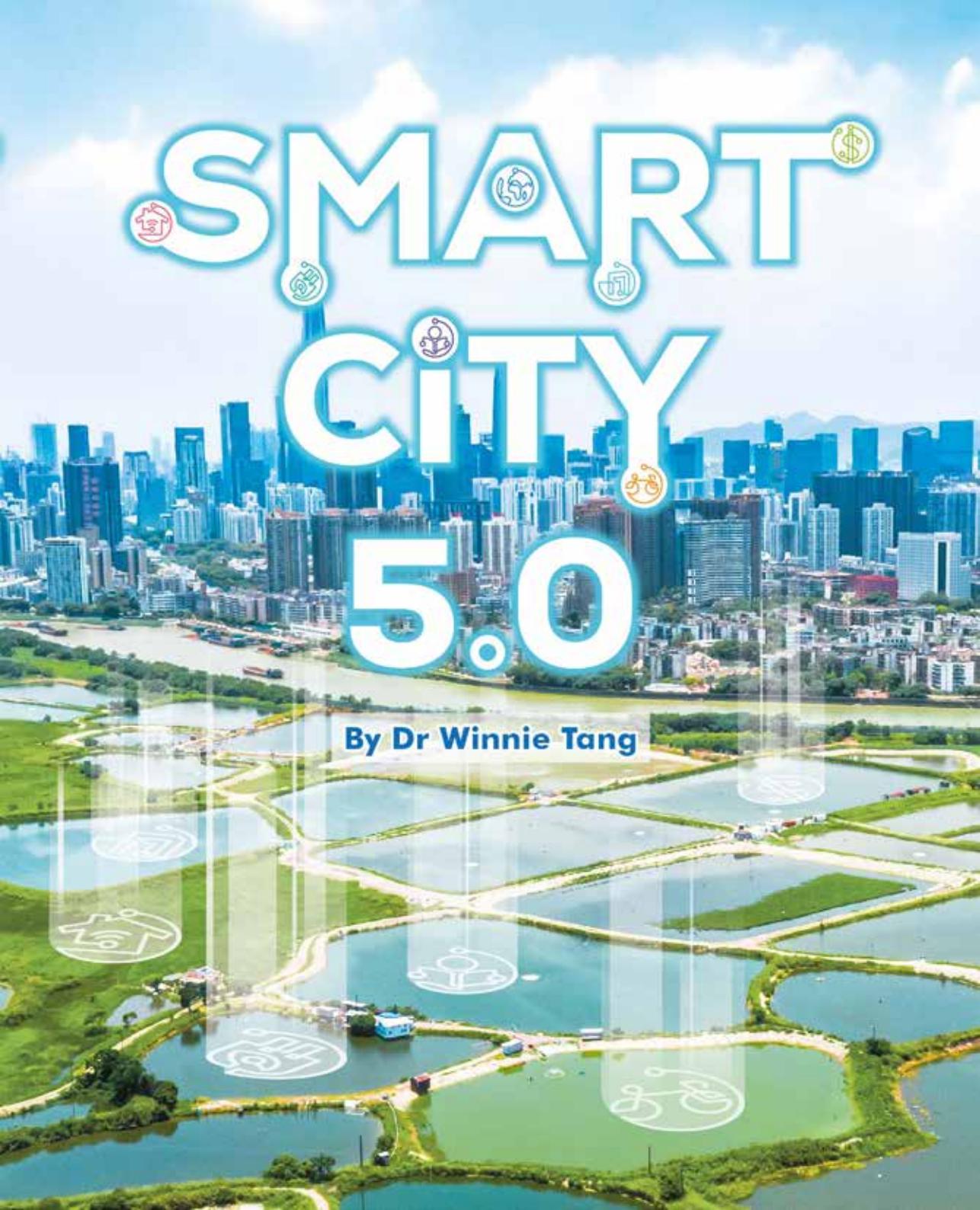


SMART CITY 5.0

By Dr Winnie Tang



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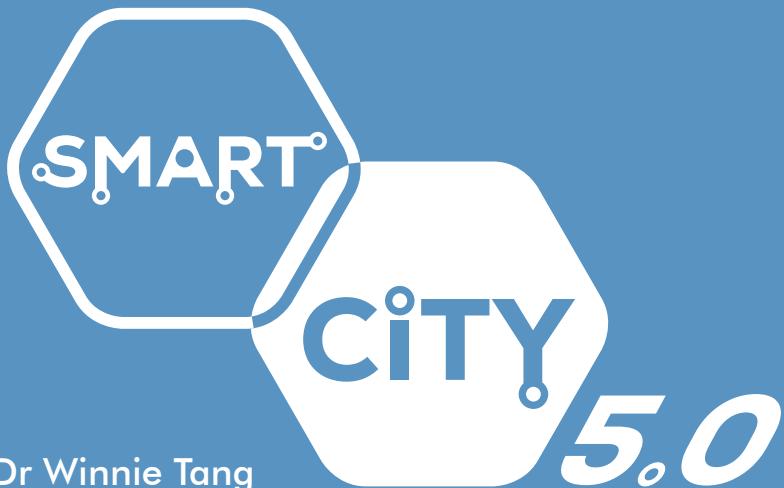
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Smart City 5.0 is a deep-dive version of 3.0 and 4.0. Version 3.0 emphasises the balance between development and environmental conservation, while 4.0 focuses on innovation, technology, with geographic information systems (GIS) driving change. Version 5.0 further analyses how to implement sustainable development in a practical manner.

This consists of a two-pronged approach to reduce carbon emissions in the context of sustainable urban development and improving efficiency in the face of an ageing workforce and applying innovative technologies such as GIS, which continue to play a key role.

For example, under the global trend of urbanisation, buildings are one of the main sources of carbon emissions. So, when planning land reclamation in new development areas, we should strive to use innovative technology to ensure that the planning, execution, and management of projects are handled well to minimise the impact on the environment, especially biodiversity. By doing so, we can achieve harmony with nature.





By Dr Winnie Tang



Spatial understanding enables a sustainable future

It is expected to be warmer in the coming five years because of increasing greenhouse gases. Various climate scientists, such as from the World Meteorological Organization warn of El Nino hitting the world in the second half of 2023 with increased heat, drought, or rainfall in different parts of the world. A U.S. study estimates that El Nino could cost the global economy trillions of dollars over the coming five years.

At the HKU President's Forum, I told the audience a story about Wangari Maathai, a great woman who planted millions of trees in Africa, and why she had that ground-breaking concept of tree planting. Nicknamed "Mama Miti", Wangari told me that she once, having got on a wrong bus when she was supposed to go to her village, tried to stop the bus to get out but neither the driver nor passengers listened to her. She said the global society was on a wrong bus. Since the Industrial Revolution in the 1800s, we have been on the wrong carbon bus, and it is hard to turn the bus around.

As a member of the global community, we are all at a critical crossroads for climate action. Climate change and biodiversity loss are existential threats facing our planet. As people and the planet are inextricably linked, we rely on the natural environment and the biodiversity it harbours. Therefore, our survival, and in turn, our economic prosperity is tied to our being good stewards of the environment. But the equilibrium between humans and nature has long been disturbed. How can we juggle between the competing needs

of industrial and commercial advances on one hand, with the conservation and preservation of the natural world on the other hand?

In addition to climate change, urgent issues of urbanisation, shortages of food, ageing populations, and other challenges of the world are beyond our current means and are on the horizon. These are all global and multidisciplinary problems. In addressing these challenges, working within a single discipline can slow down or even prevent collaboration from happening. We need concerted approaches at all levels of society and within organisations to identify optimised solutions while trade-offs will be inevitable. To facilitate consensus in this highly diverse global community, the pre-requisite is a holistic understanding of the problem. This is where geospatial language or geographic information system (GIS) is required.

Geospatial language or GIS has two basic characteristics.

Its visualisation allows everybody to quickly grasp what is happening. It is a common language among decision makers, people, politicians, and scientists across all disciplines and is used to evaluate the impacts of various proposals. In other words, GIS provides a framework for mutual understanding.

Equally important is its ability to integrate all different kinds of information, no matter if it is remote sensing, building information modelling (BIM), surveying, satellites, or artificial intelligence, and when fed into digital twins or real-time sensors, this can bring updated data into portals that contribute to better decision-making and broader understanding. The integrated data is accurate enough for measurement, analysis, planning, and ultimately

empowering more decisions, such as how to implement a data driven smart city, where to plant trees, how to better reduce human-elephant conflict or what part of a city needs better broadband access in order to narrow the digital divide.

Our work with Yale University support Edward O. Wilson's call to protect "half" of nature for global biodiversity is another example. The data is used by GIS analysts in nations, states, and cities to identify areas important for conservation. Known as the 30x30 initiative, the target to protect 30% of land, inland waters, and the ocean by 2030 is a key climate and biodiversity objective.

We also worked with organisations like NASA to extend access to Earth data including new datasets from nearly 100 spaceborne sensors, measuring atmospheric health, land-based phenomena, and characteristics of the oceans with the broader global community. With help from AI and machine learning, a new, high-resolution global map of land cover showing changes on the earth's surface on a weekly basis has also been developed. Therefore, we can do more to protect the planet using information with modelling to predict what may happen next. We can see what level of sea could flood land, where crops are at risk, and where conservation policies can be enacted to make an impact.

With collective and collaborative efforts, a geographic approach can bring positive change.

That's why I am excited about the Hong Kong government's leverage on an all-of-government approach to mitigate the effects of natural disasters by



adopting a Common Operational Picture, and an interactive map dashboard to give updates on the latest situation of the Covid epidemic in early 2020. The latter also required the effort of an NGO, the Smart City Consortium which was founded by Winnie.

This is Winnie's fifth book on smart city in seven years with a focus on sustainability. Along with her passion for GIS, Winnie also shows her commitment to supporting the younger generations. She has set up over six scholarships, provided the GIS software for research and development, especially to those geo-spatial related projects, and shares industry experience through seminars, talks and lectures as an Adjunct Professor of the local universities so that more and more young talent can excel.

Can we turn the carbon bus around? With collaborative efforts and holistic thinking through the application of GIS, I am confident that we can contribute to the great effort required to turn the climate risking situation around and create a better and smarter future.

Jack Dangermond
Founder & President, Esri

Building a better home together for our future

As the world continues to urbanise, achieving sustainable development in modern cities has become an increasingly pressing issue. Balancing economic growth, environmental sustainability, and social inclusion is a complex challenge in many cities around the world. Hong Kong is no exception. Developing a smart city has become an indispensable means to address this challenge by leveraging technologies, particularly information technology, to optimise resource allocation, improve service delivery, and enhance citizens' quality of life.

Winnie's new book *Smart City 5.0* represents the latest evolution of this concept, building upon earlier iterations that focused on technology-driven innovation, citizen engagement, and stakeholder collaboration. In *Smart City 5.0*, the emphasis is on concrete smart city measures that will reduce the environmental impact of modern city development and achieve long-term sustainability.

Geographic information systems (GIS) are a critical foundation for smart cities. Recent advances in artificial intelligence (AI), such as generative AI systems, have sparked enthusiasm for their potential to address a host of problems, including environmental sustainability, in highly developed cities like Hong Kong. Modern GIS and geospatial analytics tools, empowered by cutting-edge AI technologies, enable cities to collect, analyse, and visualise vast amounts of structured and unstructured data collected from various sources, including sensors, social media, and mobile devices. By turning this



three-dimensional data into accurate forecasts and actionable insights, cities can make more informed decisions about resource allocation, infrastructure development, and service delivery.

For example, GIS can map air pollution levels in real-time, allowing cities to identify hotspots and take targeted measures to reduce emissions. Similarly, big data analytics can help optimise traffic flows and waste collection routes, construct greener buildings, enhance drainage management, and reduce fuel consumption and greenhouse gas emissions. These technologies are particularly relevant to the ongoing sustainable development of Hong Kong as we embark on building the Northern Metropolis, with the Lantau Tomorrow Vision also on the development roadmap.

Realising environmental sustainability is a long battle. Professor Tim Lenton of the University of Exeter posited that “positive tipping points” would need to be identified to allow humanity to fight against the negatives brought by the climate crisis. A technology-driven approach offers sources of hope. By leveraging information technology, such as GIS, BIM, and geospatial analytics, in new town planning, design, construction, and management, Hong Kong can better achieve its long-term environmental sustainability goals. These include reducing carbon emissions by 50% before 2035 vis-à-vis the 2005 level and achieving carbon neutrality before 2050, as per the *Climate Action Plan 2050*. We must strive to act as a role model for other cities to follow.

Relying on government’s efforts alone is insufficient. On the enterprise level, it is encouraging to see companies increasingly emphasise ESG (Environmental, Social, and Governance) considerations. ESG is becoming an essential factor for investors, policymakers, and citizens alike as they seek

to ensure that cities are not only economically successful but also socially and environmentally responsible. By adopting information technology that enables more informed decision-making and greater transparency, cities can better demonstrate their commitment to ESG principles.

In his encyclical *Laudato Si*, Pope Francis said: "The gravity of the ecological crisis demands that we all look to the common good, embarking on a path of dialogue which demands patience, self-discipline, and generosity, always keeping in mind that realities are greater than ideas." The Pope highlights the interconnectedness of everything in our modern world, where environmental protection is an integral part of development, and various ecosystems are interrelated to form a whole. Information technology can help integrate and analyse the data and information from different sources to develop visualisations and predictions, facilitating constructive dialogues and well-informed concerted decisions.

Winnie's book explores the potential of Smart City 5.0 to help humanity achieve environmental sustainability, which is particularly relevant to our beloved city – Hong Kong. Her profound insights and pioneering efforts in this area enable all of us to work collaboratively to protect our common home. It inspires and informs city leaders, policymakers, academics, industry players, and citizens about the potential of Smart City 5.0 to create more sustainable, resilient, and equitable urban environments. By harnessing the power of technologies and ESG principles, modern cities can build a brighter future for all and ensure a better home for future generations.

Victor Lam Wai-ku, SBS, JP
Ex-government Chief
Information Officer

July 2023







Global Case Study

Six case studies combining a variety of technologies and novel ideas to promote in areas such as convenient mobility, environmental protection, economic development, and green transformation. Experiences in various places have proved that the successful development of a smart city depends on the collaboration of the government, the public and private sectors, and the general public.

Chapter
1



1.1 Smart Mobility

Tokyo, Japan: A crowded yet bicycle-friendly city



Reducing energy consumption and making the environment greener are the key objectives of the *Smart City Blueprint 2.0 for Hong Kong*. What could be more attractive than cycling for smart mobility, a mode of transportation that reduces emissions and prolongs life? What is the key to success in making cycling part of the daily commute?

A University of Oxford study in 2021 on how effective cycling or walking is in reducing carbon dioxide emissions found that if you ride a bicycle or walk once a day and reduce driving once a day while commuting or going to school, you can reduce your emissions by about 0.5 tons in a year (200 days). In terms of Hong Kong's annual per capita carbon emissions of 4.5 tonnes (2020), the decrease is more than 10%, which is very significant.

The Hong Kong government has always regarded cycling as only a leisure activity rather than a mobility option because there is insufficient road space for cycling safely. But what can Hong Kongers learn from the experience of Tokyo, which is densely populated but is also renowned as a cycling city?

- **Cycling is an important mode of transport in Tokyo, mainly used for shopping and commuting;**
- **To increase the use of bicycles, it is necessary to start with planning, whether in new development areas or the redevelopment of old areas, to reserve sufficient space for cycling.**

2 km the most common

With a population of over 14.06 million (11.1% of Japan's total), Tokyo has narrow streets not well served with sidewalks, but bicycles can still be widely used for commuting.

A 2017 study by Tokyo University found that biking, used as a mode of transport, was much higher in Japan than in many European countries. In Tokyo, for example, cycling accounts for 14% of transportation modes. On average, there is one bicycle for every 1.5 Japanese, the highest in Asia. Its main use is for shopping (64%), followed by commuting (17% for long-distance work trips, 4% for short trips to train stations). The average travel distance is 2 kilometres.

Japanese bicycles have the following characteristics:



1) Targeted at housewives

Tokyo's residential neighbourhoods which are mostly self-contained with supermarkets, kindergartens, schools, and clinics can be accessible to residents by cycling for only 5-10 minutes. Therefore, utility bicycles are mainstays for a slew of errands, including hauling groceries and ferrying children around which are common sights in Japan's urban landscape.

According to nippon.com, Japan's "mom's bike" (Mamachari) was born in the 1950s. In 1956, the Smart Lady bicycle was launched and became the best seller, with a wheel size of 24-26 inches, and a lowered seat and handlebar suitable for small built women especially those wearing skirts. At the same time, its design caters for practical use. For example, the lock is directly mounted on the frame, and it can be locked with just one button; the lights are fixed to the frame of the bicycle and cannot be easily stolen. There are sludge shutters above the wheels to avoid clothes being soiled. In addition, a shopping basket or child seat can be added in the front and can be easily removed, so it can carry two children at the same time. In addition, the price is very affordable, and it is only about 10,000 yen (about HK\$520) today, so it is no wonder it is popular among housewives.

2) Cycling on footpaths

One of the reasons why bicycles are so popular in Japan is that cycling on the pavement is generally accepted.

"Cycling in Japan really is a polite form of anarchy. People ignoring the rules, cycling and parking wherever they like, yet doing their best to impact as little on others as they can." This is the observation of Byron Kidd, founder of the Cycling Embassy of Japan.

In fact, under Japanese law, a bicycle is classified as a light vehicle and must therefore be driven on the carriageway (Section 17, Section 1 of the *Road Traffic Act*). However, due to the lack of bicycle infrastructure such as dedicated paths in the city, the number of deaths in cycling accidents increased sharply in the 1960s and 1970s, with about 1,800 people killed each year, equivalent to nearly 20% of the total number of traffic fatalities. In 1978, the law was amended to allow bicycles to drive at a slow speed (about 4-5 km/h) on the footpaths signposted with a bicycle passable sign but giving priority to pedestrians. Since then, cycling on a sidewalk has become a national consensus.

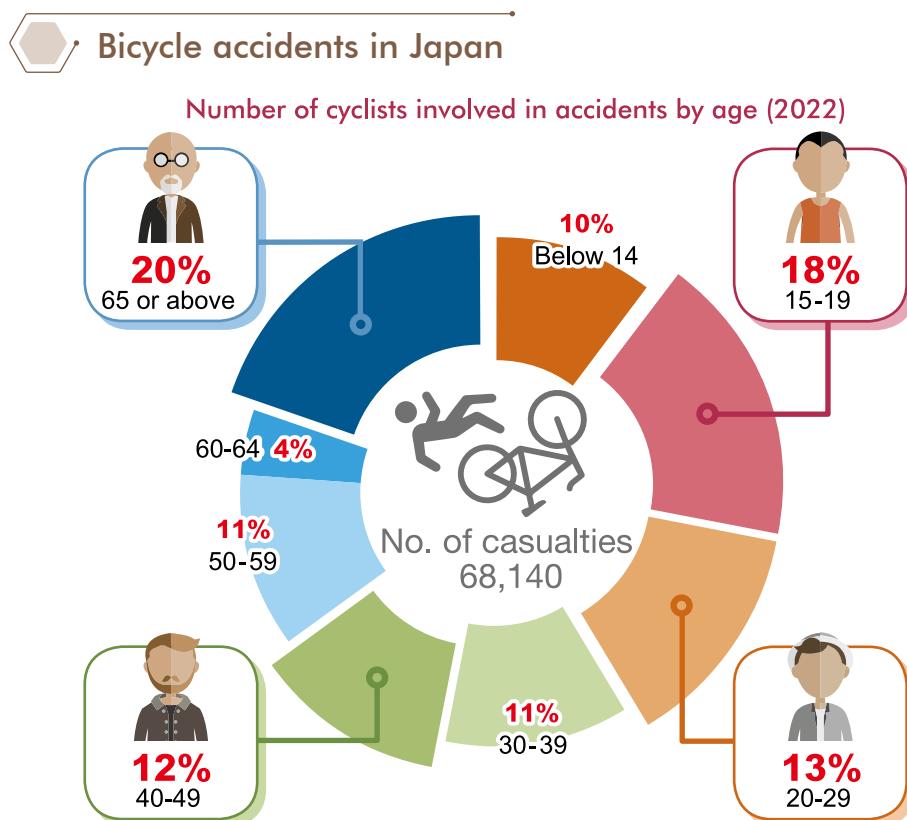
However, in reality, pedestrians and cyclists do compete for the road space. In October 2011, the government issued a circular requiring cyclists to comply with traffic laws on the roadway on the basis that "a bicycle is a vehicle". However, there was a strong reaction from the public, saying that it subverted the so-called "common sense of the Japanese" that bicycles should be allowed on the pavement.

Despite the lack of infrastructure for urban cycling, cycling accidents in Japan fall somewhere in between that of Europe and the United States. Between 2011 and 2015, the number of deaths among cyclists per 100 million km in Japan was 2.3 (2011-2015) in contrast to 0.8 in the Netherlands and 4.7 in the U.S. (2009), all measured by the same methodology as cited in a discussion paper at the International Transport Forum in 2018.

However, while the total number of traffic accidents is declining, the proportion involving cyclists is rising. Taking 2012 as the baseline, by the end of 2022, the number of overall traffic accidents in Japan had decreased by more than 50% to 300,000 in 11 years, but the proportion of bicycle



accidents in the total number of accidents increased from about 16% 11 years ago to 19%. At the same time, accidents involving bicycles increased by 1,977 cases in 2021 compared to the previous year, with a particularly significant rise in casualties among young people under the age of 20 and the elderly over 65 years old.



Source: *Statistics about Road Traffic, Statistics of Japan, 2022*

3) Wearing a helmet a must

As half of the deceased suffered fatal head injuries from bicycle accidents, the Japanese government amended the law to make wearing helmets mandatory for cyclists regardless of age starting from 1st April 2023.

In fact, globally, three-fifths of serious bicycle casualties involve head injuries, and about 70% of cyclists in Hong Kong who suffered severe injuries were not helmeted. A report by the Legislative Council (LegCo) Secretariat cites a medical study that the bicycle mortality rate in Hong Kong from 2010 to 2012 was 34 per billion vehicle-minutes, much higher than in New York (18), Los Angeles (7), Chicago (4), and Stockholm (3). In 2021, bicycle accidents accounted for more than 16% of the total traffic accidents in Hong Kong, reaching 2,994 cases, a new high in the last 20 years.

The effect of compulsory helmet wearing is almost immediate as seen in Singapore's enacting of relevant legislation in 2019. Since then, the bike mortality rate has plummeted by 61%, to just 1.2 per million residents, the lowest in Asia Pacific.

Currently, Hong Kong has a cycle track network connecting east to west in the New Territories, from Tuen Mun, Yuen Long to Sheung Shui and Ma On Shan. Over the territory, we have a total of 225 km of long cycle tracks as of 2020.

How can we make better use of this facility? Enhancing safety measures is the first step. However, proposals regarding mandatory helmet use for cyclists have been discussed at the LegCo for at least four times over the



past five years (2017–2022), they were all rejected on the grounds that they might discourage cycling. The Transport and Logistics Bureau again submitted a paper to the LegCo proposing mandatory helmet wearing in mid-2022, but by the time of writing in February 2024, there was still no further development. It is hoped that the authorities can enact the laws as soon as possible to protect cyclists.

Good cycling infrastructure

In addition to wearing a helmet, to promote cycling in urban areas, there are two essential factors needed to make it a success.

Launched in 2011, the Copenhagenize Index assesses the provision for cycling in more than 600 cities around the world using three aspects, namely infrastructure, cultural climate, and urban planning. Tokyo ranked 5th in the first year globally and first in Asia. However, by 2019, it had fallen to 16th place, due to the lack of infrastructure in the city in terms of more bicycle lanes and further improvement.

To attract foreign tourists, the Japanese government designated some of the best cycling routes with good infrastructure as a National Cycle Route.

In 2023, when Japan reopened after the pandemic, many tourists praised the National Cycle Route for cycling facilities, pointing out that the six certified bicycle tracks, such as the Tokapuchi 400 in the Tokachi area of Hokkaido, allowed people to visit scenic spots safely and comfortably, and the design shows caring.

For example, on the left side of the road, a dedicated width for bicycles is marked with navigation signs and access to cycle lanes are provided at train stations, with bicycle rental facilities and changing rooms, and more. Along the way, there is a stop every 20 km for people to rest and inflate their wheels. Accommodation for cyclists is available at approximately every 60 km intervals with facilities to lock bicycles inside rooms. Information is available in both Japanese and English.

Starts with urban planning

The Netherlands, a country known for cycling, is the best example for promoting cycling through urban planning.

Although Utrecht, the fourth-largest city in the country, has a population of only 360,000, its train station garages provide 22,000 bike parking spaces, the most in the world. This is an indispensable part of the Dutch transportation network. On each workday, more than 400,000 people bike to a station, so abundant, safe, and conveniently located bicycle parking spaces are critical. Since 2012, the government has allocated €221 million (about HK\$1.8 billion) to build a total to 500,000 parking spaces nationwide. Yet, another 100,000 spaces will be added by 2025.

Moreover, the country's road design is also well-planned ahead: narrow bicycle lanes and sidewalks are separated by low and gentle curbs; roads are designed to different standards, colours, and styles according to their use, instead of relying on signposts.



Therefore, if Hong Kong wants to turn cycling into one of the major mobility modes, it must start with planning. On the one hand, designated space must be reserved from the design stage of new development areas, and on the other hand, cycling needs should be considered during urban redevelopment. In this way, we can enjoy this economic and eco-friendly mode of transportation in the future.

Health implications

Although a modal shift from car to bicycle may reduce CO₂ emissions, some Dutch researchers studied if individuals' health benefits of cycling could outweigh the risks of exposure to air pollution and encountering a traffic accident. They examined multiple studies of 500,000 people, and found that, on average, cycling was about nine times more beneficial than car driving, especially for those aged 65 or over, who could expect their life expectancy to increase by 10.8 years, the most of any age group.

With an ageing global population, especially for Hong Kong, which officially entered the hyper-aged society in 2022, do the research results give much inspiration to us?



Texas, U.S.: Love and hate of green energy



Clean energy is an indispensable part of the Smart Environment. Despite Texas' want of embracing renewable energy to boost the economy, its people and opinion leaders reject the idea of environmental protection. This is a place full of contradictions in conservation.



What does Texas make you think of? A western cowboy galloping through the prairie? Or the epic classic film *Giant* starring James Dean in the second-largest state in the United States by both land area and population, covering an area of 690,000 square kilometers (equivalent to more than 620 Hong Kongs) and having a population of 30 million in 2022. The mid-south state was originally established around animal husbandry, but later flourished 130 years ago through the exploitation of oil resources.

Environmental protection? No way!

Today, there is a consensus that fossil fuels cause global warming, but some Texans are still sceptical. Todd Staples, president of the Texas Oil and Gas



- **Texas earns much income from clean energy, contributing tens of billions of dollars to the economy;**
- **The diversified Texas' economy has attracted talent to make it the nation's leading state for tech talent growth in 2022.**

Association, the state's oldest and largest trade association, and a former agriculture commissioner, is a prime example of those who not only attacked the climate change bill, but also urged the United States Department of Agriculture to fire all its employees involved in promoting Meatless Monday for being "treasonous."

Conservative Texans may be dismissive of green energy or environmental proposals, but it is a fact that the state earns much income from clean energy. *The Economist* cites an investment return of US\$8 per acre from cattle farming, US\$15 from deer hunting but hundreds of dollars from renting to wind farms. Climate Central, a nonprofit organisation, estimates that Texas landowners can earn up to US\$33 million in rental income annually from a 100-megawatt wind farm (about a 30-year equipment life cycle), and one megawatt of electricity could power 200 Texan homes.

The conversion of wind power into green energy has contributed tens of billions of dollars to the local economy. *The Economic Value of Renewable Energy in Texas*, published in 2018, estimated that green energy provided more than US\$200 million in revenue to local governments in 2017, nearly double the amount in 2013. The landlords' annual rental income is more than US\$90 million. Meanwhile, it saves users more than US\$800 million a year in electricity bills. The industry also creates as many as 33,000 jobs,



a three-fold increase in five years (2013-2017), and there is no shortage of high-paying jobs, with Texas paying at least \$2 billion a year. In addition, emissions reductions are expected to benefit human health and save water, which is believed to be worth US\$11.1 billion (2010-2017).

From below 1% to 23%

Texas' electricity generation has also gradually shifted from relying on fossil fuels to green energy.

According to the Electric Reliability Council of Texas (ERCOT), which supplies 90% of the local electricity, more and more electricity has come from green energy over the past 20 years (2002 to 2021). In 2002, 85% of electricity came from coal and natural gas, which fell to 64% by 2022. The proportion of renewable energy such as wind and solar increased from less than 1% to 23% during the same period. Looking forward, Texas hopes to attract large-scale hydrogen and carbon sequestration projects to expand its green economy.

Texas leads the country in green energy due to its vast size and geographic diversity, which provide abundant wind, solar, and biomass resources. According to the U.S. Energy Information Administration (EIA), in 2021, the state produced more energy than any other state, accounting for nearly 12% of the nation's total energy generation, with wind power generation topping the nation for 16 consecutive years.

Success Factors

In recent years, Texas has not only achieved great success in green energy,



but also has developed a vibrant local economy. I think there are at least three factors for its success:

1) Diversification

With the developments after the oil crisis of the 1980s, Texas no longer relied solely on oil and gas, but positioned itself at the forefront of new energy technologies and committed itself to diversifying its economy. Not counting real estate, each big city has its specialty, including technology in the capital city of Austin, energy in Houston, finance in Dallas, and more.

Diversity is also reflected in the demographics. The state's population has surged by nearly 4 million people over the past decade due to its relatively low living cost - both the cost of living and housing are cheaper than other states at 7.5% and 15% lower than the national average respectively. Houses in Texas are more than half the price of similar ones in California. Many of the newcomers to Texas are young, well-educated, and non-Caucasians which adds diversity and vitality to the Texan society.

2) Big market, small government

In addition to incentives for businesses (such as the Biden administration's hundreds of billions of dollars to curb the use of fossil fuels), the boom in green energy can also be attributed to the local governance philosophy of large markets and small governments. To avoid the over involvement of the government, the legislature meets only every other year. It also has low tax rates (no personal assessment tax), low cost of regulation and services (in 2017, Texas ranked 49th out of 50 states in terms of public spending per capita, spending about \$3,925 per capita, 52% lower than the national average).



With less red tape and the government's pro-business attitude, combined with the abundance of land available for expansion (the federal government owns less than 2% of the land there, so a lot of private land is available to rent out) has attracted a lot of foreign funding and businesses, with 63 companies announcing plans to move their headquarters there in 2021 alone, including Samsung's US\$17 billion investment plan.

3) Strategic Infrastructure

While Texas is largely market-led, its Public Utility Commission of Texas made a major decision in 1999 to add 5,000 megawatts of green energy by 2015 and set a goal of doubling to 10,000 megawatts by 2025. To that end, the state has built thousands of miles of transmission lines. In 2009, the local green energy development exceeded the 2025 target, and this prescient investment established Texas as a leader in green energy.

Leading talent growth

Today, Texas is full of talent, and the Computer Technology Industry Association announced that Texas has become the leading state in the growth of technology talent in the United States since 2022, with a net increase of 5.5% in technology employment (45,000 workers). The professional social platform LinkedIn also noted in April 2023 that Austin continues to be a talent magnet with 98 out of every 10,000 LinkedIn members in the region having only arrived in the past 12 months. In addition, the city was voted as the most climate-resilient smart city by *Architectural Digest*, a publication with more than 100 years of history. ProptechOS, a real estate startup founded in 2017, ranked Austin 7th in March 2023 and first in November 2022. Their



selections were based on risk, infrastructure, weather defence measures, green infrastructure, skilled labour job markets, and more.

Texas excels in renewable energy and natural disaster resilience. Despite this, Texas led by Republicans, disagree with the view that climate change is caused by the use of fossil fuel. A Pew Research Center poll released in April 2023 found that a majority of Democrats (59%) said tackling climate change is a top priority for the Congress, while only 13% of Republicans agreed. Just as we aspire to reduce emissions but also enjoy air conditioning, perhaps most Texans choose one or the other.

Shares of electricity consumption by energy source in Texas (%)

	2002	2007	2012	2017	2022
Natural Gas	46	46	45	39	48
Coal	39	37	34	32	16
Nuclear	13	13	12	11	8
Wind	1	3	9	17	22
Solar/Biomass	—	—	—	1	1
Other	1	1	1	—	5

Source: *The Economic Value of Renewable Energy in Texas*, ERCOT, 2018;
 Column: Reduced wind generation puts Texas power system to the test, Reuters, 2023
 Note: Figures may not add up to the total due to rounding.

1.3
Smart
Government

Singapore: The secret behind the smart city champion



Information technology plays a key role in Smart government, and Singapore is striving to satisfy the business community and the public with an efficient government.



Over the past decades, Singapore has transformed from one of the Four Asian Tigers into a veritable cosmopolitan city. The country is widely recognised in the global ranking of smart cities and in the use of technological innovation. Further, it has the most unicorns (startup companies valued at or over US\$1 billion) per person in the world, apart from Israel. For Hong Kong to catch up, it might be good to learn from Singapore's experience.

1) Smart ways to multiply resources

Like Hong Kong, Singapore is a coastal city with a rather limited land resources (Hong Kong: 1,113 sq km with less than a quarter of the land having been



- Singapore multiplies the benefits from its limited resources through spatial data infrastructure;
- eID is widely used in public services, and the mobile app developed for purpose allows users to quickly fill in forms or to share personal data.

developed; Singapore: 710 sq km). Hong Kong has always been focused on land resources, in fact, the sea is also part of our natural resources. Facing a scarcity of resources, the Lion City has examined details before planning how to make good use of them.

The ocean is important, because the seabed can absorb twice as much carbon emissions as land, it can help mitigate climate change. In addition, the data of seawater temperature, oxygen content, salinity, and changes in water flow can be used in many applications, such as the planning of waterfront use and land reclamation, coordination of desalination plants and sewage discharge, installing submarine cables and pipelines, the design of shipping fairways and ports, fisheries management and the conservation of marine biodiversity, developing tourism and recreation for the general public, and more.

In Singapore, the Maritime and Port Authority of Singapore (MPA) developed a single information platform in 2019 for marine, coastal, and land data, and built a virtual twin called GeoSpace-Sea, allowing data to be presented in 2D and 3D formats for the government agencies to monitor coastal and



sea activities in real time, and plan building projects. The data are collected from 11 government departments such as the Public Utilities Board (PUB) and the Housing Board.

In Hong Kong, the Urban Renewal Authority has planned to develop the most densely populated areas Yau Ma Tei and Mong Kok. It is challenging to satisfy the residents' desire to be relocated within the original districts, and at the same time to increase the green area and improve the accessibility. There are suggestions that the authority can develop underground space as in Japan, South Korea, and Singapore for commercial activities and pedestrian access. Underground space is warm in winter and cool in summer, it will help promote commercial activities and greatly increase the available floor area after redevelopment. However, the priority is to first build a comprehensive database or spatial data infrastructure (SDI) on the underground space, which requires the coordination and contribution of various government departments.

If the Hong Kong government can actively connect internal data like Singapore, a bright new chapter can be created for the town.

2) No smart city without eID

Adopting electronic personal identity or eID is an important feature of smart government. It facilitates people enjoying online services, and allows the government to promote e-government services that benefit all citizens.

Singapore launched its eID "Singapore Personal Access" (Singpass) in 2003. Since then, the service has continued to expand and improve.



Today, Singpass is a mobile application, with a digital identity card (digital IC), it is used in almost all government services, from medical consultation (appointment booking and clinic registration), borrowing books from public libraries, registration at government buildings for entry, collecting passports, booking flats, and key collection at the Housing Board.

There is personal information MyInfo in the application, users can quickly fill in online forms or authorise the sharing of certain personal information by scanning the QR code. The security settings include a password, fingerprint detection, and facial recognition.

The Singapore government is also encouraging private sectors wider use of the digital IC for more functions, such as opening an account in telecom companies and banks. On some occasions, however, physical identity documents are still required, such as marriage, exams (because mobile phones are not allowed), and during national service enlistment when physical identity cards are surrendered.

At present, 97% of Singaporeans aged 15 and above have Singpass accounts. There are 4.2 million Singpass app users as of March 2023, and about 350 million personal and corporate Singpass transactions every year.

Hong Kong's eID (called "iAM Smart") was officially launched at the end of 2020, there were over 2.8 million registered users by July in 2024.

According to the local authority, iAM Smart can access "more than 379 commonly used government, public and private online services". The government has set a goal that by 2025, the digital government service would be available through eID on a one-stop-shop platform.

3) To nurture highly intelligent talent

According to the United Nations, the replacement level is defined as 2.1% – that is, an average of 2.1 children per woman for the population to be self-sustaining. In Hong Kong, however, the average number of children a woman can expect to bear in her lifetime, or the fertility rate, has hit a new low of 0.7% in 2022; this has raised many concerns.

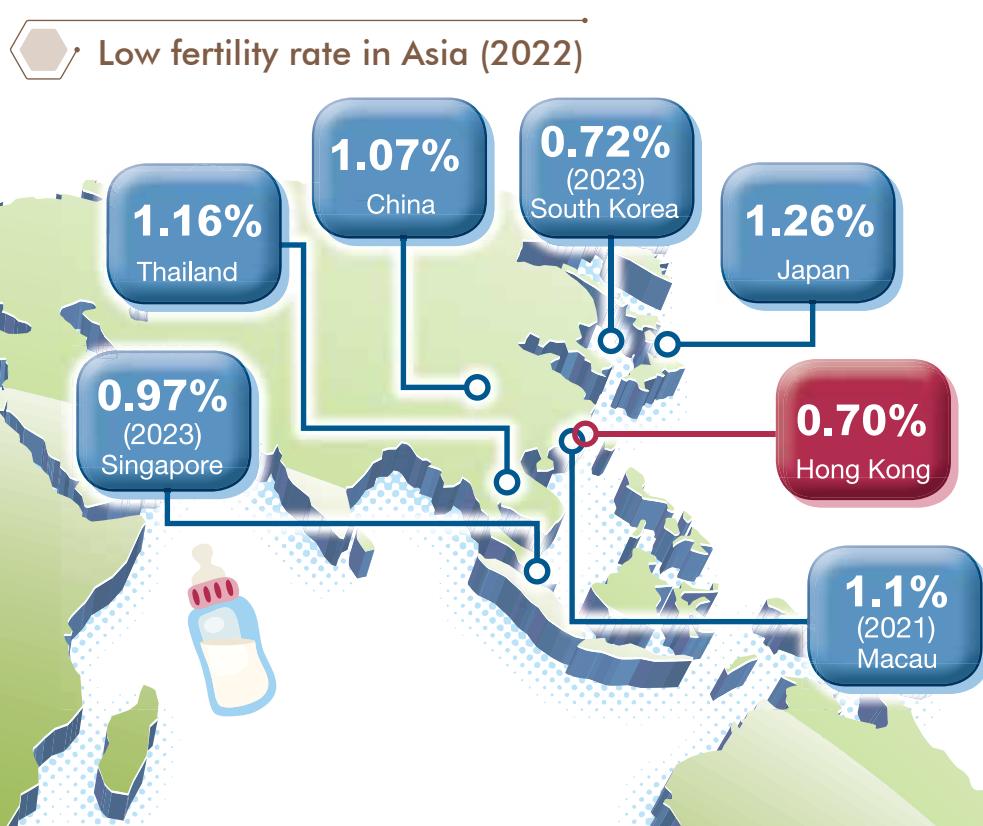
Though Singapore is ahead of many economies in smart city development, it has also suffered from a low fertility. While Hong Kong people are starting to explore measures to encourage childbearing, Singapore has gone through a number of experiments over the past 40 years.

With the spread of contraceptives in the 1970s, Singapore's fertility rate dipped to 1.82% in 1977. In the early '80s, then-Prime Minister Lee Kuan Yew began rolling out a series of measures to encourage women with better-education, which was defined as those with at least five O-level passes, to have children. Incentives included priority in school admission for children and generous tax incentives for women (5%, 10% and 15% tax rebates for the first, second and third child respectively). For those less-educated and low-income women, however, the government offered a cash grant of \$10,000 to ensure that they would only bear two children at most in their lifetime. Due to the discriminatory nature of the policy which led to great public reaction, the government withdrew the scheme.

Since then, various incentives have been introduced, such as providing up to a 75% subsidy for In-Vitro Fertilisation (IVF), an assisted reproductive treatment for eligible couples. It cost the government RM20 million (about HK\$110 million) in 2019. Others include paid maternity leave, childcare



subsidies, tax relief and rebates, one-time cash gifts, and grants for companies that implement flexible work arrangements. However, these are unable to stop the decline of the fertility rate, which was 0.97% in 2023.



Source: World Bank; Ministry of Health, Labour and Welfare of Japan; Singapore Department of Statistics; Korean Statistical Information Service (KOSIS); people.cn; Nation Thailand; Census and Statistics Department of Hong Kong

Population anxiety

The fertility rates in many advanced economies have continued to decline. How to improve the willingness of the younger generation to have children is an inextricable problem. Although efforts have been made in many places, only a few results have been achieved. Introduction of immigration has become a common method.

At the same time, a report from the United Nations Population Fund *State of World Population report 2023* reminds us to avoid two problems caused by population anxiety:

1. Distracting us from other serious but more solvable problems;
2. Becoming a rationale for denying women and girls the rights of their bodily autonomy.

These are in line with the main principle of smart cities, that improving the quality of life and sustaining people-oriented development are equally important prerequisites.

**1.4**
Smart
Living

Helsinki, Finland: A happy place for students?



Enabling citizens to feel safe and happy has been the core value of Smart Living. The country which has topped the *World Happiness Report* for six consecutive years, what can Hong Kong learn from them?



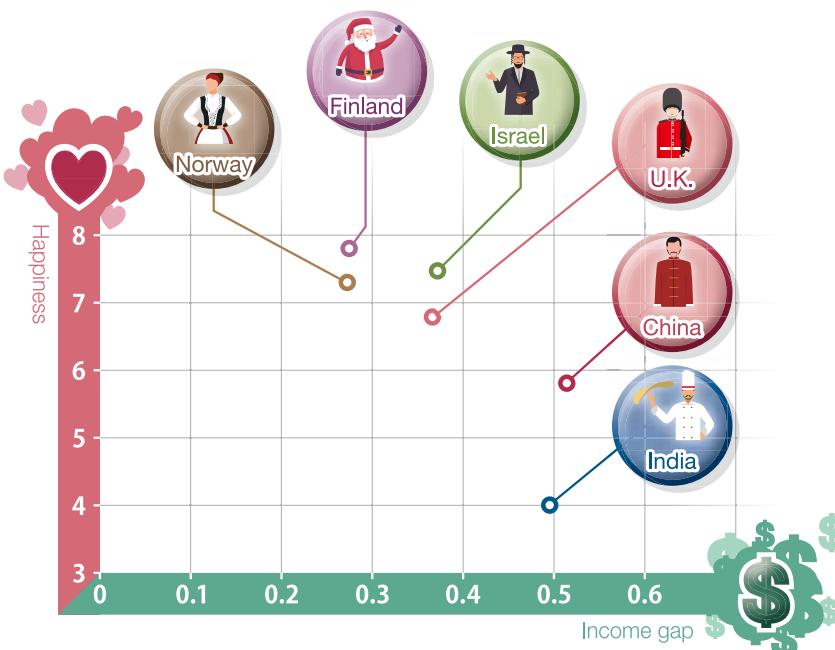
Do you know of Finland through Nokia, a mobile phone manufacturer that shot up more than 20 years ago and contributed 3.1% of the country's gross domestic product (GDP) in 2000? Or the video game Angry Bird released at the end of 2009 or the 2012 mobile game Clash of Clans, or the 1945 cartoon character Moomin?

Happy but not very wealthy

This quiet Nordic country has topped the United Nation's World Happiness Report for seven consecutive years (2018-2024). The report, which has been released for 12 years, covers 143 countries and regions in 2023, and

- Finland has been ranked as the happiest country with even new immigrants feeling content as well;
- Excellence in education with adequate funding and policy support;
- Helsinki, where paid maternity leave can be up to 320 working days, is considered the best place for motherhood, but her fertility rate is declining over the past decade along with the worldwide trend.

Income inequality and happiness, 2023



Source: *Why Finland is the happiest country in the world – an expert explains*,
Danny Dorling, University of Oxford, 2023; World Happiness Report 2023, United Nation



is ranked by more than 100,000 citizens on a self-assessment basis (0 to 10, 0 the worst, 10 the best) based on factors such as GDP per capita, life expectancy, social support, freedom of life choice, economy, corruption, and more. The final score is based on the average score of the past three years.

In 2018, the report added a measure of the happiness of newcomers for the first time and found that immigrants in Finland felt as content as the locals, indicating that the country's social support is good and equal, even for the disadvantaged, and people feel safe.

At the same time, the high tax rate (43.1% on average for single persons, higher than the OECD average of 34.6%) narrows the gap between rich and poor. The status of men and women is also equal. In addition, more than 80% of Finns trust the police, education, and health care systems, which is a blessing when combined with low corruption rates and abundant personal freedoms. Yet, this does not seem to be directly related to wealth: according to the World Bank's 2021 data, Finland's GDP per capita is not among the top 20 in the world.

Education: No single one is missed out

The notion of equality for all in Finland is one of the main reasons for the country's outstanding educational performance. At a time when young students in China, Japan and South Korea are trying to catch up with past papers, Finnish play-based education model is out on top of the competition – the country has repeatedly ranked high in the OECD's Programme for International Student Assessment (PISA).

In 2000, it was ranked first in reading, third in science, and fourth in mathematics. In recent years, mathematics scores have caught up, and other subjects are still ranked within the top 10 in the world, attracting much attention. As a result, there has been an increase in the number of foreign officials coming to learn about Finland's success, and the authorities have even charged a fee of at least 1,150 euros per hour for a school visit (plus 24% tax, totalling more than HK\$12,000).

In 2019, a delegation from the Panel on Education of the Legislative Council of Hong Kong also visited Finland. In the post visit report, it concluded that Finland's outstanding educational achievements are related to policy support with the government being responsible for formulating education strategies and adequate funding. In 2017, Finnish spending on education was 5.3% of GDP or €11.8 billion. In contrast, in the same year (2017-2018), Hong Kong's total expenditure on education amounted to about HK\$88.5 billion, accounting for only 3.3% of GDP.

The Finnish education philosophy is that all people are equal, and no one should be left behind. Irrespective of ethnicity, age, domicile or financial status, no tuition fee is needed from pre-school to tertiary education. For pre-primary and basic education, parents do not need to pay for textbooks nor lunches, and students can enjoy free transportation to and from school if their residence is far from the school. Lunches are free for senior secondary students, while school meals for higher education students are subsidised by the state.



Extensive use of smart technology

The country is also known for its use of smart technology.

For instance, Helsinki, the capital of the Baltic Sea with a population of about 650,000 has excelled in several international assessments. Being named as one of the 25 Most Innovative Cities in the World by the World Economic Forum in 2022 is one example. The Smart City Index of the IMD Business school in Switzerland has ranked the city among the top 10 in the world for four consecutive years (2019 to 2023). Meanwhile, in Helsinki 7.7% jobs are related to R&D (compared to about 1% in Hong Kong).

In addition to serving citizens with advanced technology, such as carbon-neutral drones to deliver emergency medical supplies to remote areas, it is also actively exploring solutions to climate change, such as the development of plant-based protein to reduce the demand for land and water resources in the meat industry; the development of wood-based product to replace plastic; and new farming methods to increase the amount of carbon dioxide stored in soil and improve harvests. Artificial intelligence is widely used to advance healthcare and industrial technologies as well.

Best place for motherhood

However, even with Finland being the happiest country and Helsinki being ranked top in the Cities for Work-Life Balance Index for years, its fertility rate has been declining, which is consistent with the trend of rich economies.

In fact, the quality of life in Helsinki is much better than that of many Asian cities and Hong Kong. The working hours per week there is less than 40

hours, and the commute to work is less than 23 minutes. In addition to public holidays, those who have worked for more than one year can enjoy 30 days of vacation per year, and the living conditions are superior. The city has also offered up to 320 working days of paid maternity leave, the most in the world. At the same time, the partner also has 18 days of paternity leave, and it is no wonder that it is widely regarded as one of the best places in the world to be a mother and a working woman.

Nevertheless, the Nuusimaa region, including Helsinki, has seen a downward trend in fertility over the past decade, from 1.5 babies per woman in 2013 to 1.2 in 2022. Although it rebounded in 2020 and 2021, it fell again after the pandemic. It is much lower than the replacement level of 2.1%, which means an average of 2.1 children per woman for the population to be self-sustaining.

This echoes a theory of Ronald Inglehart, one of the world's most cited political scientists, that a sense of crisis can prompt people to reconsider and value the fundamentals of life. In a society with insecurity, where disasters such as disease or drought can wipe out children's lives or crops overnight, a larger family is often the only means of defence. But as wealth accumulates and life becomes more stable, people's sense of survival gradually subsides and they become more likely to care more for themselves.

How to improve the willingness of the younger generation to have children is an inextricable problem. Many efforts have been made in the developed economies, but few results have been achieved, and attracting immigrants appears to be a common method.



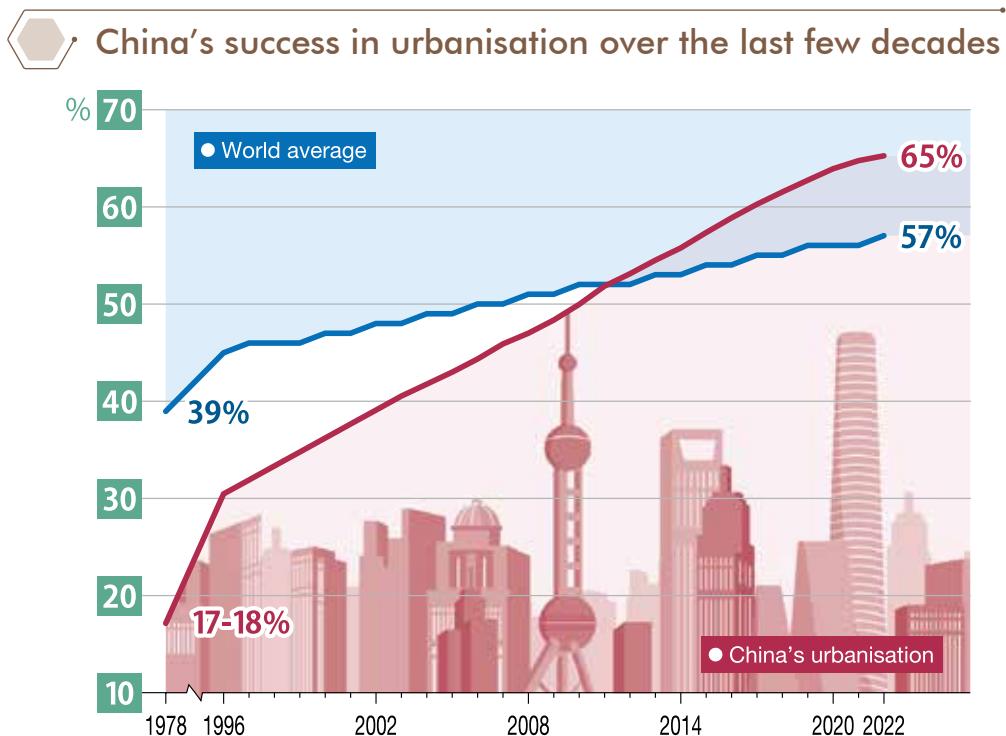
China: From building white elephants to people-centric infrastructure

The Mainland has urbanised at a rapid pace in recent years, and how to promote economic development through infrastructure construction for the broader masses of people at the same time is a challenge, especially in the era of super ageing.

According to a World Bank analysis back in 2000, the larger the urban population, the more prosperous the economy and the higher personal income will be. In this aspect, China's accomplishment in recent years is very obvious. In 1978, the country's national urbanisation rate was only 17%, by 1996 it had increased to 30%, and by the end of 2022, it reached 65%, higher than the world average of 56%.

As early as 2014, the central government announced the development directives, main objectives, and key tasks of smart cities through a number of

- The urbanisation rate in China has reached 65% in 2022, which is higher than the world average;
- The challenge is to upgrade existing infrastructure into facilities for the benefit of the people, and to adapt urban planning to the needs of an increasingly ageing population.



Source: National Bureau of Statistics; Baidu; World Bank; Statista



policy documents. Many cities have closely followed the central government's policies with Beijing, Shanghai, Guangdong, Nanjing, and other provinces and cities having taken the lead in including smart cities as their construction priorities. According to 2014 statistics, at that time, all cities at or above the sub-provincial level, 89% of cities at the prefecture level and above, and 47% of cities at the county level and above had proposed to develop as smart cities.

Smart city infrastructure is yet to meet actual demand

Smart cities have now become big business in the Mainland. According to data company Statista, China invested 8.07 trillion yuan in building smart cities within the six years from 2015 to 2020. Data analysis firm IDC estimates that in 2022 alone, investment in the smart city market led by the Chinese government was US\$21.4 billion, up 21% from 2021, and is expected to approach US\$40 billion by 2026.

What are the main objectives to be achieved with this huge investment?

A Mainland website for local industry practitioners "Smartcity.Team" sorted more than 3,000 pieces of information on the winning tenders of provincial, municipal, and district-level governments and state-owned enterprises in the first half of 2022 which won government allocation of funds amounting to about 78 billion yuan. They found that the projects covered various categories of smart cities, including government affairs, transportation, community, water supplies, emergency response, education, medical care, and more.



The top three provinces with the largest funding allocation were Sichuan (8.4 billion yuan), Shandong (8.3 billion yuan) and Guangdong (6.9 billion yuan). Investment focused on smart cities and operation centres (10.5 billion yuan), government affairs-related, such as government cloud and government informatisation (8.5 billion yuan), and transportation (6 billion yuan).

However, in recent years, the development of smart cities in the Mainland has encountered many challenges. One of which is how to make use of the relatively perfect infrastructure to benefit citizens, that is, the practicality and effectiveness of scenario-based applications commented on by IDC. The report says that the current construction of some smart city scenarios lacks actual demand, and there is still much room for improvement in practicality and effectiveness.

To build an age-friendly society

Another challenge is the accelerating ageing of the population, which requires the optimisation of urban planning.

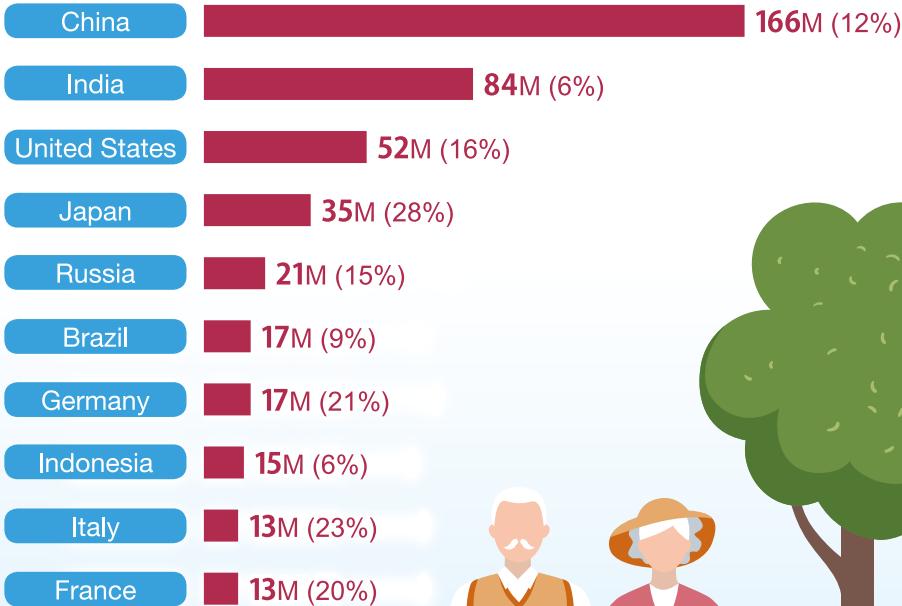
The 2020 National Census found that the average age of the population was 38.8 years (compared with 38 in the United States and 28 in India). At the same time, the population aged 60 and over has reached 18% (260 million people) which constitutes a high proportion. The ageing trend has accelerated significantly in recent years.

Between 2010 and 2020, the portion of people aged 60 and over increased by 5%, compared to just 2% in the previous decade. Sixteen of the country's 31 provinces have more than 5 million people aged 65 and over.



Top 10 countries with the most elderly

Population over 65 years old (proportion of the country)



Source: *Countries with the Oldest Populations in the World*, Population Reference Bureau, 2021

One of the measures taken by the authorities in response was to gradually increase the statutory retirement age to reduce the impact of a shrinking working population and take advantage of the knowledge, experience and skills of the elderly. As many as 36.69 million people (13.9%) aged 60 and above have a high school education or above.

In addition, the government has expanded smart city development to grassroots communities, such as increasing investment in public services and healthcare in the counties, and upgrading infrastructure in large cities, including adding elevators to older residential buildings as residents age.

Some large companies have also cooperated with governments to provide "smart elder care". In Shandong Province, for example, the government has formed a partnership with private companies to set up an online hospital to provide a series of services. They include consultations with doctors, diagnoses, prescriptions, disease management and other follow-up services. During the pandemic, this was particularly useful as the service both saved patients from in-person hospital visits and reduced pressure on the healthcare system.

Don't miss rural areas

To better address ageing and urbanisation, the World Bank published *Silver Hues: Building Age-Ready Cities* in 2022, which suggests that the Mainland needs to prioritise the following three issues to enable the elderly to reach their full potential:



1. Improving accessibility standards in cities so that universal design is no longer an option or afterthought. This requires compliance by urban planners and architects with the further training of construction engineers and related professionals.
2. Equal attention needs to be paid to the construction of new facilities and the renovation of old ones. It is recommended to use public-private partnership (PPP) to raise funds to retrofit old buildings.
3. In terms of funding allocation for building "age-friendly cities", the government should pay special attention to ageing residents in rural areas where the proportion of people aged 60 and above is 23% in the 2020 Census, nearly 8% higher than that for urban areas. Innovative solutions such as low-cost medical technology can be encouraged.

I hope that China's smart city development can improve the quality of life so that citizens everywhere can experience the benefits of advanced technology as soon as possible. At the same time, as President Xi Jinping has outlined a people-centric development direction, it is advisable for the authorities to increase citizens' participation in the municipality and brainstorming to better leverage the benefits of smart cities, thus leading the Mainland to become a model for other countries.

1.6
Smart
People

Bangalore, India: An unliveable unicorn city?



One of the purposes of developing a smart city is to increase quality employment opportunities for citizens, so nurturing STEM talent and encouraging startups to create more unicorns are the goals of many cities. In this regard, Bangalore is a role model.



A decade ago, Silicon Valley in the United States was a leading region for nurturing innovative technology companies, but in recent years its position has been challenged by many rising stars.

According to CB Insights (CBI), a U.S.-based data analytics company, in 2011, there were only 27 unicorns (startup whose value is considered to be US\$1 billion or more) worldwide, 20 of which were headquartered in the U.S. The first *Global Startup Ecosystem Report* published in 2012 by research firm Startup Genome also stated that the startup world was much smaller then, with six of the top 10 startup hubs in the U.S. and just one in Asia.

In recent years, however, the situation has significantly changed.



- After China and the United States, India ranks 3rd in the world for having unicorns;
- Bangalore has 3 advantages when creating a unicorn: abundant technical talent; a deep interaction with the world; being backed by local venture capital.

In 2023, China's Hurun Research Institute (Hurun) and CBI respectively released the list of global unicorns and found that the U.S. has more than 600 unicorns. Although it still ranks first, it only accounts for about half of the world. China is firmly in second place (Hurun: 316 unicorns, CBI: 170) while India remains third. Hurun also pointed out that Indians have co-founded 70 unicorns in foreign countries and 68 in their own countries, while Chinese co-founded 32 outside of China, compared with 316 in the home country.

3 criteria for establishing unicorns

Unlike U.S. and Israeli startups that look abroad, or Beijing startups which focus almost entirely on the domestic market, Indian startups, similar to Singapore's, target regional rather than global markets, and apply ready-made business models to the local market. Take Flipkart as an example. Acquired by Walmart in 2018, the startup specialises in e-commerce and is duly known as India's Amazon. Grab is another example, it is like Singapore's version of Uber.

Bangalore (Bengaluru of India), the capital of Karnataka in southern India, has long been known as the Silicon Valley of India, and is home to a quarter of the country's startups. Ranked the fourth city in the world with the most unicorns, Hurun also ranked it sixth in the Global Unicorn Corporate Headquarters City, with 33 unicorns.

To successfully nurture a unicorn, at least three conditions are required:

- (1) a large pool of technical talent;
- (2) active interaction with the world;
- (3) substantial support of venture capitalists.

A large pool of technical talent

With a population of over 10 million, Bangalore is the third largest city in India. As early as 1909, the city established what was later known as the Indian Institute of Science, the most prestigious academic institution in India. Nowadays, there are nearly 70 engineering colleges in the city, training a large number of STEM (science, technology, engineering, and mathematics) talents. It attracts many talented people from other provinces as such immigrants make up more than half of the city's population.

On the professional social platform LinkedIn, more than 55% of Indians have programming skills (compared to about 42% of Americans and Britons). Orios Venture Partners, an Indian venture capital firm, pointed out that eight out of ten unicorn founders in the country have an engineering background.

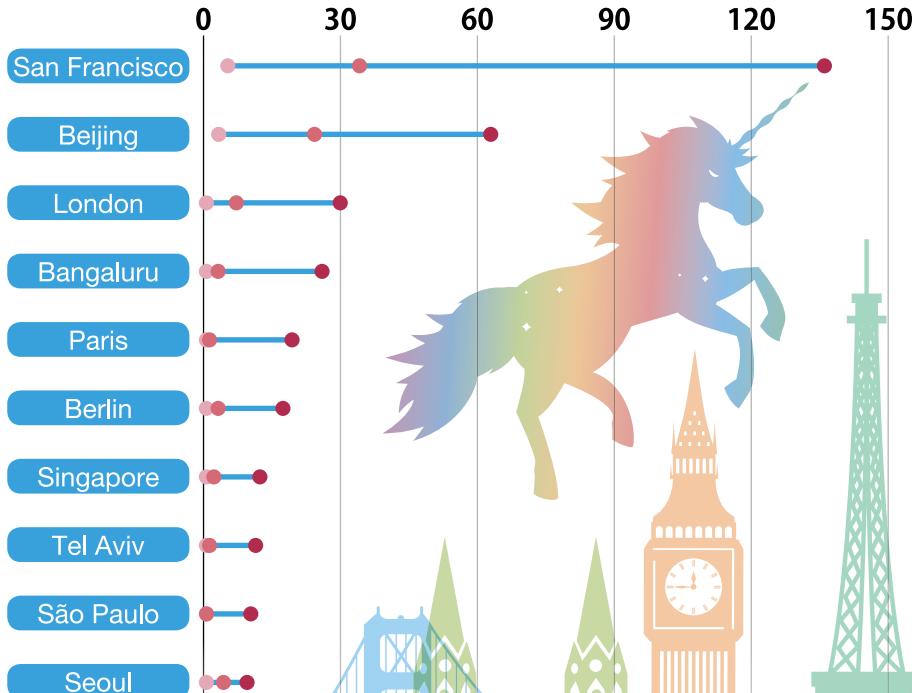
India is widely known as a popular place for outsourced IT jobs from countries such as the U.S. Due to the geographical location, the time



Top 10 cities by number of unicorns*

● 2011 ● 2016 ● 2021

Number of unicorns (units)



*One per country

Source: *Can Silicon Valley still dominate global innovation?*, The Economist, 2022



difference between India and the U.S. is nearly 10 hours, so workers in both places can work in relay, allowing businesses to operate 24 hours a day. At the same time, the competitive salary of Indian technicians is also an attraction for foreign investment. According to Glassdoor, an online employment company, the average salary of a software engineer in India is less than US\$10,000 a year, whilst in America, the average salary for the same position is about US\$110,000 a year, an 11-fold difference.

Proficient English connects with the world

Because of India's large engineering talent pool, Texas Instruments, a multinational semiconductor company in the U.S., set up its R&D centre in Bangalore as early as 1985, and many multinational companies have followed suit since then. At present, there are about 400 R&D centres and more than 80 chip design companies in the city. It is also home to the global headquarters of three of India's biggest players in the IT industry, namely Infosys, Wipro and Tata Consultancy Services.

The advantage of being proficient in English is also an important bridge for Indians to connect with the world.

Professor René Belderbos of the University of Leuven in Belgium has studied the co-authoring of patents by inventors in different locations and their evolution. Bangalore is in the top 10 cities for cross-regional cooperative growth (alongside Shanghai, San Francisco, and Seoul). In Tokyo, where English is not widely spoken, the number of unicorns is relatively few.



Extraordinary VC support

In addition, venture capital is indispensable for sustaining startups.

According to research by *The Economist*, the share of Indian venture capital (VC) funding captured by Bangalore rose from 15% to 34% between 2011 and 2021. Dealroom, a U.K.-based startup data analysis firm, also found that Bangalore outperformed Beijing and Shanghai in terms of the amount and number of VC funds raised in 2021.

Crucially, many of the founders or teams with extensive startup experience in the region have successfully turned into angel investors, helping promising local entrepreneurs raise capital or manage their businesses. According to data provider Tracxn, Flipkart's former employees have founded more than 250 startups, including four unicorns.

Infrastructure lagging behind

Startups, talent, and funding in abundance which offers a lot of job opportunities are important features of a smart city, but is Bangalore a desirable city to live in? According to the 2022 assessment of the Economist Intelligence Unit (EIU), a think tank, the city may not be up to the mark.

The EIU's Global Liveability Index rates living conditions in 172 cities across five categories, namely stability, health care, culture and environment, education, and infrastructure, and was originally used as a reference for companies to calculate the hardship allowance for expatriate employees.



Unfortunately, Bangalore performs poor in this index.

Though the metropolis is home to a number of multinational companies and the choice for startups, its infrastructure only scored 46.4 out of 100. The "infrastructure" score is based on the quality of roads, public transport, international links, energy supply, telecom, water, and housing. Bangalore, formerly known as India's California, has been criticised in recent years for its "concrete forest" and severe traffic congestion. With such a contradictory combination, no wonder the city only ranks 110th in the Swiss IMD 2023 Smart City Index, with a poor score among the 141 cities assessed.

Conclusion

From Bangalore, Helsinki, Texas, and Tokyo to Singapore and China, efforts are being made to create smarter cities that are more liveable and workable. Although there have been ups and downs in the process, there is much experience which Hong Kong can learn from, and we must catch up quickly, otherwise we will only be left behind.





Smart Mobility

In addition to facilitating citizens reaching their destinations more quickly, smart mobility also emphasises low-carbon and environmental protection. The construction of a 15-minute living circle with a balance between work and dwelling, the construction of environmentally friendly roads that integrate bicycles and cars, and the use of GIS to assist urban planning and realise autonomous driving are all directions worth considering in Hong Kong.

Chapter
2



2.1

Shaping a low-carbon mobility model in the Northern Metropolis

The Northern Metropolis is the key to our integration with the Greater Bay Area, it is also an ideal place for developing sustainable low-carbon living, while transportation is the most important supporting sector. Can we use an innovative approach to better strike a balance between environment conservation and development? Are there any successful practices from other places that we can follow?

Hong Kong's transportation development has always stressed public transportation such as railways. However, in recent years, the number of private cars has been growing in contrast with the passenger traffic volume on public transport. From 2010 to the beginning of 2023, licensed private cars have increased by more than 40%; the growth was not dampened by the epidemic. According to the government data, however, the public transport ridership has been decreasing since 2019, from an average of 11.64 million passengers per day in 2010 to 8.92 million passengers in 2020, and only rebounded to an average of 10.6 million passengers per day in January 2023.

The increase in private cars has not only caused traffic congestion, but also affects air quality. Carbon dioxide from cars constitutes around 15% of the world's total emissions into the atmosphere, according to the Environmental

- Traffic congestion caused by a significant increase in the number of private cars has worsened air quality;
- Responses vary from region to region: free rides, congestion tax on private cars, incentives for the purchase of electric vehicles;
- The Northern Metropolis should adopt sustainable urban planning to enhance walkability and encourage green mobility.

Defense Fund, a U.S.-based nonprofit environmental advocacy group. Therefore, suppressing the growth of cars has become a pressing issue.

Decrease in public transport ridership

This is not unique to Hong Kong. In fact, passenger journeys by public transport have shown a downward trend in many cities in recent years. According to data from the American Public Transportation Association, the number of passengers on public transport has been decreasing year by year since 2014, despite the continued growth of population in the United States over the past 10 years. In Toronto, adult trips have fallen every year since 2014, (the city made public transport free for young children, so their numbers are up), according to *The Economist*. In London, Paris, and Berlin, public transport ridership did not follow the growth of employment rate.



There are many reasons for the decrease in public transport ridership which include the popularity of ride-sharing services, working from home, and cycling. Autonomous vehicles are expected to further nibble at public transport ridership in the future.

Facing the continuous decline in ridership, Estonia has made a bold attempt to subsidise public transport and allow citizens to enjoy free rides, aiming to reduce private cars usage. Since 2013, buses, trams, trains, and trolley buses in the capital Tallinn have been free for its 430,000 citizens. However, the National Audit Office of Estonia issued a report in 2021, concluding that the result of the plan was not as expected. More than half of the people still travel to work in their private cars.

New normal: increasing number of cars

The pandemic has undoubtedly made things worse. *The Economist* analysed mobility data from Apple, Google, and TomTom in 10 major cities, including Tokyo, New York City, London, Paris, and Rome, and found that in August 2020, when Covid-19 began to subside, the public transportation consumption only returned to 40% of the pre-pandemic level. Many people preferred to drive by themselves because they worried about being infected or did not want to get fined for not wearing a mask. Upon release of lockdown in these cities, the increase in car usage was far more than public transportation and walking. Traffic congestion in Berlin increased by 8% from pre-pandemic levels from August to October, the vehicle registrations also increased in New York during the same period. The same happened to Hong Kong where the number of private car licences has grown over the past few years.

Many cities have long planned to reduce the number of cars but have failed. The measures include implementing a congestion charge (London: £15, about HK\$150; Stockholm: up to SEK 105, about HK\$88), raising parking fees (New York: US\$35 for two hours, about HK\$272), prohibiting non-electric vehicles from entering urban areas, such as Madrid, Oslo, and Brussels.

Alternative travel: e-bicycles & e-scooters

Alternative travel modes, apart from electric vehicles, are also gaining popularity in recent years. According to research firm NPD, in 2021, global bicycle sales were up 57% year-on-year to US\$6.5 billion, a 140% increase from 2019. This is the case for traditional bicycles, while the market of electric bicycles is also expanding, in Europe in particular. It is estimated that by 2030, among the 30 million newly purchased bicycles of the year, 17 million will be e-bicycles.

The sales of electric scooters are also on the rise. According to research firm CB Insights, millennials prefer cheap, practical, and environmentally friendly e-scooters to motorcycles which have sent the stock of Harley Davidson down nearly 20% in 2018.

At the same time, countries have been shifting away from private cars to alternative mobility modes. London has added 40 miles of temporary cycling tracks, and the government plans to allocate £2 billion (about HK\$20 billion) to build new cycling infrastructure. Many western cities, such as Athens, Budapest, Milan, New York, and Paris have channelled pedestrians in their streets to help citizens maintain social distancing and create new cycling paths.



In Hong Kong, many people also fell in love with cycling during the epidemic. Data from online trading platform Carousell revealed that nearly 40,000 bicycles were sold in Hong Kong in 2020, with 300,000 related searches per month. Unfortunately, due to a dense population and narrow sidewalks, e-bicycles or e-scooters are banned on Hong Kong's roads. Fortunately, the authorities are aware of the emerging trend and have proposed to allow the legalisation of e-scooters and e-bikes with a speed limit of 25 km/h.

Low carbon possibility in the Northern Metropolis

When planning the Northern Metropolis, can we also take these new environmentally friendly means of transportation into consideration?

I think the *Beijing Master Plan 2004-2020* is a good reference. On the premise of ensuring the sustainable development of a city, walking and cycling are among the transportation development strategies of the *Master Plan*, so road construction should "provide good conditions" to facilitate these activities.

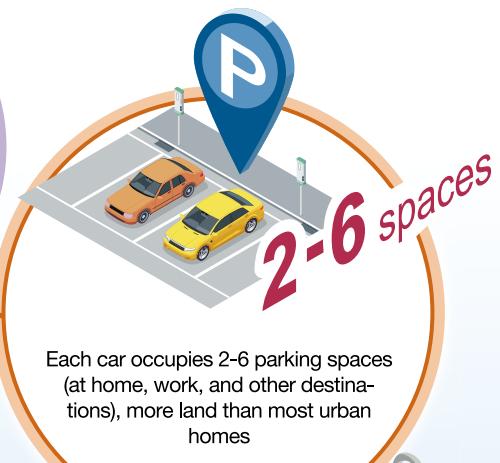
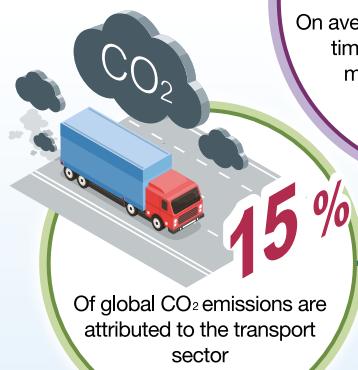
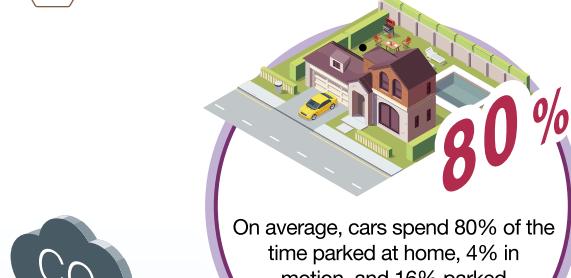
Can the Northern Metropolis follow Beijing's urban planning to improve accessibility and encourage environmentally friendly means of transportation? This includes designated bicycle lanes on all roads and flyovers and adopting a bicycle-friendly road design, such as sufficient waiting space before crossing the road which clearly separates people and vehicles, and paying more attention to the gradient of ascension and descension, and the design of bends, as well as planting trees along roads.



The Northern Metropolis is not only a new development area, but also a major planning breakthrough for Hong Kong to be integrated with Shenzhen. Therefore, I hope that the government can use innovative thinking to strive for the best possibilities in both development and environmental protection.



“Cost” of driving



Source: Centre For Liveable Cities, the Ministry of National Development, Singapore;
 Brits spend an average of 2500 hours of their lifetime looking for parking, FleetNews, 2013

2.2

Is the 15-minute city concept workable in Hong Kong?

In recent years, the 15-minute city concept has emerged in various places and enables everyone to access most, if not all, of their needs, including going to work and school within a 15-minute walk or bike ride from their home, so as to reduce carbon emissions and improve liveability.

The wave of 15-minute city-style has swept across China, and cities such as Paris, Barcelona, Milan, Melbourne, Ottawa, Portland, and more. What is so special about it? Is it workable in Hong Kong?

Is 15-minute city a "utopia"?

The C40, a global network of about 100 city mayors from different countries have defined the core principles of a 15-minute city, they include:

- Living Necessities: Residents of every neighbourhood have easy access to goods and services, particularly groceries, fresh food, and healthcare.
- Community inclusion: Every neighbourhood has a variety of public and private housing types, of different sizes and levels of affordability, to accommodate many types of households and enable more people to live closer to where they work.



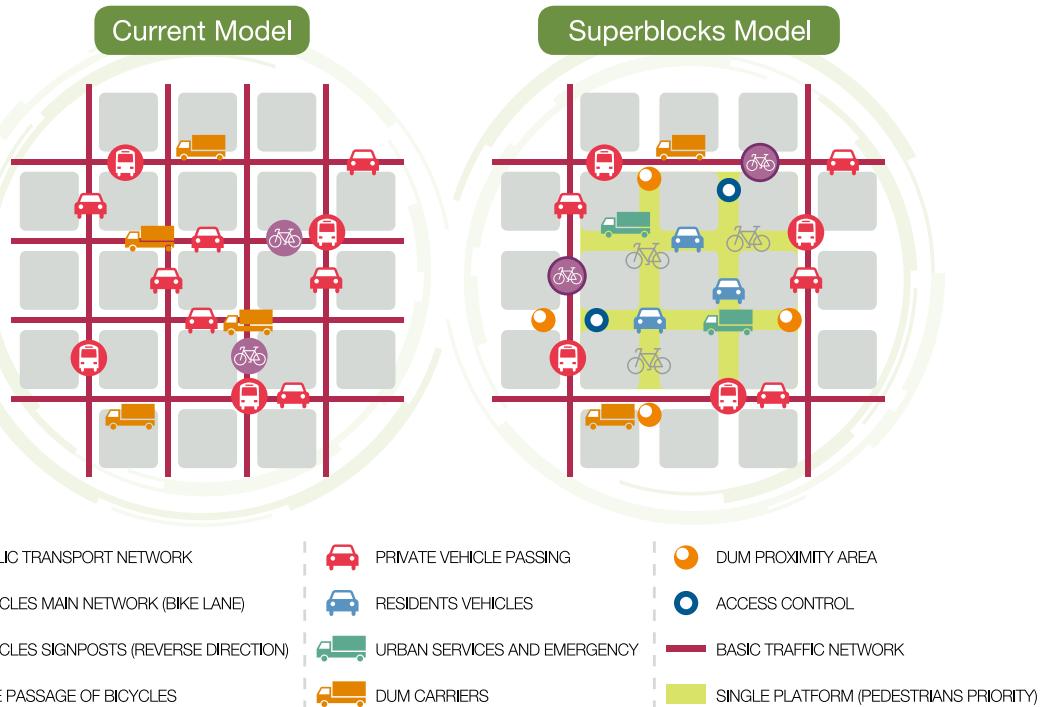
- The 15-minute city refers to the provision for going to work, to school, or meeting daily needs within 15 minutes of walking or cycling, achieving both a work-life balance and emission reduction;
- The Intelligent Road Network (IRN) should cover cycling tracks and be replaced with a professional map and API by the Lands Department to facilitate startups to incorporate them into their mobility applications.

- Green Spaces: There are green spaces for everyone to enjoy.
- Work-housing balance: More people can work close to home or remotely from employers' main offices with the presence of smaller-scale offices and co-working spaces, retail, and hospitality.

In Paris, "hyper-proximity" and the "15-minute city" were key pillars of Mayor Anne Hidalgo's successful 2020 re-election campaign. The hyper-proximity programme allows citizens to find everything they need in their daily lives within a 15-minute walk or cycle from home, including grocery stores, offices, parks, schools, coffee shops, fitness studios, hospitals, and clinics. By 2024, a cycle path on every street and bridge will be installed, while 60,000 private car parking spaces will be converted into office space or co-working hubs. At the same time, there will be small parks in school

Barcelona's Superblock

The Superblock modifies road networks within 400x400 metre blocks to improve the availability and quality of public space for leisure and community activities, and for pedestrians and cyclists



Source: *How to build back better with a 15-minute city, C40 Knowledge, 2020*



playgrounds opened to the public outside school hours to address the lack of public green spaces.

In the past few years, the Mainland has also been building 15-minute Community Life Circles ("15-minute Circles") which have been resolutely implemented. In 2021, 80 pilot projects across the country were first introduced. Since then, more than 1,000 15-minute Circles were built in Beijing, Shanghai, Guangzhou, and other cities, covering more than 2,000 communities and serving more than 23 million residents. By 2025, the authority plans to build "100 convenient community life circles with reasonable layout, complete business types, and comprehensive functions; they are smart and convenient, standardised and well-managed, offering high-quality services, harmonious for business and residence". CCTV reported that the overall satisfaction of residents in the first pilot areas reached 93%.

Hong Kong's urban planning is yet to catch up

Bloomberg News described the idea of a 15-minute city as a "utopia" of urban planning. Is this utopia achievable in Hong Kong?

According to the Transport Department's Travel Characteristics Survey 2011, the average commute time for people using public transport was more than 40 minutes, the same as in 2002. If the 15-minute city concept can be applied, the commute time will be shortened by two-thirds, that will be fascinating.

However, Hong Kong currently is unable to transform into a 15-minute city, yet. Such a community emphasises work-life balance and self-sufficiency,



rather than the current plan of dividing functions as industrial, commercial, and residential areas. Moreover, pedestrians and bicycles should play an important role in this community-friendly lifestyle, which is completely different from today's reality.

In fact, we have a 82 km-long cycle track network in the New Territories. It runs from east to west, covering a 60 km section connecting Tuen Mun to Ma On Shan, through Yuen Long, Sheung Shui, Fanling, Tai Po, and Shatin, and the backbone section of about 22 km from Tsuen Wan to Tuen Mun which will be rolled out in phases. However, to the authority, cycle tracks are only for leisure and recreational use by the public, they do not constitute a principal mode of transportation. This is also reflected in the Transport Department's mobile application *HKeMobility*, where the integrated route search for public transport does not include cycle routes in parallel with driving and walking.

Many hope that when planning the enormous new development areas in the Northern Metropolis, the authority will adopt out-of-the-box thinking, incorporating elements of reducing emissions and enhancing the balance of work and housing. Actually, why don't we start changing now?

Cycling should be one of transport modes

For example, the Transport Department can first include cycle tracks in the Intelligent Road Network (IRN), turning the network into "one-stop public transport, driving, cycling and walking routes". In the meantime, the map of cycling tracks can be changed from the version used by the private sector to the professional version from the Lands Department, with an application programming interface (API) available to facilitate the private sector's



incorporation of information into mobility applications. Meanwhile, when planning the roads in the New Territories, the safety islands can be widened to reduce competition between bicycles and pedestrians. Also, the authority should consider providing more bicycle parking spaces and strengthening management to use the cycle tracks as a transport infrastructure.

The goals of reducing emissions, improving quality of life and citizens' sense of belonging to the community cannot be achieved instantly. However, a journey of a thousand miles begins with a single step. If the government is willing to take the first step, things will begin to change.

2.3

GIS incorporating AI optimises urban planning

The annual Esri Young Scholars Award is for local tertiary students to research topics of their choice using geographic information system (GIS). In terms of reward, the top 3 winners of individual applicants can be awarded a summer internship at the Urban Renewal Authority as before, and all winners can participate in the online Esri User Conference held in the United States in July for free. They could exchange ideas with GIS professionals from all over the world in real time and learn about the latest application cases around the world.

Both champions of the individual and group category of 2022 are from the Department of Geography and Resource Management in the Faculty of Social Science at the Chinese University of Hong Kong (CUHK), while the University of Hong Kong (HKU) obtained seven awards, the most among all institutions. The research subjects are quite diverse with four excellent works on urban planning.

When you look at the award-winning works, you can't help but admire young people's broad vision, concern for society, and innovative thinking.



Sum Tin Lam, Alvin from CUHK was champion of the individual category of the Esri Young Scholars Award in 2022 with the project *Wheeling to Go — Wheelchair Users Accessibility in Kwun Tong District*

Wheeling to Go

BY ALVIN TIN
Wheelchair Users' Accessibility in Kwun Tong District

RESEARCH BACKGROUND

Wheelchair users' accessibility has been a hot topic in the research field. In this study, the author aims to explore the accessibility of wheelchair users in Kwun Tong District. The author also aims to propose a solution to improve the accessibility of wheelchair users in the future.

In Kwun Tong District, there are not enough facilities for wheelchair users. The author aims to propose a solution to improve the accessibility of wheelchair users in the future.

RESEARCH OBJECTIVES

1. Evaluate the importance of wheelchair accessibility. The author is aiming to evaluate the importance of wheelchair accessibility for the development of the study area.
2. To evaluate the wheelchair accessibility score as an indicator of wheelchair accessibility.
3. To propose a solution to improve the accessibility of wheelchair users in the future.

STUDY AREA

Kwun Tong District is located in the Kowloon Peninsula. The Kwun Tong Peninsula is a small island in the Kowloon Peninsula. It is the second largest island in the Kowloon Peninsula. The Kwun Tong Peninsula is a popular destination for tourists. The Kwun Tong Peninsula is a popular destination for tourists.

By this project, the author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District.

ACCESSIBILITY VARIABLES

Wheelchair accessibility is a measure of how easy it is for a wheelchair user to move around in a specific area. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District.

METHODOLOGY

The author is based on the GIS (Geographic Information System) and research design. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District.

RESULTS & FINDINGS

WHEELCHAIR ACCESSIBILITY SCORE

The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District.

SERVICE AREA ANALYSIS

The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District.

GO WHERE OTHERS CAN

The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District. The author will propose a solution to improve the accessibility of wheelchair users in the Kwun Tong District.

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- The winners of the 2022 Esri Young Scholars Award focused on smart mobility and urban planning, including accessibility for wheelchair users in Kwun Tong, the network of electric vehicle charging stations, and how to make good use of brownfield sites to develop a modern logistics industry;
- GIS plus AI can assess many variables such as geographic and socio-economic factors more comprehensively, making well informed decisions.

Research projects on mobility: Wheeling to Go

First of all, I would like to share two works about smart mobility.

Sum Tin Lam, Alvin from the Department of Geography and Resource Management, Faculty of Social Science at the CUHK, was champion of the individual category with the project *Wheeling to Go — Wheelchair Users Accessibility in Kwun Tong District*. The work also won him the two outstanding awards: Best Introductory Video Clip and Best Use of Open Data.

Sum believes that whether people are healthy or not, they should be able to obtain basic needs within a 15-minute walk to minimise their dependence on transportation. He has used this principle to review Kwun Tong which



is the most densely populated and ageing community in Hong Kong. For a normal pedestrian, it only takes a 14-minute walk from East Kowloon Health Centre to Lam Tin MTR Station, but 53 minutes if the mobility aids route is chosen, according to the HKeMobility app. Through the Lands Department's 3D Pedestrian Road Network dataset, Sum found that the area is full of travel obstacles, including steep walkways (from the waterfront to Sau Mau Ping there is a rise of up to 200 metres), staircases, narrow passageways less than 1.2m wide, roads without traffic lights, and more than 75% of the passageways lack shelter (motorised wheelchairs may malfunction in heavy rain).

He also conducted a survey of the places where the elderly often go to further investigate the problems. For example:

- MTR stations: such as Lam Tin Station Exit A and Exit D, where escalators are the only way to reach the station from these exits. Wheelchair users have to detour and travel 40 minutes longer to Yau Tong Station instead;
- Medical and rehabilitation services: wheelchair users in Sau Mau Ping and Ngau Tau Kok have to travel an extra 15 minutes to reach rehabilitation facilities, such as a hospital, 8 health centres, and a day centre;
- Markets and shopping malls: residents of Sau Mau Ping and Ping Shek need to spend 15 minutes more to buy food;
- Recreational facilities: there is a series of stairs to the main entrance of Lam Tin Park, wheelchair users have to spend an extra 15 minutes to enter the park.



Sum concluded that given the ageing population, the authority has to address and eliminate physical barriers as soon as possible to ensure social inclusion and a better living quality for wheelchair users.

Better EV charging facility distribution

Another piece on mobility is about the charging network for electric vehicles (EV). The project *Charging for the Future?* from Chan Chun Ping, Dieter, student of the Department of Urban Planning and Design in the Faculty of Architecture at HKU, was the 2nd runner up in the individual category.

While the government encourages the purchase of EVs, the lack of charging stations is deterring car owners. It takes time to charge, so the charging facilities should be within a 10-minute walk from one's home or office, suggested Chan. He reviewed the distribution of CLP charging stations and the government's 3D Pedestrian Road Network data, and found that Kowloon City district, including To Kwa Wan and Ho Man Tin, needs to be improved the most.

Chan recommends the government to actively collaborate with property owners of suitable sites and bear the installation costs. This enables a better allocation of charging stations through central planning, and can meet users' needs more effectively and efficiently.



GIS with AI can modernise the logistics industry

The champion of the group category composed of four CUHK students: Bao Wen Wei, Li Wen Yu, Luo Hao Wen, and Zeng Bin Cheng Joyce, worked on the project *Redevelop Our Brownfield Sites: Evaluation of planning scenarios for developing modern logistic industry on brownfield sites in the New Territories*.

The logistics industry is one of the four traditional pillar industries in Hong Kong. It is scattered mainly in the New Territories, but the lack of land has constrained its development. At the same time, the northern metropolitan area has been identified as the new development area. The students studied how to make the best use of the area to promote and modernise the logistics industry. They evaluated 11 categories of existing and potential land use, such as cold chain storage, dangerous goods storage, and more, from seven perspectives such as economic value and environmental impact, and made recommendations according to the land use and characteristics.

According to the students, GIS incorporating artificial intelligence (AI) in the process of urban planning can make well-informed decisions. Planners can not only adjust evaluation variables such as geographical and socio-economic factors, but also specific weights for each objective in reference to the needs of their plans.

For example, the team identified the spatial characteristics of different types of logistics land use in their analysis: cold chain for fresh produce and pharmaceuticals needs to be close to highways; dangerous goods should be kept away from residential areas; and port-related logistics have to be



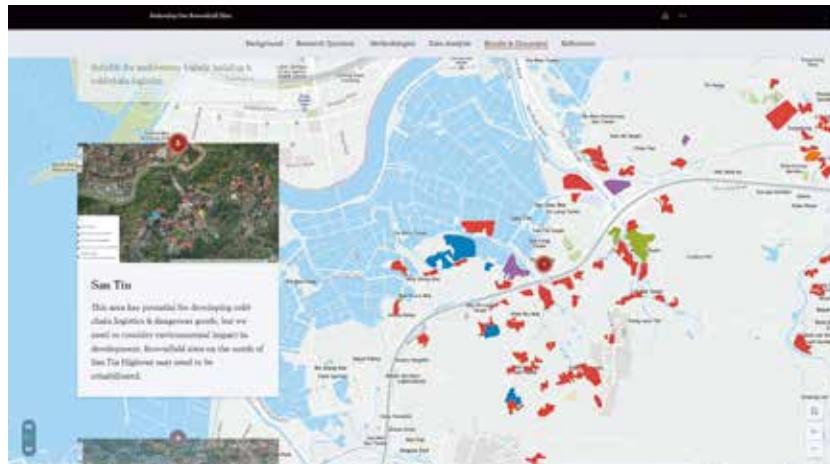
closer to the seashore and ports. The model also benefits future brownfield and other land use planning. It is not surprising that some judges praised the work with "really excellent study, innovative, topical, important and well executed with meaningful results that can guide the Northern Metro project".

The other three excellent works on land use are all from HKU's Department of Urban Planning and Design. They are:

- Smart Redevelopment: Suitability of Public Facilities Provision for Private Redevelopment Projects, the 1st runner up in the individual category by Chu Chit Hei, Sebastian. He suggests that the government should recognise and promote the significance of private development in providing planning gains, in addition to enhancing the housing supply and improving the living environment.
- Urban Renewal of Mong Kok: Based on Urban Vibrancy Analysis, the 1st runner up in the group category by a team of six HKU students: Cai Zhongyu, Chen Boran, Hui Chun Yin, Lu Zhi Mao, Ng Chun Hin, and Peng Jingyi. Referring to the examples of other cities together with an analysis of spatial characteristics, the group suggests a people first and public participatory approach to perfect the Urban Renewal Authority's redevelopment proposal.
- Development of Smart Environment in Hong Kong by Chan Yi Man in the individual category won the Best StoryMap Design award. The project explores solutions to enhance green buildings.



Four CUHK students from the Department of Geography and Resource Management were champions of the group category of the Esri Young Scholars Award in 2022 with the project *Redevelop Our Brownfield Sites: Evaluation of planning scenarios for developing modern logistic industry on brownfield sites in the New Territories*





Other interesting topics

The topics of three other award-winning works are:

- Analysis of the relationship between MTR travel record and the Covid disease by Huang Hanting, Hsu Ya-cheng, and Yan Junchen from HKU;
- How BIM and GIS technology can be integrated and applied in building facility management by Fok Chun Fung from the Department of Construction and Surveying in the Faculty of Construction and Engineering at Vocational Training Council;
- Coastal Defense and Taxation: Qing Military and Check Post in Hong Kong During the 19th Century by Chan Hoi Yuet, Chiu Sin Him, Fung Kai Leung, Ngai Ching Yu, and Sze Kuen Yung from the Department of History in the Faculty of Social Sciences at Hong Kong Baptist University. This topic is quite unique, the work displays several maps of Hong Kong 200 to 300 years ago, it is very interesting.

Last but not least, I would like to extend my heartfelt thanks to the judges for their hard work. The 17 members include 11 professors from seven universities and tertiary institutions, the principals of three professional bodies and three public organisations. The strong judging team makes the results more representative.

2.4

Unlimited potential of GIS - walkability, Feng Shui, hiking sustainability

In order to develop young people's ability in spatial intelligence and enhance their problem-solving capability, more than 10,000 universities around the world have offered courses related to geographic information systems (GIS) or used them for research projects. At the same time, the annual Esri Young Scholars Award brings tertiary students together to research and propose topics of their choice using GIS.

In terms of prizes, in addition to free admission to the annual Esri User Conference in the United States in July where they share their insights with more than 18,000 GIS users from all over the world for the champion of the individual category, students will also be invited to join the Esri Young Professionals Network (YPN) and the GIS Academy I established in 2022 in which they can interact with other talented and professional users around the world and advance their knowledge and career opportunities. In addition, the awardees will receive internship opportunities in the Urban Renewal Authority to apply what they have learnt.

Comprehensive assessment of walkability

Winner of 2023 in the individual category in Hong Kong was won by Evan Cheung Chi Cho from the Department of Urban Planning and Design,



- The importance of walkability is its effect on the health and life of residents, among which population density, greening, and pollution are important factors;
- To achieve hiking sustainability and reforestation, education and active monitoring are required;
- CSDI needs improvements on: the machine-readable data format to suit analysis, an increase of commonly used contents, and data accuracy.

Faculty of Architecture of the University of Hong Kong. His work *A Walk to Remember - Measuring Objective Walkability with Environmental Considerations in Hong Kong* examines the ease of walkability in 18 districts.

As Evan said, ease of walkability is not only a mobility problem, but it also has a significant impact on the health and life of residents, so it is worth city planners paying attention.

In addition to using factors of a previous study which was "mainly based on evaluating connectivity, proximity to destinations, and the mix of facilities available in the area", he added population density and environmental factors, including air quality, greenness, heat island effect, noise, and more, a total of eight perspectives to form a Walkability Composite Index for a more comprehensive assessment.

These new elements are particularly relevant to the assessment of Yuen Long, which has seen the district's score drop significantly with the addition of environmental factors. Yuen Long's below-average facilities coverage and poor environmental setting in population density and heat island effect are areas needing improvement. The analysis enables the government to address local and district walkability in a more timely and effective manner.

Overall, the Southern District, Eastern District, and Wan Chai District are the three best areas for walking as they are close to hiking trails with vast amounts of greenery, and are away from major sources of air and noise pollution.

To make the neighbourhood more walkable

Evan examined the local walkability at a macro level, while his classmate Poon Ka Yiu chose to analyse it in depth at the microscopic level. Poon's *3D Pedestrian Network Analysis — Road to a Walkable District* was the second runner-up and won the Best StoryMap Design Award in this year's individual category.

Ms Poon pointed out that the ageing of Hong Kong buildings and urban planning has discouraged the elderly or wheelchair users from travelling. Targeting the Yuen Long city centre, which began development in 1977, she uses the government's 3D pedestrian road network and contrasts it with Tsuen Wan, which became a new town in 1961, and has a similar proportion of the population aged 65 and above.



She found that Yuen Long is less accessible than Tsuen Wan. For example, there are fewer weatherproof pathways (11%, Tsuen Wan: 36%), but more ramps (93, Tsuen Wan: 25), and less than 60% of staircase have elevators or ramps in parallel to assist in ascending and descending (Tsuen Wan: 73%).

The author suggests that a new footbridge network and lifts around the MTR stations in Yuen Long should be equipped, or simply “adding covers along pedestrian pathways, especially those with high pedestrian flow such as those outside MTR stations and around bus stops, can make more footways weatherproof.” The authorities should also encourage malls to open more entrances on the ground and upper levels that connect to the footbridge network which helps increase the proportion of weatherproof pathways, in addition to the permeability of the network.” She also proposes introducing plants and artworks on the footbridge to make the walking experience more enjoyable. As a native of Yuen Long, I cannot agree more.

Rooms for improvement of the CSDI

In addition, the Common Spatial Data Infrastructure (CSDI), which was officially launched at the end of 2022, has played an important role in assisting students in the research process. However, Evan found that the quality of the big data needs to be improved.

Firstly, CSDI lacks commonly used data, such as shopping malls and restaurants; secondly, although some data like from parks is available, due to incompatible formats, users need to convert them for analysis, which is time-consuming; thirdly, some data may be inaccurate or duplicated.



The government has put a lot of effort into building CSDI and open data, and in order to realise its potential, the authorities should respond to this feedback and improve as soon as possible.

When GIS meets Feng Shui

I often say that GIS has unlimited potential in urban design, planning and management, and students have excellent opportunities to demonstrate here.

For example, GIS Application in Feng Shui - Rating the Feng Shui of Residential Buildings in Hong Kong during Nine Luck Period, which won the first runner-up in the individual category and the Best Use of Open Data Award, is novel and interesting. It integrates innovative technologies such as GIS with China's ancient feng shui practice.

This is the work of Adrian Chan Yin Wang, Department of Geography and Resource Management, Faculty of Social Science, the Chinese University of Hong Kong. He believes that despite Hong Kong's modern metropolis, feng shui remains a popular culture, and many people still apply feng shui to bring good luck in activities from interior design and decoration to moving house and planning building layouts.

Feng shui is a study of the relationship between people and the environment, but how can it combine with GIS to establish a score on residential buildings? Through GIS, the details of a building, including the location and environment, such as proximity to mountains and water, traffic flow, and noise which are "fake water" in feng shui, as well as surrounding ancillary facilities, like a bridge, hospital, fire station, and more can be clearly shown on the screen.



The analysis found that due to the small size of Hong Kong, the feng shui scores are generally similar regardless of east, west, south, or north, but the scores may vary greatly according to the spatial characteristics of individual places in each district. At the same time, Adrian pointed out that because of GIS's capability to analyse complex spatial data and visualisation, it can have more possible applications for GIS in Feng Shui. These include designing the indoor living environment for the placement and layout of rooms, furniture, and decorations, and even building orientation to avoid the "evil" which generally means taboos that hinders the flow of luck.

Hiking can be more sustainable

Another two students also make use of the visualisation of GIS to improve the local countryside.

The first prize in the group category was won by Lam Yi and Otto Yu Kai Him from the Department of Land Surveying and Geo-Informatics at the Faculty of Construction and Environment of The Hong Kong Polytechnic University.

The three-year pandemic outbreak has caused Hong Kong people who cannot travel abroad to set foot on local hilltops, and country parks have recorded more than 10 million visitors. Streams of hikers have eroded the topsoil, resulting in a countryside without grass.

The winner's work *The Hiking Sustainability - Discuss the effects of active hiking on suburban terrain studied three locations, namely Tuen Mun, Lion Rock and Ap Lei Pei*. These places are close to railway stations and are popular hiking trails.



The two students pointed out that to restore the landscape, a three-pronged approach is required, including:

- Reforestation – planting grass and trees along the side of hiking trails to recover the biomass and the forest;
- Education – to raise hikers' awareness of environmental protection through publicity;
- Active monitoring – In view of the scarred hillside caused by hikers carving their own mountain trails, it is recommended that the authorities change the passive mode of only setting up warning signs and posters in the past, and proactively establish a forest management system with innovative technologies, such as using Lidar data from the Civil Engineering and Development Department to compare changes in tree height and number, checking by field visits, and displaying the information on an interactive map dashboard for continuous monitoring.

As the above winning works have shown how diverse the topics of the entries can be. Other award-winning pieces, for example, exploring whether the provision of elderly healthcare services can meet the future needs of the ageing population, proposing an itinerary on how Mainland tourists can see the wonderful places of old and new Hong Kong in a day trip. Their suggestions for improvement are also constructive which demonstrate the creativity and independent thinking of young people.



Finally, I sincerely thank the panel of judges for their efforts. The 15 members, including nine professors from eight tertiary institutions, senior members of three professional bodies and three public organisations, made the results more representative.

2.5

When will genuine autonomous driving come true?

In the BYD annual report communication meeting held in 2023, Chairman of the carmaker Wang Chuanfu considered autonomous driving (AD) as impractical and misleading, saying that it was a "false promise". He believes that advanced assisted driving instead is actually the way forward for the industry.

Is this really the case? AD has been the talk of the town for years, people expected that one day vehicles could travel automatically to anywhere as directed without any human intervention and under all conditions during the journey.

Co-existence of robotaxi and private cars

According to SAE International, a global standards development and professional association, AD is divided into six levels (L0 to L5). L0 to L2 are assisted driving, L3 is conditional autonomous driving. At L4, a pedal and steering wheel may not be required but human intervention would be needed in an emergency, while L5 is completely unmanned under all situations.



- Whether autonomous driving can become a reality will depend on the development of sensors and highly precise maps;
- With the rapid development of the high-definition map industry, the demand for geospatial talents continues unabated.

Investment bank UBS estimates that fully autonomous robotaxis could generate US\$2.1 trillion a year by 2040, but that only accounted for 6% of all mileage driven. As Amnon Shashua, founder of an Israeli automated driving technology company Mobileye, pointed out at CES 2023, the recent developments made him believe the likelihood of co-existence between robotaxis and private cars, whereas compared to seven years ago, most carmakers were worried about people not buying cars one day and all turning to robotaxi.

Due to the high cost and distant payback period, coupled with the uncertain business model, many car manufacturers gradually abandoned investing in AD.

For example, Ford Motor in the United States decided at the end of 2022 not to develop L4 driverless cars because of the long-term unprofitability of the technology. In the letter to the National Highway Traffic Safety Administration (NHTSA), the carmaker requested the withdrawal of a petition to allow it to



test up to 2,500 autonomous vehicles per year, after closing down the Argo AI venture for developing AD systems earlier.

Rise of L2+

"L2+", however, has become a hot topic in the industry. It is an advanced version of "partial automation". It means that the driver can enjoy hands-free driving, but the brain and eyes have to still be engaged. The lane changing, speed, distance control, and braking are taken care of by the system while at the same time, it will ensure the human driver be alert and focused on the road. There is an eye-tracking technology to monitor whether the driver remains awake and focused. Mainland IT technology website 51CTO explains: "Having L2+ technology does not mean that you can get home in a car and sleep all the way, but that the price of L2+ is much more affordable for consumers, and the technology challenge is lower."

In a presentation to investors in mid-2023, Volkswagen, a German automotive group with luxury brands such as Bentley and Porsche, also made it clear that it would focus on L2+ in the coming years. Consultancy firm Frost & Sullivan predicts vehicles at L2+ will reach over 11 million units by 2025, almost a 100 times (from 115,450) increase compared to that in 2020. McKinsey's 2023 report echoes this and estimates that L2 will account for more than half of the US\$150 billion to US\$225 billion in revenue generated by AV systems by 2030. L4 will not become mainstream until 2035.



SAE levels of autonomous driving

	SAE LEVEL 0™	SAE LEVEL 1™	SAE LEVEL 2™	SAE LEVEL 3™	SAE LEVEL 4™	SAE LEVEL 5™
What does the human in the driver's seat have to do?	You are driving whenever these driver support features are engaged - even if your feet are off the pedals and you are not steering	You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety		You are not driving when these automated driving features are engaged - even if you are seated in "the driver's seat"		
			When the feature requests, you must drive		These automated driving features will not require you to take over driving	
	These are driver support features			These are driver support features		
What do these features do?	These features are limited to providing warnings and momentary assistance	These features provide steering OR brake/acceleration support to the driver	These features provide steering AND brake/acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met		This feature can drive the vehicle under all conditions
Example Features	<ul style="list-style-type: none"> automatic emergency braking blind spot warning lane departure warning 	<ul style="list-style-type: none"> lane centering OR adaptive cruise control 	<ul style="list-style-type: none"> lane centering AND adaptive cruise control at the same time 	<ul style="list-style-type: none"> traffic jam chauffeur 	<ul style="list-style-type: none"> local driverless taxi pedals / steering wheel may or may not be installed 	<ul style="list-style-type: none"> same as level 4, but feature can drive everywhere in all conditions

Source: *SAE Levels of Driving Automation™ Refined for Clarity and International Audience*, SAE International, 2021



Precision maps are the key

The obstacle of moving up to L4 or above is the high development cost of high-definition maps (HD maps).

There are two very different approaches for AD, the so-called Waymo model and the Tesla version, according to Wang Xiao, founder of Beijing AD system developer Idriverplus.

Wang explained that the Waymo model, which aimed at the highest levels (L4/5) of AD at the beginning, deploys complex and expensive sensors and equipment. The cost and technical challenges of this approach are extremely high, making it difficult to commercialise. The Tesla model (self-declared as L2) is based on continuous data collection through relatively inexpensive sensors, such as cameras mounted on mass-produced vehicles. With massive data, its automation algorithms can gradually improve.

The major difference between the two modes, in addition to the cost of sensor equipment, is whether to use HD maps or not. Serving as the "eyes" of AV, HD maps provide road geometry, route profile, and traffic signs which are essential for highly automated driving.

According to an insider at Baidu Map, L2 vehicles mainly require maps for advanced driver assistance systems (ADAS), with an accuracy of between 1 and 5 metres, and the map information mainly provides the basic features and geometry of the road. The precise level of HD maps is however down to centimetre, with L3 between 0.2-0.5 metres, and L4/5 as much as 0.1 metres.



The cost of achieving such precision is high. A vehicle with high-precision map collection capability in the Mainland is reported to cost more than one million yuan. The cost of a fleet of 200 vehicles, including labour and maintenance, is roughly estimated to be one billion yuan. However, this scale of investment may only be able to cover the national expressway with the mileage of about 177,000 kilometres, accounting for just 3.3% of the total mileage of highways in the country. Considering those in urban cities with much richer details, data collection becomes a huge challenge, to keep HD maps updated becomes even more difficult.

Today, in China, players including internet giants, traditional map makers, overseas suppliers, domestic innovation companies, and more, have engaged in HD map making, leading to diversified data sources with different labelling methods. Due to a lack of an industry standard, data cannot be shared between enterprises.

In view of this, China's Ministry of Natural Resources released a 2023 edition of guideline for the standard on intelligent-vehicle basic maps. To meet the needs of the country's technological and industrial development, it includes formulating more than 10 standards by 2025, covering technical requirements and specifications such as general application, data collection and distribution, production updates, quality detection, and security management to address the urgent need for the in-depth application of basic maps. By 2030, a relatively complete basic map standard for intelligent-vehicles should be finalised.



Prepare for golden opportunities

Meanwhile, investment bank Goldman Sachs expects the global HD maps market to grow to US\$9.4 billion by 2025. The Mainland industry also generally believes that the HD map industry will enter a golden era in the next 15 years.

With the rapid development of HD maps, the competition for talent will intensify. How can we meet such great opportunities? The *UK Geospatial Strategy 2030*, published by the Geospatial Commission of the U.K. in mid-2023, proposed a series of talent training programmes, including the launch of a pilot programme in 2023 to upgrade the skill of geographers in the public sector with digital and coding skills, in preparation for a wider rollout to other public and private sectors. At the same time, the Commission has also supported various local universities to establish master's degree and doctoral training centres in spatial geography, and plans to embed geospatial into the university's geography and data science courses in the near future. Will the Hong Kong government draw inspiration from this?

Conclusion

The winning entries of the Esri Young Scholars Award reflect that if we can improve urban planning with rich and diverse geographic information, we can solve not only mobility problems but also urban planning and sustainability in a more organised and effective way. Meanwhile, the development of AI and highly precise maps will help society achieve smart mobility faster.





Smart Environment

Construction, maintenance, and the daily running of buildings generates roughly 60% of Hong Kong's carbon emissions. In connection, the construction industry is also facing the problems of an ageing workforce and rising costs. The combination of GIS, BIM, and IoT can plan, construct and manage buildings more efficiently. Therefore, digital transformation and its further development will be the best choice for the industry.

Chapter
3



3.1

Digital transformation roadmap of local construction industry

In face of ageing labour and rising costs, how can the local construction industry use technology to turn crises into opportunities?

According to an estimate from the Hong Kong Construction Association in early 2024, there are currently as many as 18,000 unfilled vacancies in the industry. As at October 2023, around 45% registered workers were aged 50 or above. Using government figures in 1975 as the base, the construction cost in 2021 has increased by 16 times, the payroll by 23 times.

Digitalisation to enhance efficiency

Private buildings over 50 years old account for a quarter of all private buildings in Hong Kong, it is expected to increase to 50% by 2046. Therefore, there is an imminent need to redevelop old areas and maintain old buildings. In addition, the development of the Northern Metropolis, a 300-square-kilometre new development area, needs to be built by workers in time, but where can the required labour force come from? To tackle the crises, the industry has turned to digital transformation with innovative technology.

- Hong Kong's construction industry faces two major challenges: an ageing workforce and rising costs;
- Therefore, a highly compatible GIS at its core in combination with BIM can serve as the best digital transformation solution for the construction industry.

The CIC Construction Digitalisation Award 2021, hosted by the Construction Industry Council, encouraged the construction industry to improve efficiency, quality, safety, and environmental protection through digitalisation. As a member of the organising committee, I was pleased to see the brainchild of the whole year's hard work, and very optimistic about the development of a more economical and environmentally friendly construction industry.

Construction projects are often complicated and cumbersome. One of the major issues is how to properly manage the huge amount of information and assets including building plans, documents, site materials, and machinery, and to comply with various government regulations. It also requires coordination with a client, consultant, contractor, and various stakeholders. To effectively manage the intricate data, which is often of diverse format, while at the same time smoothly communicating with internal and external parties, the best solution is to use compatible software like a geographic information system (GIS) as the core in combination with building information modelling (BIM).



GIS and BIM: a way forward

GIS is powerful in analysis and 3D display, it can also integrate data in different formats, such as BIM, computer-aided design (CAD) drawing, internet of things (IoT), and digital twins. A user can remain on the same platform without the need to switch from one interface to another.

This central repository for storing engineering information is also called Common Data Environment (CDE) in the construction industry.

It collects and stores various project-related information which helps the team to fully evaluate project results, the impact on the surrounding environment, and the long-term benefits. The advantage of using GIS to establish CDE is to provide a single source of truth (SSOT) of which all data is consolidated to a specific source, avoiding the trouble of mixing old and new data, real and false data. By breaking down data silos, it allows users to get the holistic picture. It can also be directly connected to the cloud platform for further analysis. In short, CDE is the key to the success of project management.

However, the winners of the CIC Construction Digitalisation Award 2021, from the government, public and private enterprises to universities, mostly did not master the above mentioned innovative technological advantages of GIS. Only 6 out of more than 20 organisations and projects knew how to use it. Among them, there were two examples. One was the Hong Kong Airport Authority, which won two awards, both combined GIS and BIM; the other was in the category of "startup company". Among the three winning companies, two had integrated GIS and other advanced technologies in their solutions, such as IoT, artificial intelligence, blockchain, and more. Therefore, we can see the future of the digital transformation of the construction industry.



U.K. showcase

CDE has four major advantages, including improved project coordination efficiency by connecting both external and internal parties to share instant updates on information; effective management of information flow to reduce workloads related to the double-checking and broadcasting of updates; higher transparency to better predict and reduce the risks of the project. Upon improving efficiency, it can reduce waste and carbon emissions.

Ir Thomas Ho On-sing, Chairman of the Construction Industry Council cited the U.K. example that the construction industry there started to explore and practice CDE early in the 1980s. As a result, it possesses “the first mover advantage”, their industry practitioners “have been continuously exporting their technology and experience in recent years. Their works are widely hailed as industry models, their local economy and productivity are benefited as well”.

The Common Geospatial Information System Platform (CGISP) is similar to CDE but CGISP mainly aims at the construction of new development areas and large-scale projects. One example is the U.K.’s Crossrail, or the Elizabeth line as it is now known, which was officially opened in May 2022 and costed £19 billion. It is Europe’s largest infrastructure project which is managed by CGISP.

The new railway includes 42 kilometres of tunnels and 10 new stations, and is the connecting rail link between the suburbs, the city centre, and London Heathrow Airport.



One of the challenges of this mega project was how to properly organise the massive 12 terabytes of information, including 2 million CAD drawings and models, 8 million documents, 1 million assets, and 50 million GIS diagrams, all of which were used simultaneously. In order to control costs more effectively, reduce project delays and overruns, and ensure cybersecurity, the authorities established a range of GIS applications that could be accessed online, on a mobile with 3D functions, and a CDE to document and manage the huge project.

As stressed by Ir Ho, the construction industry needs to be digitalised by employing CDE which is closely related to BIM and GIS and they complement each other. I totally agree with him. Through the confluence of these important technologies and an open data initiative, the construction industry can unleash unlimited opportunities, and help pave Hong Kong towards its development of smart city.

3.2

Emissions reduction a top priority for the construction industry

Currently, buildings account for nearly 40% of energy-related carbon emissions globally, according to the World Green Building Council. The emissions come from two sources: The first is the daily operation of households, industrial, and commercial buildings, as well as shopping malls. Lighting, air conditioning, and more, account for 27% of the world's annual carbon emissions. The other source of emissions is from the building process, maintenance, and demolition which account for about 10% of annual carbon emissions.

The United Nations predicts that 2.5 billion people will move to cities over the next 30 years, which from the perspective of the construction industry, will translate to building 13,000 houses every day until 2050, in order to keep pace with the global population growth. The building-related carbon emissions may double by that time.

Eco-friendly buildings can sell 5% higher

The Hong Kong Green Building Council estimates that since Hong Kong is densely populated, buildings account for more than 60% of local carbon emissions, and up to 20% for construction projects.



- As the construction and maintenance of buildings accounts for more than 60% of local carbon emissions, green construction and management within the industry are of paramount importance;
- Example can be drawn from the promotion of the MiC experience in Singapore in the mandatory selection of private development projects, funding, and training of talent.

As there are more than 500 new buildings in Hong Kong every year, how to construct and manage buildings in a more environmentally friendly way is an important task.

BEAM Plus is the local initiative to offer independent assessments and certification of building sustainability performance, with an aim to make buildings more efficient and emit less carbon. Since 2011, more than 2,000 buildings have been registered with BEAM Plus (not equivalent to certification).

In fact, customers in general appreciate green buildings. A study from the Hong Kong Polytechnic University found that the price of flats in BEAM Plus-certified buildings is 3.4%-6.4% higher than those in nonregistered buildings. This is also the case in other places, such as Singapore, where there is a 4-5% premium for officially certified green buildings, and about 5% in Tokyo, Japan.

However, the sales premium cannot offset the high cost. A study conducted by the Hong Kong Institute of Surveyors in 2017, referring to examples from many places around the world, including China, Hong Kong, Japan, New Zealand, Singapore, the Philippines, and the Middle East, concludes that there is on average a 34% increase in the capital cost of green building projects which holds back many real estate developers.

MiC is an innovative yet affordable way?

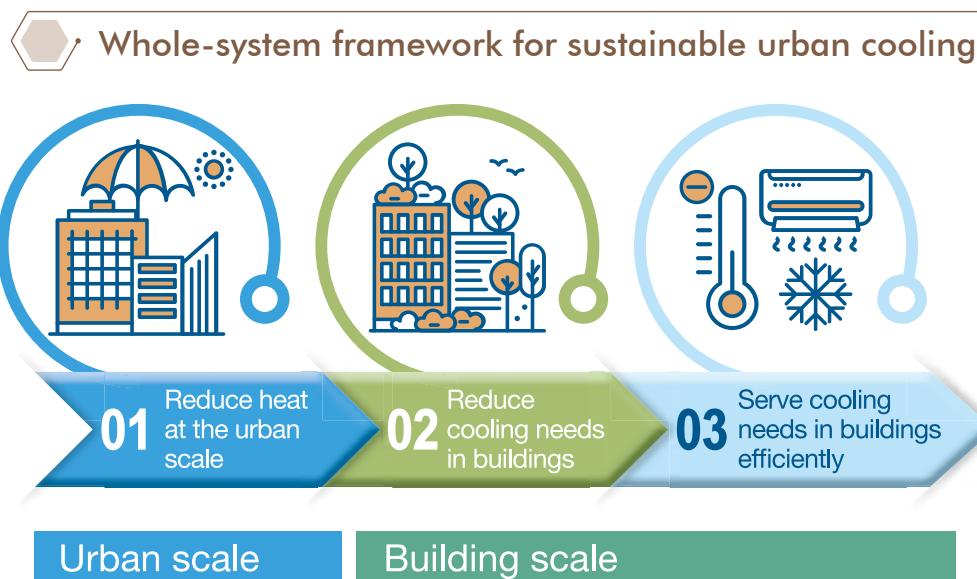
Problems bring business opportunities. Startups, venture capital and cement manufacturers are looking for more innovative yet environmentally friendly options to replace concrete.

Meanwhile, in Finland, Norway, and Sweden, nearly half of new homes are factory-built by assembling components in a factory before moving them on-site. The method is called prefabrication of which the advantage is a much faster construction period as the production of components can be carried out at the same time as the foundation works.

Hong Kong has also adopted this method which shortened the construction time by 50% for the InnoCell at Pak Shek Kok, Tai Po with a reduction on material wastage by up to 85%, energy consumption by 5% and greenhouse gas emissions by 3%. As early as the 1960s, Hong Kong had used this method to build Lower Ngau Tau Kok Estate. But again, cost is still an issue. The prefabrication of modules could increase unit construction cost by 17%, according to a study by the Legislative Council Secretariat.



The authorities have seen the housing issue and the net-zero mission as more pressing. Therefore, to speed up the construction of public housing in a more environmentally friendly way, the Secretary for Housing has said that prefabrication would be adopted more frequently. In addition, Hong Kong currently only adopts the modular integrated construction (MiC) method in six types of government buildings, such as schools and office buildings. Is there any scope for promoting the method to private developers?



Source: *Beating the Heat: A Sustainable Cooling Handbook for Cities*, United Nations, 2021

Singaporean ways

A study by the Legislative Council Secretariat cited the example of Singapore, pointing out that MiC has been extensively used due to labour shortages and a high demand for building as many as 19,000 public housing units each year, and a number of concurrent infrastructure projects. The method is environmentally friendly, and saves manpower. Therefore, the Singapore government mandates selected private development projects, such as hotels and residential buildings, to use MiC to build at least 65% of the total floor area. It also provides subsidies for construction companies that use the MiC method (there are similar measures in Hong Kong). At the same time, the authority also relaxed traffic regulations for transporting MiC modules. Through a multi-pronged approach, the use of the MiC method doubled from 19% to 39% during 2017-2020.

I think it's worth emulating the advocacy of the local production of building modules. Singapore not only allocates land to help the relevant enterprises to establish there, but also provides a tax allowance to boost the local production of MiC modules. Meanwhile, construction workers displaced by MiC are provided with associated training. It is expected to train 80,000 people with knowledge of the latest building technologies in five years, expanding the talent pool. Will Hong Kong's re-industrialisation actively consider following Singaporean practice?

Apart from that, existing buildings are also a significant source of carbon emissions. According to government statistics, power generation is the largest source of the problem, accounting for more than 60% of total emissions. In the electricity consumption category, commercial and residential air conditioning consumes the most energy. Research and development of green technology to enable more efficient use of air conditioning and to reduce overall power consumption is of top priority.



AI to find energy saving methods

DeepMind, a British startup company that defeated the world Go champion with artificial intelligence AlphaGo a few years ago, claimed to have developed algorithms in 2016 to cool the millions of computer servers in Google's data centre with energy savings of 40%. In Hong Kong, a local company has also developed an energy-saving solution by installing sensors to reduce power consumption and carbon emissions in buildings.

However, the issue of ageing buildings in Hong Kong has worsened the problem. The number of private buildings aged 50 years or above has surged to 8,600 in the past 10 years. The Operation Building Bright takes the immediate needs of the public such as fire safety, lift replacement, and drainage system repair as the primary consideration. Whether to use environmental-friendly materials is not the priority.

In fact, the maintenance of old buildings is expensive, Italy is an example. In order to revitalise the economy under the Covid-19 epidemic, the government launched the Superbonus 110% Scheme in mid-2020. Each family can enjoy a tax credit up to 110% on the cost of upgrading their home, about €100,000 (about HK\$ 850,000), for installing green facilities such as insulation systems and solar panels. The Italian government has so far spent €21 billion (about HK\$178 billion) in two years, it is staggering.

How can these global problems be solved? Young people and startups, I hope you can find innovative solutions for us as soon as possible.

3.3

Award winning examples of construction and property management

In response to the ageing workforce and rising costs in the construction industry, the Construction Industry Council has been actively encouraging digital transformation in various ways, organising competitions is one of the effective methods.

Following the "CIC Construction Digitalisation Award 2021", which aimed to promote the adoption of digitalisation to improve productivity, quality, sustainability, and safety in the industry, the first "Hong Kong Construction Common Data Environment Award" (CDE Awards) were co-organised with the Development Bureau in 2022 to recognise local projects and organisations that best utilise Common Data Environment (CDE) to improve project management, productivity, collaboration and sustainability.

Long-term benefits

What is the significance of CDE? Construction projects not only require the management of architectural plans, documents, construction site materials, and machinery, but must also satisfy government regulations and environmental requirements, and coordinate with clients, consulting firms, contractors, and potentially affected stakeholders. It is a very difficult and



Gold Award winners of the first CDE Awards in Hong Kong:

- **Gammon:** This GIS-centric digital construction solution is an integrated collaboration platform to connect all project members;
- **HKUST:** Using GIS combined with BIM and IoT to improve the efficiency of campus property management, which is of inspiring significance to university campuses, shopping malls and the Northern Metropolis.

complicated task. How can we effectively manage these complex and diverse data formats while ensuring smooth internal and external communication? CDE is used to collect and store various types of data, facilitating internal communication and helping the team assess project outcomes, environmental impacts, and long-term benefits.

Therefore, I believe that a solution powered by the highly compatible geographic information system (GIS) and combined with building information modelling (BIM) is currently the best choice. GIS not only has profound analytical and 3D display capabilities, but it can also integrate various data formats such as BIM, Computer-Aided Design (CAD) drawings, the internet of things (IoT), and digital twins without users having to switch between different interfaces. Establishing a CDE with GIS offers the advantage of providing

a single source of truth (SSOT), eliminating issues of data inconsistencies or uncertainties, and directly connecting to cloud platforms for analysis and improving communications with all stakeholders. In short, CDE can enhance the effectiveness of project management.



Advantages of CDE:

Improve Project Coordination Efficiency	As a single source of truth (SSOT), CDE connects both external & internal parties to share instant updates on information, libraries, and project data
Effective Management of Information Flow	With information shared efficiently and precisely, it saves communication time and cost for all project participants
Risk Reduction	It improves transparency of the entire project, helping with forecasting and reducing risks while improving predictability
Reduction of Wastes and CO ₂ Emissions	It facilitates planning, facility management and, budgeting, hence, reducing waste and carbon emissions

Source: Construction Industry Council



Gammon: GIS with BIM can improve quality and safety

Coincidentally, the core technology two Organisation Category Gold Award-winning works in 2022 used was GIS. Gammon Construction Limited used it to integrate data throughout the construction cycle, while the Hong Kong University of Science and Technology (HKUST) has improved property management efficiency and energy conservation by applying it.

One of the Gold Award winners, Gammon won the project for the expansion of Terminal 2 at the Hong Kong International Airport. The contractor's GIS-centric digital construction solution is a showcase of how the industry's application of advanced technology can enhance engineering standards through a self-developed integrated collaboration platform to connect all project members. Sharing BIM data as a key element, the software minimises manual processes, tracks and reports progress anytime and anywhere to ensure that the project proceeds as designed, improving project quality and safety at the same time.

HKUST: Best practice of property management

The digital twin created by HKUST for its smart campus is also a demonstration of asset management and property technology, showcasing the feasibility and effectiveness of combining GIS with BIM and the IoT.

Multiple decentralised systems are in place within the HKUST campus,



including the physical campus IoT, indoor air quality control, building management systems, facility maintenance/space management, engineering analysis, and indoor navigation systems for mobile devices. The purpose of the project was to connect these decentralised systems to make campus management more intelligent. They adopted an integrated data platform, displaying daily operations such as Wi-Fi status and indoor air quality all on one screen, allowing management to monitor the flow of people in both indoor and outdoor locations, and adjust air conditioning temperatures accordingly.

This not only improves property management efficiency but also saves energy and ensures air quality. I believe that this example of technology usage is highly inspiring for university campuses, shopping malls, and new development areas such as the Northern Metropolitan Area.

Seeing past entries from private enterprises, public institutions, and universities embracing advanced technology is encouraging for the future of digital transformation in the local construction industry. I urge the industry to participate more proactively in these kind of competitions and seize the opportunity to learn from each other.



3.4

Modern management using Mixed Reality

It is estimated that the total length of underground utility services in Hong Kong is 100,000 km, which is at least 47 times the length of the roads. At the same time, the Director of Audit's report in 2018 pointed out that the number of major public utilities in Hong Kong increased from 10 in 1995 to 18 in 2017 (including 12 telecom companies). It has led to an increase in road excavation works which has made the traffic congestion even worse, while poor coordination among the works further exacerbates the problem.

Maintenance of underground pipes has been a problem for many public utilities, especially in areas where the underground network is dense. How can advanced technologies help solve the problem and improve efficiency?

Toms River Municipal Utilities Authority (TRMUA) in a small town in New Jersey of the United States had an innovative attempt a few years ago. This small place, Toms River, with a population of only 100,000, and 700 km of underground utility lines and 18 pump stations, used cutting-edge mixed reality (MR) to assist the staff managing the underground utilities, greatly reducing engineering costs, improving efficiency, and enhancing site safety.

The authority adopted a combination of geographic information systems (GIS) and augmented reality (AR). The holographic headset includes audio, tiny

- Coordination of road excavation works is important as underground public pipelines in Hong Kong are 47 times longer than the road surface, the construction and maintenance of underground public pipelines have exacerbated road traffic congestion;
- Combined with GIS, AR and MR, holographic headsets with audio, miniature cameras, sensors, and systems bring underground pipe wiring diagrams to life;
- Improving the accuracy and digitisation of underground space data can help prevent future epidemics.

cameras, movement sensors, and a system for confirming the wearer's exact location relative to the underground pipes. While wearing the HoloLens transparent visor, utility workers see a view mixed with the real world in front of them as well as the lines of underground wastewater pipes.

The pipes are colour coded and projected to scale, so that the relationship and depth between the pipes is more clearly displayed. With slight movements or audio commands, the wearers can summon screens showing relevant information. At the same time, the hands-free operation of the smart headset allows the on-site personnel to connect with an engineer in the office, so that the engineer can view the scene in real time and give guidance. For instance, if the engineer notices a grouping of utility pipes



such as high voltage cables, the worker would be directed to stop using heavy equipment and start digging by hand until the pipes are exposed. In the past, fieldworkers would only resolve these incidents over the phone or by summoning the engineer from the office to the field, a slow and pricey process.

Today, the application of smart glasses and headsets that can project information, give guidance, or display images is becoming popular. They are deployed in factories to guide the maintenance of parts, while manufacturers use them to assist in quality inspection, and retailers use them to show customers a kitchen or house after the completion of renovation. In 2016, the *Wall Street Journal* reported that the application of these smart facilities by commercial organisations increased the efficiency of quality inspection by 20% and production speed by 25%.

However, the basis enabling these advanced technologies is an accurate and digitised geospatial database. A lot of infrastructure information in Hong Kong is up to the requirements, but there is still room for improvement. For example, during the sewage inspection under the epidemic, the authority found that the drainage records of some private buildings were incomplete or had not been updated.

Complete information of underground networks like drainage is crucial to the smooth operation of a city. Therefore, I suggest the authority improves and digitises the information of the drainage and sewerage network, especially those underground, while ensuring an update mechanism to facilitate management. This will help contain the next epidemic, and enable Hong Kong to use advanced technologies to step on to a true digitally transformed journey.

3.5

How to strike a balance between conservation and development

The development of the 1,000-hectare Kau Yi Chau Artificial Islands (KYCAI) project aims at building a carbon-neutral community with the wider use of renewable energy, energy-efficient designs and technologies, according to the government. However, the conflict between environmental conservation and the sustainability of fisheries has become one of the key concerns.

According to the Hong Kong government proposals, a three-island design of KYCAI will adopt a 15-minute neighbourhood concept for a liveable community to accommodate a population of up to 550,000 and provide 270,000 employment opportunities. However, in a letter to the government, Steven Ho Chun-yin, the Legislator (Agriculture and Fisheries sector) pointed out that the preliminary survey findings of the government "show moderate to high levels of fishing activities" in the area, how adversely the large-scale reclamation will impact the industry is unknown yet. It is certain that in the process of developing transport infrastructure and new waterways, designated areas like restricted zones, sludge pits, or marine parks are highly likely to be introduced. They will inevitably impinge on fishing activities in the waters.



- Higher transparency of information can minimise public concerns on reclamation;
- GIS which combines voxels can measure the characteristic of seawater to analyse a variety of data and piece together a 3D image of the underwater world.

Information transparency fosters conservation

To better engage the public and reduce their concerns about the reclamation, the government can establish a marine life database to facilitate the planning and monitoring of natural resources, as well as a comparison of changes in marine life before and after reclamation as transparency of information can minimise misunderstandings.

That is the reason why I am so glad to learn that the Agriculture, Fisheries and Conservation Department (AFCD) and the Swire Institute of Marine Science of the University of Hong Kong signed a Memorandum of Understanding in early 2023. The MoU is to facilitate collaboration in the management and dissemination of marine biodiversity data, and to plan the launch of the Biodiversity Geographic Information System (BGIS) in 2024. The more comprehensive data repository can foster better understanding and conservation for Hong Kong's wealth of biodiversity.

The launch of BGIS has made the local biodiversity data database more comprehensive, what should be the next step? The government may follow the example of the World Wildlife Fund which set up the Global Observation and Biodiversity Information Portal (GLOBIL). The online platform uses a cloud-based geographic information system (GIS) platform to support conservation efforts around the world using geospatial data.

The platform includes key datasets for download, and dashboards displaying key statistics. This advanced technology GIS is an open system to integrate information and data for analysis, including above- and below-ground facilities, land use, demographics, and more. Even images, such as voxel layers for ocean variables like seawater temperature, salinity, or dissolved oxygen can be presented. To integrate with data from sources, including sonars, satellites, submarines, and underwater cameras, 3D images of the comprehensive view of the underwater world can be formed for better decision making.

Furthermore, the Hong Kong authorities can also make use of these advanced technologies with an interactive map dashboard to illustrate and compare the changes in marine life before and after reclamation, similar to the government's newly launched online map dashboard of hygiene black spots, allowing the public to compare the situation before and after cleansing operations.

Synergy of government departments

In addition, to create synergy for conservation efforts by various government departments such as AFCD, the Civil Engineering and Development



Department, and the Development Bureau, the government could use a digital platform Common Operational Picture (COP), with geospatial information as the core to enable different departments in communicating with each other to co-ordinate efforts in conservation. The technology behind this is also GIS.

In fact, to address climate change, good resilient design and management, and emergency preparedness, the authorities should embed flexibility and forward-looking design concepts in the planning of all the new development areas, such as Kwu Tung North, Hung Shui Kiu / Ha Tsuen, Yuen Long Industrial Estate Extension at Wang Chau, Liantang / Heung Yuen Wai Boundary Control Point, San Tin / Lok Ma Chau Development Node, and Tung Chung New Town Extension.

Since GIS is one of the best solutions to link various data, I suggest it be used as a single source of truth (SSOT) to coordinate data from all parties for planning and construction of these new development areas. This advanced technology should be used starting from the technical feasibility study stage to prioritise infrastructure such as roads and railways and to improve efficiency and reduce costs. What's more, the visualisation of GIS can also illustrate why massive projects including land reclamation are required so as to allay public concerns.

By doing so, Hong Kong can move one bold step towards the goal of carbon neutrality with a better balance between conservation and development.

3.6

The myth of the hydrogen economy

Hydrogen is the most abundant element in the universe, for example, water (H₂O) contains hydrogen. With the global trend of reducing carbon emissions in recent years, the hydrogen economy has become a hot topic. In the Ministry of Science and Technology's *14th Five-Year Plan* announced in 2021, hydrogen energy technology is one of the 18 key projects for *China's National Key R&D Programmes* (NKPs). Different provinces and cities, including Beijing, Shanghai, Guangdong, Hebei, and Hubei, have successively released supporting policies for hydrogen energy planning.

According to the National Hydrogen Association (NHA) based in the United States, the National Aeronautics and Space Administration (NASA) currently uses the most liquid hydrogen worldwide, primarily for rocket propulsion. By the 1970s, the alarming oil crisis was pushing countries to explore alternatives, and the commercial potential of hydrogen fuel cells began to attract attention.

Fuel of the forever future?

In theory, hydrogen can generate three times more energy than fossil fuels per molecule, it is a clean energy source that achieves zero carbon



- Hydrogen which produces 3 times more energy than fossil fuels is a clean energy source with zero carbon emissions;
- China aims to significantly increase the number of hydrogen fuel cell vehicles from about 10k in 2020 to 100k in 2025;
- It is recommended to set up a Net-zero Interactive Map Dashboard for individuals to monitor the progress and use sensors and smart devices to display in real time how energy-saving appliances, walking, bringing your own utensils, increasing vegetarian diets, and reducing shopping can reduce carbon emissions.

emissions. However, there is a joke in the energy industry: "Hydrogen is the fuel of the future, and it always will be." Elon Musk, Tesla CEO, once said that the idea of hydrogen fuel cell vehicles was "mind-bogglingly stupid", which has aroused much controversy.

The problem is that there is no natural source of hydrogen on Earth, most of it is combined with other molecules like those of fossil fuels, biomass, or water. The current hydrogen extraction technology is not cost-effective, hydrogen is difficult to capture directly and use, and the extraction process needs to

consume more energy than obtainable from the resulting hydrogen.

At present, global hydrogen energy production can be divided by colour according to carbon emissions during its production:

- Grey & Black: Grey, if made from natural gas, or black, if made from coal.
- Blue: Made by technologies and materials as Grey and Black, with the carbon dioxide being separated out and stored away underground, known as carbon capture and storage (CCS).
- Green: Produced by electrolysis. According to the China Energy News, the cost of hydrogen produced by alkaline electrolysis in Mainland China is as high as 35 yuan per kg.
- Pink: Use nuclear energy in electrolysis.
- Turquoise: Heating methane until the hydrogen is separated out, leaving solid carbon behind.

As mentioned in a report released by the International Energy Agency in 2019, the current production of hydrogen energy is almost entirely from fossil fuels, with 6% from natural gas and 2% from coal. As a result, production of hydrogen is responsible for carbon emissions of around 830 million tonnes of carbon dioxide per year, equivalent to the total carbon emissions of the United Kingdom and Indonesia!



The hydrogen colour spectrum

Color	GREY	BLUE	TURQUOISE	GREEN	PINK
Process	SMR or gasification	SMR or gasification with carbon capture (85-95%)	Pyrolysis	Electrolysis	Electrolysis
Source	Methane or coal 	Methane or coal 	Methane 	Renewable electricity 	Nuclear energy

Source: Grey, blue, green – why are there so many colours of hydrogen? World Economic Forum, 2021
 Note: SMR = steam methane reforming

Russia-Ukraine war makes alternative energy a priority

As the cost of renewable electricity continues to fall (electricity accounts for most of the cost of electrolytic hydrogen), and with the trend of falling prices and the improved efficiency of related facilities such as electrolytes, the U.S. Department of Energy (DoE) announced the Hydrogen Shot in 2021, which seeks to reduce the cost of various clean hydrogen (i.e. except grey and black ones) by 80% to US\$1 per kg within a decade.

With the outbreak of the Russia-Ukraine war in early 2022, many European countries started to move away from the status quo of over-dependence on Russian natural gas, and finding alternative energy sources has become a top priority for the region. For example, Germany began to reduce the proportion of imported oil in total energy from 35% to 12%, and the proportion of imported natural gas from 55% to 35%.

Moreover, Europe wants to demonstrate its ambition to take the lead in hydrogen energy, which is becoming increasingly competitive internationally. As of June 2022, more than 31 countries or regions around the world have announced hydrogen energy strategies, making this new hydrogen provide three times more energy than fossil fuels, and it is a clean energy source with zero carbon emissions.

Transportation accounts for around 15% of global greenhouse gas emissions and causes many health problems. This makes people particularly eager for fuel cell electric vehicles powered by hydrogen. One of the highlights of the Tokyo Olympics in Japan originally was the demonstration of hydrogen-



powered vehicles. China is also ambitious in setting the goal to increase the number of the country's hydrogen-powered fuel cell vehicles from less than 10,000 in 2021 to 100,000 by 2025. In Hong Kong, the first-ever hydrogen double deck bus has commenced daily passenger service in February 2024. More trial projects on hydrogen fuel technology are on the pipeline. I cannot wait to see the progress of these initiatives over the next few years.

The whims of emissions reduction

To reduce carbon emissions, public support is also important, but there are often conflicting interests between public welfare and personal interests.

The *Economist*, a magazine, quoted that a survey done by BritainThinks, a polling firm, for the Green Alliance, a group of think-tanks, indicates that the public is keen on green taxation, with around 60% supporting a levy on carbon. However, when it comes to specifics, the public loses enthusiasm. As more and more people use electric vehicles, the government may switch to implement new road taxes to replace fuel duty, but only 37% of people supported the proposal.

It requires more thoughts on how to motivate the public to take part in supporting environmental protection.

Two of the methods are to provide financial incentives and to increase facilities for recharging electric vehicles. Hong Kong has implemented the First Registration Tax Concessions for Electric Vehicles since 1994. As of June 2024, the total number of electric vehicles in Hong Kong is about 96,600.



However, the number of quick chargers does not keep up with this pace, we only have 1,511 quick chargers currently. There have always been long queues of electric vehicles waiting for chargers. Therefore, the authority should work hard to increase the charging facilities in Hong Kong.

Net-zero interactive map dashboard

Furthermore, when people witness the effectiveness of their emissions reduction, they will definitely be more engaged.

Suddenly I have a thought: If one day, we can set up a Net-zero Interactive Map Dashboard of a person or family, connecting multiple sensors and smart devices, displaying in real time our carbon reduction efforts like using energy-saving appliances, walking instead of riding a car, bringing our own tableware and food containers, increasing vegetarian food and reducing the use of plastic bags, it will help individuals monitor the progress of their efforts. Maybe some companies can even encourage their customers to reduce carbon emissions through rebates, just like encouraging users to take 10,000 steps a day. Then, we will get twice the result with half the effort by joining hands.

Conclusion

With the dilapidated buildings and intricate underground pipes in Hong Kong, as well as the development of the Northern Metropolis and Kau Yi Chau, there will be increasing requirements for construction efficiency. The success of the industry's digital transformation and efficiency enhancement depends on its mastery of technology, and it is advisable for the Hong Kong government and the industry to collaborate more to bring urban planning, construction, and maintenance to a new level.





Smart Government

Chapter
4

The purpose of transitioning to a smart government is to enhance the effectiveness of governance, solving the problems of the public and injecting momentum into social development. Unfortunately, since the launch of the *Smart City Blueprint for Hong Kong* in 2017, the general public has not felt the benefit from it. One of the missing parts is a performance indicator dashboard so that the public can see the effectiveness of the policy at a glance and to facilitate monitoring.



4.1

From a smart city's perspective, what President Xi's four proposals mean for Hong Kong

On 1st July 2022, China President Xi Jinping put forward four proposals for Hong Kong. I am confident that Hong Kong can realise these expectations through the development of the smart city with innovation and technology (InnoTech). Based on my understanding, I prioritise his four proposals with suggestions as follows:

First of all, to "earnestly address people's concerns and difficulties in daily life", we need to accelerate the development of the smart city.

Hong Kong must accelerate the construction of the smart city. For a long time, different places around the world have set the goal of building a smart city to solve livelihood problems, such as shortages of resources, an ageing population and facilities, and a rising unemployment rate, and more.

In Hong Kong, the government announced the Smart City Blueprint for Hong Kong 2.0 in December 2020. It is time to review the progress and identify the deficiencies before moving forward. The key is whether the

- The development of smart cities can address people's concerns & difficulties in daily life;
- The Northern Metropolis can create strong impetus for growth;
- We should "work together to safeguard harmony" by improving youth employment, and encourage education institutions to expand to GBA to enrich the talent pool;
- The CSDI can help improve governance.

government has thoroughly implemented the measures. For example, one of the vital initiatives is open data. Have the government agencies used it in decision making to make the most out of the data or is it just pure talk about stratagems on paper?

Secondly, by developing the Northern Metropolis, we are able to "create strong impetus for growth".

The country hopes that Hong Kong will "seize historic opportunities offered by China's development and actively dovetail itself with the 14th Five-Year Plan and other national strategies such as the development of the Guangdong-Hong Kong-Macao Greater Bay Area (GBA)" to attract talent and integrate with the overall development of the country.



Hong Kong, as an international financial centre, is also a world shipping and trading centre. The development of the Northern Metropolis will help Hong Kong and GBA complement each other with their own advantages, establish a cross-regional ecosystem, and turn Hong Kong into an international InnoTech centre. One key is smart land use planning.

How to modernise the logistics industry, promote the integration of innovation and technology with GBA, and at the same time, increase the housing supply with a mix of industrial and commercial facilities and public transportation to facilitate the residents' livelihood and employment in the Northern Metropolis. All of these require holistic thinking and smart planning.

Thirdly, we should "work together to safeguard harmony" by improving youth employment and encouraging education institutions to expand to GBA to enrich the talent pool.

On one hand, the government should be committed to increasing research and development (R&D) investment to the level of 1.5% of GDP; on the other hand, it has to promote public-private collaboration to provide pre-employment training and job matching for young people, and to strengthen InnoTech education. This not only enriches the domestic talent pool but also provides a well-rounded development for the next generations. President Xi reminded us that "Hong Kong will have a bright future only when its young people have good career prospects".

Further, Hong Kong has world-class high-ranking universities. The government has to encourage more institutions to set up branches in GBA to create more opportunities to cultivate innovation and collaboration for students



in Guangdong and Hong Kong. The move also strengthens the integration of talent in Shenzhen and Hong Kong. At the same time, it can uplift the standard of scientific research, create a better industry chain, and allows GBA to realise its potential. In the end, we can further expand such development to other provinces across the country.

Finally, it is necessary to make the best use of CSDI to “further improve the level of governance”.

It is a must to strengthen the training of the civil service team, and to prepare them to use the latest technology to “improve the governance system, capacity, and efficacy”. The Common Spatial Data Infrastructure (CSDI), developed by the Development Bureau and launched in 2022, is a strategic tool to connect all parties. CSDI is one of the core infrastructures of the *Hong Kong Smart City Blueprint* announced in 2017. The infrastructure not only supports various smart city applications and interoperability within the government, but also benefits public and private sectors, SMEs and startups in particular, unleashing the potential of location data. It will contribute to a liveable, competitive, innovative, and sustainable smart Hong Kong.

Through these suggestions, I believe that Hong Kong will certainly live up to President Xi's high expectations, and the city will gradually realise the four proposals he put forward and build Hong Kong as a world-leading smart city.



4.2

Smart city starts with smart planning

Smart city starts with smart planning, and geographic information system or GIS is the foundation technology for smart city development. It empowers town planners to determine how, where, and when their designs can have the greatest impact to improve the quality of life.

Hong Kong SAR is celebrating its 27th anniversary in 2024. In the last 27 years, through applying GIS, Hong Kong has become a better living place mainly in the following four areas:

- **Smart mobility:**

My very first GIS project was for land resumption and the planning of the routing and alignment of the West Rail by the then Kowloon-Canton Railway when I started my company in 1997. Providing comprehensive support to develop an Intelligent Road Network (IRN) for the Transport Department is another one. IRN links multiple layers of data with geographic information such as the latest driving and turning restrictions at road intersections, roadside parking restrictions, and more. It is useful for not only internal reference but also the private sector to develop smart mobility applications such as car navigation, fleet management systems, and personalised mobility services for the general public.

GIS for smart cities in Hong Kong:

- **Mobility:** planning railway alignments and the Transport Department's Intelligent Road Network;
- **Government:** COP coordinates natural disaster prevention; aerial photography and drones for mapping to examine land use;
- **Environment:** planning garbage truck routes, real-time video tracking of illegal waste disposal;
- **Living:** planning the orientation, location, and elevation of public housing estates; enables the Urban Renewal Authority to break through the restrictions.

- **Smart government:**

Facilitating the coordination and division of responsibilities among government departments in natural disaster relief with a centralised platform, the Common Operational Picture; mapping the change of land use over time with remote sensing technologies such as aerial photo and drone; helping facility management of water pipes to reduce the disruption of water supplies; enabling the monitoring of the real-time ponding situation of all tunnels and scheduling their maintenance are some of the examples.



- **Smart environment:**

From the routing of refuse collection vehicles to minimise contact with residents, to pollution tracking through live video streaming for surveillance, compliance monitoring, and emergency responses to pollution incidents, GIS mapping has proved to be very effective in all these aspects.

- **Smart living:**

To improve the quality of life, GIS has been used in district-based redevelopment by the award-winning Urban Renewal Information System developed by the Urban Renewal Authority. The technology is also applied in the planning of the orientation, location, and height of public housing estates with wind flow simulations and ridgeline viewshed analysis.

In 2003, I formulated the world's first SARS mapping and data analytics with the infection case information. These have become indispensable for timely and effective epidemic monitoring and response. 17 years later, I was also fortunate to work with a team of Smart City Consortium expert volunteers, together with the government's various bureaux and departments to develop an interactive map dashboard on the Covid-19 epidemic in February 2020. Completed in only three days, the bilingual interactive map dashboard facilitates the public's understanding on the changing situation of the epidemic at a glance, which is pacifying. GIS was also used to detect Covid-19 cases through the visualisation and



analysis of vast amounts of data from the beginning of the outbreak, and it enables the planning of sewage surveillance to identify infection sources since the fourth wave of the epidemic.

Looking forward, new development areas such as the Northern Metropolis are the key projects that will reshape our future. To optimise the land use and value, application of advanced technologies is a must for a smarter and also sustainable future.



4.3

A one-stop platform to boost the effectiveness and efficiency of construction

In the early years of returning to Chinese sovereignty, the Hong Kong government was criticised by the central government as "discussion without decisions and making decisions without implementation". It is a pity that there has been no improvement after a quarter century.

In recent years, the government has been planning to develop a number of new areas. Three Legislative Councillors, Elizabeth Quat, Chan Siu-hung, and Andrew Lam Siu-lo have advocated the use of technology to innovate infrastructure. They proposed "using a geographic information system (GIS) technology to collect, integrate and analyse geospatial data, and display the analysis results in an integrated manner. It will allow stakeholders from various bureaux and departments to make accurate and faster decisions based on a single source of data, reduce the duplication of research and review, and speed up the planning and construction process of new development areas."

Simply speaking, with GIS as the core, a one-stop data platform should be established to coordinate infrastructure projects and improve efficiency.

- The planning of new development areas involves a large number of databases and systems, which make it difficult for the government and the public to interact and participate;
- The Common Geospatial Information System Platform (CGISP) can integrate data from all parties to facilitate the planning, construction, monitoring, and maintenance of new development areas.

In fact, early in the 1990s, large-scale infrastructure projects in Hong Kong had been managed by GIS with detailed records of every screw being used in each part to facilitate maintenance. By 2015, the Commission on Strategic Development announced the smart city development initiatives ("2015 document"), and clearly instructed the Development Bureau/Planning Department to use Fanling North and Kwu Tung North new development areas with detailed designs as a pilot project to explore how to use the Common Geospatial Information System Platform (CGISP) and to "facilitate planning, construction, monitoring, and maintenance".

Why is there such a recommendation? The document points out that when planning new development areas in Hong Kong, the databases used are of different formats, which record in different software and systems, and it is difficult for the government and the public to interact and participate effectively in different stages of the planning process.



To better engage the public

There are six or seven of these databases and systems, namely: (1) Territory-wide survey for land use classification and the annual update of Land Utilization Map in Hong Kong; (2) Pearl River Delta region planning and infrastructure database; (3) Territorial Population and Employment Data Matrix (TPEDM) that supports planning analysis in optimising transport, population and employment distribution; (4) Computer-aided Sustainability Evaluation Tool (CASET) that enables project proponents to systematically analyse the environmental, economic, and social sustainability of a development proposal; (5) Geoinfo One Stop 2 (GOS2) for internal government communication; (6) Statutory Planning Portal 2 (SPP2) for communication with the public; (7) Public Participation GIS (PPGIS) for the public to provide comments on planning and development proposals.

Such complex and fragmented data hinders collaboration and public engagement. Therefore, the authority proposed to use CGISP for data collection, analysis and information sharing to assist various applications of urban planning and to facilitate public participation.

CGISP is strong in integrating data from all parties. For example, new development area projects generally involve three types of data in planning: lands data (base map, boundary, cadastral, quality, quantity, use, and Outline Zoning Plan); engineering data (road, slope, building, transport, water supply, and drainage); and environmental data (country park, heritage). This platform allows stakeholders to view, search, compare, analyse, and share project information so that all parties can follow the development. According to the Commission on Strategic Development's



2015 document, the experience of the CGISP pilot project can be used to explore similar applications for other new development and strategic growth areas, promoting development with an advanced information platform.

In fact, with the change of officials and the change of term in the government, together with the three-year epidemic, the deployment of CGISP has been delayed.

The government stated earlier that it has set aside HK\$100 billion to promote the development of the northern metropolis through infrastructure-led and capacity-creating planning approaches. It is time to build CGISP to speed up the progress. The platform solves the problem of public housing construction, facilitates planning of green tree corridors, helps realise a walkable city and encourages citizens to walk more, so as to achieve zero carbon emissions by 2050. Hong Kong needs to speed up smart city construction with advanced technologies such as CGISP now!



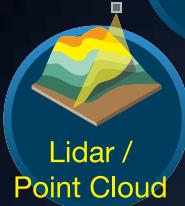
GIS integrating every type & format of data



Unstructured



Tabular



Lidar /
Point Cloud



Terrain



Imagery



Voxels



Vector



CAD/BIM



3D



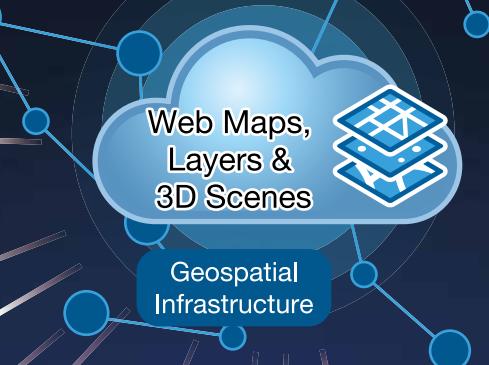
Big Data



Multidimensional
Data



Real-Time
(IoT)



Web Maps,
Layers &
3D Scenes

Geospatial
Infrastructure



Low Earth Orbit (LEO)
Satellite

Source: Esri

4.4

Combining drones and geographic information to improve efficiency

Three-dimensional (3D) maps are good at visualising areas such as hiking trails, making outing information vivid. Behind the scene is the geographic information system (GIS) which seamlessly connects various data.

In fact, with the popularity of drones in recent years and the improvement of image resolution, more and more organisations have added aerial images to 3D maps, and integrated different data riding on the strengths of GIS to perform cumbersome tasks that would otherwise be labour and time intensive. These tasks include, regular inspections of infrastructure to determine the need for maintenance, coordination of disaster relief during wildfires, monitoring garbage collection to ensure standards are met, reclamation projects, and environmental conservation.

Japan: When both infrastructure and population are ageing

Through the application Site Scan, users can upload images to the cloud to facilitate information collection, processing, and analysis. Artificial intelligence (AI) can be added to enhance the analytic capability.



- Adding drone imagery to GIS's 3D maps saves time and effort in tasks such as infrastructure inspection, wildfire relief, garbage collection monitoring, reclamation works, and conservation;
- A Japanese company uses Site Scan to inspect ageing infrastructure, reducing costs by 75%;
- A U.S. port relocation project by using drones and Site Scan only took a quarter of the usual time to complete the measurement of land, footpaths, and buildings.

The application of Japan Infra Waymark (JIW) established in 2019 is a typical example.

Figures from the Japanese government reflected that much infrastructure across the country is ageing, with 20% of tunnels, 30% of water sluices and river dikes, 17% of port seawalls, and more than 140,000 highway viaducts all over 50 years old on average. The obsolete infrastructures and extreme weather can cause serious damage. Therefore, regular inspections are very important. However, these tasks are labour intensive and are particularly demanding in Japan with an ageing population.

JIW, founded by NTT West and headquartered in Osaka, combines AI technologies such as drones, machine learning (ML) and computer vision to

collect hillslope and infrastructure data, such as flyovers, transmission towers, wind turbine generators, solar panels, and assists in identifying damaged and obsolete infrastructure, such as bridge cracks or component damage. Apart from being used for routine maintenance, they also help deal with landslides and natural disasters. Site Scan can plan the drone's flight route, the inspector can also remotely conduct inspections in different locations while in the office. The data collected by the drone is stored in the cloud and can be shared with relevant department personnel in real time. The efficiency improvement also means cost saving. In just one year, the technology helped JIW decrease the cost-per-bridge inspection by 75%.

U.S.: Balance between development and conservation

Using drones with cloud software can also assist in reclamation projects and conserve nature.

Duluth, located in the port of Minnesota, the U.S., is one of the world's largest baymouth bars, home to several protected animals. The local airport was built in 1939, and the runway cannot meet current standards and requirements, it needs to be relocated and rebuilt.

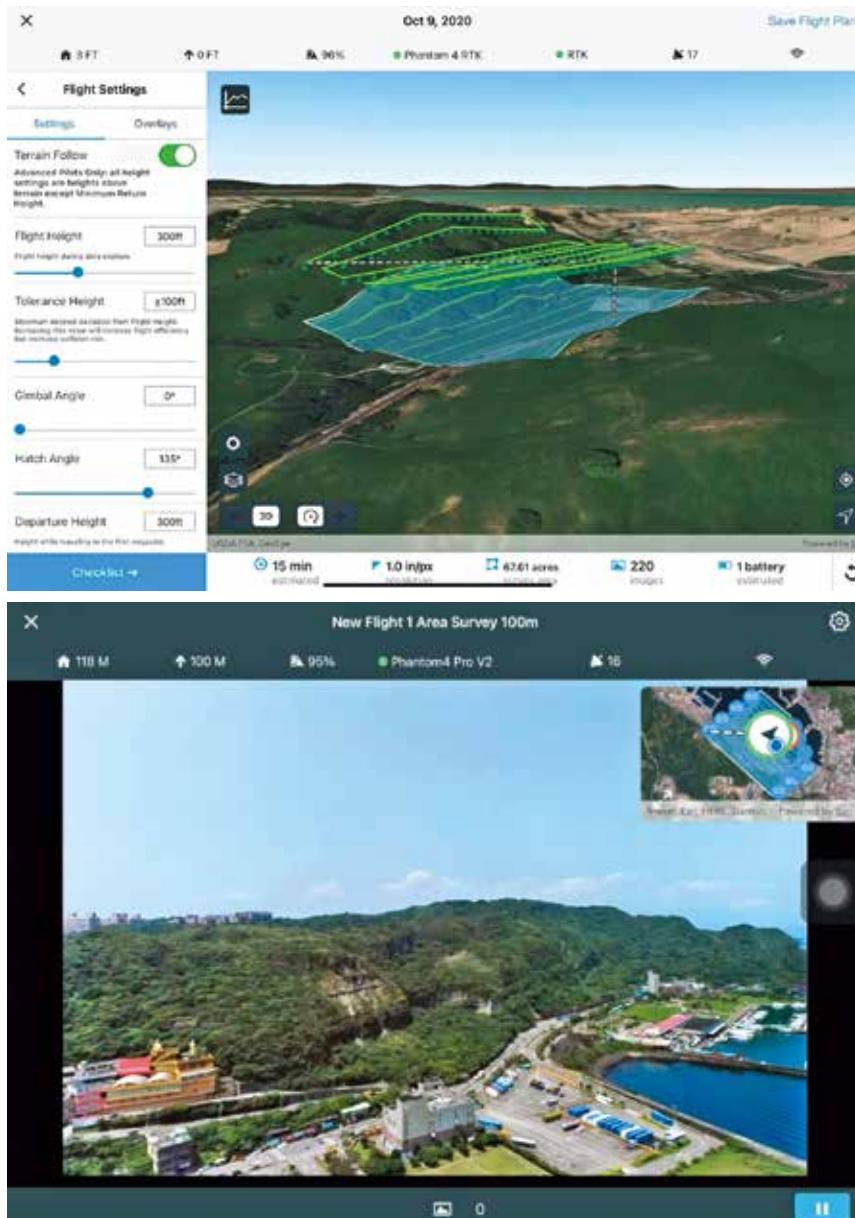
This requires the use of 200,000 tons of materials to reclaim 7 acres of land in the open sea. After analysing different methods of transporting materials, the engineering company decided to use barges to reduce the impact on the urban area. At the same time, to protect the living environment of wild animals, it is important to conduct regular inspection on the water's floating silt curtain, which acts as a filter to prevent contaminants from entering the clean water of the bay.



In this regard, drones paired with Site Scan are very useful. The team can quickly measure the size of the land, buildings, footpaths, etc., with only a quarter of the time used in the past. This cloud-based application also facilitates the integration and connection of various images and data from different sources, making analysis, communication and sharing more convenient. This is a good example of how advanced technology improves people's living and work efficiency.



Site Scan enables remote inspections of infrastructure, and the data stored in the cloud can be shared with relevant personnel in real time



Source: Esri



4.5

Good use of caverns will increase our land reserves

Online shopping and working from home have become the new normal after the three-year pandemic, driving the demand for network connectivity and creating a strong demand for data centres. At the same time, to consolidate Hong Kong's position as a hub for international data centres, there is an urgent need to find more land to develop data centres, and caverns are one of the options.

According to the authorities, the advantages of a cavern as a data centre are safety, power saving, easy heat dissipation, and less radiation effect, all of which can reduce operating costs. So far, eleven caverns have been identified for development.

Worldwide examples

Caverns can provide additional land supply and can be one of the solutions to land shortages in densely populated cities. Around the world, famous examples include Finland's swimming pool which can accommodate 1,000 visitors at any one time, and a 240,000-square-metre cavern in Missouri, U.S. housing facilities like warehouses, logistics centres, manufacturing, and cold plants. Singapore has also promoted the development of underground space in recent years, with 60 hectares of land available from the Jurong Rock

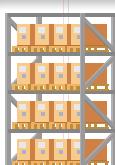
- The development of caverns and underground space can increase land supply;
- The cost of obtaining land by underground construction is several times higher than that by ground surface construction, due to the unclear underground condition and high complexity;
- Using GIS and AI to build more accurate predictive underground models can greatly reduce risk.

Cavern for liquid hydrocarbon storage depot and 110 hectares released from the deep sewage tunnel project.

Actually, within the past few decades, the Hong Kong government has conducted a number of underground space studies, most of which are related to caverns. As early as 1980s, the feasibility of building oil depots in underground space was examined. In 1991, rock cavern development was covered by the then Hong Kong Planning Standards and Guidelines. By 2016, the Civil Engineering and Development Department's Cavern Master Plan had identified 48 strategic cavern areas covering 4,500 hectares, equivalent to over half of Hong Kong Island. Among them, 11 locations are in Hong Kong Island and are distributed in Mount Davis, Braemar Hill, Pokfulam and Ap Lei Chau. 31 sites are distributed widely in the New Territories, including Tsing Yi, Siu Ho in Lantau Island, Lam Tei in Tuen Mun and A Kung Kok in Sha Tin, each ranging in size from 20 to 200 hectares.



Worldwide examples of rock cavern development



U.S.
Missouri's Springfield Underground
• facilities including warehousing, logistics, manufacturing, and cold storage



Switzerland
Brünig Park
• a 2-storey indoor shooting centre, tunnels for firefighting training and a restaurant



Finland
Itäkeskus Swimming Hall
• comprising a 50m swimming pool, a learner's pool, etc.



Japan
Underground shopping street systems
• offering excellent commercial opportunities and convenient accessibility
• connected to metro and railway lines



China
Guangzhou's "Mall of the World"
• containing 400 retail outlets and over 3,000 parking spaces
• connected to 1 metro station and 4 Automated People Mover stations



Mexico
Alux Restaurant
• a themed restaurant



Singapore
Common Services Tunnel in Marina Bay
• housing various utilities including power cables, telecom cables, water pipes, and district cooling pipes

Source: *Long-term Strategy for Cavern Development*, CEDD

Everyone expects to increase the land reserves through the cavern development. However, by 2020, only four of these development plans were completed. Why?

The major reason is that the construction cost is generally several times higher than that carried out on ground in open air. A 2020 study by the Legislative Council Secretariat mentioned that due to its complexity, a typical cavern project could cost up to \$77,000 per square metre (5.2 times the \$14,600 per square metre for the Tamar government Headquarters project). One of the major reasons is a lack of data that increases the uncertainties in underground conditions.

How to lower the cost

According to the Legislative Council's study, unclear underground conditions, whether it is related to the bedrock and soil conditions or the existence and distribution of underground utilities in the shallow subsurface, are the main obstacles to the development of underground space. If the government can widely develop and apply three-dimensional (3D) maps and models of the underground environment, and adopt geographic information systems (GIS) combined with GeoAI technology, it will help to gain deeper insights for building more accurate predictive models which will significantly reduce the risks in planning and development.

In addition, the authorities should further formulate a clear and transparent planning and development framework, clarify the ownership of underground land, and draw up subterranean maps for selected areas, which is believed to be essential for promoting the use of underground space in Hong Kong.



4.6

Advanced technology perfects smart city design

In his speech *Smart Technology and Smart City* in the 2022 Science and Technology Lecture Hall, the Chinese Academy of Sciences academician Prof. Anthony G.O. Yeh introduced smart city and future urban transportation services to participants. During the event, a student asked about the technical design of smart cities, in which Prof. Yeh mentioned that all designs had deviations, such as the global positioning system (GPS).

The accuracy of GPS is estimated to be 5 metres. Meanwhile, the low Earth orbit (LEO) satellite can provide a much more detailed image with higher accuracy. As a result, users can have more accurate data with LEO satellites.

The issues of GPS are that it is easy to jam and very expensive for both operation and maintenance, according to the GPS Lab of Stanford University, the United States. They have noticed the emergence of LEO satellites in recent years. Thousands of satellites are cheaper than GPS, as they are closer to Earth, the quality of images is better, and communication is smoother.

Both of them are satellites. GPS satellites operate over 20,000 km above Earth and circle the earth only twice a day; while LEO satellites can operate as low as 160 km above the surface (the flight altitude of civil aviation aircraft is generally 14 km), and there is no need for them to follow a

Low Earth Orbit (LEO) satellites are integrated with GIS to facilitate the planning and management of services, such as:

- monitoring parking in open car parks;
- Assessing property quality;
- Inspection of inventory, equipment, and construction sites;
- Evaluating the flow of people and vehicles.

particular path around Earth, so there are more available routes for satellites in LEO. At the same time, they can take about 90 minutes to circle Earth, that means they can travel around Earth about 16 times a day.

Recently, the growth rate of LEO satellites has been astonishing. According to the Satellite Database of the Union of Concerned Scientists, by the end of April 2022, there were more than 5,000 satellites in orbit around Earth, six times the number in 2007. Among them, LEO satellites accounted for 86%. The number of satellites will continue to soar in the future, consulting firm McKinsey forecast that there will be a ten-fold increase to 50,000 within a decade.



Use case

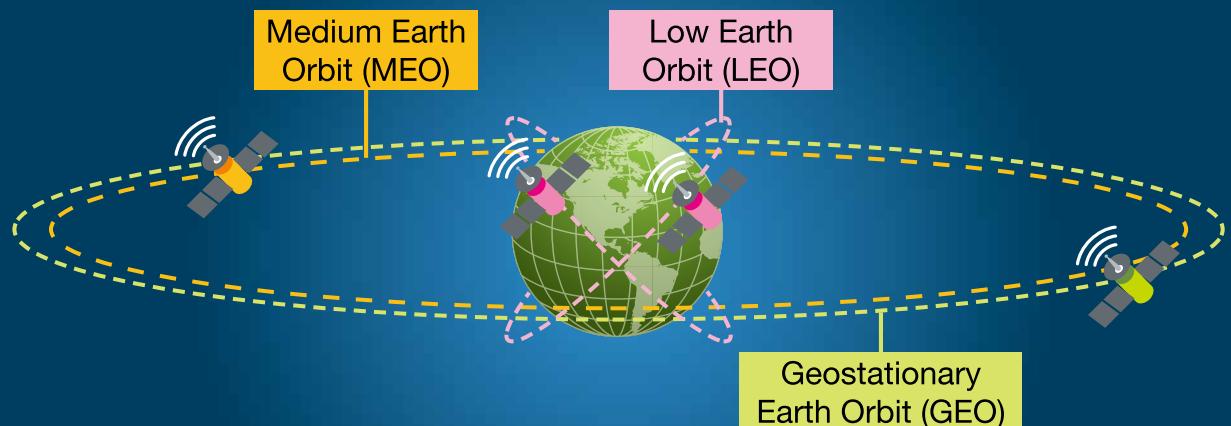
These satellites are used for a variety of purposes, such as sustainable development and dealing with climate change. Investment bank Morgan Stanley quoted some examples: food supply (combining imagery with weather, temperature or air pressure could optimise agricultural yields); greenhouse gas monitoring (using satellites and spectroscopy to monitor carbon emissions from various sources, including oil wells, landfills, and industrial operations); utilities (using predictive models of sunlight and cloud cover to adjust solar panel installations), and more.

What's more, many public and private organisations use a geographic information system (GIS), a platform compatible with different types of data, together with LEO satellite imagery and video for business planning and management. For example, telecom companies classify and count buildings to determine the investment of resources, retailers detect the number of vehicles in industrial and commercial areas to assess market potential, city planners examine the distribution of sports facilities to make good use of open spaces, management companies count the parking occupancy of open-air car parks, real estate companies assess property quality, construction companies carry out stocktaking of equipment and site inspections, governments use them for assessing traffic flow at different times, the mapping of road features, and the detection of illegal waste disposal.

From the 5-metre satellite image resolution of GPS to the fine-grained centimetre-scale imagery of LEO satellites, advanced technology can reduce deviation and perfect the designs, it is an important element in promoting the development of a smart city.



One of LEO's diverse applications is to address climate change challenge



MEO satellite	VS	LEO satellite
~5 m	Accuracy	5 cm
8,000-20,000 km	Altitude	160 km
4-12 hours	Orbital period	1-2 hours
31	Quantity	>5000
GPS, navigation, positioning	Main applications	Telecom (5G/6G), remote surveying (environmental monitoring, meteorological monitoring, ocean current analysis)

Source: Regulation of NGSO Satellite Constellations, Digital Regulation Platform (joint effort of ITU and World Bank)



4.7

KPI Dashboard could facilitate new style of governance

Although we have returned to normalcy, we should not forget the lessons learned during the Covid-19 pandemic so that we can improve our governance and make our city smarter.

Immediately before the Lunar New Year holiday in 2023, when all the 14,000 daily high-speed rail tickets to the Mainland had sold out, and passengers were required to present a negative PCR test result obtained within 48 hours, the distribution of the Hong Kong government's testing resources did not change. As a result, long lines at the Maple Street Playground were seen each day. One wonders why the authorities did not consider the high proportion of immigrants in Sham Shui Po when allocating resources. Apparently, residents preferred the testing centres in their own neighbourhood. This episode suggested that the authorities did not make the most of the huge amount of data they had gathered — an indication that Hong Kong is a long way from becoming a smart city.

Even if the information was consolidated, the lack of maintenance and updates were equally troubling. At the start of the pandemic in 2020, the authorities and the nonprofit organisation Smart City Consortium jointly launched an interactive dashboard map to gather and publish information, which was updated daily and won applause. But after three years, the

- The *Smart City Blueprint for Hong Kong* was launched in 2017 but the public did not feel the benefits due to the government's failure to make full use of data to demonstrate new practice and it lacks regular progress updates;
- The KPI dashboard, which visualises policy effectiveness for the public at-a-glance and gives easy monitoring can address the problem.

dashboard map was used only for showing static information such as the distribution of testing centres and vaccination sites. The authorities should have made the most of the one-stop information platform by showing the appointment status and real-time footfall in the testing centres and vaccination sites on the interactive map. For example, when a light was green in Kowloon West, it meant the line was not long, while an area with a red light was best avoided, making it easier to plan trips. But the authorities failed to use this technology and wasted a lot of resources.

KPI dashboard helps improve perception

Recently, I re-read an article from 2016 that left me frustrated. Hong Kong's first smart-city blueprint had not been published then, and the article quoted the then-government chief information officer as saying that once the blueprint was released, the relevant policies would be implemented and would last



until 2030. In reality, the first and second copies of the *Smart City Blueprint for Hong Kong* were launched in 2017 and 2020 respectively. While the *Smart City Blueprint 3.0* was nowhere to be seen, the government had another *Hong Kong Innovation and Technology Development Blueprint* at the end of 2022. All these blueprints have the same goal: to bring convenience to people's daily lives through information and technology.

But do people feel that Hong Kong has become smarter? Have the smart measures proposed seven years ago been implemented? I am afraid not many people have a clear idea. Why? In addition to the lack of making better use of data within the government, the authorities do not regularly and openly share their progress; it gives people the impression that public policies lack continuity.

How can it be resolved? In 2022, the *Policy Address* set out a number of key performance indicators (KPIs), I would like to suggest that Chief Executive John Lee Ka-chiu set up a "KPI Dashboard" with a dedicated team responsible for updating and monitoring the data. The KPI Dashboard should be in graphic form for sharing with the public and show which departments need to work harder to meet the required standards, so that everyone can see the performance at a glance.

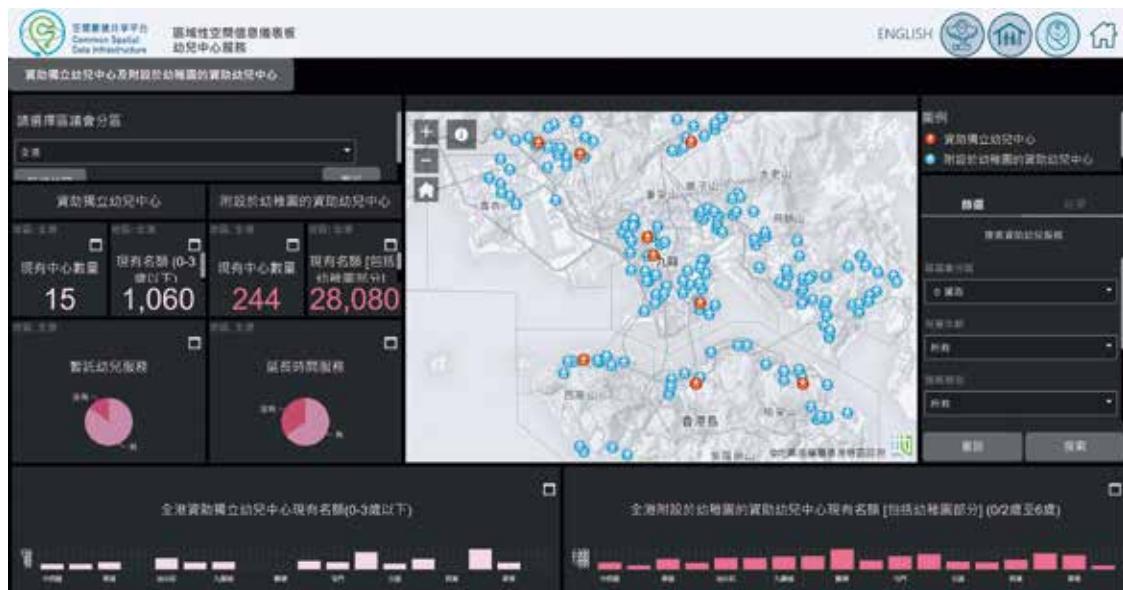
This is similar to the website launched in January 2023 about the Government Programme on Tackling Hygiene Black Spots. In addition to listing more than 700 hygiene black spots in Hong Kong, the website also lists the urgent problems of rodent and mosquito infestation, back-alley hygiene, wild bird gatherings, air conditioners dripping water, discarded construction waste, or shops blocking streets, as well as showcasing the progress of the cleansing



efforts of authorities, and allowing the public to compare the past and current status of black spots in different districts on an interactive map. Deputy Chief Secretary for Administration Cheuk Wing-hing said that with the full support of colleagues from other bureaus and departments, and the engagement of the public, Hong Kong can become a liveable and proud home.

This should also be the goal of the KPI Dashboard, which is to promote the concerted efforts of all people to build a smart city. This integrated interactive map is easy to understand, and the images can attract the attention of the people, which is a good way to gather public opinion. Meanwhile, the government should use it widely and publicise it, so that it is well-known and conducive to good governance.

The District-based Spatial Information Dashboard, under CSDI, promotes understanding of the benefits of spatial data among public and private organisations and the general public



Source: Geospatial Portals, Lands Department, Development Bureau

4.8

Three elements in making the best use of an interactive map dashboard

At the beginning of the Covid-19 epidemic outbreak in 2020, John Hopkins University in the United States launched the world's first interactive map dashboard on epidemic information, which was well-received. The Hong Kong government immediately launched a local version, which greatly reassured the public.

Due to their significant effectiveness, as many as 139 interactive map dashboards have been developed for the pandemic globally. There are three elements to ensure the best use of this tool:

1) Set clear goals

Is it used to facilitate coordination among departments? Or to improve operational efficiency?

In dealing with emergencies such as typhoons and flooding, real-time and consolidated information is particularly important. An existing successful example within the government is a Common Operational Picture (COP). The map-centric, cloud-based dashboard is for internal use. The Civil Engineering



- **Set clear goal:** Used to improve the efficiency of action? Promote internal coordination?
- **Computer vs mobile phone:** The mobile phone screen is small, many people look at it while walking, so the mobile version should be concise;
- **Official vs Commercial:** maps from the Lands Department are accurate, professional, and informative, and there are no advertisements.

and Development Department uses the COP to collect data from various departments, including the Buildings Department, Highways Department, Drainage Services Department, Housing Department, and Lands Department, and displays the data on a map for real-time monitoring and emergency support, so as to facilitate disaster relief swiftly.

2) Computers vs mobile phones

In the fourth quarter of 2022, mobile devices (excluding tablets) generated over 59% of global website traffic, consistently hovering around 50% since the beginning of 2017 before consistently surpassing it after 2020.

Therefore, when designing an interactive map dashboard, it is essential to include a mobile version. The desktop version is different from that of

a mobile, of which the screen size is small, and many people use mobile devices while walking, making it difficult to interact with the dashboard without a mouse. Therefore, the information of the mobile version should be simple and direct. Instead of stacking a lot of charts in one page, it is better to create a separate dashboard. In other words, for the mobile version, less is more.

3) Official map vs commercial information

Many government departments use maps on their websites. They are supposed to use the more accurate, professional, and rich geographic information from the Lands Department. However, many of them actually use readily available commercial maps, which are neither accurate nor real-time, plus they are inserted with advertisements which interrupt and confuse the main message. Therefore, the government must be careful not to repeat the same mistake.

The government team should make the best use of geographic information to enable more effective internal and external coordination and communication so that it not only enables an emergency mobilisation mechanism for civil servants to prepare for upcoming crises, but also helps restore the confidence of the general public by visualising the performance of key projects.



“Smart Construction in Hong Kong”, an interactive map dashboard by the Construction Industry Council



Source: Construction Industry Council

4.9

Three obstacles Hong Kong's smart city faces

As we are expecting the *Hong Kong Smart City Blueprint 3.0*, it is time to review the effectiveness of its first version issued seven years ago.

What makes a smart city smart is its use of massive amounts of data to drive urban development. Today, the government has opened 5,400 datasets. But due to the lack of clear directions, Hong Kong's smart city development has been slow with isolated and scattered projects but no synergetic effect.

To drill down, there are three obstacles Hong Kong is facing:

1st obstacle: The lack of a chief data officer (CDO) to lead, and no training for civil servants on how to use data to increase efficiency.

In 2016, the Smart City Consortium submitted an advisory paper to the government, stating that a high-level body for open data gatekeeping is required to ensure "digital by default". That means open data with an application programming interface (API) as a basic standard. This new establishment should also coordinate major tasks, such as data standardisation and guidelines for data definition, collection, processing,



- **1st obstacle:** The lack of a chief data officer to lead data strategy, and no training for civil servants on how to use data to increase efficiency;
- **2nd obstacle:** There is no legislation on opening data;
- **3rd obstacle:** The effort to engage the public is minimal.

and the review of regulations for the development of technologies, their usage, and particularly the protection of personal information.

Because of the heavy workload, creating a new post of Chief Data Officer (CDO) is essential. However, after eight years, there is no response to the suggestion while the Chief Executive's Steering Committee on Innovation and Technology is only responsible for reviewing project progress rather than giving direction. Government departments responded with window-dressing as seen in the *Annual Spatial Data Plan* and the *Annual Open Data Plan* released by various departments in 2021.

The two Plans are the same about open data, the former focuses on "spatial data", which should be a subset, the latter is supposed to be a superset covering all the open data, but this is not the case.

For example, the *Annual Open Data Plan* (superset) published by the Civil Engineering and Development Department only covers 13 of the 15

datasets in the Annual Spatial Data Plan (subset), why not all? Moreover, the two documents are not uniform, for example, one merely lists the past "release date" and the other only has a future "target release date", which is confusing. The Education Bureau is even more puzzling because most datasets in its seven-page *Annual Spatial Data Plan* (subset) are not found in its 16-page *Annual Open Data Plan* (superset). Even the ones which appear in both documents, such as the "Secondary School Places Allocation System School Net Boundaries", have target release dates of 04/2022 and 12/2022 respectively. These illustrate the loose management towards open data.

To make the most out of massive amounts of data for higher efficiency and better-informed decisions, the government should establish a Single Source of Truths (SSOTs) which provides clean, verified, and authoritative data commonly used for decision making and service delivery. This can ensure the comprehensive digitisation of government records with machine readability.

2nd obstacle: There is no legislation on opening data which requires public data to be made available.

In 2012, New York City's Open Data Act was signed to mandate all public data to be shared with the public by the end of 2018. But since Hong Kong lacks a legal basis of open data to-date, it makes the task difficult.

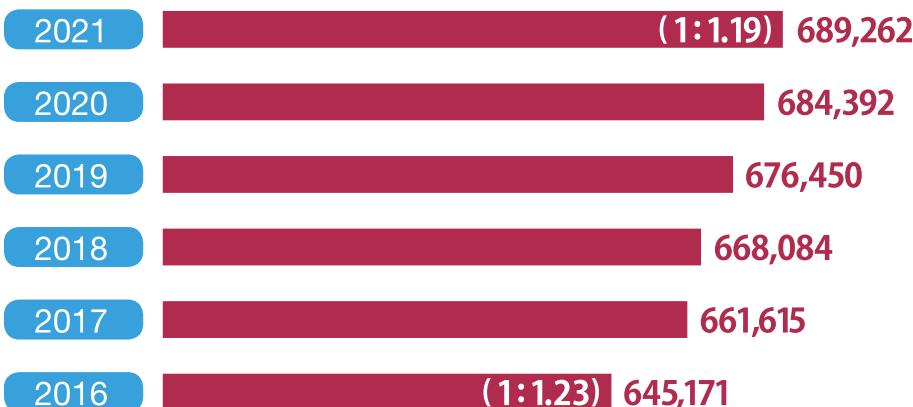
For example, in smart mobility, the number of private cars and light goods vehicles has increased by more than 36% in the past 10 years, while the corresponding parking spaces have increased by just 8%. Parking is



increasingly difficult with vehicles often queuing outside parking lots or continuously circulating in busy districts which aggravates traffic congestion and pollution. Real-time data on vacant parking spaces can help solve the problem.

By March 2021, the real-time information on vacant parking spaces on the HKeMobility application covered 96,000 parking spaces, accounting for just 42% of the total. In the absence of corresponding legislation, the authorities can only depend on encouraging private car parks to provide information.

Parking space for private cars as at February of the year



Note: Parking space for private cars include public parking spaces operated by the government and the private sector, and private spaces exclusively for private use. Figure in bracket is the ratio of the number of licensed private cars to the number of parking space.

Source: *Private cars in Hong Kong*, Research Office Information Services Division, Legislative Council Secretariat, 2022

3rd obstacle: The effort to engage the public is minimal without legislation on data sharing and ethics.

To improve the data literacy of the public, education is crucial. I began to promote geographic information systems (GIS), a professional data analytics tool, to local students in 2015. Primary and secondary school students are offered free use of GIS to identify solutions for social issues while the Esri Young Scholars Award aims at tertiary students. Meanwhile, the Development Bureau has launched the Geospatial Lab to reach out to the public.

But this is not enough. I proposed the Education Bureau incorporate GIS into STEAM (science, technology, engineering, arts, mathematics) education, so as to enrich young people's problem-solving skills, and to expand the talent pool, but it has not received any response.

In addition, to boost the digital economy, the government should facilitate a data ecosystem by establishing a trustworthy platform for the industry to share data such as the mobility of mobile phone users, and consumer behaviour collected by online shopping platforms. The public should also be engaged on privacy issues, and legislation is the endgame.

In summary, we need to establish a CDO as the data custodian to lead open data initiatives, to engage the public and improve data literacy, and to develop legislation for data management on personal privacy issues. If the Chief Executive is serious about smart city development, he needs to push harder and lead the way forward.

Conclusion

The Hong Kong government is actively promoting a number of developments, including land reclamation, industrial planning, and disaster prevention and control. In order to effectively implement these projects and minimise public concerns, the authorities should take the lead in formulating a more comprehensive data policy and strategy by appointing a full-time senior official to coordinate the areas.





Smart Living

The pandemic has changed the way many people live, from shopping, working, and medical treatment, to coping with disasters and epidemics, they have become more dependent on the internet. While the public enjoys the convenience, there is a fear of the invasion of privacy, the use of technology under control to improve our lives is a test of how we can live wisely.

Chapter
5



5.1

3D maps enhance disaster prevention and rescue

Abnormal and even extreme weather has become more frequent. The Observatory forecast that tropical cyclone incidence and total rainfall in 2023 would be "normal to high". The once-in-a-century black rainstorm in that year is the best example. To be well-prepared, the Civil Engineering and Development Department recently issued a consultancy report which studies the impact of storm surges and waves on coastal low-lying or windy locations under extreme weather and climate change. There are three recommendations, including:

1. Implement the design and construction of improvement works;
2. Devise action plans for the implementation of management measures;
3. Liaise/coordinate with the relevant government departments, private sectors/ stakeholders for implementation arrangements.

Among the three measures, the last one on coordinating internal and external parties of the government is the most important and urgent item for improvement at present. Taiwan is also facing the same problem each year; we can definitely learn from their experiences.

- To enhance Hong Kong's disaster preparedness capacity, it is most important to improve co-ordination among government departments, the private sector, and stakeholders;
- Taiwan uses 3D GIS to assist in disaster relief and flood control, including resource allocation, evacuation support, material distribution, and delivery route deployment.

Concerted efforts for disaster relief

Earlier, three researchers responsible for disaster management from the National Science and Technology Center for Disaster Reduction (NCDR) jointly shared their experience of disaster relief and flood control in an article. Using a 3D geographic information system (GIS), the NCDR has put together a war game simulation for different scenarios of disasters or floods. The objective of the simulation is to help officials comprehend various disaster situations and determine whether their emergency response plans and procedures can reduce the impact of a flood-based disaster, including resource deployment, evacuation support, and route planning for the distribution of relief supplies. Now, officers at emergency operations centres (EOCs) across Taiwan's 22 cities, counties, and special municipalities can use the platform to analyse both disaster risk and preparedness for flooding.



In addition to examining different terrains to estimate the depth of floods, the GIS platform also examines the population composition (communities with many elderly or young children), assets to be protected (infrastructure, main roads, schools), and assesses the location of nearby emergency shelters, the number of residents that the shelters can accommodate, as well as the distribution of emergency supplies. The information is presented on a 2D map, allowing central and local EOC commanders to view them on-screen and arrange corresponding actions.



3D GIS facilitates disaster relief and flood control with maps displaying terrain, CCTV, satellite images, and the street



Source: Esri



The 3D GIS platform goes a step further to present a digital terrain model (DTM) displaying terrain and non-terrestrial information (such as overhead railways and bridges) in an equally spaced 20 x 20-metre grid, with overlays of satellite images, street maps, and 3D building models. It also integrates real-time video feeds from Taiwan's closed-circuit television (CCTV) monitors. During flood simulation exercises, this helps on-site rescue units communicate and coordinate with each other so they can develop emergency solutions that take into account the potential damage to buildings and traffic.

The platform also enables helping the disadvantaged more efficiently. For example, all elderly homes can be displayed on the screen, while care homes which are located on the ground floor will be specially marked for priority treatment. The detailed information not only helps social welfare organisations assess their own disaster risks, but also facilitates their follow-up with the government's prevention and evacuation plans, as well as staff training.

The use of innovative technology has greatly improved coordination among the government, the public, and private enterprises, so that everyone can act with coordination when responding to crises.



5.2

Balancing personal privacy with convenience

In July 2022, the government sent SMS messages to 240,000 people who had submitted valid claim requests for early withdrawal of their Mandatory Provident Fund (MPF) or benefits under occupational retirement schemes on the grounds of "permanent departure from Hong Kong", stating that they did not meet the eligibility criteria for the second phase of consumption voucher, which aroused criticism.

Some people claimed though they are currently working in both the Mainland and Hong Kong, they have to apply for a Statement of Travel Records from the Immigration Department. Some said that they had filed tax returns after returning to Hong Kong and questioned why the authority had not checked the relevant records. According to the authority, a wide range of proof of living in Hong Kong, such as a payroll slip, rental receipt, credit card record, hospital follow-up records, and more, can be used to qualify for the voucher.

The public's discontent is that the government owns a lot of personal data, but they are not used for checking eligibility, instead people are required to provide the proof themselves.

Personal privacy and convenience of living have always been one of the

- **Consumers' contradictions: they want personalised content but are worried about the theft of their identity data;**
- **The government's commitment to not disclose information collected to anyone or any sector is appreciated.**

biggest issues in the digital age, data is an important driving force for the development of smart cities. How should we choose between the two?

In fact, we have to balance personal privacy with convenience every day, even every minute. For example, when you take photos with your mobile phone, have you ever thought about whether the photos will show people's house numbers or car plates? You have chosen convenience in the end. When you want to send photos to your friends, have you thought about whether the communication software has encryption? Will it share your photos with other organisations or use them for other purposes? You have chosen convenience again. What about the photos stored on the phone, are the files encrypted? Convenience may win again in such cases.

A survey found that nearly 70% of 1,000 respondents said that they expected companies to automatically adjust content based on the customers' online behaviour, making it more personalised. More than 40% of respondents also reflected that a lack of personalisation was more likely to drive them away from a purchase than poor design or a lack of optimisation.



Another global survey, which interviewed more than 5,000 consumers, also found that consumers generally do not mind merchants sharing their personal data, with 76% reflecting a better customer experience. However, paradoxically, the same survey found that 67% of respondents were also concerned about identity theft, and 57% had even been exposed to identity theft.

Since you cannot have it both ways, then how to balance personal privacy with convenience? Among various types of personal data, I think those about finance (Inland Revenue Department) and health (Hospital Authority) need to be protected the most, compared with other data such as travel records, MPF, and mobile phone activities. For example, data from smart mobility should be limited to aggregated information where individuals cannot be personally identified. Most importantly, the authority must maintain the transparency of data usage and give citizens the right to choose whether or not to share the data, preferably with the right of "opting out".

Speaking on the consumption voucher incident, it reflects the government's commitment to data collection. For example, the Inland Revenue Department has a confidentiality clause and cannot disclose individual tax information, including whether a tax payment has been made, to anyone, including government departments. The authority has not sacrificed personal privacy to different departments just for convenience. As a citizen, I really appreciate such practice.

5.3

Invaluable personal data

Personal privacy protection must have been one of the most newsworthy topics in the information technology industry in recent years.

Google has just reached a settlement with 40 states in the United States in November 2022 with regard to its location tracking function. The company agreed to a US\$392 million (about HK\$3 billion) settlement, accounting for 0.5% of its revenue of US\$69 billion in the third quarter. A media outlet described it as "a slap on the wrist for Alphabet". According to the lawsuit filed in 2020, Google has illegally tracked users for many years though the company had assured users of Android devices that they could opt out of tracking at any time. Even with location history disabled, Google could still track and store users' locations by other means, including their web and app use. The prosecutor said that location data, the most sensitive form of personal information, is the core of Google's digital advertising business and the most valuable part. Although the amount of location data is limited, it can reveal a person's identity and whereabouts, and infer other personal information. The user profile constructed using these data could facilitate an advertiser finding their target customers.



- An increasing number of countries have stringent laws and regulations in place to protect the privacy of individuals;
- Replacing real data with synthetic data has become an emerging industry, from banking and medicine to autonomous driving;
- There are many variables and room for improvement in the industry, and it is up to different industries and startups to explore its potential together.

Responsibility for protecting personal privacy

In another major event, Apple released the operating system iOS 14.5 in April 2021, and began to implement the App Tracking Transparency policy that was said to be "advertisers' worst fear". Following that, merchants must obtain permission from iPhone, iPad, and Apple TV users to use technology such as the Identifier for Advertisers (IDFA) to track user activities in order to accurately place advertisements. Meta, which owns Facebook and Instagram, told investors that the iOS change of policy would cost the company about US\$10 billion in 2022.

Apple's move also impacted Google. Google had expressed that it would "develop new privacy measures that remove the ability to track users across apps on Android devices" to protect personal data.



Then, how do consumers perceive personal privacy? According to the analytics platform Flurry's study of more than one million mobile apps, it found that in April 2022, about a quarter of global users did not mind being tracked, compared to only 18% of U.S. users. According to another survey released by data analysis company Exploding Topics in September, among the more than 1,600 U.S. users interviewed, more than half of them trusted Apple the most with their data, the most among all technology giants. As for the densely packed privacy policy, half of the respondents indicated that they would only agree to it after reading the whole policy. Among the big technology companies Microsoft has the longest privacy policies, containing an average of 11,806 words per policy, taking 59 minutes on average to read. If you read every Microsoft privacy policy since 2000, it would take you more than 22.5 hours to finish reading.

Therefore, after a White House listening session on the accountability of technology platforms in September 2022, the authorities announced the core principle of reform was to limit the amount of information collected by these platforms, rather than shifting the responsibility to people and requiring them to read fine print to protect their own privacy.

However, massive amounts of data are required for training algorithms essential for artificial intelligence. As personal data will become increasingly difficult to obtain in the future, the industry has begun to develop options.

Consumers regain data ownership

According to a survey conducted earlier by the data analysis company



Exploding Topics, from over 1,600 American users interviewed, 47.9% of them did not mind their personal data being sold to other companies. At the same time, following the European Union, more countries have implemented stricter measures to protect personal privacy.

This has led to two trends: first, through advanced technology like blockchains, consumers and sellers can regain ownership of personal data. Second, the cost of collecting personal data has increased due to more stringent privacy protection measures. As a result, companies are seeking alternative solutions, one of which is synthetic data.

Let's start with how consumers regain ownership of their personal data.

For a long time, technology platforms have held the personal data of consumers and turned it into a cash cow to make huge profit. This is an open secret, there are also insidious data brokers who collect your data without your knowledge or authorisation, including photos, job position/industry, participation in public events (such as speeches, papers, videos, social media accounts), email address, and phone number. A U.S. company claimed to have data on 2.5 billion people worldwide, the global size of this market was US\$232.6 billion in 2019 and is estimated to reach US\$345.1 billion by 2026.

Personal data is valuable. Market research firm IDC predicted that by 2024, "35% of organisations will employ a privacy engineer" to design privacy protection principles for IT systems, process, and product development strategy.



Today, a number of startups are trying to use blockchain to regain data ownership for consumers and create new business opportunities.

Earlier, three Canadian scholars conducted an experiment by using blockchain with a hotel reservation system to share personal data in understanding whether it is possible to establish a system that can ensure privacy, user control, and incentives for sharing. Using blockchain, it is possible to track who had shared what, with whom, when, by what means and for what purposes in a verifiable fashion. At the same time, data is shared with other travel service providers according to the privacy preferences in the smart contract. This method of sharing data is efficient and inexpensive, each transaction takes less than 0.125 seconds; and it takes little memory capacity, and only needs 100 MB for 1 million transactions; the cost of each transaction is only US\$0.18 (0.001247 ether). Although this research involves a few enterprise nodes and is relatively simple, it shows the feasibility of the idea.

These new data sharing models are likely to change future business models. In fact, many startups related to new data sharing have emerged in recent years. Countries from Mauritius (the place is known as "Ethereum Island"), South Korea, Germany, and Britain to the U.S. want a slice of the action. Different media outlets have different ideas about which startups are the most promising each year; there is also a unicorn (unlisted companies with a valuation of at least US\$1 billion) on the list.

Synthetic Data: Pros and cons

Artificial intelligence (AI) depends on massive amounts of data being



available. As many countries have tightened privacy protection measures, synthetic data that does not violate personal privacy regulations has emerged. It is estimated that its cost is only 1% of real data, which is attractive to enterprises.

Real data may not reflect the truth due to different apportioning arising from races and nationality specifics, while synthetic data can reduce bias. Besides, synthetic versions provide more diverse data including rare cases, making up for the difficulty of obtaining such information from real situations.

This kind of data can be in the form of text, media (video, image, sound), and tabular. Based on the content of real data, it can be roughly divided into three categories: fully synthetic, partially, and hybrid.

Today, it is used in a variety of industries, ranging from banking, and medicine to self-driving cars.

American Express is reported to have begun testing with deepfake videos and fake data for at least two years already. For example, looking at credit card transactions, in order to improve the ability of AI algorithms to detect fraudulent behaviours. JPMorgan Chase also used synthetic data for anti-money laundering, as well as to develop innovative products and services when historical data may not meet the needs.

In the medical field, Roche, the Swiss pharmaceutical company, in partnership with a startup, uses synthetic data instead of patients' in clinical research to improve its analytical ability. While in Germany, the Charité Lab for Artificial Intelligence in Medicine (CLAIM) which has been involved

in stroke research, pointed out that each patient's brain structure is unique, and anonymised images are of little significance. Therefore, they generated synthetic data while preserving its statistical and predictive properties.

For the past few years, the self-driving company Waymo, owned by Alphabet, has been using synthetic data to generate lifelike driving datasets, including complex and diverse scenarios, such as involving cyclists, or adjusting the speed of approaching vehicles to test Waymo's reaction.

Synthetic data is better suited for straightforward problems, like fraud detection or credit scoring, according to industry insiders. However, it cannot cope with complex and changeable situations. The Economist gave an example. In the past, purchase of a one-way air ticket would be regarded as an obvious predictor of fraud by the automatic detection model, but under the Covid-19 epidemic, many customers were forced to do so. Another example is facial recognition, which is difficult to function when wearing a mask becomes the norm during the pandemic.

Further, synthetic data may not be adequate to serve its purpose when accurate and real data is needed for detailed planning. In the U.S., the American community survey (ACS) is distributed to 1% of the population once a year to study the relationship between education, health, income, demographics, and geography. The authority has been criticised for attempting to replace real data with synthetic ones, while it may be good for creating large-scale estimates, poor and small communities with limited resources would suffer.

Synthetic data is an emerging industry, it depends on different industries and startups jointly exploring its potential.



5.4

Smartwatch data may ease the medical burden

Wearable smart devices that help people monitor their health conditions and track vitals, such as blood pressure, heartbeat, and sleep quality are becoming more popular. According to research firm IDC, global shipments of wearable devices grew 5.6% in 2023 compared to the previous year, and are expected to reach 519.8 million units in just one quarter, more than five times that of 2016. The data analysis firm forecasts the global shipping figure to go up to over 600 million by 2027.

In addition to monitoring health, these smart devices also encourage people to move more. This was concluded by Danish researchers after reviewing more than 120 studies of personal-activity trackers, which included healthy people and those with various health conditions. After wearing smart watches, all people increased activity, taking an average of 1,200 more steps per day. The study also found that increasing steps by an extra 1,000 per day reduces mortality by as much as 36%, especially for those who are sedentary.

Mobile apps help manage health

Furthermore, with data analysis, chronic diseases such as diabetes can be

- Smart devices and data analysis can prevent chronic diseases such as diabetes at an early stage;
- Due to limited accuracy and a lack of access to the medical system, doctors only use data from smart devices for reference;
- If the privacy and system compatibility issues can be solved, the medical burden can be reduced.

prevented. A study found that for people with prediabetes, if untreated, 37% of them may have diabetes in 4 years. Since everyone's blood sugar response to eating the same food varies, by analysing data such as blood pressure, sleep quality, exercise, height, weight, and excrement, it is possible to accurately predict an individual's blood sugar response. As a result, people can easily master their own health conditions and manage their weight.

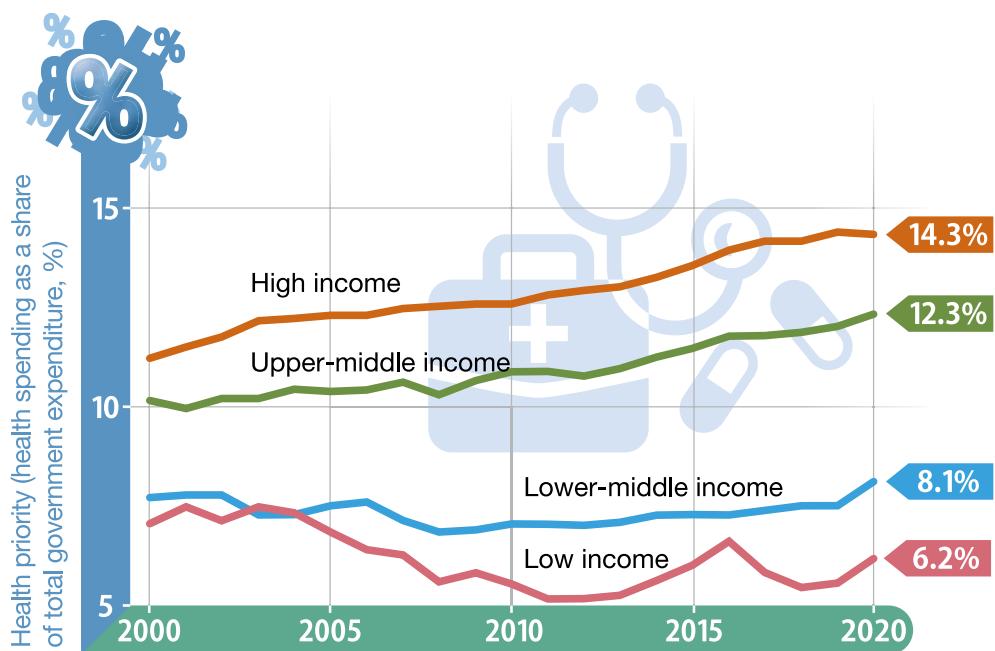
Medication is also a daunting part of medical care. According to a survey by the Centers for Disease Control and Prevention (CDC) in the United States, half of chronically ill patients have taken their medication incorrectly, particularly with regard to timing, dosage, frequency, and intervening duration. This issue is estimated to have increased direct medical expenditure by US\$300 billion every year. At the same time, another study found that about 80% of the burden from disease in America is caused by lifestyle factors.



The huge demand for medical care has prompted startups around the world to develop solutions. According to the *Economist*, there are more than 400,000 health and wellness apps on the Apple and Google app stores with 250 new ones added daily. In 2015, the majority of more than 30% of these applications focused on exercise and fitness. By 2021, however, disease related applications increased from less than 10% to 22%, of which psychiatry accounted for more than 20%, followed by diabetes. Though there are 5 million downloads per day, 95% were deleted within 24 hours. The reason is that many of these apps are not personalised, for example, one on anxiety problems for young people is unlikely to fit the elderly.

A caring assistant to help you take medicine correctly, change your lifestyle or improve your mood whenever you need is an ideal scenario. An Israeli startup has developed an application that combines the role of a personal secretary with a coach, it keeps you motivated, gives you reminders or compliments at the right moment, and in the tone of voice that you are most comfortable with. For example, if your calendar shows that your next meeting will start in 45 minutes, the app will suggest you use the available time to buy a cup of coffee two blocks away, which helps you reach your daily goal of walking 30 minutes, or it will encourage you to have dinner before eight o'clock so as to fulfil the weight loss plan. The app incorporates both artificial intelligence and behavioural psychology. The company is said to have 700 million solutions to communicate with customers, and through customer responses, it learns which methods are most suited within four to five weeks.

 **Health priority rose sharply in low, lower-middle and upper-middle income countries in 2020**



Source: *Global spending on health - Rising to the pandemic's challenges*, World Health Organization, 2022



Data inaccuracy and user anxiety

Smartwatches are becoming more popular and can be divided into two categories:

1. Those aimed at healthcare, with varying degrees of accuracy. Some people joke that some brands are “stingy” and always under-count the steps walked.
2. Medical-grade wearables, such as smart patches which are often prescribed by healthcare professionals. They use photoplethysmography (PPG, measuring heart rate through light transmission or reflection), the data obtained is highly accurate and comparable to professional medical equipment. They can detect the user's stress level and heart rate through artificial intelligence. If necessary, a warning will be issued.

According to the research of consulting firm Deloitte, professional-grade wearable smart devices will grow by nearly 20% every year in the next few years, and the global shipments in 2024 are expected to be 90% higher than that in 2021. On the contrary, the annual growth rate of healthcare and weight loss smartwatches was only 10% in recent years. The epidemic has accelerated the trend, because blood oxygen level (SpO₂) is regarded as a quick and convenient method to confirm whether one is infected and can be used to monitor recovery status. As a result, 15% of Americans purchased smartwatches after being infected with Covid-19.

Though the smartwatch manufacturers claim that the data they collect are



professional and accurate, doctors generally use them for reference only. There are three reasons for this:

1. Data accuracy –

A local startup reflected that some users like to wear smartwatches or smart bracelets loosely. This hinders the stability and accuracy of data reading, so they have started to research using a headphone as a replacement.

Besides, products that are approved by the U.S. Food and Drug Administration (FDA) or other regulators may be useful to patients like those who have been diagnosed with atrial fibrillation. In this case a smartwatch can be used to monitor the situation and send an alarm on a daily basis. But for generally healthy people, it can produce false positive results, creating unnecessary pressure on healthy users and additional work for medical institutions.

2. No connection to the medical system –

Even though smartwatches are widely used by Americans, only 10% of doctors said that they have linked data from patient wearables into their electronic health records. If a doctor really wants to use the data, they have to input it manually.

3. User anxiety –

Patients being monitored by smart devices may make them anxious and obsessive about their pulse or heartbeat, which may lead to adverse physical reactions, such as atrial fibrillation.



Concerns on data security

In addition, health data is a personal data in which the protection of privacy and security has attracted much attention. John Torous, professor at the Harvard Medical School said that many apps cleverly position themselves outside the medical regulatory framework to allow them to gather personal data and share them for commercial interests.

At the same time, the issue of network security cannot be ignored. In 2021, over 61 million customer records, including name, date of birth, weight, height, and gender, were found being uploaded and made public, they can be viewed without a password.

In recent years, many local universities have conducted research on the use of wearable smart devices under the Covid-19 epidemic, ranging from monitoring physiological changes during isolation, screening acute cardiovascular patients, and collaborating with telemedicine systems and sensors to carry out teletherapy, and more. If the issues of privacy and compatibility with the medical system can be resolved as soon as possible, it can eventually ease the increasingly heavy medical burden.

5.5

No health without mental health

The universities in Australia made a bold move in 2021; they decreased the tuition fees by 42% in five subjects, including two medical-related subjects, nursing, and clinical psychology. According to the education minister, it is expected that these areas will account for 62% of total employment growth over the next five years. The changes would cover an extra 30,000 university places in 2022, and up to 100,000 places by 2030. The policy was proposed before the Covid-19 pandemic, now it seems that the government has foresight.

Why? The mental health tsunami brought by the 3-year epidemic is likely to significantly increase the suicide rate around the world including in Hong Kong which may see the suicide figures exceed the historical peak of when SARS hit Hong Kong in 2003. In fact, before the epidemic, the Food and Health Bureau estimated that one in seven people aged 16 to 75 suffers from anxiety, depression, or other mood disorders. In addition, ageing also posed a negative impact on mental health. According to various studies by local scholars, it is estimated that the number of dementia patients in Hong Kong could reach 100,000, close to one-tenth of the elderly population.

When demand outstrips supply, the queuing time for psychiatry specialist outpatient clinics becomes much longer. According to the Hospital Authority's



- One in seven people aged between 16 and 75 in Hong Kong are estimated to suffer from anxiety, depression or other mood disorders, and an ageing population also significantly increases the demand on mental health services;
- One of the Chief Executive's goals is to enhance people's well-being.

figures, the median waiting time for "stable cases" (73% of new cases) in 2021 ranges from 14 weeks (in Kowloon Central) to 61 weeks (New Territories East and West). In the treatment of mental illness, psychiatrists who prescribe drugs, clinical psychologists who provide assessment and psychotherapy through interviews and exercises, and occupational therapists who provide daily self-care training are equally important. There are not enough psychiatrists in the public medical system with only 5.2 per 100,000 Hong Kong people. Clinical psychologists are even more scarce with only 1.4 per 100,000 Hong Kong population. Therefore, when the government examines how to improve mental health services, talent training is indispensable.

According to the World Happiness Report released in 2024, among nearly 150 countries/economies evaluated, Hong Kong, despite its high ranking (within top 20 in the world) of per capita GDP, only has a happiness ranking of 86th!



As the World Health Organization (WHO) said, there is no health without mental health. Therefore, I agree with the suggestion of Prof. Paul Yip Siu-fai, Director of the HKJC Centre for Suicide Research and Prevention (CSRP), University of Hong Kong, that the government should reopen some recreational facilities as soon as possible, because leisure activities are crucial for the physical and mental wellbeing of the elderly.

By the same token, playing video games, a hobby that has long been criticised by parents and teachers, may have great value in mental health. When the epidemic spread globally in mid-2020, researchers from Oxford University found that playing video games could help players gain "a sense of freedom and competence" based on the data collected. Oxford scholars pointed out that the WHO and many governments' restricting screen time is a disregard of scientific evidence. I think more research is needed, especially on the allegation that video games can lead to addiction for young people.

Conclusion

The wider range of technology applications in our lives means that companies providing their services will collect more and more personal information. This will require the government to step in and enact stricter laws and regulations to protect the privacy of individuals, and to strive and strike a balance between the interests of all parties.

Metaverse





Smart Economy

Hong Kong is a leader in many aspects of smart city development, and we have the strength to overcome the economic development dilemma by exporting technology services, promoting the application of new technologies from enterprises, facilitating virtual asset trading, and developing artificial intelligence supercomputing centres. To achieve these goals, the government will need to raise our R&D spending to 1.5% of GDP and enhance the geospatial intelligence of civil servants while also setting targets to ensure that public money is well spent.

Chapter
6



6.1

Exporting smart city experience is the way forward

In late 2022, the IESE Business School in Spain released its annual Cities in Motion Index 2022 (CIMI), covering the smart city performance of 185 cities in 92 countries around the world. Hong Kong's ranking has been quite stable over the past few years, hovering between 10th and 11th from 2018 to 2020. However, it has plummeted to 26th in 2022, with a one-year pause in 2021, reflecting Hong Kong's poor economic situation in recent years.

The CIMI rankings are based on nine criteria: from human capital (developing, attracting and nurturing talent), social cohesion (harmony among different social groups), economy (current and estimated GDP), governance (quality of state involvement), environment (pollution levels, water quality, and other ecosystems), mobility and transportation (ease of movement and access to destinations), urban planning (including health infrastructure, sanitation services, and housing policy), to international profiles (branding and tourism outreach) and technology (smart uses of information technology).

Hong Kong is improving

When compared with previous evaluations, IESE's rankings this year are almost exclusively tied to economic dimensions. The 3-year epidemic has

- Hong Kong excels as a smart city in Asia, with a particularly strong presence in the use of technology;
- Exports of experience to Asian countries, such as ASEAN and India range from financial services, MTR and airport services, and COP for disaster response to CSDI for startups to use shared spatial data.

significantly affected worldwide economies and has become a major factor causing changes in the ranking of individual cities. Dublin, the capital of Ireland, for example, was one of the biggest beneficiaries from Brexit, leading to multinational employment hitting a record high in 2020. Supported by strong growth, it jumped from 33rd in 2020 to 18th in 2022.

Although Hong Kong ranks 26th in the world, it still ranks fourth in Asia, only behind Tokyo, Singapore, and Seoul. Based on the popularity of smartphones and internet access, Hong Kong is the world leader in terms of "technology" but is weakest in "environment", followed by "economy" and "human capital".

In terms of environmental management, the authorities have been actively applying innovative technologies to enhance the environmental planning and assessment process to achieve a smart environment in recent years. For example, to improve and expedite environmental planning and assessment, the Environmental Protection Department has been using a three-dimensional geographic information system (3D GIS) to show the Environmental Impact



Assessment results. Environmental modelling data and development web tools were shared to facilitate project proponents and their consultants in conducting technical assessments as well. The department also uses artificial intelligence to assist in the identification of environmental issues in Hong Kong. Therefore, I hope that the environmental score will improve soon.

Smart city is big business

However, the economic aspect is a problem. Can we leverage the strong economic impetus of ASEAN to improve our own economy?

Globally, the development of a smart city has typically brought in great business opportunities. Research firms CB Insights and Frost & Sullivan both predicted that by 2025, the global value of the smart city would range from US\$1.4 to US\$1.56 trillion.

Meanwhile, the economic output of ASEAN countries (Indonesia, Malaysia, the Philippines, Thailand, and Vietnam), are expected to rebound rapidly - 4.6% and 4.8% in 2023 and 2024 respectively in the post epidemic era, according to OECD estimates. From my encounters with government officials and academics from these countries over recent years, I have perceived their strong need for advanced urban planning and development. In short, these countries all have a high demand for smart city services such as housing, public security, education, and medical care as they cannot keep up with economic improvements.

India aims to build 100 smart cities

India is another country that we cannot afford to miss. In 2021, India's GDP



was US\$3.18 trillion, less than one-fifth of China's (US\$17 trillion). However, India strives to increase GDP by more than 50% to US\$5 trillion by 2026 and to US\$40 trillion by 2047; accelerating urbanisation is the key.

As early as 2015, India proposed to engage in a Smart City Mission to build 100 smart cities across the country, which was originally scheduled to be completed in 2022 but postponed to June 2024. The ambitious plan aims to improve infrastructure in all aspects, from water supply, electricity, health, and education to waste disposal, transportation, housing, and digital government services, involving more than 7,000 projects with an overall budget of Rs 2 lakh crore (about HK\$190 billion). Many countries are also actively participating including Singapore, the United States, Japan, Germany, and Israel, with Hong Kong being said to be one of the investors as well.

As of 30 April 2023, the cities had completed 5,700 projects or 72% of the total number of projects, but around 90% of the released funds had been utilised. The authorities therefore announced that the completion date would be postponed to June of 2024.

With a plan of this magnitude and scale, it is not uncommon to overspend and overrun. According to a joint analysis by NITI Aayog, a government think tank, and the Asian Development Bank, the first of the 17 "key problem areas" towards urbanisation in India is the "lack of common economic vision and planning" of different sectors, which is not an isolated phenomenon, but is seen in all Indian cities. Actually, a few years ago, I pointed out, in my article 10 Tips for Developing Smart Cities, that in order to successfully develop smart cities, the public, public and private sectors, and opinion leaders need to agree on the objectives to be achieved in order to mobilise the participation of all parties, otherwise it is likely to only be half successful.



Government-led effort

Meanwhile, both the Mainland and Singapore are very ambitious in promoting smart city services, with high-level government officials driving collaboration. In 2019, Shenzhen and Singapore signed a memorandum of understanding on smart city cooperation. This was followed by a statement from the Ministry of Foreign Affairs to support eight Mainland cities, including Shenzhen, and to form partnerships with ASEAN cities to enhance competitiveness, the green economy, and sustainability through smart city projects and initiatives.

Over the past few years, Shenzhen has undertaken about 29 projects with Singapore, including the launch of the Asian SME hub to connect businesses and facilitate transactions between ASEAN and China. One of the focuses is to drive digital connectivity as well as ease cross-border access to market opportunities in Southeast Asia and the Guangdong-Hong Kong-Macao Greater Bay Area.

In November 2022, the collaboration was further strengthened with the launch of 14 new projects, covering e-commerce, cross-border data exchange, FinTech, and green technology. Key projects include exploring the use of advanced technologies and artificial intelligence (AI) to reduce carbon emissions and improve the battery management of electric vehicles. Another example is the cross-border big data platform which not only facilitates the exchange of trade data to improve the efficiency of cross-border trade, but also serves as a “demonstration zone” to look for business opportunities in finance, logistics, and information technology services.



Singapore's ambition

As for Singapore, the country is good at optimising its strengths and exporting to other countries as well. For example, the Singapore Land Authority (SLA) has produced the renowned Virtual Singapore over the last 10 years. It is a real-time interactive three-dimensional (3D) map that combines details of buildings, streets, infrastructure, green spaces, and almost every aspect of life, from demographic data about where elderly people are living, where businesses, shopping malls and restaurants are, and the schedules of public transport, to benefit not only citizens and businesses, but also emergency relief teams in the event of natural disasters.

In recent years, the country has gone a step further and created business potential by sharing these experiences with other countries. For example, in May 2023, the SLA signed a Memorandum of Understanding (MoU) on geospatial technology and infrastructure with the Estonian Land Board under the Ministry of Environment, paving the way for "deeper knowledge sharing... in geodesy, precise positioning infrastructure, 3D mapping, remote sensing, artificial intelligence, machine learning, and data interoperability" to improve capabilities in productivity and the environmental sustainability of both countries. In June of the same year, the Land Transport Authority (LTA) signed another MoU with the Seoul Metropolitan government of Korea, a renewal to the previous agreement signed in 2008. The updated version covers a number of smart mobility initiatives. These include promoting a pedestrian-centric and "car-lite" lifestyle which encourages cycling and walking, reduces driving, and implements car-free zones, with a hope to improve the city's sustainability and liveability.



It can be seen that Singapore is actively seeking opportunities to export its smart city experience, not only to Mainland China, ASEAN and neighbouring regions, but also to the European continent.

Hong Kong's opportunities

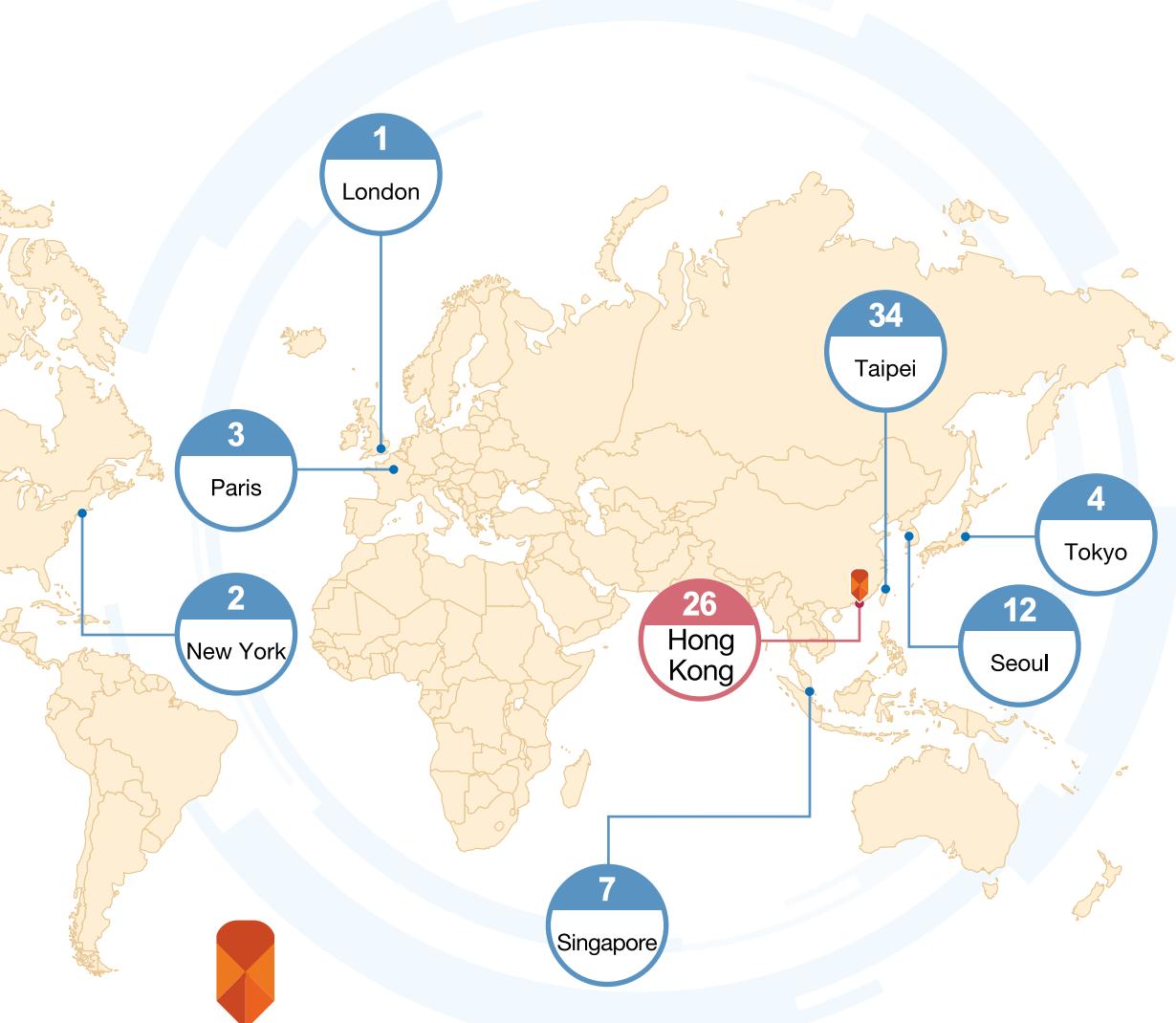
As for Hong Kong, ASEAN has always been our second largest trading partner and has close ties, but we have not grasped their smart city business opportunities. The government should strive to catch up as soon as possible. Financial services are one of the many services that Hong Kong is renowned for, the MTR and airport services are also well known for their efficiency. In addition, the government's use of advanced technologies is also of valuable reference to other countries.

For example, the Common Operational Picture (COP), a digital data platform for typhoon and flooding management, should be particularly useful to ASEAN where natural disasters are not uncommon. Since 2019, the Security Bureau has joined forces with more than 30 policy bureaux and departments to hold inter-departmental tabletop exercises every year in response to the threats arising from super typhoons. The Common Spatial Data Infrastructure (CSDI) is another example. The one-stop data supermarket makes it easier for startups to use open data for innovation. These are some of the smart city solutions that we can share with ASEAN.

I hope that the government will be more proactive in exporting smart city services to boost Hong Kong's economy and increase employment opportunities for our talent.

 Hong Kong's smart city ranking is above many Asian cities

Cities in Motion Index 2022



Source: IESE Cities in Motion Index 2022, University of Navarra



6.2

Real-time aerial imagery completes digital twins

The expansion of the metaverse economy in China is ready to take off. A Mainland research firm askci Corporation estimated that starting from 2022, the market size of China's metaverse is expected to grow by more than 20 billion yuan a year in the next few years. It is predicted to rise from 42.5 billion yuan in 2022 to 118.6 billion yuan in 2025 when the development will peak.

Twenty provinces and cities across the country, including Beijing, Shanghai, and Guangdong, have successively announced a development roadmap for the metaverse. Not only will they work hard to attract talent, they will also allocate land for industrial parks, in order to fully grasp this new business opportunity.

At the same time, the *List of the Hurun China Metaverse Companies with the Greatest Potential 2023* mentions five major industries in the Mainland's metaverse. This includes underlying technology, ecological applications, platform technology, the terminal industry, and network technology. The report also estimates their proportion in different provinces and cities, aiming to promote internal competition.



- Enterprise version of metaverse includes both CityEngine and ArcGIS Reality;
- CityEngine, a 3D city modelling software in GIS, and a digital twin combined with real-time aerial imagery provides 3D simulation scenarios such as where more floors can be built without obstructing ventilation, facilitating urban planning;
- ArcGIS Reality is compatible with real-time information, such as aerial imagery, and can be combined with BIM to bring 3D models to life.

Metaverse = 3D map

What does the metaverse look like from a user perspective? When people float between physical stores and virtual sites, the storefront of the metaverse has to be the same as its physical store, with products on the shelves and the street buildings being no different.

As a geographic information system (GIS) professional, I see that the metaverse is actually a map, a three-dimensional (3D) map that looks almost real, with individual's data being stored on the blockchain which can be extracted from different metaverses when people move from one metaverse to another.



We can create different metaverse maps and analyse the data in the maps. Through GIS, we can plan a city, and analyse the information collected in the virtual space, including the flow of people, geographical or group value, distance from related vendors, and more, so as to assist retailers in improving the virtual storefront, targeting high potential communities, choosing better locations, just as in the real world.

Although the metaverse is still in its infancy stage, some people refer to digital twins as the enterprise version of the metaverse, which consists of two important elements: (1) GIS' 3D city modelling software; (2) combining real-time aerial images.

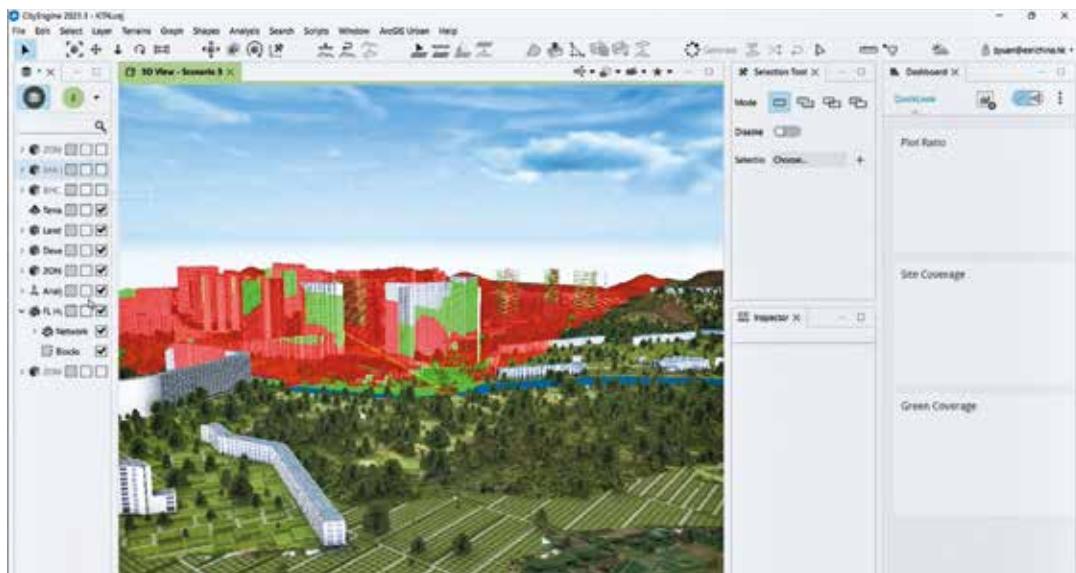
Enterprise version of metaverse

The 3D city modelling software named CityEngine can create large, interactive, and immersive urban environments today. The software is more effective compared with traditional methods and has been widely used in urban planning. Singapore has applied it to expand new districts for a long time, Jurong Lake District is an example. Major cities in the Mainland, the United States and Europe have also used CityEngine's advanced functions in urban development planning.

CityEngine can instantly convert 2D city data into an interactive 3D city model, providing city planners with a variety of hypothetical simulation scenarios, that is, showing the state of the city before and after development, such as how to route new railways at the most cost-effective way while minimising disturbance at the same time, where to build more residential



3D city design software CityEngine can create large, interactive and immersive urban environments, and is more effective compared to traditional methods



Source: Esri



towers without obstructing ventilation and ridgeline views, and how to incorporate environmental concerns. Further, its visualisation function can bring ideas to real life, facilitate stakeholders in understanding and expressing their opinions, and help an authority choose the best solution.

In addition to helping solve housing needs and transportation design, CityEngine is also commonly used in construction, development of simulation games (SIM), and film production.

Today, the metaverse has not really taken shape yet. People may just see it as a conceptual hype and dismiss the concept. If we choose to stand idly by, we risk missing out. To succeed in this emerging world, the government has to learn the framework, nurture and gather talent, and build a solid technological foundation to seize the golden opportunity brought by the metaverse.

Advanced version of digital twins

Digital twins, which originated for aircraft and automobile manufacturing, have gained popularity in other areas in recent years, including in construction, urban planning, disaster relief operations, and environmental conservation.

Digital twins create highly accurate 3D models by replicating the real world, which can be construction sites, complex cityscapes or even entire countries, with real-time interactive data to assess the feasibility of different solutions or improve management efficiency. Since digital twins need to aggregate data from multiple sources, GIS provides the required important technical foundation.



Today, digital twins take it a step further. With the wide use of aerial imagery, low Earth orbit satellite imagery and LiDAR scans captured by drones and aircraft, coupled with image detail accurate to centimetres, means still pictures of the entire world can be converted into dynamic digital images, making digital twins more accurate and perfect. As a result, some studies have pointed out that the demand for reality capture has gradually expanded the aerial photography market, which is expected to rise from US\$1.4 billion in 2017 to more than US\$4 billion in 2025, an increase of nearly three times with new applications such as ArcGIS Reality being introduced.

This new photogrammetry software can improve the interaction between digital avatars and the real world. It collects, processes and analyses drone and aerial imagery, along with data from other real-time sensors, and combines traditional GIS data, such as underground pipelines, traffic light distribution, and weather changes, into highly precise maps and 3D models for the real-world mapping of entire buildings, cities, and countries, while people can share visualised information for collaboration or communication with the public.

Bring digital twins to life

AEC Magazine described ArcGIS Reality as compatible with real-time information, inclusive of dynamic data from above and below the ground, and, when combined with building information modelling (BIM), can bring 3D models or digital twins to life which "helps make those important facilities related decisions". This is an essential component of a digital twin solution,



concluded the publication.

For example, a project called Texas Coast in Houston, U.S., is the largest civil engineering project the country has ever seen, even larger than the Panama Canal. The project is to build a series of dikes and locks to protect the Houston coast and ensure regional security and the oil industry. Authorities need 3D imagery to map the terrain of the entire area before building the dikes, and ArcGIS Reality allows the team to consolidate all this information together in a single solution.

As we continue to leverage GIS and digital twins and introduce next-generation technologies that can greatly improve the effectiveness of construction, urban planning, and environmental conservation, we are realising our expectation of digital transformation.



3D models through ArcGIS Reality and BIM integration facilitate more informed decision making



Source: Esri



6.3

Four recommendations for I&T development in Hong Kong

As the Central Government has clearly shown its support for Hong Kong to develop as an international innovation and technology (I&T) centre, we should seize this golden opportunity. I would like to put forward four recommendations for our I&T development as follows:

1) Increase R&D to 1.5% of GDP

We have to increase the research and development (R&D) investment from 0.99% to 1.5% of gross domestic product (GDP).

In the last few years, the government did step up its financial support to develop I&T, but the investment is far from enough to enable us to be ranked among the top in the global competition.

The success of Israel, nicknamed the “startup nation”, is mainly contributed to by the continuous investment in R&D for innovative and high technology over the past five decades. Since the 1970s, the country has been keen on developing I&T. In 2018, its R&D spending accounted for 4.94% of GDP, over twice the Organization for Economic Cooperation and Development (OECD) average of 2.26%.

- R&D amounts to 1.5% of GDP;
- Strengthen the spatial intelligence of civil servants to lead disaster prevention and the resilience of cities in the Greater Bay Area;
- A mechanism for matching talent and professions is needed, and enterprises should continue to be subsidised to employ STEAM graduates and introduce on-the-job training programmes;
- KPIs for R&D expenditure to ensure that the results are proportional to the investment.

Years of investment have yielded remarkable results. Especially under the Covid-19 epidemic, where only a modest adverse impact was seen in Israel compared to other developed countries – its GDP grew by 8.6% and 6.4% in 2021 and 2022 respectively, much better than most advanced economies. Today, high-tech companies account for 40% of the Israeli Tel Aviv Stock Exchange 35 Index (or TA-35, a benchmark equivalent to the Hang Seng Index in Hong Kong) and contribute more than 40% of the country's exports.

Shenzhen is another example. In 2009, R&D expenditure accounted for more than 3% of GDP (27.9 billion yuan) and has steadily increased since then to 5.49% in 2022. Compared to our investment of nearly HK\$200 billion in



innovation and technology from 2015 to 2022, Shenzhen's R&D in 2022 alone is close to that (168.2 billion yuan).

Therefore, our investment in R&D must be persistent and intensified, or we may lag behind others and waste much of our previous investment.

2) **Boost civil servants' soft power**

We need to strengthen geospatial intelligence for civil servants as this soft power is essential in the coming century.

In early 2019, the Central Government announced the *Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area*, which mentions the need to strengthen infrastructure to promote co-operation within the region, including the development of interoperable "public application platforms" (equivalent to Hong Kong's Common Operational Picture or COP), "Smart City Spatiotemporal Cloud Platform" (similar to our interactive map dashboard), and "Spatial Information Service Platform" (like Hong Kong's Common Spatial Data Infrastructure (CSDI) and other facilities).

The above three information infrastructures have one thing in common, that is, geospatial data as the core.

Why? What we often call "city resilience" today is actually based on measurable data and consistent, accurate, and authoritative information about the location of incidents. For example, the COP, developed and managed by the Civil Engineering and Development Department, not only shows information about the location of landslides, but also links the



situations within the region and beyond, as this interconnectedness is key to enhancing the resilience of the city. From natural disaster prevention, and tree management to flood control and net-zero emissions, geospatial data is an important element in boosting Hong Kong's urban resilience.

The format and content of data used by different sources are different, but these have common data, that is their geographic location. By linking data to geolocation information, a complete picture can be pieced together, allowing people to analyse it and make better and faster decisions.

Therefore, it is imperative to nurture more relevant talent, enhance Hong Kong's soft power in spatial intelligence, and consolidate our existing advantages. In addition to strengthening the training in the Geospatial Lab for all civil servants, it is also necessary for each department to establish their own COPs for their staff to familiarise and fully master this skill, so that they can lead the GBA cities with geospatial intelligence in promoting disaster prevention and resilience.

3) Talent vs market demand

Uplifting the quality of talent is crucial while at the same time, we have to make sure the talent has favourable employment prospects.

The success of smart city development depends on the ability to build a strong technology talent base. It is especially important to attract academic high-achievers to pursue degree programmes related to science, technology, engineering, arts and mathematics (STEAM) in universities. However, many top students opt for Medicine (based on the best six subjects in the 2020



HKDSE, median entrance scores: 45), Business (Business Administration in International Business and Global Management: 45) and Law (38), but not STEAM subjects (Engineering: Best 5 subjects, 25; Science: 23).

At the same time Hong Kong is transforming into an advanced smart city, there is a mismatch between local degree graduates and higher-skilled job positions. According to analysis from the Legislative Council Secretariat, the unemployment rate of graduates with a research postgraduate has been higher than that of graduates of a bachelor's degree programmes over the past 20 years. The former recorded a 5% jobless rate in 2019, while the latter was 2.8%, and the Hong Kong overall was 2.9%. Due to unfavourable employment prospects, the number of local research postgraduate students funded by the University Grants Committee dropped by 41%, from 2,575 to 1,510 between 2002/03 and 2019/20.

It's a chicken and egg problem. If there is no booming ecosystem, why would parents encourage their high-achieving children to take science and engineering courses? That's why I started a business after graduating 27 years ago. To promote the geographic information system (GIS), a digital mapping method, we must first create an ecosystem where the market demand drives the talent supply. Over the past 20 years, GIS has been widely adopted by the government, and public and private enterprises, and GIS courses have grown from just within the University of Hong Kong to a number of other local universities as well, which has greatly expanded talent training and helped attract top students.

What can be done now, apart from continuing to subsidise companies to employ STEAM graduates or considering a substantial reduction in tuition

fees, the authority needs to review how graduate degree programmes can match the market demand, and they need to actively collaborate with companies to launch on-the-job training courses to improve the quality of talent.

4) KPIs for R&D expenditure

For the long-term development of I&T, we have to set key performance indicators (KPIs) to track the effectiveness of R&D spending.

The government has invested HK\$10 billion in the InnoHK clusters, a flagship project of Hong Kong's I&T, recruiting 28 research laboratories from 11 economies. This has strengthened our capability in basic scientific research. The question is how do these clusters benefit the society at large? To ensure we have a reasonable return on investment, we must set up KPI and timetables, while at the same time taking into account sustainable development in the future.

KPIs not only evaluate the effectiveness of R&D, but can also be used to compare with other places, allowing the authority to understand whether their R&D investment in the current market sentiment and competitive context is fruitful, and whether they are achieving their goals over time. It also helps people understand whether public funds are used properly.

At the same time, KPIs should be simple and easy to understand. According to consulting firm McKinsey, there are two R&D conversion metrics that can serve as KPIs. One is the ratio of how R&D spending is converted into new-product sales, that is, the average revenue from new product sales for



every dollar spent on R&D; the second one is a new-product sales-to-margin conversion ratio, which looks at each dollar of new-product sales and sees how much gross margin is generated. Besides, the years each industry takes vary. The innovation cycle of consumer products is generally shorter, a three-year period is suitable for measuring gains and losses; however, for specialties such as chemicals or specialty materials, a five-year period is more common.

The epidemic has accelerated the development of science and technology. Hong Kong has a solid foundation in basic scientific research, which must be used wisely so that it will not become a white elephant. After all, the ultimate goal of I&T is to boost the economy, improve people's livelihoods and solve problems. Chief Executive John Lee pointed out that the next few years are crucial for Hong Kong to transform from governance to prosperity. We hope that through effectively promoting I&T, together, we can open a new chapter for Hong Kong.

6.4

Is Web3 a technological revolution?

Web 3.0 has become a hot topic in recent years because of substantial funds flowing into the related industries. In 2021, the global crypto sphere, including cryptocurrencies, non-fungible tokens (NFT, such as digital artwork) and decentralised finance (DeFi) grew crazily with venture capital transactions increasing to US\$25 billion from less than US\$5 billion in 2020.

However, by the end of 2023, with the bust of cryptocurrency platforms such as FTX and Hong Kong's JPEX, while NFT's have also been accused of being 95% worthless due to an oversupply, the craze has cooled. At the same time, there are predictions that Regenerative Finance (ReFi) will become a new wave of influence. All of these are products of the third generation of the internet.

Three stages of internet

Let's briefly review the development of the internet, which can be divided roughly into three stages as follows:

Web 1.0 (1990-2005), the first generation of the internet, similar to traditional books and journals, the communication is one-way. These



- The three benefits of Web3: enable customers to switch between companies, which drives companies to improve their services; reduce hacker threats; direct online interaction without an intermediary or authorisation;
- Voices of scepticism mention cryptocurrency mining consuming too much energy; highly fluctuating cryptocurrency value and regulatory risks, etc.;
- The emerging ReFi is an example of Web3's direct real-world impact by rewarding customers with cryptocurrency for their actions to combat climate change and support the diversity of production.

websites mainly provide information in the form of text and images without much interaction.

Web 2.0 (2005-present), the second generation of the internet is today's network form with interactive content, monopolised by a few corporate giants, such as Alibaba, Baidu, Google, Amazon, and Meta (Facebook), and more.

The United Nations estimated that the number of internet user surged to 5.3 billion in 2022. This has generated an enormous amount of data in which personal information is a valuable asset. The tech giants have vast amounts



of data on their own central servers, including customer interests, dietary preference, income, credit cards, browsing habits, searches, and online purchases, all of these are saleable.

It therefore exposed the inadequacy of Web2, namely personal privacy and network security.

Web 3.0 or the next generation of the internet, is characterised by pro-privacy and antitrust, and the central concept is decentralisation with the use of blockchain. It is expected to be the basic technology that drives the metaverse.

Through blockchain technology, the central database that internet giants used to rely on has become a shared resource, any user can access without authorisation. The unique feature of a blockchain is that it does not control the account information of its own customers, like what banks do currently, rather the information is maintained collectively by the users themselves. The earliest application of a blockchain were cryptocurrencies such as Bitcoin, today it is expanding into fields such as NFTs and DeFi.

Major benefits of Web3

In addition to enabling users to have the right to make decisions about their own personal data, Web 3.0 has at least three other major benefits:

1. Better services:

No company owns the customer's data, therefore if the customer is



dissatisfied, they can switch to another company's service. This drives companies to work harder and satisfy customers while remaining innovative.

2. Lower threat of hackers:

Because the data are scattered and stored in multiple nodes, it can prevent service interruption due to failures or the hacking of an individual machine.

3. More freedom:

At present, you need to join a website or social media site which serves as an intermediary to communicate and interact with others online. One of the characteristics of Web3 is "trust-less" and "permissionless". Participants can interact with each other directly without going through a trusted intermediary or authorisation from a governing body. Internet user activity, therefore, cannot be banned because of geography, income, or gender.

Today, the business involved in building the infrastructure for Web3 is quite extensive. For example, a startup provides developers with tools to build blockchain applications, so that they can easily create services based on Web3; while another company has built a decentralised network that cuts messages into segments and mixes them up before sending them out so that no one else can tell who is sending what to whom, keeping messages from prying eyes. Also, there are websites for sports fans to buy and sell digital collectibles.



But these are doubts...

Web3 targets the drawbacks of personal information being sold by tech giants for profit. By storing the data on a blockchain and being distributed in multiple "nodes" without a central database, the blockchain is administered by users collectively. Web3 is gaining momentum but there are also voices of doubt, including:

1. Convenience over privacy: Many users may not care about privacy at all, instead they treasure the convenience provided by social media and websites more.
2. Not environmentally friendly: Cryptocurrencies are an important feature of Web3, but the coin mining can consume a lot of energy. According to the New York Times, starting from 2018, Bitcoin mining uses more electricity yearly than the entirety of Denmark which has a population of 5.83 million. Mining activities peaked in May 2021 with at least 13 years of typical household electricity being consumed per mined coin. Although the blockchain has developed different verification and confirmation methods, which can reduce power consumption, Bitcoin mining is still being criticised and requires significant improvement. "Why is data privacy more important than environmental protection?" some people asked.
3. Back to square one: If all data is stored on blockchains, where are these blockchains physically stored? In the end, will the data be hosted by giants like Alibaba, Amazon, Google, or Microsoft? Due to the complexity of the technology, most people cannot interact directly with the blockchain. As a result, many people may rely on intermediaries, which go against the original intention of Web3 to remove the middlemen.



4. Currency instability: In November 2021, the value of Ethereum and Bitcoin climbed to historical highs, with the former reaching US\$4,646 and the latter at US\$68,000. It is a huge increase compared to 2020 where the former rose more than four times, the latter rose more than six times. Since then, both have been on a roller coaster ride - in a year's time, both dropped sharply with a residual price about 25%, but in March 2024, it recorded the highest price at US\$73,750. So how to ensure that these fluctuating currencies can be used to settle water, electricity, and gas bills, or pay a salary in the future?
5. Less effective: Web2 requires several tech giants to develop the technology with a substantial amount of their resources. Since Web3 focuses on decentralisation with no clear ownership, there are concerns that resources for the development of technology will not be forthcoming.
6. Regulatory risk: How to regulate and block hate speech and cybercrime under a decentralised framework? How should legislation and enforcement be implemented to comply with the laws of different countries?

Survival in the digital world

Just as Web1 without any interactive component still exists today, it is likely that Web2 and Web3 will coexist in the future. The former by giant tech companies is committed to improving the algorithm to make users continue to be "addicted"; the latter occupies niche markets, such as NFTs.

In the metaverse, Web3 will serve more functions, for example, a blockchain can be used to track the ownership of digital objects and transfer them from one virtual world to another.



Hong Kong has also stepped up its efforts in this regard. In April 2023, the Institute of Web 3.0 Hong Kong, a non-profit organisation, was officially established, and is headed by Norman Chan, the former Chief Executive of the Hong Kong Monetary Authority. Chan pointed out that Web3 will be about the survival of various industries in the virtual world in the new digital era, and the new establishment aims to motivate the business ecosystem construction of Web3 in Hong Kong and is committed to driving technological changes and building industry standards. Chief Executive John Lee also pointed out that in order to unleash the potential of Web3 and related technologies, the government needs to provide appropriate supervision for the market, including the licensing regime to ensure the steady and orderly development of the market and to protect investors.

From virtual to real world

Meanwhile, smart city expert Dr Boyd Cohen predicts that the emerging key trend is regenerative finance (ReFi) built on Web3 technology. ReFi aims to reward behaviours that contribute to green development, including addressing climate change and supporting biodiversity, through cryptocurrencies to promote social sustainability, which is also a practical use case of Web3.

It remains to be seen whether these predictions will come true, but I appreciate the fact that ReFi projects use cryptocurrencies to encourage companies and individuals to participate in solving the world's environmental problems, and to demonstrate the ability of Web3 and cryptocurrencies to improve the real world.



6.5

Unlimited potential of crypto assets

At the FinTech Week held in Hong Kong in October 2022, the government issued a policy statement on the development of virtual assets in Hong Kong, demonstrating the authorities' openness to virtual asset innovation.

Virtual assets are units of assets that are digitally expressed, calculated, or stored in value, that can be transferred, stored, or traded electronically, ranging from financial assets such as cash and bonds to physical assets such as art and property. Cryptocurrencies are the most well-known part of the virtual asset ecosystem.

Hong Kong starts moving fast

In early 2022, the Hong Kong Monetary Authority released a discussion paper on crypto assets and stablecoins, but no new policies have been announced after the consultation period. At the time, Singapore also proposed various measures to attract FinTech talent, which, when coupled with relatively strict anti-epidemic measures in Hong Kong, made the brain drain in Hong Kong's financial sector a hot topic for a while.

Fortunately, in the policy statement at the end of 2022, the Hong Kong

- Hong Kong can be the first to experiment with the regulatory measures for virtual assets;
- The digital economy market in ASEAN has huge potential, and Hong Kong needs to develop in tandem to seize business opportunities;
- As new types of jobs in future are derived from virtual assets, it is advisable for the authorities to recruit and train relevant talent as soon as possible.

authorities clarified that the consultation was to establish a consistent and clear comprehensive regulatory framework, and to formulate different pilot schemes, involving non-fungible tokens (NFTs), green bond tokenisation, and e-HKD, to test the technological benefits brought by virtual assets.

The government also pointed out that an open and compatible attitude towards global innovators engaged in virtual asset business is conducive to attracting the development of the global virtual asset industry to Hong Kong. Later, in the 2023 Budget, \$50 million was allocated to strengthen the promotion and development of the third-generation internet (Web3) in Hong Kong, especially to promote cross-sector business cooperation. Initiatives such as Cyberport has set up a Web3 base in early 2023 to better integrate startups and talents from around the world. In addition, virtual assets are one of the key elements of the Web3 ecosystem, and the government will set up a virtual asset development team to take a positive stance.



Singapore: No to Cryptocurrency Speculation

Many countries have moved steadily to embrace this emerging trend with a prudent attitude. One of them is Singapore, where the head of the Monetary Authority of Singapore (MAS) explicitly explained the authority's wish to become a crypto asset hub. Its managing director, in his 2022 speech titled "Yes to Digital Asset Innovation, No to Cryptocurrency Speculation", said that the authority welcomes digital asset innovation though a license is required for service providers, and at the same time "strongly discourages and seeks to restrict" cryptocurrency speculation. With the authority clearly drawing the bottom line, it makes it easier for businesses to decide whether to make a move.

Cryptocurrency has become a mega trend. However, a World Bank blog in February 2023 pointed out that the market value of the total crypto assets plummeted drastically from US\$3 trillion in 2021 to less than US\$1 trillion within a year.

The Mainland announced a ban on cryptocurrency trading in 2021 due to the high risk. But the country returned to the top ten of the 2022 Global Crypto Adoption Index published by a financial data analysis company Chainalysis in September 2022, showing that there are still lots of activities.

Hong Kong to optimise "two systems"

As for Hong Kong, the dilemma faced by the local government is whether we should incline to the spirit of "one country" or that of "two systems", as an article of the *Hong Kong Economic Journal* pointed out.

Nowadays, crypto assets are becoming more connected to the traditional financial system, the former Citigroup CEO believed every major financial institution will be considering trading crypto "in one to three years"; Bloomberg reported that JPMorgan Chase, Bank of America, and other investment banks were hiring talent in these areas, reflecting the accelerated adoption of crypto assets by institutional investors. Goldman Sachs has also started offering cryptocurrency futures trading.

In addition, many ASEAN countries with close commercial and trade relations with Hong Kong have developed the internet and virtual currency rapidly in recent years. The World Economic Forum states that ASEAN is the fastest growing internet market in the world, with 125,000 new users every day. It is expected that the ASEAN digital economy will bring US\$1 trillion to the region's GDP over the next 10 years. According to the 2022 Global Crypto Adoption Index, among the 154 countries, four ASEAN countries rank in the top 20, including Vietnam (1st), the Philippines (2nd), Thailand (8th), and Indonesia (20th). Therefore, to grasp the huge opportunity of the ASEAN market in Fintech and smart city services, it is essential for Hong Kong to develop virtual assets.

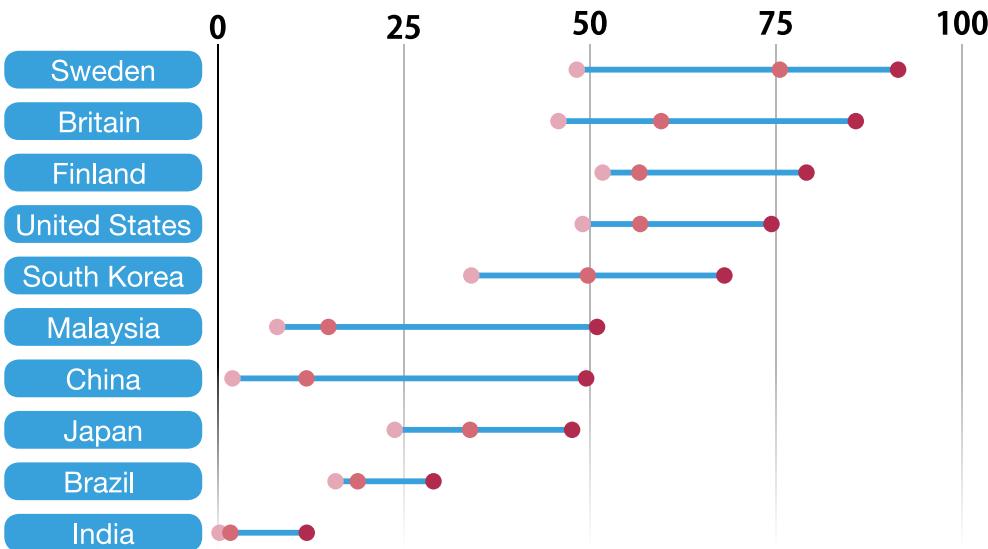
Furthermore, to help attract local and overseas companies to carry out related business here, we need clear and flexible regulation. What's more, when the Mainland cannot fully regulate cryptocurrencies in the short term, Hong Kong can take the lead to serve as a model for other cities in the Greater Bay Area. This is also conducive to the creation of new jobs and new types of work. Therefore, the authorities should gear up as soon as possible to attract and train these talents.



Non-cash payments as % of all transactions

● 2011 ● 2016 ● 2021

(By volume %)



Source of info: *As payments systems go digital, they are changing global finance*, The Economist, 2023

6.6

How to harness quantum advantage

Quantum mechanics, which is still in the development stage, has already given birth to major inventions such as the transistor and the laser since its inception in the early 20th century, and is known as the first quantum revolution in the scientific community. Recently, the second quantum revolution, represented by quantum computing and quantum communication, is emerging. In 2022, three Nobel laureates in physics proved further possibilities of quantum mechanics through experimental methods. Boston Consulting Group (BCG) predicts that quantum computing will become a reality by 2025, which has attracted more attention to the development and potential of this emerging technology.

What quantum computing is

Currently, computers and calculators can only process problems in a simple linear way, meaning they can only perform one calculation at a time. Our computers today work in binary, 0s or 1s, to form a long string of instructions, indicating what the computer should do, such as displaying videos, Facebook posts, or allowing you to input emails. Computers process complex calculations based on logic, in black and white, like the heads and tails of a coin. However, computers are not good at dealing with problems of



- Quantum computing will transform a number of industries, including medicine, materials science, banking, and energy, creating hundreds of billions of dollars in value over the next decades;
- On the flip side, it is expected that quantum computing could break through encryption technology within 10 years, threatening personal privacy and cybersecurity.

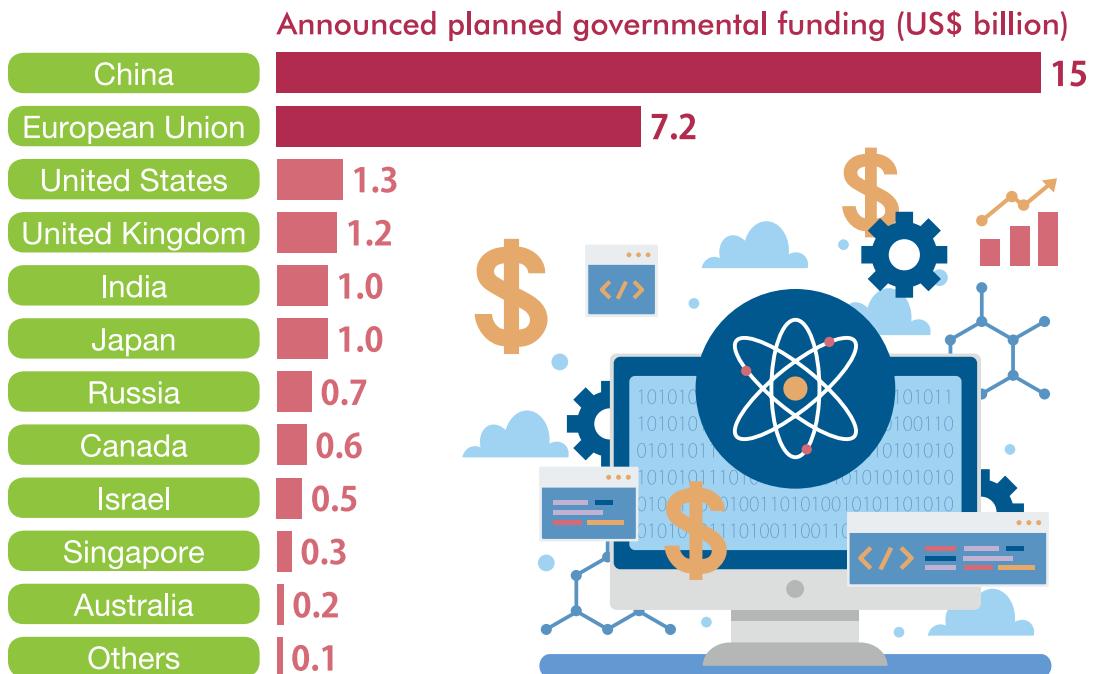
multiple dimensions, and this is where quantum computing comes in.

Quantum computing applies techniques from multiple disciplines such as computer science, physics, and mathematics. It operates faster than traditional computers and can solve more complex problems. It is like spinning a coin where both heads and tails could appear at the same time if you stop it mid-spin. If you try to use a current computer to calculate the route of a maze, a computer will only look at each path to the exit one by one until it finds the best route. However, a quantum computer can simultaneously examine every path and find the solution. In addition, traditional computers solve problems via a series of decisions, while quantum computers can quickly find the best solution in a decision tree.

Another characteristic of this science is "entanglement". Entanglement is a mysterious feature and has been described as the existence of "spooky



China and the European Union lead significantly on public funding for quantum computing



Source: *Quantum computing use cases are getting real—what you need to know*, McKinsey, 2021



action at a distance" that even Einstein once denied. If you toss two coins, the result of one coin has nothing to do with the result of the other. However, in quantum computing, the behaviour of one quantum particle may be correlated with another quantum particle, even if they are separated by millions of miles, due to some reason, like a mirrored image. The Nobel Prize in Physics winners in 2022 proved the existence of "entanglement" in their experiments.

Combat climate change

Some people believe that these characteristics enable quantum computing to perform super complex calculations, handle uncertainty more comprehensively, and ultimately apply it in the financial field to find the best investment portfolio or in the pharmaceutical industry to screen more drugs effectively and precisely simulate the chemical reactions of drugs at a faster and cheaper rate, solving problems that even the most powerful supercomputers cannot solve. It is a technology that holds great promise.

Currently, many global technology giants, such as IBM, Google, Microsoft, and several governments around the world, have increased investment in quantum computing technology though it is still in the development stage. For example, in 2017, Chinese and Austrian scientists launched a satellite, Micius, to implement the world's first quantum secure intercontinental video call, marking a breakthrough in early applications of quantum technology. Since 2019, the U.K. government has also invested millions of pounds in quantum innovation projects.

According to estimates from several consulting firms, quantum computing will change multiple industries, including medicine, materials science, banking, and energy, creating hundreds of billions of dollars in value in the next decades.

In response to climate change, quantum technology can promote the development of more efficient chemical catalysts, thereby reducing carbon emissions, and developing better carbon capture and storage solutions in early applications. Later, it can assist in developing lighter, stronger materials for use in manufacturing cars and airplanes. One of them is BMW which uses high-precision computational simulation software to replace the currently expensive physical build-test-improve cycles, with the potential to help automakers build lighter parts, making vehicles safer, low-carbon, and low-cost. In the financial industry, JPMorgan Chase, Credit Agricole, and other banks are also actively testing this new technology to see if it can improve the solving of complex problems such as investment portfolios and index tracking. It is expected that this new technology will bring in \$2 to 5 billion in revenue for financial institutions over the next 10 years.

Threats to privacy

However, this revolutionary technology may also pose unprecedented threats to personal privacy and network security. Today, technology giants have access to big data, which can predict individuals' consumption habits and preferences. In the future, as the processing power of quantum technology explodes, will social media advertising penetrate more deeply into our lives and consciousness?



At the same time, the super processing power of "quantum advantages" can easily crack passwords. Sundar Pichai, CEO of Google, predicts that quantum computing will crack the encryption technology we know today in the next five to ten years. Michele Mosca, founder of the Institute for Quantum Computing at the University of Waterloo in Canada, believes that by 2026, there is a one-in-seven chance that quantum computing will crack the "RSA-2048 encryption," the golden standard of public key encryption (PKC) used to protect hundreds of millions of internet users worldwide. By 2031, this chance will increase to 50%, rendering today's network security virtually useless. Therefore, data security and regulatory enforcement have never been more important to prevent improper use. In other words, cryptography in the new era has become necessary, and one idea is to use quantum-powered defence to counter quantum attacks.

Like artificial intelligence, new technologies always bring new challenges, and the key is how we seize opportunities. Actively training talent, keeping up with the times, especially in critical and innovative thinking, is the key to human beings harnessing new technologies.

Conclusion

Hong Kong has a strong foundation in R&D, but there are many challenges to overcome in the fierce technology competition. I hope that the government and the business sector will effectively promote innovation and technology and develop a more diversified economy, so as to usher in a new chapter for Hong Kong.





Smart People

With the development of science and technology in the future, 6G will replace 5G, and artificial intelligence will replace manpower so that the talents needed by society will be completely different. In order to cultivate appropriate talent, it is necessary to introduce courses such as GIS in the curriculum to enable students to acquire multiple intelligences as early as possible. In addition, empathy, and the ability to work in a group are equally important.

Chapter
7



7.1

Why GIS Academy is needed to cultivate talent

2024 is the 27th anniversary of Hong Kong's return to the motherland. During the past 27 years, information technology has made rapid progress. For example, the proportion of households with internet access has increased from about 30% in 1997 to more than 99% in 2022, while mobile phones have evolved from 2G to 5G. Among the changes, there is one that we are not fully aware of, but it has an extensive impact on everyday life — the digitisation of urban planning. In simple terms, it is the transformation of paper maps to digital versions on the computer to enable the processing of increasing volumes of data and to allow informed decision making.

GIS improves livelihood behind the scenes

As a result, the people's livelihood has been improved in many aspects, including mobility (the routing and alignment design of the West Rail Line, the Transport Department's Intelligent Road Network); housing and urban renewal (Urban Renewal Authority's renewal of old districts, location and orientation of public housing estates); natural disaster prevention and rescue (the joint operation platform connects multiple departments for flood control and disaster relief, real time monitoring of tunnel water level). These have brought unprecedented benefits to society.



- The application of advanced technologies such as GIS has made Hong Kong one of the world's leading smart cities;
- The GIS Academy aims to develop young people's geospatial intelligence and problem-solving skills. The courses range from basic concepts to advanced applications and are provided free of charge.

Behind these is the use of the geographic information system (GIS) which has also been widely deployed in various areas, from identifying the best route for fire trucks to rush to a scene, and designing routing plans for refuse collection vehicles to reduce contact with the public, to assisting the Environmental Protection Department in investigating pollution complaints. It is also used in the daily release of epidemic information to the public on an interactive map dashboard since the beginning of the Covid-19 outbreak, and the planning of sewage inspection and the enforcement of restriction-testing declaration operations since the fourth wave. The advanced technology applications have made Hong Kong one of the top smart cities in the world.

The core value of a smart city is being people-oriented, promoting people-to-people connections through the application of technologies. The spatial layout of a city is particularly important as it not only affects people's life



and behaviour, but also affects social mobility. A comparison of the two new towns: Tin Shui Wai and Sha Tin, is an example.

Transformation starts with young people

Hong Kong pioneered the use of advanced technologies such as GIS twenty-seven years ago, the city acted as a leader among its Asian peers in promoting the development of a smart city and the use of innovative technology. However, in the past decades, Singapore, South Korea, and even Mainland cities have taken a great leap forward in smart city development. Hong Kong, on the contrary, appears to lag behind the prevailing global trends.

If we want to break through geographic boundaries, strengthen integration with Shenzhen and the Greater Bay Area, and formulate long-term solutions for the housing supply, the application of innovative technologies such as GIS is indispensable. GIS is strong in sorting and analysing huge amounts of data, its visualising function makes it easier for us to identify problems, discover hidden trends, and identify solutions.

However, not to mention the government officials, the general public is also not familiar with GIS technology. Therefore, I started to promote it to local young people nine years ago. I encouraged them to identify problems and use this software to incorporate social conditions while finding suitable solutions. Since 2015, a programme called Map in Learning (MiL) has allowed all primary and secondary students in Hong Kong to use the professional GIS software ArcGIS Online for free. Up to early 2024, more than 220 schools have participated in the programme, and over 1,700

students and teachers have been trained to use the software. Since 2017, the annual Esri Young Scholars Award ("Esri Award") has been organised, aiming to encourage university students to analyse their chosen topics and make practical recommendations.

GIS application potentials

Looking back at the winning works of the Esri Award over the past seven years, most of them focus on two areas: optimising planning to improve the economy and living standards and tackling various travel problems.

The former includes how to make good use of brownfield sites to develop modern logistics (2022), assessing the potential of Kowloon East to become a commercial centre (2019), identifying 19 pieces of government lands that are far away from residential areas but with convenient transportation to build 1 million columbarium niches (2020), solving traffic noise problems in old districts (2017), how public medical services in Sham Shui Po can be made more accessible to the elderly (2018), identifying the districts where public transport and land use are not yet maximised (2021), and more.

The research on mobility is also very relevant. Subjects studied include improving the existing traffic accident black spots by the Transport Department (2020), identifying the lack of inter-district bus routes in the New Territories West (such as Tuen Mun) connecting industrial and commercial districts (2018), reviewing road obstacles which make it time-consuming for wheelchair users to travel in Kwun Tong compared with normal pedestrians (2022).



Uplift problem-solving skills and employability

Although the authors are young people, their broad vision, concern for society, and innovative thinking are encouraging. I hope to further consolidate these research results and enrich the local GIS talent pool. This is the reason why I have founded GIS Academy, a platform to gather and cultivate talent in Hong Kong.

The GIS Academy is a one-stop platform for uplifting young people's problems solving skills and employability through enhanced geospatial knowledge. The Academy offers courses ranging from basic concepts to advanced applications, all free of charge. We will invite professors and teachers from tertiary institutions, teachers and students from the MiL programme, and participants of the Esri Award to join the platform. We also welcome the seven scholarship winners from four universities that my company and I have awarded, as well as selected companies of the Esri Startup Programme to join the platform. Through classroom teaching, seminars and internships, students can deepen their understanding of GIS advanced technology, providing them a chance to join this emerging industry in the future, thereby driving Hong Kong to enhance its competitiveness and improve our quality of life.

China's President Xi Jinping pointed out at the meeting celebrating the 25th anniversary of Hong Kong's return to the motherland, "Hong Kong will prosper only when its young people thrive." Through the GIS Academy, I hope to promote the diverse development of local young people, help build a sustainable and smarter Hong Kong, and allow the city to be well prepared for the development of innovative technology in the Greater Bay Area.

 **GIS Academy is to:****GIS
Academy**

			
● Nurture geospatial intelligence	● Improve problem-solving & analytical skills	● Strengthen talent pool	● Broaden global perspective
			
● Enhance sense of belonging	● Encourage innovative mindset	● Increase employability	● Prepare for smart city development



7.2

Metaverse jobs in the future

It is said that by 2030, many industries will need spatial computing talents who are good at online game design and blending the virtual environment and real world seamlessly, because by then the Metaverse will be popular. Many companies which are considered not technology-based, such as Gucci and Coca-Cola, have recently set foot in the field.

Metaverse is coming

Hong Kong people may have some idea about the metaverse. More than twenty years ago, a telecom company's commercial based on John Lennon's best-selling single *Imagine* as the theme song was popular. At the end of the commercial, a little boy sat on the floor of the living room and happily played a hand-clapping game with a virtual child. There was no computer screen or headset, the virtual and real world were smoothly integrated, it is a vision of the metaverse.

Today, technologies like virtual reality (VR), augmented reality (AR) in which sprites are embedded in the live environment when playing Pokémon for example, and extended reality (XR) to combine the virtual and real world through wearable devices, are not new anymore.

- By 2030, 5G will be replaced by 6G while sensors while AI, computer vision, AR, and spatial computing become commonplace;
- The metaverse has given rise to many new types of jobs, such as digital fashion designers, virtual doctors, smart contract lawyers, data hunters, etc.

However, Meta (previously named Facebook) said that it would take 10 to 15 years to fully realise the metaverse. Even though many technologies already exist, one of the biggest issues is the insufficient supply of talent to develop and support the entire ecosystem.

Until recently, Meta has sold nearly 20 million VR headsets, the main hardware for human-machine interaction which is essential in the metaverse. Although it is still far away from the goal of 50 million to 100 million sets expected by the company founder Zuckerberg when he acquired Oculus ten years ago, the 20 million users marked a key threshold before the explosion of the ecosystem.

What kind of talent does the metaverse need? Just like a smartphone, if there is no enriched content, such as social media, games, videos, shopping with internet access, it will stay at the stage of voice transmission.



New types of jobs are emerging

As for the content of the metaverse, its scope is broader and more diverse than today's mobile applications. New types of discipline and expertise will emerge, including healthcare, social activities, leisure, and even law enforcement. Below are the likely new professions:



Emerging new professions in 2030 by Metaverse



Digital fashion designer



Metahuman doctor



Smart contract lawyer



Data bounty hunter and security guard



Psychologists

- **Digital Fashion Designer**

In the metaverse of the future, everyone will have an avatar, a virtual twin. How to present one's personality, taste, values, and adjust them according to different scenes will become important. Therefore, digital fashion design would become a hot profession.

In order to attract generation Z (born between 1996 to 2010), many luxurious brands dip into digital fashion.

For example, a Gucci handbag was sold for 350,000 Robux (the virtual currency of game platform Roblox) or US\$4,115 (about HK\$32,000) in the real world in 2021; while in an auction in the same year, Dolce & Gabbana sold a nine-piece collection of digital NFTs (non-fungible tokens, a new carrier of digital art driven by blockchain technology, the record of owning virtual assets such as digital art cannot be tampered with, making NFT assets unique), alongside some actual couture for a total of 1,885.719 Ether (Ethereum cryptocurrency), or the equivalent of nearly US\$6 million (about HK\$46.8 million); Balenciaga has partnered with the 400-million-player online game Fortnite to release four virtual outfits ("skins") and accessories.

- **Metahuman Doctor**

All of our biometric and physiological data will be digitised and contained in our metahuman avatars, thanks to inserted nanotech sensors, these data will be updated in real-time. This allows metadoctors to diagnose and run tests of different treatments to find the best options for our real bodies.



- **Smart Contract Lawyer**

To conduct transactions in the metaverse, people need a consultant, a Smart Contract Lawyer. This professional will ensure that the terms of your agreement are perfectly encoded for confidentiality and stored in the blockchain, and the cryptocurrency, asset transactions, and related royalties are also protected.

- **Data Bounty Hunter**

If data is the energy that drives the metaverse, personal data is the most precious part of it. By then, sensors will be everywhere, and the metaverse platform will record more user information than any current social media.

How can individuals control their data scattered across different websites, organisations, and governments? A new service will emerge to search for your data to ensure that you have access to and ownership of all your data. These companies have expertise in personal privacy regulations in different places and are able to manage personal data. They are also strong in data mining in order to track your data like a Data Bounty Hunter.

At the same time, the risk of data theft will be more severe than today. It will be a big challenge for companies to ensure the protection of users' privacy and to prevent the dissemination and manipulation of false information. This makes the jobs related to information verification a popular choice of profession.

- **Psychologists**

This profession is very important no matter in the metaverse or in the real world.

The popularity of social media has not eased the problem of interpersonal alienation, although our images in the virtual world look beautiful. We still have to face real problems in school, work, family, relationships, finance, and more.

How to balance the virtual and real world can be troubling, especially for young people born in the digital world. A research team from the University of Hong Kong found in 2022 that more than 16% of respondents in a youth mental health study of over 3,000 local residents had suicidal thoughts, and the university appealed to health authorities to tackle the mental health impact of technology on young people. In the U.S., the Boston Children's Hospital launched a Digital Wellness Lab in 2021 which studies the effects of digital technology on our brains, bodies, and behaviours, so as to propose feasible solutions based on scientific evidence.

Except for the traditional profession of psychologists in the real world, all the jobs mentioned above require mastering digital skills and the knowledge of artificial intelligence (AI). Therefore, I must urge the authorities once again to include these areas in the regular curriculum of primary and secondary education in Hong Kong, allowing young people to equip themselves for the future.



7.3

How to position our AI supercomputer centre?

Professor Sun Dong, Secretary for Innovation and Technology and Industry, said that the investment in the proposed AI supercomputer centre would be "huge", and "if you make reference to supercomputer centres in neighbouring areas, the amount involved may be billions of dollars". According to 2011 data, the total investment for the Shenzhen Supercomputing Centre was 1.23 billion yuan for a world-class supercomputer, and by taking account of inflation within these 13 years, it is not surprising to see Prof. Sun's high estimate. Further, with the globally tight supply chain of high-end technology products, especially in terms of chips currently, the considerations may be even more complex.

Well-defined goals

To make good use of public funds, we may learn from the experience of Mainland cities.

Firstly, beware of price disparity.

It has been reported that the construction cost of the same AI computing centre – with computing power of 100 PFlops (FP16) – could differ by as

- As early as 2011, Shenzhen built high-speed computing equipment to support weather forecasting by the Hong Kong Observatory;
- In preparing Hong Kong as a supercomputing centre, talent training should not be neglected.

much as six times between mainland cities, costing 75 million yuan (HK\$81 million) to build in one city and 460 million yuan (HK\$500 million) in another. This, coupled with low price transparency, means extra caution is warranted to ensure funds are wisely spent.

Secondly, the positioning of the centre is even more important.

Zheng Weimin, academician of the Chinese Academy of Engineering and professor of computer science at Tsinghua University shared a story. He said, "When it comes to the development of AI, the first reaction of many places is to build or buy a large machine (i.e. supercomputer). But many local governments don't really figure out why they want to build 'big machines'. I asked a senior government official of a province what problems are expected to be solved by the province's AI computers. He listed face recognition and urban smart transportation. I said that face recognition and smart transportation do not need ultra-high performance 'big machines' indeed."

In other words, the goals of the centre must be well defined.



Mainland experience

Ningbo's AI supercomputer centre launched in early 2023 may be a good reference. The centre, with an investment of 585 million yuan for the first phase, is positioned as a two-in-one, both as a supercomputer centre providing the public services of society (like a general hospital); and at the same time, it is also an AI computer centre (similar to a specialised hospital) for enterprises to serve their own project needs. The Ningbo centre has three main goals:

- Supporting R&D and the transfer of results of scientific and technological institutions - there are many national, provincial, and ministerial key laboratories, as well as enterprise technology centres and dozens of universities. The AI supercomputing centre provides high performance computing power for these institutions to enhance the competitiveness of the city.
- Promoting refined and intelligent management of the government - urban governance, weather forecasting, disaster warning, and more. These require the calculation and analysis of massive data.
- Boosting the development of the AI ecosystem – the centre will incubate upstream and downstream enterprises of cloud computing, big data, and AI.

Do these appear to be similar to those of Hong Kong? Therefore, we must first define our own goals and priorities, and analyse the strengths and weaknesses of neighbouring cities to identify our best strategy, so that public funds can be well spent.

Cultivate local talent

Further, talent development is also critical to make the AI supercomputer centre a success.

The government has stressed snatching talent from other places. But as Professor C.C. Chan, Hong Kong's first academician of the Chinese Academy of Engineering, fellow of the U.K.'s Royal Academy of Engineering, and dubbed the "Father of Asian electric vehicles", said in a recent media interview, there are two types of talent science and technology needs. The one the Hong Kong government is recruiting around the world can be compared to "flower arrangement". In addition to that, it is also necessary to plant flowers by cultivating your own local talent.

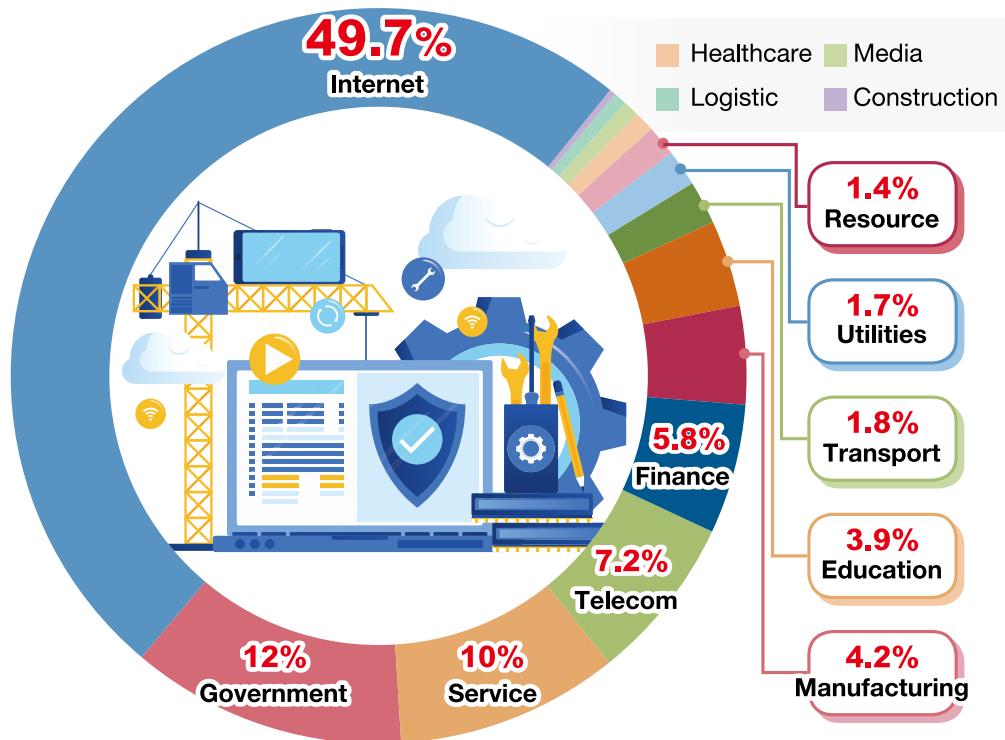
Though the government is expected to have the AI supercomputer centre launched in the next 2-3 years, do we have sufficient professionals to manage and operate it? Hardware is easy to come by, but talent is hard to find.

Just like the Common Spatial Data Infrastructure (CSDI) officially launched in 2022, due to a lack of matching education and training resources, there is still not adequate professionals with the skill to use it. Open data is another example. The government started to open a number of datasets in early 2019. The authorities may believe that publicising data will automatically yield benefits and every sector can make use of open data. But according to the findings of a survey on Hong Kong people's views towards open data, only 20% of those interviewed had used "open data", reflecting low usage.



Without proper promotion and education, the huge potential value of spatial data cannot be realised.

Promoting Hong Kong's digital economy, building a smart city and developing AI technology ultimately relies on talent. Therefore, in addition to planning the hardware of the supercomputing centre, it is also necessary to strengthen relevant education and professional training to cultivate more local digital professionals, so as to realise the potential of the large investment on hardware.


 Use of computing power in China by industry


Source: *White Paper on China's Computing Power Development Index (2022)*, China Academy of Information and Communications Technology



7.4

Human-robot collaboration, spatial intelligence, and empathy: key qualities for the future

With a lack of ground-breaking technological innovation over the past few decades in highly industrialised countries, the labour productivity growth there has diminished. This is the conclusion of a German study on 25 countries including the United States, Canada, Japan, South Korea, France, Germany, Italy, the Netherlands, and Britain. Without a great leap forward in productivity like mechanisation, economic growth and the income of workers have stagnated.

At the same time, a study from OpenAI and the University of Pennsylvania found that OpenAI's latest language-processing model GPT-4 could most affect educated, white-collar workers earning around US\$80,000 a year in the U.S. workforce, including financial analysts, accountants, and writers.

Parents' anxiety

No wonder parents around the world are pessimistic about the next

Personal qualities needed for employment in future:

- Human-machine collaboration - the application of AI in various aspects of school life can improve personal digital literacy;
- Spatial intelligence - to integrate GIS into STEAM to enrich young people's problem-solving skills;
- Empathy - a unique human quality to be cherished and enhanced.

generation's financial well-being. A 2022 survey by the Pew Research Center found that a median of 70% of adults across 19 countries including Japan, South Korea, Australia, the U.K., and the U.S., said that "children will be worse off financially than their parents". Parents tend to see the worst aspect of things, but such widespread negative sentiment is quite rare in this annual survey.

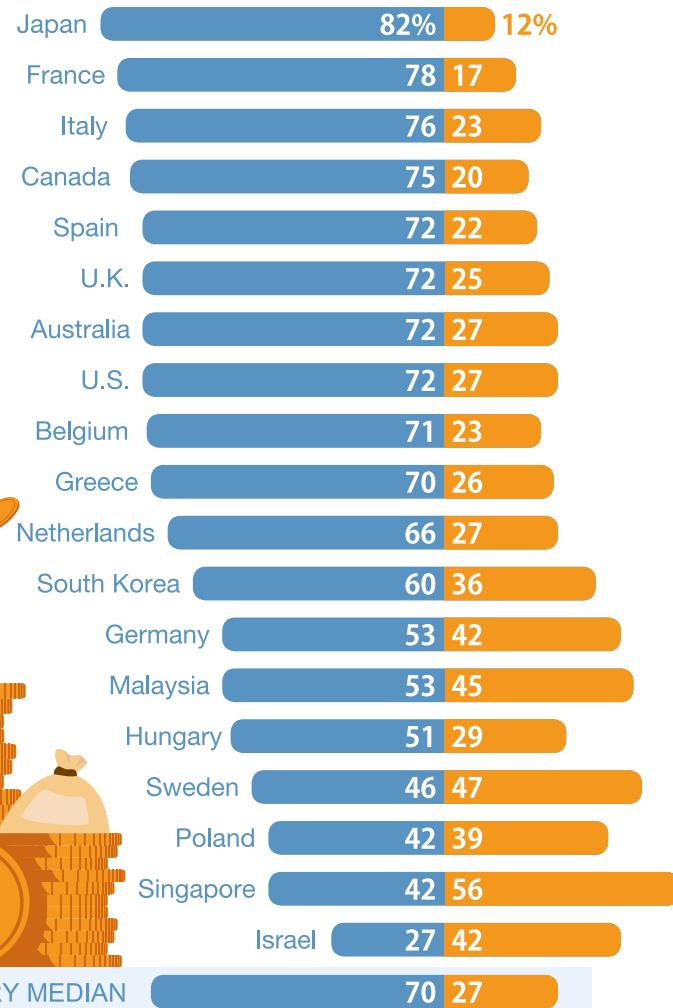
With AlphaGo defeating the world Go human champion in 2016 and the generative artificial intelligence (AI) ChatGPT released at the end of 2022, people start thinking again whether advanced technologies will subvert the world as prophesied. Will humanity one day succumb to AI?

I, however, think that in the next five, ten or 50 years, even if AI or other innovative technologies become common, a greater demand for certain



Majorities in most places surveyed are pessimistic about their children's financial well-being

% who say that when children today in (survey country) grow up, they will be ___ financially than their parents



Source: Large shares in many countries are pessimistic about the next generation's financial future, Pew Research Center, 2022



personal qualities required in the interaction and cooperation between humans and advanced technologies will be even more acute. Other essential qualities include spatial intelligence and empathy.

1) Human-robot collaboration

The World Economic Forum's The Future of Jobs Report 2023 released at the end of April predicts that as many as 69 million new jobs may emerge by 2027 to meet a new division of labour between human and AI machines. The latter will focus on tasks of information processing, and administrative and manual tasks. What makes humans retain their advantage includes management, decision-making, communication, interpersonal and human-computer interaction. New job positions include data analysis scientist, AI and machine learning specialist, big data specialist, digital marketing and strategy specialist, and more.

Therefore, we need to promote digital literacy. We need to have a better understanding of digital technology, not only its benefits but also the drawbacks and ethical risks it poses, such as cybersecurity and personal privacy.

The Hong Kong government has followed this trend. In the Policy Address of 2022, the government proposed putting more emphasis on STEAM (science, technology, engineering, arts, mathematics). Then the Education Bureau launched AI modules in mid-2023 for junior secondary level students. Topics include basic concepts, ethics, computer vision, computer speech and virtual reality, and the impact of robotics and AI on society. This is undoubtedly on the right track. However, I can't help but wonder how effective it can be with



just six to seven lessons each of 35 minutes, or about four hours of study a year in a busy academic curriculum.

If AI is also applied to school life, it can enrich the learning experience. For example, using AI to relieve teachers of routine tasks, answering students' frequently asked questions (virtual teaching assistants can answer 40% of students' common questions, according to research), and even grading routine assignments (research shows machine learning and predictive modelling can have an 85% match with human grading) can assist teachers, so that they can concentrate more on identifying the early disengagement of students. The first-hand experience of human-machine collaboration also helps teachers and students to reflect on how to use innovative technology and create greater value.

2) Spatial intelligence

Furthermore, spatial intelligence will be indispensable in the future. Smart cities use a massive amount of data. With the number of connected devices worldwide expected to jump to 125 billion in 2030, according to IHS Markit, geographic information systems (GIS) can efficiently collate and analyse data to help make better decisions.

These systems, which combine knowledge of spatial geography, statistics, mathematics, and modelling, can help visualise the results of analysis for easy communication and sharing with different stakeholders. Combining these systems and big data can make it easier to explore deeper insights, such as helping the Fire Services Department analyse images taken by drones to find and rescue missing hikers faster and more efficiently.

Spatial data is a driver of the new economy. According to the U.K. government, the private sector using location data in areas such as retail, logistics and mobility could unlock an economic value of up to £11 billion (HK\$109 billion) a year.

Despite this, there is a serious shortage of talent with geospatial expertise. Hong Kong is no exception. We need to start with education. I hope the authorities will add GIS to the existing curriculum to enrich young people's problem-solving skills, expand the local talent pool, and build an advanced smart city.

3) Empathy

Smartphones have conquered the world with their ease of use, thanks to user experience (UX) design, which blends mathematical engineering, psychology, and marketing.

The tech industry has long been dominated by men, with women making up only 28% of the U.S. tech workforce as of 2022. But according to human resources firm Zippia, four out of 10 UX design positions are held by women.

A 2022 study of more than 300,000 people in 57 countries by researchers at the University of Cambridge showed women scored better than men on a test that measured putting themselves in others' shoes and imagining what the other person is thinking or feeling. This sounds a lot like UX, which AI does not take into account.



However, while women have accounted for more than half of university students in Hong Kong for more than 10 years, less than 40% of them are studying science, technology, engineering, arts and mathematics (STEAM). The number of people working in the information and communications industry rose from 109,000 in 2008 to 132,000 in 2021, but the proportion of female employees saw no growth, from 32% in 2008 to 31% 13 years later.

Women should make the best use of this advantage to not only fight for better pay but also to promote the application of technology.

As AI has started to be a key competitor in the workforce, we should bank on our unique quality of human empathy to keep the upper hand.

7.5

Let young people see the future

The government is formulating the youth development blueprint and youth policy while the latest news about the youth is worrying.

First, the youth workforce in Hong Kong has been shrinking considerably. According to data released by the Census and Statistics Department (C&SD), the population of Hong Kong decreased by 1.9% in the first six months of 2022, of which the labour force aged 20 to 24 dropped sharply by 23.4%, while those aged 25 to 29 decreased by 8.6%. There was a loss of more than 80,000 young and strong people in the labour force within six months.

Second, the income of the youth sector ran contrary to the level of education. C&SD data shows that the proportion of people aged 15 and above who have received post-secondary education increased from 15.2% of the total population in 1996 to 35% in 2021, an increase of 1.3 times. However, in 1996, median monthly income from main employment of working youths was HK\$7,500, 78.9% of the median (HK\$9,500) of the whole working population. By May-June 2021, the median monthly income of youths was HK\$13,700, only 73.3% of that of the whole working population, it had decreased by 5%. When factors like minimum wage and inflation are taken into account, their income has barely grown in 25 years.



- While youth income and education levels diverge, enterprises report a mis-match between talent skills and employers' needs;
- It is recommended to include GIS in the regular curriculum to enhance students' multiple intelligences;
- With a significantly diminished youth labour force, the authorities should seek to return formerly imprisoned young people to school and provide them with job opportunities.

Talent skills ≠ employers' needs

Meanwhile, the suicide rate of teenagers is at an all-time high. The Hong Kong Jockey Club Centre for Suicide Research and Prevention at the University of Hong Kong pointed out that the suicide rate under 15 reached a historical high of 1.7 per 100,000 people in 2021. Although the base is small, it has nearly doubled in two years (2019: 0.7, 2020: 1.3) and shows an upward trend which has caused much public concern.

On the other hand, a survey by Our Hong Kong Foundation found that 58% of the companies surveyed indicated that a shortage of talent is the major barrier to their upgrading and transformation, reflecting a mismatch between the available talent skills and industry needs.

Three suggestions for youth policy

To turn chaos into governance, Hong Kong needs to strengthen its youth policy. I have three suggestions for the development of our future masters.

Young people must have good mental health, multiple intelligences, and social inclusion, all three are indispensable.

1. Mental health:

As the World Health Organization says, there is no health without mental health. I agree with the reminders by Prof. Paul Yip of the University of Hong Kong and other scholars that the government should avoid the suspension of face-to-face classes. This allows students to return to a normal school life and develop social interaction skills, which would help reduce academic and mental pressure. Even though e-learning is cost-effective and can reduce fatigue in travelling to and from school, social interaction has an irreplaceable value, especially in improving the resilience of junior grade students.

2. Multiple intelligences

In recent decades, technology has developed rapidly, enhancing the multiple intelligences of students to cope with the ever-changing world is therefore a major focus. The Education Bureau released the Primary Education Curriculum Guide in 2022 to increase the flexible classroom lesson time with one of its suggested time allocations being cross-curricular learning and the reinforcement of STEAM (science, technology, engineering, arts, mathematics) education, I strongly support the initiative.



Today, however, data collected by connected devices around the world is growing explosively with 80% of the data having spatial dimensions. Therefore, it is crucial to uplift students' data sensitivity and geospatial awareness. I hope that the authority can incorporate the use of the geographic information system (GIS), an effective spatial data analysis tool in the regular curriculum, so as to improve young people.

3. Social reconciliation:

Hong Kong is severely divided after the social unrest in 2019, many young people involved are convicted or have been released. Chris Tang, the Secretary for Security said that 60% to 70% of these inmates showed remorse. Since many of them are students, the authority is discussing with the Education Bureau and the academic community on how to systematically help them return to school. They will also discuss with some employers so that these young people can get a job after release, according to Tang.

This kind of inclusive attitude is an important step towards social reconciliation. As long as the young people have been punished and they are willing to reform and start afresh, we should try our best to help them get back on the right track, so that they can also contribute to society. Furthermore, the government should ensure that those who have served their sentences are treated as equally as other students by publicly funded universities. They should not be expelled for the worry of affecting the school's reputation.

In recent years, the government has actively promoted innovation and technology, with the hope to create better employment opportunities for younger generations. However, it may take years if not decades to develop

it into an important economic pillar, like finance and logistics which employ hundreds of thousands of people. Young people are important human resources, they are also a part of our society. If the government can assure young people that the authority really cares for their well-being, the work of nurturing and retaining the youth will be more effective with half the effort.



Young People should have:



- Resilience



- Multiple intelligences to increase competitiveness



- Strong problem-solving abilities



- Broader world perspectives

Conclusion

The world environment is changing rapidly, and a person can only succeed if they have scientific and technological knowledge, multiple intelligences, and strong mental health.

Are you ready for the future?

Enhancing geospatial intelligence, it is never too late

Artificial intelligence (AI) will lead to the disappearance of many white-collar jobs, and related jobs such as accounting, analytics, writing, art design, and 3D games and videos may be replaced one by one after 2030. Even though new jobs may emerge, such as "prompt engineers" who "translate" machine language, Open AI CEO Sam Altman estimates that they will disappear by 2027... Coupled with extreme weather, tension between China and the United States, the Russia-Ukraine war, the Israel-Hamas war, and the economic recovery after the epidemic being not as expected, all of these are unsettling and creating anxiety for the future.

It was not surprising for me to see one of the 2023 Esri Young Scholars Award participants winning on the theme of research for integrating geographic information systems (GIS) with feng shui effects in the ninth period (風水九運), trying to predict the future. In an ever-changing world, I believe that the magic weapon is not metaphysics, but is geospatial intelligence, especially in this new era full of uncertainty.

Why? Today, with a global population of more than 8 billion, there are an estimated 16.7 billion smart devices constituting more than two per capita, and these smart devices are expected to double to nearly 30 billion by 2027. These range from waist watches and mobile phones, and door locks and air conditioners in homes, to enhanced geospatial intelligence in buildings and streets. Sensors of all kinds, as well as satellite imagery, have together

created a gigantic internet of things (IoT). At the same time, as humans and machines interact and collaborate more and more closely through virtual/augmented/mixed reality (VR/AR/MR) in work and play, communicating with machines through text, voice, eyes, gestures, and the integration of the real and virtual worlds, coupled with the increasing popularity of digital avatars and the metaverse, this megatrend has generated another “universe” for people to live in with an unprecedented amount of data.

The potential of these data to harness their infinite potential for the benefit of humanity is why geospatial intelligence and GIS are all the more important.

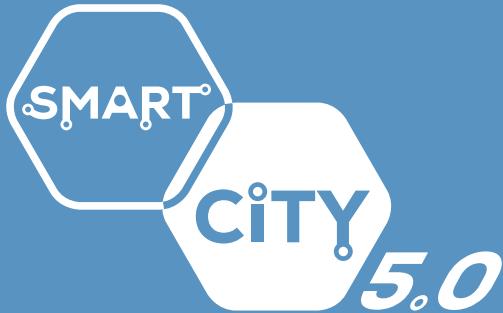
Some research institutions predict that the global spatial computing market will soar from US\$120.5 billion in 2022 to US\$620.2 billion in 2032, increasing more than 5 times in 10 years.

Because of the importance of geospatial intelligence, I have always encouraged young people to learn geography and GIS as this knowledge enables us to grasp the intricacies of the world's problems and helps us explore the best solutions. As the former U.S. President Barack Obama said, studying geography helps us understand the complexity of the world and the diversity of different cultures, helps us resolve our differences, and enables humanity to live together in harmony.

Therefore, this book mainly explores the practice and potential of GIS in different fields. Unlike previous books on smart cities, this book focuses on unique country and city cases from around the world, and looks at the potential local strengths and solutions, hoping to lead young people and leaders from all walks of life not only to understand the techniques, but

also to enhance geospatial intelligence and its application, and to improve people's lives and benefit the world with the sustainable development of Smart City 5.0.

Finally, I would like to thank Victor Lam, Ex-government Chief Information Officer, and Jack Dangermond, President and Co-Founder of Esri, for writing the preface and sharing their insights. Victor pointed out that technology can combat the climate change challenge, and that GIS helps cities make smarter decisions "about resource allocation, infrastructure development and service delivery", which is particularly meaningful for the Northern Metropolis and Lantau Tomorrow. Jack, known as the godfather of GIS, said straightforwardly that one of the important functions of GIS is to promote multi-party collaboration and get the misguided carbon emission bus back on track. Is this also the common aspiration of Hong Kong?



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Dr Winnie Tang

Dr Winnie Tang, MH, JP, is a locally born IT entrepreneur from Hong Kong. She is the Founder and Chairman of Esri China (HK) Limited, and the Founder and Honorary President of the Smart City Consortium. She is also an Adjunct Professor in the Faculty of Engineering (Computer Science), the Faculty of Social Sciences (Geography) and the Faculty of Architecture at the University of Hong Kong (HKU).

Dr Tang specialises in geographic information systems (GIS) and smart city technologies, and led the world's first SARS mapping and data analytics effort in 2003, which have become indispensable for timely and effective epidemic monitoring and response. She is also keen to ensure the younger generations have better problem-solving skills and a stronger geospatial sense through a number of initiatives. An e-learning programme Map in Learning was launched allowing primary and secondary school students in Hong Kong to use the professional GIS software ArcGIS Online for free. She also founded GIS Academy in 2022 to nurture local talent with the knowledge of GIS and spatial data analysis in Hong Kong.

She has been teaching master's degree courses on 'smart city' in various local universities, from HKU's Engineering Faculty, Social Sciences Faculty and Architecture Faculty, to the Division of Public Policy of the Hong Kong University of Science and Technology, Lingnan University, and the EMBA programme of the Chinese University of Hong Kong.

In addition, Dr Tang has set up many scholarships and startup funds, aiming to unlock the potential of young entrepreneurs to serve the community. She has also shared her insights at international conferences organised by the World Bank Group, International Telecommunication Union, and the Asian Productivity Organization. She has published 15 Chinese and English books and over 600 research papers and newspaper articles. Her Chinese book, *Surfing the IT World*, won the publishing award (the category of Commerce and Management) in the Hong Kong Publishing Biennial Awards 2017.

In recognition of her work, Dr Tang was awarded an Honorary Fellow by Lingnan University in 2020, a Distinguished Alumni by the HKU Faculty of Science in 2009, the Ten Outstanding Young Persons award in 2006, the Women of Influence – Young Achiever of the Year Award by the American Chamber of Commerce in 2004 and the Ten Outstanding Young Digi Persons Selection in 2001.





We need to develop the economy and protect the environment on one hand alongside the rapid development of technology and the menacing threat of AI on the other hand. How can we achieve that?

Dr Winnie Tang will tell you key survival wisdom for the next 30 years. This book is the fifth one in the author's Smart Cities series, and outlines six cases from different countries using detailed information and personal insights to highlight how to use geospatial intelligence and the latest technologies to build a truly people-centred and sustainable smart city at the mobility, environmental, governmental, living, economic, and personal levels.