to improve the digital skills and well being of its citizens. On the environmental front, the objective is to facilitate the choice of climate-friendly alternatives for transportation by the citizens, in order to reduce local greenhouse gases emissions.

As stated in the publication "Smart Urban Planning starts with interdisciplinary thinking and action" (Zsuzsanna Balasz, Euroscientist, 2020) : "In order for an urban area to become smart, the "smartification" of the citizens as well is of utmost importance."

## An Alternative Benchmark for Smart City Solutions

As part of the Smart Cities Framework proposed by the Smart Cities Council, the first step is setting up the "Outcomes" (goals and targets for the city, based on recognised frameworks (eg. UN Sustainable Development Goals) which has been localised and informed by community engagement. "Repeat" is the fourth step of the Smart Cities Framework. Social engagement in order to review the process and targets and build transparency and trust with the community is of utmost importance. Based on this, the community develops a unique Smart City which has specific needs and solutions.

Based on the application of this framework globally and the development of a market for Smart Solutions, five main vertical categories were identified in the "Smart Cities: Opportunities for the UK" (ARUP, 2013): water, waste, energy, transport and assisted living.

Smart solutions across the verticals become beneficial when:

1) where resources are being consumed (better monitoring and management + users can be better informed in their use and how to lower consumption).

2) This reduces utility costs and extends the operating life of the related infrastructure.

"Smart city solutions apply digital technologies to address social, environmental and economic goals. Smart city solutions can combine physical and digital infrastructure or can be based on digital infrastructure alone. This confusion is a barrier to growth of this market as confused customers find it difficult to justify investment."

The study focused in the following five main verticals by Smart Cities:

**Smart Energy Management** - Smart energy management technologies can help utilities and distributors to forecast and manage loads better, reduce the need for costly infrastructure expansion, and improve service quality and customer satisfaction. Meanwhile consumers benefit from service quality reliability improvements, new tariff options, the ability to reduce their energy bills. However, the full benefits to all parties will not accrue unless the whole energy system is made smart end-to-end.

Latest market and technology trends include: Smart Distribution Networks, Advanced Metering

Infrastructure (AMI), Smart (domestic) appliances, microgeneration management, and Building Engineering and Management (BEM).

**Smart Water Management** - Smart water management solutions are a means by which water companies use technology to optimise performance, minimise disruptions and conserve water.

Water management systems worldwide have an inherently ineffective nature, so there is a need to develop and use technology and smart water management in order to enable reductions to the present capital and operational running costs currently incurred by the utilities.

**Smart Transport Management** - Increasing urbanisation means cities are facing more congestion and associated carbon emissions, while still needing to provide good quality of life. … The growing demand for smart transport solutions to address congestion from city authorities and commuters means that the global 'Smart Transport' market, including digital and physical infrastructures, and associated design and advisory services, is expected to be worth over $100 billion by 2018.

Recent technologies that reduce congestion, improve quality of life, reduce emission from traffic, improve safety and optimise traffic flow include: Transport Information Application development, Intelligent traffic features, Digital City features.

**Waste Management** - Waste is a by-product of economic activity and the smart management of waste will have economic implications, however waste has never seen the same level of research, innovation, product development or investment as the water or energy sector. Human behaviour towards waste, its generation and treatment, plays a significant role in explaining why the uptake in smart waste management is lagging behind those of other smart sector.

Most of the "smart" technology used for waste management enhances the efficiency of waste collection and separation, while looking for cost reduction and improvement of the recycling performance by cities. Smart technologies developed include: Smart public realm bins, RFID tagging (use of pay-by-weight mechanisms) and Refuse Collection Vehicle GPS Tracking, Automated waste Collection and Mechanical Separation of Waste.

**Assisted Living** - Healthcare and social care systems around the world are seeing increasing demand as populations increase and more people live longer with long term conditions, disabilities, or the difficulties that come with age. There is an increasing need to help people live at home or in their communities longer.

Assisted Living Technologies (ALT) are becoming rapidly a mature market given the change in the demographics globally with an expected population aged 65 years or older of 1 billion people by 2030, feeding into a growing "silver" economy. Adoption of more affordable,

innovative and technologically advanced alternatives to traditional solutions support the development of a more strategic approach to ALT. Enhanced visibility in the value chain, with less fragmentation , improved collaboration between suppliers and information transparency are the growing trends in ALT. There is a rapid progress towards wearable and skin-contact devices using mobile and wireless technology to collect vital signs data and keep up with the health status of the users.

The study recommended that “large scale trials of whole systems shall be implements, with a focus on business models and deployment, rather than just technology.” Deployment of innovative products and services shall be made easier by cities and utility companies. Attraction of capital and creation of organisational structures which have the authority and capacity to deliver innovative programmes shall be main priorities for cities to achieve.

While the 5 verticals above may sound generic and quite logical and clear to common sense, the possibilities to benefit from the growing technological advancement by standardizing this into the professional practice and cities’ management could be exponential.

## Biography

**Alexander C. Ngai Siu** is an Architect and Urban Designer with wide experience in physical planning and conceptual sustainable design often in the context of tourism planning and master planning. He obtained the Bachelor Degree in Architecture at the Ricardo Palma University in Lima, Peru, subsequently he has taken postgraduate studies on Landscape Design and was awarded the Master Degree on Urban Design at the University of Hong Kong. He is a professional member of the Hong Kong Institute of Urban Design.

Mr. Ngai has over 20 years of professional experience, having acted as project manager and designer for residential, institutional, mixed-use and community-oriented developments. In the last decade, he has been involved in tourism development projects in Asia by international agencies such as UNWTO and ADB. He also participated in urban design studies related to major urban infrastructure improvement projects in Hong Kong, mainland China, Saudi Arabia and Qatar.

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