REIMAGINING LANTAU TOMORROW

Insights for the Future Lantau Tomorrow
July 2022

ARCADIS AND BEHAVE

This report was developed by Arcadis and Behave as a collaborative partnership.

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Behave

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PREFACE

This report has been prepared by Arcadis and Behave by leveraging their expertise and market experience and was supported by market research, international benchmarks, reference to case studies and a stakeholder engagement exercise in the form of 4 open-panel discussions held on the 17th and 19th August 2021 with private sector leaders, heads of councils and associations, and academics.

For their input and insightful discussions with us, many thanks go to Albert Cheung (Chairman of Hong Kong Green Building Council), Daniel Chun (Vice President of Smart City Consortium), Ryan Ip (Head of Land and Housing Research at Our Hong Kong Foundation), KK Ling (Director at Design Institute of Social Innovation), Prof. Donald Choi (Vice President (Local Affairs) of the Hong Kong Institute of Urban Design), Dr. Gregg Li Ka-Lok (Chairman of OASA HK), Jacqueline Hui (Public Policy Researcher in at Our Hong Kong Foundation), Rosana Wong (Vice President of Smart City Consortium), Prof. Jian-Guo Dai (Professor at PolyU), Kevin O'Brien (Chief Executive of Gammon), Yu Kam Hung (Chartered General Practice Surveyor), Dr. Richard Pang (Director of CIC), Sir Gordon Wu (Chairman of Hopewell HK Properties Ltd.), Professor Hong Lo (Director of GREAT Smart Cities Institute), Oren Tatcher (Principal of OTC Ltd.), Andrew Kwan (Operations Director at KMB), and Dr. Jiangping Zhou (Associate Professor at HKU).

We are grateful for all the input we have received. The publication of this report is aligned with Arcadis' mission of developing solutions to meet society needs and demands through a user-centric approach, and Behave's mission to create future-ready solutions that improve the environment and people's quality of life in urban environments. This work is independent and has not been commissioned or sponsored in any way by any business, government, or other institution.

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1 EXECUTIVE SUMMARY

Hong Kong is facing shortage of land to sustain economic growth as well as land for the government, institutions and community facilities to meet the needs of society as population ages. The Planning Department (PlanD) has broadly estimated that the land shortage for residential and mixed-use development is at least 1,200 hectares. In the 2018 Policy Address, the Chief Executive announced the Lantau Tomorrow Vision (LTV) as a means to provide land for development that will meet the long-term needs of Hong Kong.

At the core of the LTV is the phased formation of artificial islands around Kau Yi Chau and Hei Ling Chau in the waters east of Lantau Island. This land reclamation will be accompanied by new strategic road and railway networks to link it with Hong Kong Island, Lantau, and the coastal areas of Tuen Mun. This mega-project is expected to cost USD 80 billion and includes the development of 1,700 hectares of artificial islands with 260,000 – 400,000 housing units, 70% of which will be earmarked for public housing. The recently opened Hong Kong-Zhuhai-Macao Bridge together with Hong Kong International Airport (HKIA) make Lantau a "Double Gateway" connecting Hong Kong to other cities of the Guangdong-Hong Kong-Macao Greater Bay Area and the world. The Government has formulated the LTV with a view to capitalising on the competitive advantages of Lantau to promote economic development as well as meeting current and future housing needs. Since the announcement of LTV, the public has raised concerns on the impact of the development on marine ecology, conservation, transport infrastructure, cost-effectiveness and the need to expedite land supply.

In this report, Arcadis and Behave explore practical ways to address key concerns raised for LTV, and discuss key considerations, insights and potential solutions for the future development of LTV. Our study takes into account the current state of Hong Kong's society and industries and lessons learned. Our resulting insights are structured around **four thematic pillars:**

Designing for societal expectations: Building resilient communities and transportation networks amidst rapid urbanisation by improving building design, using the latest technologies and the promotion of people-oriented streetscapes within the built environment.

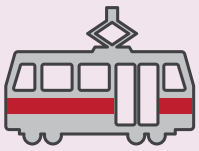
Driving innovation and modernisation: Establishing mechanisms to actively encourage and nurture development and implementation of digital tools and modern systems that support productivity, safety and sustainability improvements.

Driving efficiency-focused policy: Focusing on improving the existing approval processes and procurement strategies through leveraging digital technologies and modifying existing communication mechanisms.

Accelerating green transition: Improving connectivity and reducing commute time through more climate-smart modes of transport and raising awareness about the important challenges that climate change impacts and adaptation requirements present for the Hong Kong transport network.

DESIGNING FOR SOCIETAL EXPECTATIONS

High-density and three-dimensional neighbourhood

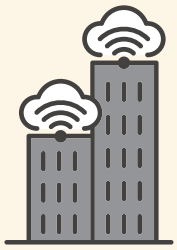


Development of multimodal transport

Provision of greenery and integration of built assets

Efficiency of housing development

DRIVING INNOVATION AND MODERNISATION



Development of a tokenised neighbourhood

Integration of Digital Twin, BIM and IoT technology

Promotion of construction digitisation

Development of Mobility as a Service (MaaS)

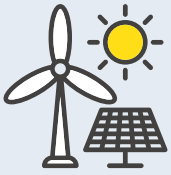
DRIVING EFFICIENCY - FOCUSED POLICY

Development of an integrated digital submission and approval

Promotion of a value-adding procurement strategy

ACCELERATING GREEN TRANSITION

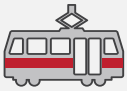
Development of green transport and e-mobility



Promotion of carbon-neutral development

Within these four pillars, we researched and explored a variety of strategies for improvement based on successful similar initiatives overseas, original ideas developed specifically for the LTV, and input from 18 interviewed key stakeholders in Hong Kong. From the four pillars, we arrived at 12 strategies which support the likelihood of success and good application of LTV. These strategies include:

- Creation of a car-free and transit-oriented, socially and technologically connected, programmable, **high-density and three-dimensional neighbourhood** of radical mixed uses.



- Development of **multimodal transport** by enhancing the supplementary transport infrastructure and facilities and the integration of public transportation to provide viable mobility choices.

- **Provision of greenery and integration of built assets** with nature in the typical local neighbourhood to have a positive effect on the quality of life of city residents.

- Promoting the **efficiency of housing development** through collaboration between governmental bodies and private companies to improve the collective community benefit.

- Development of a **tokenised neighbourhood**, which is powered by a network of sensors to reinforce and build desirable behaviours in a blockchain ecosystem.

- **Integration of Digital Twin, BIM and IoT technology** to improve the operational efficiency of building facilities in terms of building energy performance and air quality.

- Promotion of **construction digitisation** through the application of software to make the Lantau Tomorrow project more cost-effective and avoid construction delays.

- Development of **Mobility as a Service (MaaS)** platform to offer users access to a variety of transportation options and gradually improve the service levels in terms of fulfilment speed and accuracy.

- Development of an **integrated digital submission and approval** process that fully utilises the benefits of BIM, incorporating Automated Design Checking Tools and E-inspection Procedures.

- Promotion of a **value-adding procurement strategy** by adopting blockchain-based e-procurement solutions to facilitate greater visibility and maximise efficiency on each project.

- Development of **green transport and e-mobility** to decrease the number of pollutants released to the environment and build up better living conditions for the Hong Kong citizens.

- Promotion of the **carbon-neutral development** by using smart technologies and design strategies to adapt to the climate changes in the sub-tropical cities.

In the following pages we present our analysis and provide suggestions for consideration which may be complementary or additional to current planning. The feasibility of these recommendations can be examined in the future by government and stakeholders.

As such, if proven practical, the recommended initiatives will require the support of various entities in the public and private sectors in order to succeed and yield the benefits to all involved in the industry and the development of Lantau Tomorrow Vision.

2 DESIGNING FOR SOCIETAL EXPECTATIONS

2.1 Overview

This section outlines key findings for how Lantau Tomorrow can be designed according to societal expectations by taking the following into consideration: hyper social connectivity, high density high liveability, inclusionary housing, and multimodal transportation.

2.2 Hyper Social Connectivity

2.2.1 WHY we need a "Hyper-connected" City?

"Hyper-connected" versus "connected": Vertically dense, mixed-use cities already score high in terms of walkability and proximity to daily necessities. The concept of "the 15-minute city" is often used as a model for the connected city – one that provides access to all human needs within a walking or bicycling radius of a quarter of an hour or less. A connected city generally assumes a static set of daily necessities. Using such a model, we can plan for land uses and modes that satisfy this static notion – however, cities and societies also need to evolve. Eventually, fixed land uses become obsolete and a process of renewal is required. Thus, we reimagine the connected city as one that evolves simultaneously with dwellers' needs. Using new digital technologies, it is possible to implement a "phygital" connected city where the blend of physical land use and digital services create the conditions for hyper mixed uses – this is the hyper-connected city.

Catalysts for flexi-living: The COVID-19 pandemic has created seismic shifts in cities, particularly in how people work and study. There are multiple drivers for this shift towards flexible living, which includes remote, part-time and/or self-employed working modes. These drivers include new and emerging work types, the digitalisation of services, more family-inclusive company policies, the extension of 5G networks and safe digital connections, results-based working, and greater autonomy given to workers over those results (Williams et al., 2021). The result is a need for architecture that is dynamic and which, alongside new technologies, will allow the built environment to accommodate these shifts and optimise the use of available space while simultaneously reducing transportation emissions.

Towards social equity: As well as fast-tracking this shift, the pandemic also exposed inequalities in access to services. This highlights how it is critical to make investments in affordable, high-quality digital connectivity, e.g. mobile phones, computers, internet services, for everyone. This way we can realise the benefits of a hyper-connected city.

The future is phygital: Physical spaces are becoming ever-more digitally connected. The Internet of Things (IoT), enabled by placing sensors in physical spaces and fixtures across the city, is already a reality in many cities around the world, fostering new interactions between inhabitants and their built environment. Digital technologies and infrastructure are increasingly deployed throughout these cities to create successful blend of physical and digital experiences (Econsult Solutions, Inc., 2022).

> ***Social connectivity – exploring potential placemaking strategies in a high-density environment, fine-grain city fabric design, walkable communities, and ways to shape the co-existence of public and private housing – is of paramount importance.***
>
> ***Donald CHOI***
> *President of Hong Kong Institute of Architects*

> ***Today's world is becoming increasingly volatile, uncertain, complex, and ambiguous [known collectively as 'VUCA'] … The most important thing is being able to see a different world … the future of which is very difficult to forecast. This means we need to have an open mind and see the possibilities.***
>
> ***Dr Gregg LI***
> *Chairman of OASA*

2.2.2 WHAT are the key attributes of hyper-connectivity?

The quality, efficiency, and adaptability of our connections with communities and places have a major impact on how we experience city living. Creating good quality connections between people and places in an efficient and adaptable manner requires a full understanding of the four key types of connectivity:

- **People connectivity** – Connections that promote social interaction and community engagement. Places with people connectivity instil a sense of place, identity, community attachment, and social diversity; they are where people from all walks of life come into everyday contact with each other. These connections build social capital and empathy across the social-cultural spectrum. By involving users and residents in place-making, a connected place reinforces a community's positive identity and sense of ownership – in turn, this leads to inclusive neighbourhoods where equal rights and participation are valued and respected (Tiwari, 2017).

- **Place connectivity** – This type of connectivity involves land uses that allow easy access to a mix of neighbourhood activities and enable short-distance travel. They are programmable spaces managed by open-source, on-demand methods, where occupants' daily activities generate local economic growth and vibrancy, resulting in more viable local businesses, greater local employment opportunities and lower emissions (The Conversation, 2017).

- **Transport connectivity** – Crucial to this type of connectivity are low-impact transport modes that allow for sustainable mobility, enhancing the quality and liveability of places through safe, efficient and enjoyable journeys between places. Micro-, macro- and integrated transport links eliminate the need for car ownership by providing safe, convenient and affordable options for every trip distance (C40 Knowledge Hub, 2021a).

- **Technological connectivity** – This involves the provision of ethical, transparent, reliable, fast, and accessible digital spatial data and infrastructure that create balanced and fair data-driven

digital services for all, as well as voluntary and consensual data sharing among inhabitants so as to deliver environmental, social and economic improvements. Technology ensures the optimal utilisation of resources and access to real-time information for all citizens, equalising the built environment. New technologies allow place-making engagement with larger groups of community representatives, helping to elicit the most appropriate strategies (C40 Knowledge Hub, 2021b).

> ***It is crucial to make Hong Kong attractive globally. This can be achieved by turning Hong Kong into a 'programmable city' – a sustainable, dynamic and inclusive place.***
>
> ***Rosana WONG***
> *Vice President of Smart City Consortium*

2.2.3 HOW can we use hyper-connected city in Lantau Tomorrow Vision?

Creating new land and neighbourhoods involves starting with a clean slate. The primary opportunities lie in creating a car-free, transit-oriented, socially and technologically connected, programmable, high-density, three-dimensional neighbourhoods that embrace radical mixed uses. These include:

Mobility hubs and car-free zones: Travel across a city should be a choice, not a necessity, for meeting everyday needs (The Conversation, 2017). The provision of this choice can be reflected in:

- Shared and varied micro-mobility networks;
- First and last mile to mass transit, with mobility hubs integrated into mixed-use, high-density developments that incorporate a wide range of transportation options, from regional and local public transit, to walking, biking, scooters, and others;
- Pedestrian and bike-friendly core areas within a five-minute radius, car-free walkable zones;
- Integrated micro- and macro-logistics hubs connected to neighbourhood buildings through underground delivery tunnels to keep trucks off local streets.

Toronto – underground delivery tunnels

Tunnels were a key part of Alphabet's Sidewalk Labs project proposal for Toronto's Quayside waterfront district. Around the clock, electric dollies in the tunnels would move between buildings, delivering packages, transporting storage items and disposing of waste. Tunnels can improve safety by taking vehicles off the road and reducing emissions from idling engines. Emptier roads mean that activities can happen quickly and efficiently, without delays or interruptions (City Logistics, 2019).

Inclusive Digital Infrastructure: This allows for the provision of widespread wi-fi and high-speed internet throughout the city by:

- Investing in open-source, decentralised digital infrastructure to manage shared amenities and spaces, making access universal, simpler and cheaper to all.
- Enabling adaptable urban spaces and prioritising communal, recreational and cultural functions at different times of the day throughout the year.
- Implementing dynamic feedback loops, having "citizens as sensors", conducting data analysis through AI and big data, and implementing continuous improvement programmes with specific KPIs.

Increased digital offerings – London and Milan

During the COVID-19 pandemic, both London and Milan introduced virtual outpatient healthcare programmes to support patients through the various city lockdowns. The cities also plan to expand their telehealth infrastructure in the future. Other cities, including Phoenix, Arizona, USA; Rome, Italy; and Athens, Greece, either intend to continue their ramped-up online government services as the pandemic eases and/or plan to keep a proportion of city staff working from home (C40 Knowledge Hub, 2021b).

Programmable urban spaces: These increase compactness and promote mixed uses, allowing more people to live close to services. They are achieved by:

- Encouraging designs that provide spatial, engineering and structural flexibility for adaptable spaces that offer different uses on or near ground floors.
- Planning flexible land use and building use controls for efficient and transparent governance using digital technologies.
- Meeting the needs and desires of communities through optimised building density.
- Creating temporary uses – these may involve bringing activity to an area quickly, providing opportunities to trial and test uses, helping to shape the character of a local area, providing space for start-ups, and others.

Flexible schools – Paris and New York

Paris is making school playgrounds green and granting access to residents outside of school hours for recreation, community gardening and as even to act as a refuge from the summer heat. Paris is also building its first zero-carbon neighbourhood, with 100% of the spaces designed to be reversible and adaptable for different uses. Meanwhile, many public schools in New York City are allowing food stalls and farmers' markets to use their parking lots and schoolyards on weekends (C40 Knowledge Hub, 2021).

Activated public realms: These create active and pleasant public realms and streetscapes for use by pedestrians and that support local economies. They involve implementing a planning and land use regime with minimal active and street-facing uses at grade.

Ground Floor Code – San Francisco

In 2014, assisted by the advocacy group Livable City, San Francisco revised its planning code to make ground floors more active and pedestrian friendly. The Ground Floor Code reforms included:

- A requirement for active use to a depth of 25 feet from the street frontage;
- An increase in the minimum height of floor spaces to 17 feet to develop quality retail and leisure units;
- The removal of parking spaces in TOD housing, increasing public space and the visibility of active use;
- Implementing flexible zoning to allow small retail spaces in traditional "production, distribution and repair" zones, and to allow some production in commercial zones. This helped diversify use mix, which generated more activity throughout the day.

High-density and shared use spaces: These support the creation of privately- or community-run workspaces and communal spaces in multi-level residential buildings. These spaces are nearby, co-owned and cared for by residents. This practice fosters the creation of multi-purpose spaces – maker spaces, common living rooms and co-working hubs, for example – that support "work-near-home" functions, communal libraries and the sharing of services among neighbours.

The Fellehus in Vallastaden – Sweden

40 different developers were invited to build 1,000 homes on a 7.3ha plot of land with the aim of creating "social sustainability". This project produced both urban variety and a sense of community. The Fellehus delivers an updated concept of community space, as it is co-owned and cared for by residents and provides for different levels of commitment.

Open Workspaces Guide – London

Open workspaces are places where businesses and professionals reduce costs by sharing spaces, facilities, and/or specialist equipment. They are managed and run by "workspace providers" with a range of social and commercial aims and that specialise in various sectors. Open workspaces typically offer a variety of different payment structures to their users. Examples include co-working spaces, incubators, artist studios, labs, and makerspaces (Greater London Authority, 2015).

2.3 Multimodal Transport

2.3.1 WHY do we need multimodal transport for increasingly connected cities?

Hong Kong's public transport system currently comprises five different modes: metro rail, bus, minibus, tram, and ferry systems in addition to private vehicles and taxis. With Hong Kong's public transport system accounting for around 90% of passenger trips a day, disruptions to this critical infrastructure system can cause a cascading effect on the city's economic productivity and social activities (Chopra, 2020).

An efficient public transport system will also be crucial for the development of Lantau Tomorrow, as it is expected to connect its future occupants to other CBDs in Hong Kong. To achieve this, the future site will need to rely on multimodal transport.

Hong Kong's current multimodal transport system requires enhancements to provide physical connectivity between various types of vehicles (e.g., rail, ferries, automobiles, and public transit vehicles) as well as a connectivity between a comprehensive infrastructure and smart solutions such as mobile devices. According to Professor Jiangping Zhou, HKU's Transport Planning expert, stakeholders of Hong Kong's major rail, water, and road transport modes are currently fragmented. Additionally, the predominant means of travel in the area continues to be monomodal transportation.

Monomodal transport is incompatible with other transport systems due to its lack in physical connectivity between different modes of transport. Citizens are sometimes forced to still switch from a private to a public mode of transport. This leads to high carbon emissions and other environmental issues, as well as increased cost of waiting, parking, and changing modes of transport.

Fortunately, proposed transport projects for Lantau Tomorrow Vision are already underway, with feasibility studies expected to be completed by 2023. The proposals include railway improvements, specifically an extension of the Mui Wo metro line's western tip to the North Lantau area. To decarbonise and diversify the transportation options, the proposal will also include the deployment of green/electric buses.

The multimodal transportation system can also be enhanced through the integration of innovative technologies. These can include mobility as a service (MaaS) platforms, other green transport solutions, and the introduction of autonomous vehicles.

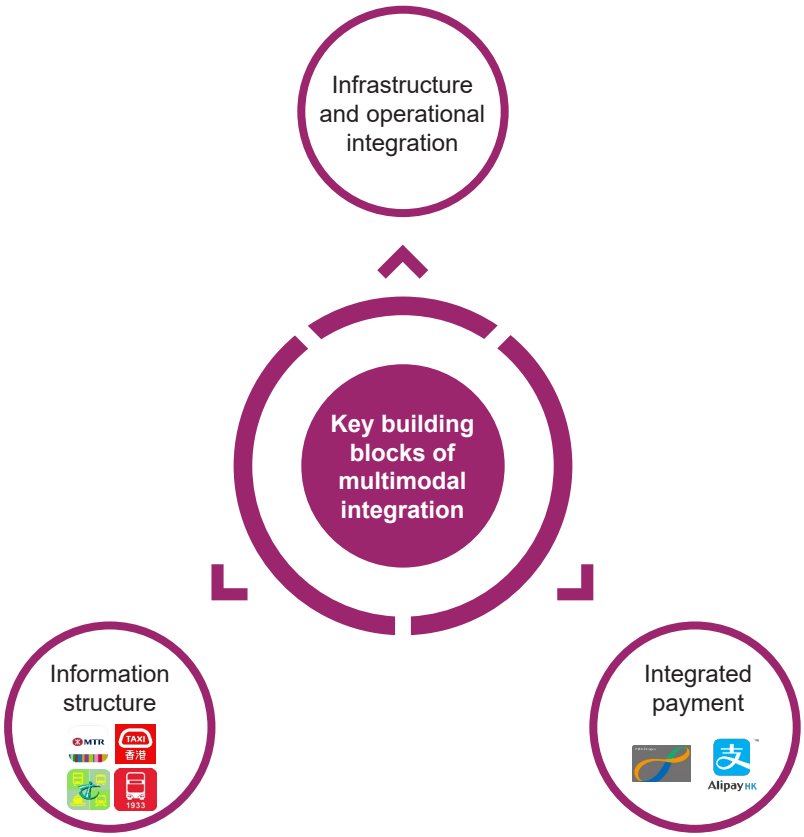
Collaboration is key to enable information-sharing and supportive regulation for the success of the project. Stakeholders must coordinate closely with governmental bodies, infrastructure owners, transport operators, and engineering and construction companies.

2.3.2 WHAT are the key attributes of multimodal transport that supports its integration with future infrastructure and facilities?

Multimodal transport can solve the common challenges and scenarios that monomodal transport providers are now facing. It can help the citizens save their time spent on parking cars, waiting in line, hopping on to the next ride, and vice versa, and eventually improve their daily travel experience and overall wellbeing of the commuters. In order to serve more riders with reliable mobility in their communities, multimodal transport is expected to be integrated with the infrastructure and facilities to improve the accessibility and the flexible mobility. The key building blocks of multimodal integration are:

- Infrastructure and operational integration. Different modes of transport are linked through a physical and an operational infrastructure.
- Information structure. A data-sharing platform based on blockchain technology is at the core of efficient transport. It provides real-time information to passengers and improve operational safety.
- Integrated payment. Integrated ticketing and payment solutions such as Octopus cards provide easier access to different transport modes, thus improving customers' experience.

Figure 1 Key building blocks of multi-modal integration



As illustrated in Figure 1 and in Table 1, Hong Kong already has two of the building blocks in place, i.e., information structure and integrated payment. This suggests that Hong Kong is already on track to achieve integrated multimodality. Nevertheless, the city must strive to achieve infrastructure and operational integration, the third building block, to seamlessly connect the different modes of transport in the city. Cities (i.e. London, Singapore, Paris) are moving towards advanced multimodal mobility by strengthening the data availability, technology readiness, and engagement of both public and private sectors (TheCityFix, 2014).

Future opportunities for Lantau Tomorrow lie in the integration of the public transport with flexible mobility solutions such as autonomous vehicles, e-scooters, bicycles, and other green transport solutions.

Table 1 Multimodal public transport in leading urban cities (TheCityFix, 2014).

City	Multimodal transportation modes	Info-structure elements	Integrated payment solutions	Future considerations
Hong Kong	Metro, light rail, bus, mini-bus, trams, taxis, ferries	MTR mobile app, KMB app, HKTaxi app, passenger information display systems	Octopus card, Alipay HK	Other flexible active mobility solutions such as autonomous vehicles, e-scooters, bicycles etc.
London	Metro, bus, light rail, trams, taxis	iBus, Web and mobile information systems	Oyster smart card	
Singapore	Metro (MRT), bus, light rail, taxis	Web-based and mobile (How2Go) information systems	EZ-Link, NETS FlashPay	
Paris	Metro, trams, bus	IMAGE project (real time traffic information)	Navigo pass	

2.3.3 HOW can we use multimodal transportation in Lantau Tomorrow Vision?

The success of a multimodal transport development depends on the supplementary transport infrastructure and facilities. A multimodal interchange hub is a place where different modes of transport are linked together within a single facility. It enhances transport solutions through better coordination of systems, reduces passengers' journey time, enhances green space, and provides greater convenience for the.

Currently, there is no standardised guidance in Hong Kong that applies to the construction of transport interchange hubs. The development of these interchange hubs is carried out by Government departments and agencies to achieve various functions. The UK Guidance of Inclusive Mobility in 2021 can serve as a reference that covers best practice in design of transport buildings. In the Guidance, a comprehensive set of measurements of facilities and access to/within facilities (Department for Transport, 2021). These requirements apply to provisions in the pedestrian

environment and in transport-related infrastructure such as bus stations and stops, airports, and rail stations.

Additionally, emerging modes of urban mobility such as bicycle-sharing, e-scooters, and autonomous vehicles must be integrated into the design and planning of the facilities. Infrastructure supporting these modes of transport, such us additional parking space and charging stations, must be considered.

> ***Hong Kong doesn't have real intermodal hubs, only co-located transport facilities, like MTR and buses. New developments such as Lantau Tomorrow are an opportunity to change that.***
>
> ***Oren TATCHER***
> *Principal, OTC Planning & Design*

Oren Tatcher of OTC Limited noted that customer experience during Hong Kong's transport transition looks promising but can still be improved. One underlying issue is the links between stations that become overcrowded during peak hours. This is due to the city's large population that necessitates a large volume of passenger transfers. To improve this, project developers must consider redesigning foot traffic sections to create adequate space for other needs of pedestrians. Examples are additional spaces for walkways, bicycle lanes, and safety islands.

Case Study
Integrated transportation facility (Miami Central Station, USA)

Miami Central Station is a mixed-use railroad station. It is one of the country's most dynamic transportation centres and serves an estimated 12 million travellers (SOM, 2014). The station includes railway lines that are within walking distance of other modes of transport such as buses, light rails, and metro lines. As illustrated in Figure 2, the station uses a skyway to connect multiple platforms of light rail lines. It also includes access to buses and private vehicles.

Miami Central Station provides users with easy-to-follow signages to regulate passenger flow and enhance user experience. To achieve effective transit, the following principles were considered during the project's design and pre-construction stage:

- Clear information on passenger pathway
- Continuous information until destination
- Signage adapted for persons with disabilities.

Additionally, Miami City authorities invested in the development of green spaces surrounding the station to form pedestrian-friendly areas and reduce carbon emissions.

Encouraging walking for transfers

The integrated transport hub forms a continuity point of transport, commercial areas, and public space. The proposed development of walkability enhances the availability, visibility, and convenience of the inter-station transit. In the final design, Miami Central will be directly connected to the Government Centre Station, another multimodal interchange hub, via a pedestrian bridge over NW 3rd Street. Diversifying the transport modes in the downtown area will thus increase travel capacity.

Key takeaways for Lantau Tomorrow

Developers of Lantau Tomorrow must consider the development of a sustainable and energy-efficient interchange hub in the future site. Apart from the operational requirements of the hub, developers must consider integrating people-centric provisions such as adequate walkways and waiting areas to manage foot traffic and minimise commuter bottlenecks. These logistical decisions also help cut transit time and, in the process, reduce operational costs. In the long term, the interchange hub will be instrumental in encouraging people to transition away from private vehicles, reducing congestions, and improving air quality in the area.

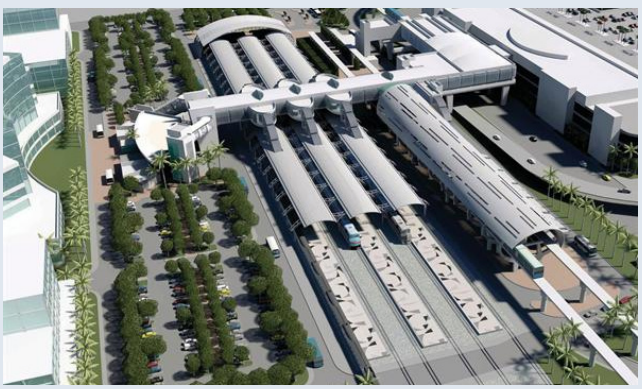


Figure 2: Site plan of Miami Central Station connected to light rails

Case Study
Setting a vision for sustainable multimodal transport (Virginia, US)

Fairfax County is home to more than one million people, around 13% of Virginia's population. Every day, 68,000 regional travellers pass through the city without stopovers. According to the 2015 City of Fairfax Multimodal Transportation Survey, about two-thirds of residents drove alone to work and expressed a desire to have the option to travel by some other means such as bus, metro rail, bicycle, or walking.

The Fairfax County Department of Transportation carried out a separate study in May 2018 on multimodal transport on highways. The study sought to determine the cause of traffic congestion in Fairfax which has limited the inter- and intra-city connectivity and reduced the level of road safety for drivers and pedestrians. To address these, Fairfax developed the City of Fairfax 2035 Comprehensive Plan, a multimodal transport plan adopted by the City Council on 12 February 2019. It envisions five activity centres supporting a mix of land uses with significant multimodal transport access. The goal is to provide Fairfax residents with more viable options for travel outside of personal cars through the integration of different modes of transport in the area.

The plan also incorporates sustainability measures by including flourishing green spaces to make the future city a vibrant and liveable place. To encourage sustainable multimodal transport, the key strategies include the following (Government of Fairfax County, 2020):

- Promote further dense, transit-oriented, and mixed-use development to allow residents and employees more opportunities to walk, bike, and use transit and reduce automobile dependency to meet their daily needs

- Further develop and expand the multimodal network by a) increasing the number of routes and frequency of service connecting urban hubs and amenities, b) enhancing services on highly travelled corridors to reduce car volume in those corridors, and c) improving pedestrian and bicycle access to transit services and activity centres

- Educate, encourage, and incentivise employers to continue to offer telecommuting options to their employees and use other transport demand management opportunities to reduce peak-hour traffic and automobile-dominated travel

- Facilitate more active transport (walking and biking) by adding, improving, and maintaining sidewalks and shared-use paths; enhancing bike facilities throughout the county; addressing first mile/last mile challenges; and educating the community on how to increase their use of active transport modes safely

- Advocate for and implement policies that motivate people to reduce their use of single-occupancy vehicles, including travel demand management (TDM), reducing minimum parking requirements, managing parking and roadway pricing, and other TDM financial and non-financial programs and policies.

A "Link+Place" street typology to support the integration of multimodal mobility with infrastructures

The multimodal mobility systems will be designed to achieve the overall vision of Comprehensive Plan in 2035. The multimodal mobility plan is also seeking support from the government. The policies and processes are under discussion with civic leaders, community members, and other stakeholders and are expected to be adopted based on the community's fundamental values and to advance the overall vision for sustainable transport (Government of Fairfax County, 2021).

In addition to the viable mobility choices that the city can provide for its citizens, the local authority also considers the efficient use of land and well-designed transport infrastructure along with its impacts on the feasibility and attractiveness of mobility choices. Better street guides will be made through the adoption of a "Link + Place" street typology appropriate to the streets and infrastructure.

The "Link + Place" street is designed and operated to prioritise people's needs (e.g., safe arrival to destinations and time saving) in designing the streets. It requires considerations on the role each street will serve, such as a sidewalk, bike lane, or a public transport drop-off point. Other considerations include frequent and safe crossings, median islands, clear signals with contrasted colours, curb extensions, narrower travel lanes, and roundabouts (Government of Fairfax County, 2021). In the Comprehensive Plan, each city street is listed as a particular type and takes into consideration bicyclists and pedestrians.

Shared mobility device programme

E-scooters and bicycles are a popular form of environmental-friendly alternative to cars. In August 2021, the Shared Mobility Device programme was implemented in Fairfax County, including 600 dockless e-scooters. The e-scooters are considered a safer and ideal transport for short trips within the county because:

- It has a maximum speed of 10 miles per hour on the street
- Riders may use e-scooters on highways, sidewalks, shared-use paths, roadways, or crosswalks in Fairfax County unless prohibited by signage
- Once the trip is finished, users park the e-scooters in a dedicated location.

The e-scooters are linked to the operator's mobile app through which the e-scooters can be unlocked for riders to use. This marks a step toward the integration of transport with information infrastructure. The deployment of e-scooters and data security features of the mobile app are managed by the Fairfax County's Department of Cable and Consumer Services (Leayman, 2021).

Key takeaways for Lantau Tomorrow

Lantau Tomorrow can benefit from an integrated infrastructure in several ways. Firstly, building an integrated infrastructure can increase the overall capacity of urban transport hubs and its amenities through its expanded routes and increased trip frequency. Through active transport options such as e-scootering, the infrastructure also mitigates transport's impact on the natural environment. It can also leverage smart solutions to connect fragmented modes of transport and streamline the travel experience for passengers. Incentivising transport operators may also be considered in the planning to engage more stakeholders.

Mobility in Lantau Tomorrow

A strong multimodal transport system offers several benefits to Lantau Tomorrow. Apart from supporting Hong Kong's growing population and urbanisation needs, the system facilitates a shift away from monomodal transport and high-emission vehicles through its efficient, expansive, and well-connected mobility services. As a result, operational costs can be reduced, and the environmental impact of transport can be minimised. On the other hand, the aging population is a pressing issue that Hong Kong is currently tackling. As citizens eventually relocate to the new site, Lantau Tomorrow will likely be faced with the same challenge. Project developers must consider the ageing population when designing pedestrian provisions such as walkways, footpaths, and sidewalks. Well-designed public spaces will impact behaviour, as they promote an active lifestyle among seniors. Considerations include:

- **Easy-to-read signs.** Signage with bright and contrasted colours will help seniors easily navigate their surroundings.

- **Wheelchair accessibility.** Adding ramps to pavements will facilitate easier mobility and encourage independence among seniors and other citizens relying on wheelchairs.

- **Lighting, washrooms, and other public facilities.** Placing enough lighting on the roads will help seniors and individuals with visual impairment to navigate their way around safely. Seniors with urinary problems will also benefit from accessible washrooms in strategically placed areas.

This multimodal transport system can be further supported by emerging technologies such as autonomous vehicles and digital solutions such as MaaS and mobile apps to provide assistance to the citizens. With the right regulatory framework in place, combined with comprehensive operation and management infrastructure, the system will significantly change the way future residents will move within Lantau Tomorrow and the rest of Hong Kong.

2.4 High Density High Liveability

2.4.1 WHY do we need to achieve "high density high liveability" spaces?

Lantau Tomorrow's main liveability challenge is having a large target population and a small target area.

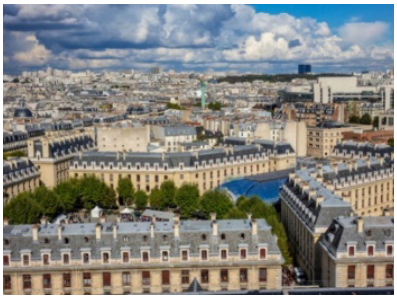
The first phase of Lantau Tomorrow will focus on the Kau Yi Chau (KYC) artificial islands, which will cover about 1000ha of reclaimed land (HKSAR Development Bureau, 2019). Compare this to Central and Western district at 1255ha, Wan Chai at 1064ha, and Kwun Tong at 1128ha.

It is estimated that the KYC islands will accommodate between 150,000 and 200,000 housing units, resulting in a population of around 400,000-700,000 people within the 1000ha, a density of around 40,000-70,000 people per sq.km – this is higher than that of Kwun Tong, currently Hong Kong's densest district, with a density of 54,495 people per sq.km (HKSAR Population By-Census, 2016).

The difference between actual and perceived density

The densest district in Paris, the 11th arrondissement, has a similar density (42,000 people per sq.km) to Yau Tsim Mong in Kowloon, Hong Kong (45,000 people per sq.km) (HKSAR Population By-Census, 2016). However, the usual height of buildings in Paris is around six or seven storeys, versus 20 stories or more in Hong Kong. Paris' 11th arrondissement presents a model of low-rise, high-density development, in which buildings and the human-scaled urban spaces in between may be better integrated and connected with one another. The high-rise urban core of Hong Kong, on the other hand, is a model of a vertical concentration of density.

Lantau Tomorrow presents opportunities to create highly liveable neighbourhoods with a hybrid of the two models, producing diverse neighbourhoods with high urban liveability.



Paris' 11th arrondissement

Mongkok (Yeung, 2016)

> ***"High density neighbourhoods: better to talk in terms of quality rather than numbers."***
>
> ***Donald CHOI***
> *President of Hong Kong Institute of Architects*

2.4.2 WHAT are the key attributes of high-density high liveability places?

Interactive mixed uses

The low-rise, high-density model provides more chances for synergy and interaction between different uses in neighbouring buildings. This speaks to a general social preference for convenient ways of navigating between locations. When a target destination falls within their line of sight, an urban dweller is more motivated to reach that destination on foot. Another aspect is convenience of circulation – people may be reluctant to climb more than two flights of stairs. We can refer to the design of shopping malls as an example, where a key design focus is circulation – malls provide visibility and ease of access spanning a few floors that are usually connected by escalators. We see that ease of circulation increases the chance for interactions in low-rise buildings.

Sky-rise greening

Another opportunity presented by low-rise buildings is the possibility to use roofs as extensive gardens. These roofs can be used as an elevated "vegetated street", complete with city views. Such buildings are often called "landscrapers". One of the first successful prototypes of this typology was the High Line in New York City. An elevated linear park along a disused rail track, the High Line became a symbol of contemporary landscape architecture and opened doors to the development of similar projects in other cities.

The provision of public spaces at the ground floor

The Brewery Redevelopment's "Horizontal Skyscraper" (Herzog & de Meuron, 2018)

Yet another opportunity presented by low-rise buildings is that they can be raised above ground, creating public open space at ground level. Commonly, residents living on the ground floor of buildings are the most exposed to noise – a problem that can be mitigated by leaving the ground floor open to public use only. This open ground remains covered by a "roof" formed from the floor above, ensuring shade and protection from the rain – features that are highly relevant in subtropical climates. These ground floors public spaces also naturally create more social interactions.

However, landscrapers also sometimes face issues related to complicated circulation, fire safety and structural considerations which must also be taken into account.

> ***This may be the last opportunity for us to create a large landmass in Hong Kong waters within the administrative boundary.***
>
> ***Prof. KK LING***
> *Director of the Jockey Club Design Institute for Social Innovation at The Hong Kong Polytechnic University*

2.4.3 HOW can we use high-density high liveability places in Lantau Tomorrow Vision?

Focus on integrating greenery

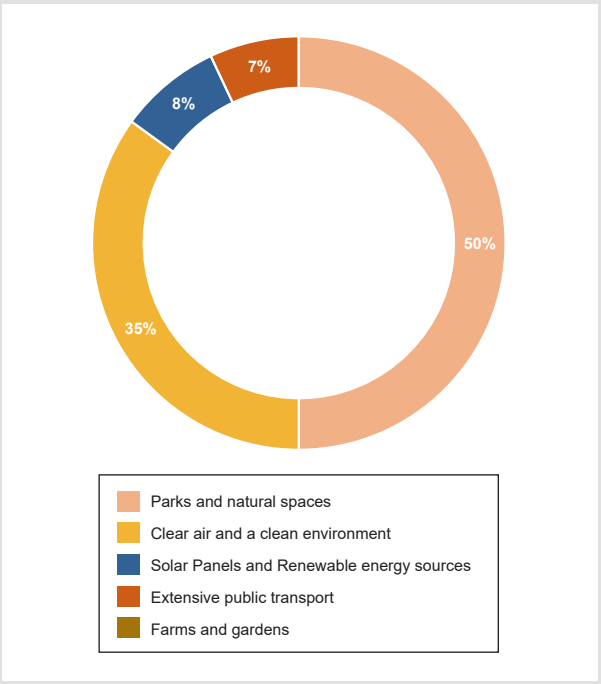
Case studies, such as the Songdo International Business District, provide some insights into high-density, high liveability developments. Many cities prioritise implementing such green features as energy optimisation or renewable energy sources. As important as these initiatives are, providing greenery and integrating built assets with the natural environment have an immediate and more direct effect on the quality of life of city residents.

Songdo Business District – South Korea

This district is built on 600ha of land reclaimed from the Yellow Sea off Incheon, South Korea. (WSP, 2012). The development is part of "The Framework Act for Low Carbon Green Growth" initiative that was meant to promote a shift towards a low-carbon driven economy. More than 40% of the district's area is reserved for green spaces, bicycling lanes, charging stations for electric vehicles, and a waste collection system that eliminates the need for garbage trucks (Lee, 2012). It also provides LED streetlights and walking lights, solar energy supplies, geothermal heating and cooling facilities, and rainwater storage facilities.

In 2020, a survey was conducted in South Korea to determine citizens' perceptions of a hypothetical green city and what its key characteristics may be (Lee, 2012; NewCities, 2014).

Songdo Business District (WSP, 2022)



South Koreans' impressions of a green city (Noh, 2020)

When asked about the potential features of a green city, most respondents (50.4%) chose parks and open spaces, while only 8% selected solar panels and renewable energy resources. The survey gives us an interesting insight: that people perhaps do not view renewable energy as a key characteristic of a green city. This may be because such initiatives do not directly affect the lives of citizens on a daily basis, or it might take a longer time for them to notice the effects (Noh, et al., 2020).

Create car-free neighbourhood: Providing tree-lined, pedestrianised streets and planted areas brings more nature into a city.

Tengah – Singapore

Sprawling over 700ha, Tegah will provide the first car-free town centre in the city-state. Roads for essential vehicles will run beneath the town centre, creating a pedestrian- and bicycle-friendly area with retail and recreational facilities ((Housing & Development Board (Singapore), 2021a).

Tengah will consist of five housing districts, each of which will have a unique character. These districts will be comprised of new homes, with public housing making up more than 70% of the units. The design will allow residents to seamlessly integrate their daily activities with the natural environment (Housing & Development Board (Singapore), 2021a).

(Housing & Development Board (Singapore), 2022)

Computer simulations were run to minimise heat gain and optimise wind flow in the design, while smart lights will reduce energy consumption. An automated waste collection system will transport rubbish through a conveyance system. Centralised cooling systems will regulate temperatures in homes, which will be more energy efficient than individual air-conditioning units (Housing & Development Board (Singapore), 2021a).

Environmental, topological and hydrological surveys were conducted to design a forest corridor and retain existing vegetation. The 5km-long, 100m-wide forest corridor will link to a larger network of greenery. At the heart of the town will be a 20ha central park integrated with water bodies. On the human level, AI, software systems and a mobile application will help residents monitor and optimise their energy use (Hwang & Feng, 2016).

> ***Lantau Tomorrow should be designed around mobility, with good coverage of MTR and bus links to other parts of HK, and with local mobility focused on ground-level walkability and last-mile services like shared bikes or autonomous shuttles.***

Oren TATCHER
Principal, OTC Planning & Design

Define the right urban block and its form

The contrast between Hong Kong and Paris illustrates that high-density living does not always mean vertical living: a compromise between towers and high-density, low-rise living is possible while also emphasising people's lifestyle preferences.

Provide inclusive neighbourhoods and economic opportunities

High liveability is often related to inclusive living – creating a place for everyone where everyone counts, and where work-life balance is achieved spatially, socially and economically. A greater variety of industry sectors can also be included in a typical local neighbourhood, which can in turn bring a diversity of uses and potentially lower rents.

These industries could include areas where Hong Kong has a track record such as meetings, incentives, conferences, exhibitions (MICE), especially those linked to sports and the arts. Areas that the government is promoting also need to be included to accommodate the talent and space requirements for research facilities, laboratories, teaching, and campus life.

> ***There is an opportunity to revive industries that were left behind because of a shortage of land. Sectors that could be revived include: creative industries, education, sports, healthcare, technology, and MICE events.***
>
> ***Ryan IP***
> *Our Hong Kong Foundation, Representative*

2.5 Inclusionary Housing

2.5.1 WHY do we need "inclusionary housing"?

To avoid social segregation caused by stigmas attached to public housing in Hong Kong

Social housing is generally perceived as being "low-income" and for "low-opportunity communities". Common terms associated with social housing in Hong Kong include "sink estates", "zones of criminality", "drug infested", and other inaccurate and scornful phrases (Denedo & Ejiogu, 2021). Social housing estates in Hong Kong house 45% of the population, approximately 3.4 million people, of which nearly one-third are rental units (HKSAR Housing Bureau, 2021). These derogatory phrases have led to a strong divide between the residents of so-called "higher quality" housing stock and the rest of the population, based on the high price of non-social housing. Any new community should avoid perpetuating these harmful stereotypes.

To create better psychological well-being

Stable, affordable housing helps to reduce the frequency of unwanted moves from one place of residence to another. Mixed-income housing – which also mixes the young and the elderly together – can bring enormous benefits to all groups. Empirical evidence demonstrates that the number and quality of a person's social ties have a direct impact on their overall health. The most striking evidence comes from prospective studies of mortality across industrialised nations which consistently show that individuals with the lowest levels of involvement in social relationships are more likely to die than those with greater involvement (Umberson & Montez, 2010; House, Landis & Umberson, 1988).

To deliver economic benefits and increases in personal income

A key argument for mixed-income developments is that attracting higher-income residents back to disadvantaged inner city and urban renewal areas can facilitate the establishment of social networks that produce social capital (Joseph et al, 2007)

> ***Hong Kong already has the smallest living area in Asia, do we want to continue to live like this? As affluence grows, don't we want to give people more space?***
>
> ***Donald CHOI***
> *President of Hong Kong Institute of Architects*

> ***In Singapore, 81% of the population lives in public housing from HDB.***
>
> ***Jacqueline HUI***
> *Our Hong Kong Foundation, Representative*

2.5.2 WHAT are the attributes of inclusionary housing?

Cross-generational integration

The population of Hong Kong – along with many other cities – is ageing. Cross-generational living delivers several mutual benefits. A recent University of Michigan-AARP survey revealed that one-third of people aged 50 to 80 reported feeling lonely, and social isolation has been proven to be detrimental to one's health (AARP Foundation, 2018). In the past, it was common practice for older parents to live with their children and grandchildren. Elements of this old model can be used in our modern reality to create social gathering spaces with cross-generational appeal, where people can engage in:

- Activities that create social bonds – part of communal living involves forming communities based on shared activities rooted in social interaction, including concerts, games, speeches, painting or singing classes, gardening, and many others;

- The design process for residential buildings – participating in the design, planning, development, and management process – through consultation and through other means – helps create a sense of ownership and allows for the development of assets that respond to the needs of residents and users, giving them a say in creating exactly what they need according to their lifestyle priorities.

> ***"Across the whole life-span of Lantau Tomorrow, potential occupants and occupants should be engaged in planning, construction, operations, and management of the new city."***
>
> ***Albert CHEUNG***
> *Chairman of Hong Kong Green Building Council*

2.5.3 HOW can we use inclusionary housing in Lantau Tomorrow Vision?

Increase the efficiency of public-private partnerships (PPPs)

Aiming to increase the efficiency of housing development through collaborations between the government and private companies, PPP procurement offers a number of advantages. One of these is speeding up construction, which in turn results in greater building efficiency through economies of scale. Since the 1990s, PPPs have become common in the UK – of the 32 councils in Greater London, 18 have engaged in PPPs.

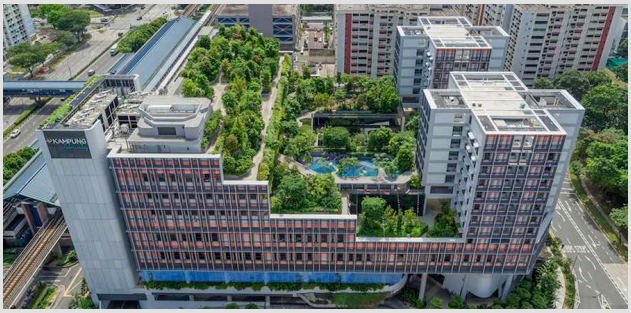
Easing financing through private finance initiatives (PFIs)

A PFI is a way of financing public sector projects through the private sector. Under PFIs, a private company handles the upfront costs, instead of the government. The project is then leased to the public and the government authority makes annual payments to the private company.

Kampung Admiralty – Singapore

Kampung Admiralty is built on a 0.9ha site with a height limit of 45m. It introduced new types of spaces that allow intergenerational bonding and promote active ageing in place. This "vertical village" has a community plaza at the lower level, a community park with apartments for seniors at the top level and a medical centre in between, creating three diverse programmes and proximities of healthcare, social and commercial services and other amenities to foster intergenerational interaction. Residents do not need to travel long distances to consult a specialist or to undergo simple procedures.

The facilities are arranged to put the central focus on the community centre and the community plaza. The shaded greenery and facilities invite the residents to come together to chat, exercise and maintain community farms. Senior care and childcare facilities are located side by side, bringing different generations together to play, exercise and eat. Outdoor sitting facilities located next to apartments make it easy for residents to interact with neighbours.



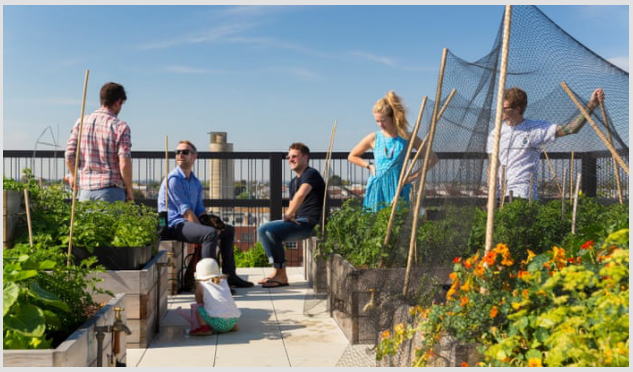
Kampung Admiralty (Woha, 2018)

Co-living is not a new concept, but it is now being specifically applied by developers aiming to address cases of social isolation (Corbin, 2020; Krüskemper, 2012). In Singapore, respondents to the One Shared House 2030 survey said the ability to socialise was the biggest benefit of co-living. The survey also showed that the trend is not only for the young: elderly respondents want to stay close to people who could help them in an emergency, for example (McCord, 2021). Since the Kampung Admiralty residents were highly involved in the development process from the start, communities were formed before people even moved in. Afterwards, they were naturally drawn to sharing communal facilities like the common rooftops with gardening facilities.

The Nightingale housing model – Australia

Nightingale is a new type of community-focused, environmentally conscious housing. The Nightingale uses “zero profit on costs” as its financial model. Housing is funded by small private developers, with no involvement from marketing teams and real estate developers – this makes this private housing much more affordable. Future residents are involved in the design process from the early design stages to completion.

The original goals of the project were to build a place where people would like to live and call home and unite a group of people with similar values to build a community.



The Commons. Andrew Wuttke (The Conversation, 2016)

Creating communal living participation schemes

The aim of such schemes is to set certain membership criteria for certain areas. Concessionary fees are tied to a specific lifestyle offered in the area, which then create collective community benefits (Hadden & Hanna, 2019).

The Blue House Cluster Revitalisation Scheme – Hong Kong

This scheme was launched in 2009. A major highlight was its "Good Neighbour Scheme" that set up criteria for acceptance as a resident of the Blue House, with a key criterion being giving an explanation of how one would contribute to the community. The goal of the project was to build a co-living model that fosters a sustainable culture of community care and integration.

Today, there are ample public spaces in the Blue House Cluster – outdoor connecting footbridges, and several open-air spaces where residents and the wider community can interact. Various communal activities are hosted year-round: painting classes, concerts, movies nights, open talks, and open markets – all of which help to build bonds between residents (Young Planners Group, 2017).

The Blue House (Viva Blue House, 2022)

Encouraging sustainable, healthy communal living

Promoting a sustainable lifestyle while providing relevant and appropriate facilities (Falk & Rudlin, 2018).

Via Verde – New York

This was the winning entry in the international New Housing New York Legacy Competition. Via Verde reflects a commitment to create the next generation of social housing. A key element is a garden that provides an organising focus for the community. The garden starts at grade and spirals upwards, becoming a promenade for the residents while creating opportunities for active gardening, vegetable and fruit cultivation, and social and recreational gatherings. The ground level integrates retail shops, a health centre and live-work units, providing a mixed-use experience.

Via Verde (Dattner Architects, 2022)

3 DRIVING INNOVATION AND MODERNISATION

3.1 Overview

This section outlines key findings for how Lantau Tomorrow can be designed to drive innovation and modernisation through tokenised neighbourhoods, application of digital tools and modern systems, workforce digitisation, and mobility as a service (MaaS).

3.2 Tokenised Neighbourhoods

3.2.1 WHY do we need "tokenised neighbourhoods"?

- Token economies (systems that use positive reinforcement to target behavioural change) have large potential transformative value (Benlian et al, 2018) that can positively affect businesses – for example, by enabling novel business models and increasing the transparency of business processes; and positively affect people's daily lives – for example, by enabling the monetisation of personal data instead of having it be just given away, and giving out rewards for participating in a digital ledger.

- A digital tokenised neighbourhood, powered by a network of sensors for indoor comfort and adaptations and a token economy, aims to reinforce and build desirable behaviours in a blockchain ecosystem (Dennis, 2022).

- **Cryptographic tokens** are programmable assets or access rights, managed by smart contracts in an underlying distributed ledger on a blockchain network (Cryptopedia, 2022a).

- **A blockchain** is a public, digital, decentralised ledger of transactions, or "blocks", between two parties, or peer-to-peer (P2P), recorded without a trusted intermediary in a way that is difficult to hack and/or alter (@samajammin, 2022). Blockchain technology is open-source, permissionless and the basis for Web3 internet.

    - Web3 decentralised applications (dApps) are built on decentralised P2P networks like Ethereum and IPFS. These networks are built, operated and maintained by their users; they are self-organising and lack a central point of failure. Anyone can build upon this shared infrastructure.

    - Web3 compatible products and services can interact with smart contracts on the Ethereum blockchain (Dabit, 2021). Ethereum allows cheap and easy token issuance with a smart contract and provides a ready-to-use blockchain infrastructure.

    - To achieve a stable, secure decentralised network, participants are incentivised with tokens and compete to provide the highest quality services to all users (Mittal, 2020). These networks offer different services: computing, storage, bandwidth, identity, hosting, and web services provided by cloud providers.

- **Tokens can represent anything:** a store of value, or permissions in the physical, digital and legal worlds. Blockchain tokens combine access, security, and/or rewards (Voshmgir, 2019).

  They can be:

  - Access rights to an underlying economic value or property;
  - A permission to access someone else's property or services or a collective good – whether public (Bitcoin network) or private (an apartment rented by a private person);
  - A reward for actions conducted in a network, for example "proof-of-work" in the Bitcoin network, where network actors receive Bitcoin tokens when they perform security functions to keep the network safe.

- **Tokenised assets** can be transferred, exchanged or stored according to the digital platform or marketplace with which the asset's token was designed to be compatible (Cryptopedia, 2022b).

  - Cryptographic tokens can be easily issued and securely traded on a blockchain network without an intermediary or escrow service.
  - Fractional ownership tokens of physical assets (art, real estate, commodities, or SMEs for example) help improve the liquidity and transparency of assets that traditionally have low liquidity because there are generally held by a sole owner.
  - Security tokenisation gives companies more options for employee ownership, which in turn benefits corporations, employees and the economy at large. The idea is to compensate employees fully or partially with fractional ownership.

- **Social profit-seeking:** the most difficult part of designing a token economy is effectively eliciting the targeted action through incentives. It is important to identify the loopholes that the incentive system might have and design the system so that individual profit-seeking actions are aligned with social profit-seeking. Again, tokens are well placed to elicit this:

  - Tokens facilitate collaboration across markets and jurisdictions as they are borderless;
  - Tokens allow transparent, efficient and fair interactions between market participants at a low cost;
  - The lower cost comes from dynamically validating each transaction. Currently, financial operations need trusted third parties for auditing. These are human resource-heavy, as domain experts are needed to avoid fraud.

The use of blockchain technology and tokenisation potentially offers a number of opportunities:

- **Keeping track of public tenders:** Automation of the public records-keeping process can create a reliable, transparent and verifiable way to manage cities, allowing developers to obtain permits quicker and more easily and allowing citizens transparent access to all records.

- **Keeping track of ownership.** Blockchain automation can create a clear record of the real estate market, factoring in all transactions, impositions and obligations. It allows individuals to keep track of the value of a property, how it is being used and gives them the ability to automatically transfer ownership. Property can be certified through records stored on the blockchain, which act as digital proof.

- **Increased efficiency of utilities.** Smart meters can make energy use more transparent and efficiently allocate energy to specified needs. Blockchain technology can ensure that no surplus is being produced and that no energy is being lost (Freewallet, 2022).

Government usage of blockchain technology

Estonia's government adopted blockchain technology for internet voting, online platforms for public consultation and citizen initiative submissions (e-estonia.com). Digital technologies can facilitate citizen participation in urban governance by overcoming the necessity for a physical presence at meetings, which is often inconvenient (Caadria2022.org, 2022).

The government of the UAE launched the Emirates Blockchain Strategy in 2021, aiming to shift 50% of government transactions onto a blockchain platform, ensuring the digital security of national document and transactions, reducing operational costs and accelerating decision making (U.ae, 2021).

> ***The most important consideration for the Lantau Tomorrow project is whether there is a multiplier effect from the different uses of technology and public policy. One of the key considerations is to use some of the newest technologies such as blockchain and perhaps 5G technology.***
>
> ***Daniel CHUN***
> *Vice President of Smart City Consortium*

> ***A token economy is not only a tool for work but also a reward.***
>
> ***MK LEUNG***
> *Principal Behaviourist of Behave*

> ***The challenge is to create a wider conversation about tokenised economies or societies, in terms of the role they can play in developmental change and how the upsides can be shared with citizens.***
>
> ***Bryant LU***
> *Founder and Chairman of Behave*

3.2.2 WHAT are the key attributes of tokenised neighbourhoods?

- **Empowered by blockchain** (see definition and explanation in section 3.2.1)
- **Various tokens have different utilities:**
    - Purpose-driven tokens are created using proof of a certain behaviour. They can also be used for reward or loyalty programmes. These tokens are created with smart contracts through applications.
    - Asset tokens and fractional ownership allow the creation of a tokenised digital twin of any physical asset or security.
    - Basic attention tokens (BATs) are locked and sent by advertisers with smart contracts. If users view the ads, the smart contract unlocks the BAT token to reward the user with up to 70% of the ad revenue. The publisher hosting the ad receives the balance to incentivise delivery of the content.
    - Lending tokens are smart contract-based credits with lower operational costs than traditional finance. Verification is made on the go. These P2P financial services require only a crypto wallet.
    - Stable tokens are a store of value, a medium of exchange and a unit of account that have a stable value against another currency or commodity. Central Bank digital currencies are a type of stable coin.
    - Privacy tokens ensure anonymity.
- Questions remain about scalability and viability:
    - **Regulatory uncertainty:** the absence of common regulations among jurisdictions, added to the borderless nature of blockchain technology make it challenging for institutions and investors to confidently embrace digital assets.
    - **Developing the blockchain infrastructure:** interested parties must develop their own blockchain infrastructure. This can be complicated from a security and compliance perspective, plus there is currently a major shortage of blockchain developers.
    - **Managing the complexities of intangible assets:** security tokenisation is relatively easy to understand for a tangible, profitable business. But when applied to less tangible goods like intellectual property or digital assets, it is more complex.
    - **Overcoming barriers to investor entry:** buying cryptocurrency is straightforward to someone already familiar with the process, but to the unacquainted, the barrier to entry is quite high. Managing token transactions with a wallet may be confusing to some new investors and may discourage people from taking part.
    - **Barriers to investor exit:** there are several issues relating to secondary markets for tokens.

> ***The city should contribute not only to its inhabitants, but to Hong Kong economy. We should also look beyond Hong Kong, in designing Lantau Tomorrow as a city that can also contribute to the Greater Bay Area development and its economy.***
>
> ***Albert CHEUNG***
> *Chairman of Hong Kong Green Building Council*

> ***There is no smart city without smart data. We need to plan now how data will be collected and used for future smart cities. Track and trace, tokenisation and the use of blockchain can help to build a tokenised neighbourhood in the next 15 years. Blockchain technology will lower the cost of tracking data for all smart features.***
>
> ***Daniel CHUN***
> *Vice President of Smart City Consortium*

> ***This strategy can be supported by creating multi-functional spaces and an inclusive community and by fostering the development of a technological ecosystem. Digital technologies can facilitate these actions.***
>
> ***Rosana WONG***
> *Vice President of Smart City Consortium*

3.2.3 HOW can we use tokenised neighbourhoods in Lantau Tomorrow Vision?

A. **Encouraging healthy, sustainable behaviours:** Use purpose-driven tokens to incentivise individual behaviours to contribute to collective, healthier outcomes:

- The “Lympo” application rewards exercise, with users continuously receiving tokens. This induces participants to integrate beneficial behaviours into their lives (Yoo, 2020).
- Other ideas include incentivising planting trees, removing plastic bottles from beaches, reducing food waste, and other healthy activities. Existing examples include: “Plastic Bank”, “Earth Dollar”, “Bit Seeds”, “Eco Coin”, “Earth Token”, and “Recycle To Coin”.

i. **Health care records:** Some years ago, Deloitte Consulting proposed that using a blockchain network for all Hong Kong electronic medical records may improve efficiencies and support better health outcomes for patients (Krawiec et al, 2016).

ii. **Incentivising CO2 emissions reductions:** People and organisations can work to reduce their CO2 emissions and receive a token which is created upon proof of these reductions. Depending on the design of the token, the CO2 rewards could be exchanged for other services provided by the organisation issuing the tokens, and would vary greatly. Tokens might be tied to the identity of a user (non-fungible), or they might be designed to be tradeable (transferable). They might be designed to expire after a while or have unlimited durability.

Government usage of blockchain technology

- "Vienna Kultur-Token," "Sweatcoin," or "Changers" – these tokens incentivise riding a bike, walking, or taking public transportation instead of using a car.
- The "Solar Coin," "Electric Chain," and "Sun Exchange" tokens incentivise the production or consumption of renewable energy.
- "Energi Mine" or "Electron" give out tokens every time people prove that they have used energy-efficient devices or turned off lights.

iii. **Incentivising social media contributions:** "Steemit" is a blockchain-based social network designed to incentivise content creation and curation. Any user can join and contribute for the public good. Contributors receive rewards for contributing to the underlying blockchain infrastructure, or for uploading or curating content on the Steemit website. These rewards are dependent on the number of posts and their popularity. As opposed to the Facebook or Reddit social networks, Steemit is collectively governed and maintained, and personal data is not exploited by one entity. Examples of other networks incentivising such contributions are "E-chat," "Akasha," "Minds," or "Golos".

iv. **Digital elections:** Startups like FollowMyVote develop blockchain technology that can be applied to elections.

B. **Property transactions:** Blockchain technology can be applied to a wide range of asset sales – real estate, cars, investment portfolios, and others. They can also generate asset registries that are transparent and accessible. Smart contracts facilitate rights management in the real estate industry, including the entire settlement process. Collective fractional ownership of physical goods or shares in an SME can be tokenised at a lower cost than in the client-server world and divided into tokens, which can then be traded on the open market. Examples include:

i. **An office building collectively owned by a co-working co-op:** The decision making can be collectively managed, with tokens granting voting rights. The co-working space could be tokenised based on usage rights, where members would have a right to use a certain share of the space;

ii. **Collective ownership of NGOs or grassroots initiatives:** A community of neighbours could buy and collectively operate a renewable energy-powered micro-grid, for example, as it is more feasible for a collective to cover the costs. A smart contract could send monthly revenue from the excess energy produced and sold to all members of the collective in proportion to the shares they own (Institutional Economics of DAOs).

iii. **Collectively owned taxis:** Fractional collective ownership tokens could allow several taxi drivers to collectively purchase a car instead of renting it. They could then split up the driving shifts and collectively cover the costs and revenues of buying, operating and maintaining the car. A smart contract could collect a portion of the revenues and allocate the expenses involved.

iv. **Manage the commons of a larger community and the right of individuals to the benefits from community-owned assets:** Both Norway and the US state of Alaska have passed on to their residents a share of their oil sales, either directly or in the form of wealth funds. Such a process could be tokenised to reduce settlement costs, while increasing transparency and accountability.

C. **Advertising, art, and entertainment:** Tokenisation could potentially resolve many of the inefficiencies of current systems: fractional ownership, provenance, digital rights management, settlement, and crowdfunding. Tokens can also create entirely new works of art.

i. **Advertising:** The “Brave” browser is a decentralised application that communicates with the Ethereum network and manages two tokens: BAT (the basic attention token) and the BAM (basic attention metrics). Users can be compensated for their time and attention and in turn spend these tokens on other online activities, such as tipping artists and content creators who provide free online content.

ii. **Charitable donations:** BAT tokens can also be used for giving charity donations to third-party organisations.

D. **Blockchain-based supply chains:**

i. Companies can use technology to track where recalled food products have been shipped and sold.

ii. BMW, Mercedes-Benz and IBM Blockchain are already providing private network solutions using blockchain technology to accurately track product supply chains (Forkast News, 2020).

iii. PlatON is an example of an enterprise in China’s automotive sector that integrates blockchain to improve efficiency (Forkast News, 2020).

iv. China Capital Logistics is a large automotive logistics company that teamed up with DBS Bank and Wanxiang Blockchain in 2018 to set up a platform that connects car manufacturers, exporters, logistics companies, and dealers. This has improved efficiency and transparency in their supply chain and helped facilitate financing from DBS (Forkast News, 2020).

> ***The New Space Economy underpins social connectivity and it is about the activity of downlink, data, products.***
>
> ***Daniel CHUN***
> *Vice President of Smart City Consortium*

3.3 Application of Digital Tools and Modern Systems

3.3.1 WHY do we need to apply digital tools and modern systems?

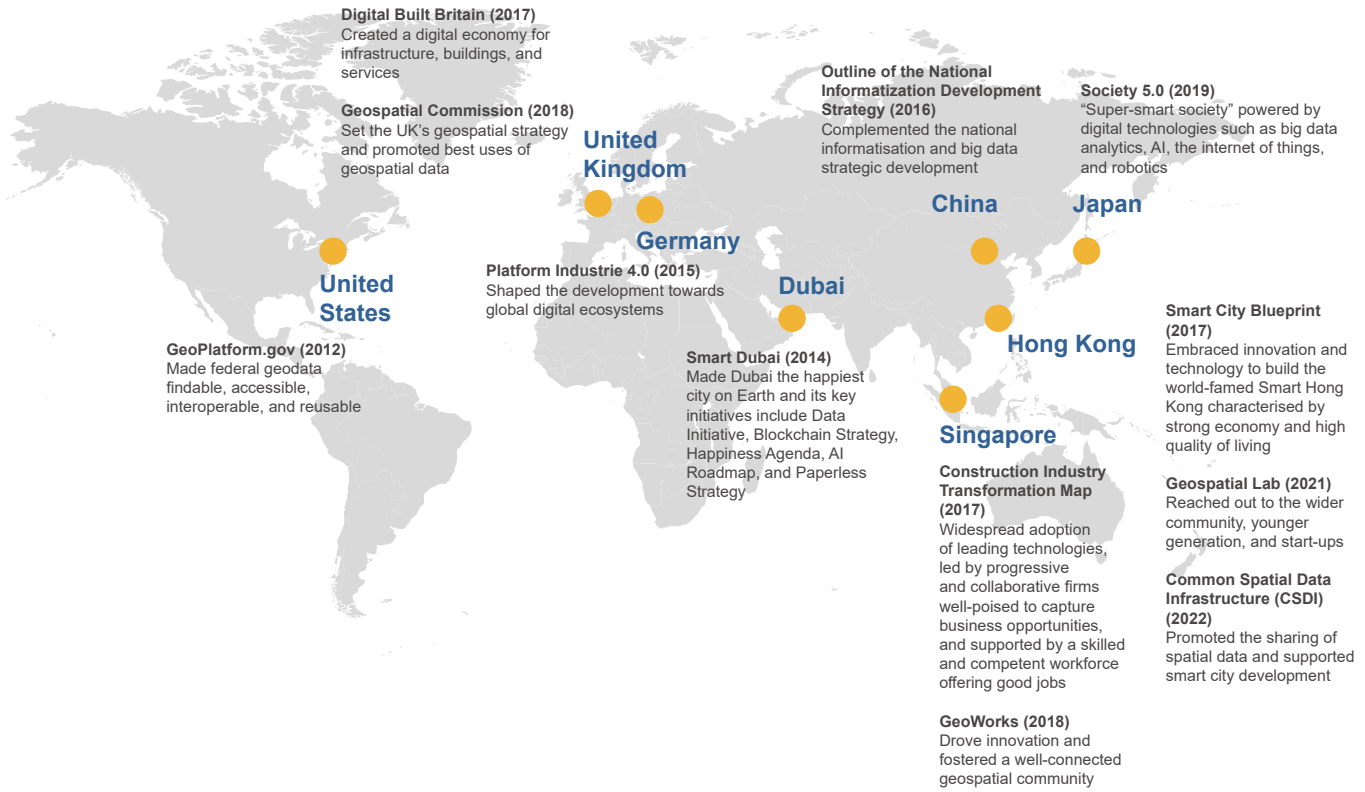
Industrialisation is supercharging the built environment to dramatically improve its time, cost, and quality performance. Modern approaches to design, such as design for manufacture and assembly (DfMA) and modular integrated construction (MiC), are pushing a shift from onsite operations to a controlled manufacturing environment. This has resulted in 50% time savings by accelerating the design process and up to 20% cost savings (Bertram et al., 2019). Apart from productivity gains, DfMA also yields socioeconomic benefits, including sustainability, improved working conditions, shorter construction time, and subsequent reductions in health and safety incidents. DfMA can enable 10% wastage reduction, 25% overall material reduction, and 20% reduction in embodied carbon. Moreover, the UK government's Infrastructure Carbon Review found that DfMA can achieve 50–80% carbon reduction and drive energy efficiency by 5–10% (Mott MacDonald, 2013).

Regionally, Singapore aims to construct 35% of its housing projects using MiC and has also set a separate target for the adoption of DfMA. There is also a clear support for construction industrialisation in Hong Kong. In 2021, the Chief Executive's Policy Address advocated for a wider adoption of MiC and innovative construction technology in private residential and public housing, social welfare, and hospital projects. From April 2020, more than 60 local designated government buildings adopted MiC following the release of a technical circular. Since 2018, the Construction Industry Council (CIC) has been promoting MiC through the MiC Display Centre and the online MiC Resources Centre. The first batch of local MiC projects, including InnoCell at Hong Kong Science and Technology Parks (HKSTP) and Disciplined Services Quarters for the Fire Services Department at Pak Shing Kok, demonstrated 10% reduction in construction cost and shortened the construction period by 30–50%.

Digital: the next leap in the built environment

Digitisation is reshaping the global construction industry at all levels by streamlining processes in the built asset life cycle to improve productivity and safety, from planning and design through to construction and operation

Figure 3 The transformation of the global construction industry through digitalisation



Locally, the CIC outlined a three-step approach to digitise construction:

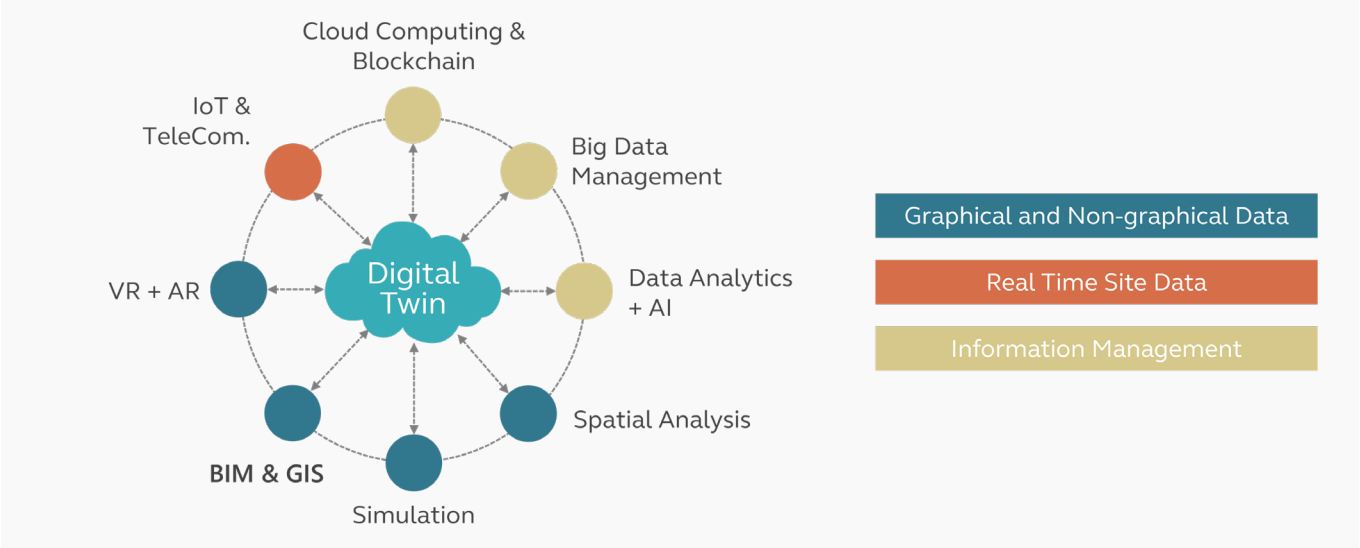
- Development of building information modelling (BIM) standards
- Development of collaborative, fully computerised construction process by integrating BIM, geographic information system (GIS), and different technologies
- Development of collaborative platforms which enable data sharing across the full asset life cycle.

Furthermore, the CIC identified six high-value areas for digital application, as shown in Figure 4. By applying digital technologies, the industry can streamline operations and augment management capabilities.

Figure 4 Six high-value areas for digital application identified by CIC

Smart data sharing, which is the core of this digitisation effort, advocates for the development of common data environment (CDE) and common spatial data infrastructure (CSDI) to achieve seamless integration between stakeholders and applications. Building these two platforms will be based on the integration of BIM and GIS. GIS will help create, manage, structure, and analyse data while BIM will come in to generate and manage building information throughout the asset's life cycle. By integrating location data, BIM can help users visualise patterns, relationships, and geographic context. This high-level of versatility opens BIM to an extensive portfolio of application.

By integrating BIM and GIS, CSDI and CDE can facilitate urban development through enhanced data synergies with CDE serving as a central repository for construction project information to spur collaboration. For each construction project under CDE, CSDI can collect individual project information such as building attributes and indoor routes. Integrating with GIS will then enable CSDI to leverage spatial data and other open data to inform smart city development at the regional level.



BIM and GIS can also be integrated with digital twin technology and an extensive suite of applications to enhance visual, predictive, and analytical capabilities by driving insights from a virtual model. For instance, Hong Kong University for Science and Technology (HKUST) applied digital twin, BIM, and IoT technologies to improve the operational efficiency of its building facilities in terms of energy performance and air quality.

Urban Renewal Authority (URA), Hong Kong (Urban Renewal Authority, 2019)

By integrating 3D GIS and digital twin, the URA developed Urban Renewal Information System (URIS) which standardises and consolidates a wide range of data, including outline territory planning, unit/street block plan, road network, infrastructure, community facilities, into an integrated database. URIS enables the URA to augment its capability and operational efficiency in implementing urban regeneration from a multitude of complex parameters.

3.3.2 WHAT are the key attributes of digital tools and modern systems?

Localised manufacturing hubs can speed up construction industrialisation

Lantau Tomorrow will create 1,700 hectares of land through reclamation in the central waters, initially focusing on the artificial islands of Kau Yi Chau which span about 1,000 hectares. To facilitate modern construction, this massive reclamation needs to have a localised and advanced construction manufacturing centre similar to Singapore's integrated construction and prefabrication hubs. These multi-storey manufacturing facilities perform highly mechanised and automated processes to produce prefabricated construction components, integrated sub-assemblies, and prefabricated prefinished volumetric construction modules. By developing advanced manufacturing hubs, Lantau Tomorrow Vision can achieve greater certainty and less carbon.

International benchmarks: the UK BIM Framework

The UK Government Construction Strategy set a minimum requirement of level 2 BIM for centrally procured public projects from April 2016. This was eventually superseded in 2018 by the UK BIM Framework which includes:

- The published standards called upon to implement BIM in the UK
- The UK BIM Guidance Framework
- Useful links to other resources.

The framework has specifically addressed integration of the BS EN ISO 19650 series into working practices in the UK. It also incorporated existing British standards, publicly available specifications, transition guidance, and ancillary information such as Government Soft Landings (Designing Buildings, 2021). It enables architecture firms and contractors to improve their understanding of the value of BIM in terms of project efficiency and build quality.

BIM framework in Hong Kong

The Hong Kong CIC has led the development of a BIM framework for local practitioners since 2019. As of December 2021, the full suite of CIC BIM Standards has made major enhancements to align with ISO 19650's principles, workflows, and requirements while also providing Hong Kong Local Annex of ISO 19650 (Construction Industry Council, 2021). The framework sets the foundation for promoting the adoption of digital tools in future construction projects in Hong Kong.

3.3.3 HOW can we capture the opportunities offered by digital tools and modern systems for Lantau Tomorrow?

Driving the adoption of advanced digital tools

As companies and individuals become more familiar with BIM, its application in building design and construction in Hong Kong has started to grow. For instance, BIM technology has been used in mega-infrastructure projects such as the Hong Kong Boundary Crossing Facilities (HKBCF). A survey conducted by the Hong Kong Institute of Surveyors in 2019 found that the adoption of BIM in Hong Kong construction projects is driven by:

- Knowledge and information sharing — conducting sessions/workshops to share experiences about using BIM in real-world cases
- Technical support and incentive programmes — enabling and ensuring sufficient digital/software capability and government support
- Documentation and practice — establishing standards, specifications, and new forms of contracts for wider use of BIM
- Promotion and education — developing initiatives and training courses to encourage client and stakeholder participation
- Project management — allowing enough time in project programme for BIM model development.

Case Study
Hong Kong Boundary Crossing Facilities (HKBCF), Hong Kong-Zhuhai-Macao Bridge

HKBCF is a multimodal transport hub in western Hong Kong and provides clearance services for vehicles and passengers entering and leaving Hong Kong via the Hong Kong-Zhuhai-Macao bridge. In this project, BIM was integrated in the detailed design and construction stage to streamline workflows and identify potential engineering clashes (Leighton Asia, 2017).

Productivity and cost savings with BIM

BIM can provide relevant stakeholders and engineering teams with a collaborative modelling environment that will enable them to design and construct a wide range of infrastructure and underground utilities on a common platform. According to Leighton Asia BIM technology facilitated clash detection, which reduced rework during construction, saving approximately 12% of the construction budget. It also enabled the survey team to compare 3D design models to point clouds to avoid onsite discrepancies, which saved 15% of the survey budget (Leighton Asia, 2017).

Key takeaways for Lantau Tomorrow Vision

The practices applied in HKBCF presents a collaborative model for infrastructure design and can enable the developer and engineering team to manage the building data during the project's entire life cycle. Using BIM in Lantau Tomorrow Vision will promote the implementation of digital tools during construction, provide the public and private sectors with easy access to accurate and up-to-date project information, and reduce the project's carbon emissions.

Optimising Hong Kong's development as a smart city

The vision of Lantau Tomorrow focuses on the importance of sustainability and conservation. Enhancements in Hong Kong's technology is a critical factor in conserving resources and reducing Hong Kong's impact on the environment. It also promotes the city's development as a smart city by 2030.

Case Study
Moorfields Eye Hospital relocation

In 2021, the century-old Moorfields Eye Hospital was relocated from its original home in London's Old Street to a 2-acre site at St Pancras Hospital in King's Cross. The move used digital technologies (AI, analytics, digital twins) to innovate service provision to NHS patients and redesign hospitals and the wider health (eco)system (University of Cambridge Centre for Digital Built Britain, 2021).

Digital solutions for physical construction and service provision

The research team in the Moorfields Eye Hospital project relied on digital twin to successfully address the project's challenges. The team initially collected data related to the hospital's physical environment and how the built environment can be digitally transformed. The researchers then applied mobile-based AI and indoor/visual tracking, such as WayMap and Navvis, to aid patients in navigating the new hospital building. Additionally, digital technologies were used to make the purpose-built smart environment become suitable as a modern service model that can be used by a variety of stakeholders, including clinicians, technicians, and caregivers.

Key takeaways for Lantau Tomorrow

Sustainability and creating a liveable city will be key to Lantau Tomorrow, as it addresses environmental pressures, infrastructure needs, and growing demands from residents with the help of smart technologies. Hong Kong is driving the use of digital applications (e.g., sensors, AI, robotic automation, etc.) in smart buildings and in designing open data portals. Advanced toolsets, such as digital twins, BIM, etc., will be able to help address major construction problems through data analysis and machine learning. Lantau will not only benefit from these smart technologies but can also be a driving force for the rise of data ecosystems.

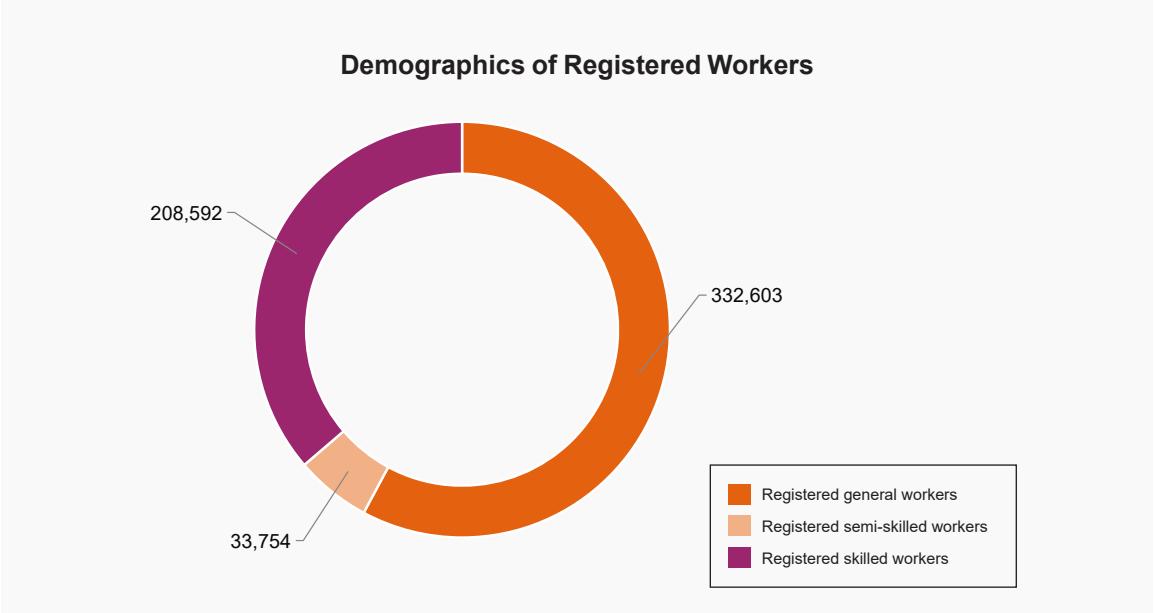
3.4 Workforce Digitisation

3.4.1 WHY do we need a digitised workforce?

There are about 575,000 registered construction workers in Hong Kong, and only 208,592 (~36%) of those are registered skilled workers, as illustrated in Figure 5 (Construction Industry Council, 2021). The industry's lack of skilled workers can constrain the delivery of Lantau Tomorrow Vision. One possible reason for this shortage is the "designated workers for designated skills" provision proposed under the Construction Workers Registration Ordinance. This ordinance stipulates that, except in specified circumstances, only registered skilled workers or semi-skilled workers of designated trade divisions are allowed to independently carry out construction works of related trade divisions on construction sites.

Adopting digital tools can supplement existing skilled labour, enhance project productivity, and support the training of semi-skilled labourers. Amidst the construction industry's reliance on skilled labour and the industry-wide shortage thereof, it is time for Hong Kong to invest in technologies that can improve workforce productivity and implement workforce digitisation as an integral part of Lantau Tomorrow.

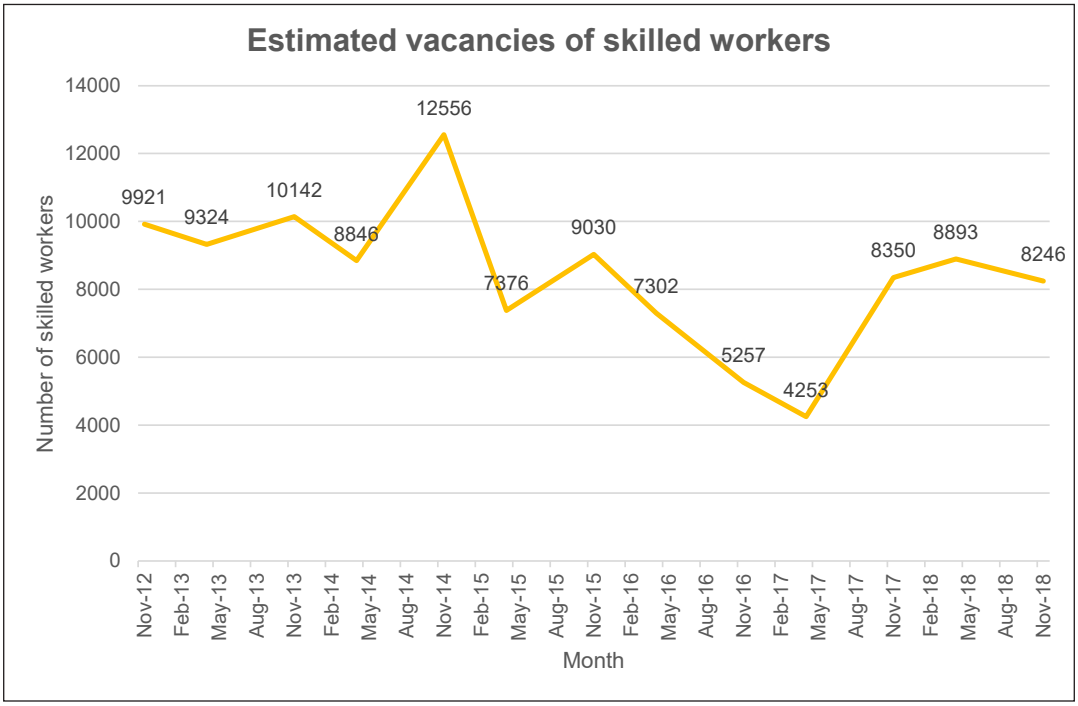
Figure 5 Demographics of registered workers in Hong Kong (as of June 2021) (Construction Industry Council, 2021)



Increasing and improving skilled labour

The impact of Hong Kong's skilled labour shortage is being felt throughout the entire construction industry. This shortfall, exhibited in Figure 6 (Construction Industry Council, 2019), has caused delays in the construction of infrastructure projects while skilled workers have started to shift to other industries due to heavy workload, tight deadlines, and low job satisfaction.

Figure 6 Estimated vacancies of skilled workers by HKCA (Construction Industry Council, 2019



Source:

To address this shortage, the CIC launched various initiatives and programmes, including the Enhanced Construction Manpower Training Scheme and the Contractor Cooperative Training Scheme, to train more semi-skilled workers. However, the current construction industry places too much focus on semi-skilled workers. This imbalance between semi-skilled and skilled workers can result in:

- Rising costs to both project owners and contractors
- Safety concerns due to less qualified workers
- Lack of project communication and coordination.

This is a growing global concern, as the 2020 Construction Hiring and Business Outlook report revealed that 81% of construction businesses find it challenging to hire qualified skilled labour (Associated General Contractors of America, 2020).

Based on market demands, Hong Kong should review and adapt training programmes using digital tools to upskill existing semi-skilled workers. Government incentives and training partnerships with institutions such as the Vocational Training Council (VTC) can also be developed to help industry workers. Given the ongoing shortage of skilled workers, the high volume of construction activities driven by Lantau Tomorrow Vision could lead to other issues in the industry, including health and safety risks.

3.4.2 WHAT are the key attributes of workforce digitisation?

Application of digital tools

The COVID-19 pandemic changed the global workforce and workplace. Digitisation became a critical component in the delivery of construction projects, including the construction of Lantau Tomorrow Vision. With the ongoing skilled labour shortage, the industry can benefit from the application of digital tools to:

- Improve operational efficiency
- Attract younger talents who feel comfortable around new technologies thereby transforming their perception of construction and making them see it as a long-term, sustainable career
- Streamline operations and reduce approval waiting time (e.g., real-time monitoring and approvals among stakeholders for enhanced communication)
- Improve productivity (e.g., automated sensors and tools that can track a contractor's activity)
- Reduce site-based labour costs (e.g., eliminate in-person site visits via virtual site visits)

Remote monitoring technology (RMT)

The Lantau Tomorrow project can establish best practices for remote monitoring technologies in Hong Kong by introducing sensors and high-speed wireless communications in the design and construction stages. The implementation of RMT can include building more data centres and portable equipment for outdoor workers. These digital solutions can help improve project delivery, modularise construction and facilitate remote operations while reducing risks and enhancing safety.

RMT is currently being used in hospitals to help stop the spread of COVID-19 or improve care for people who have already contracted it. By lowering physical contact while improving communication between physicians and patients, RMT has made healthcare more involved and efficient despite current challenges. Using RMT to build Lantau Tomorrow Vision can help generate time and cost benefits by allowing project owners and contractors to remotely monitor the project through high-quality photography and live videos. Furthermore, RMT can foster a safer working environment and prevent workplace injuries.

Case Study
PlanRadar tracks construction activity remotely

PlanRadar is designed to digitise daily construction tasks and provide communication solution for construction and real estate projects. It supports a collaborative environment and enables sharing of project status with anyone who is connected to the cloud-based application. PlanRadar can bring many benefits to different project stakeholders:

- Contractors. The PlanRadar platform ensures that stakeholders have access to current plans, documents, appointments, and contacts. Contractors can consistently implement their project objectives through direct communication with their clients.

- Architects and engineers. Architects and designers can distribute drawings and discuss them with the engineering team to ensure that the construction is working according to the current plan. Videos, voice memos, or photos in real-time can be received and saved in the application. PlanRadar also works in offline mode.

- Project manager. The up-to-date development of reports can be generated in the system. The responsible personnel will not miss any important or real-time information and always has a complete overview of the construction site.

- Owners. Owners get to know the real-time project status and identify bottlenecks. This helps to eliminate costly large-scale changes.

Managing latent defects or problems at early stage

Construction defects could cause delays in a project's progress if subcontractors fail to report the problem to the site manager or project manager. Moreover, latent defects can be difficult to detect during an inspection. PlanRadar has a ticketing tool which can help site managers mark a defect's location on the construction plan that can be seen by designers and engineers from their smartphone or laptop. For certain issues, external experts can be invited to an online discussion to provide assistance or contribute valuable insights. The system's backend documents the progress of a defect report, and team members can be assigned to solve the defect within a deadline.
In traditional construction projects, minimising construction defects can be achieved by strict onsite supervision and appropriate training of personnel. However, technology-aided solutions are more efficient than conducting daily inspections by contractors or subcontractors.
Key takeaways
RMT is more than just a video surveillance. Project stakeholders can communicate directly with each other, share files in the cloud application, and forecast the project completion. The idea behind digitisation is also useful to construction companies that are struggling to deal with the challenges caused by the pandemic. Digital tools and technologies will continue to thrive in a post-COVID-19 world.

3.4.3 HOW can we use workforce digitisation in Lantau Tomorrow Vision?

Digitising the construction stage can help Lantau Tomorrow Vision become more cost-effective and avoid construction delays. Software can be used to enable both broad and detailed views of all construction phases, helping mitigate or avoid problems in such a large-scale project. The shared digital platform can engage all participants in the project to facilitate communications and address the problems. A tailor-made digital tool will be able to support the complexity of Lantau Tomorrow Vision.

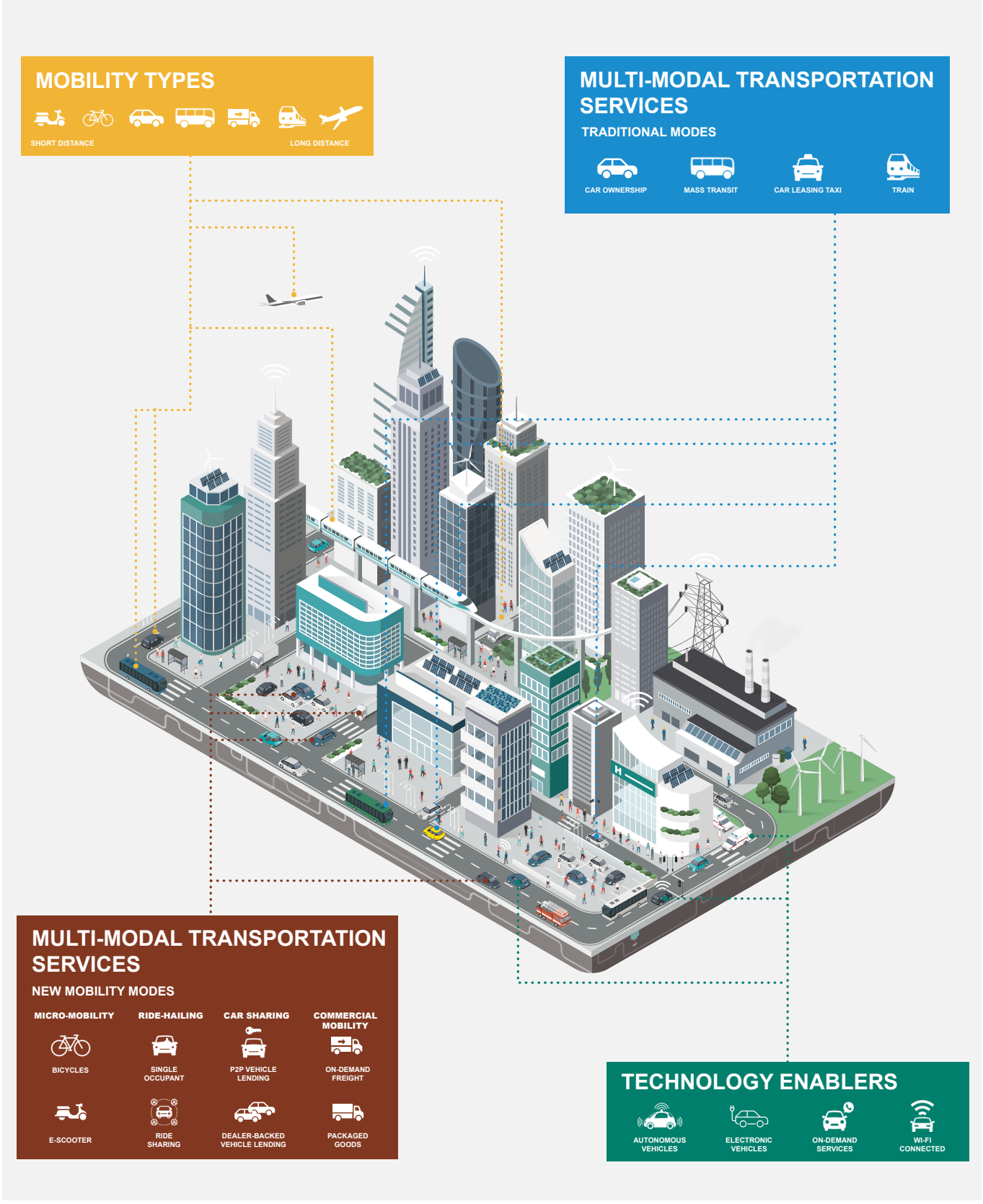
3.5 Mobility as a Service (MaaS)

3.5.1 WHY do we need MaaS?

The last decade has been a time of unprecedented change in how we move people through cities. The rise of Mobility-as-a-Service (MaaS) platforms shared and networked vehicles, and other transportation technologies have changed the way we think about cities, transport, and data (Marsh & McLennan Companies, 2020). Launtau Tomorrow Vision provides urban planners with the opportunity to adapt these innovations into the fabric of the new site and place Launtau Tomorrow on the path to becoming a benchmark of new mobility in Hong Kong.MaaS is a digital platform that provides users with options across different modes of transport. These range from taxis, car rentals, and other public transport vehicles to shared bicycles and e-scooters. Users will then have a more affordable option that best suits their needs. MaaS also provides a single payment channel through a single application to facilitate a streamlined end-to-end trip planning for users. By helping reduce congestion and emissions on the road, MaaS can potentially change the mobility landscape and improve quality of life in the city.

To deliver multimodal transport options and user-centric services, MaaS needs to involve various, sometimes competing, stakeholders in both public and private transport market. For example, private bus companies such as Citybus, Kowloon Motor Bus (KMB), and NewWorld First Bus (NFWB) should collaborate to develop an effective mobility plan for Lantau Tomorrow. Emerging shared mobility services, including micromobility options (see Figure 6) must also be incorporated in the mobility plan. In essence, collaboration from stakeholders across the board is key to a successful development of MaaS for the future site.

Figure 7 Integrated mobility modes and technology drivers of MaaS (Marsh & McLennan Companies, 2020)



3.5.2 WHAT are the key attributes of MaaS?

MaaS will be applied in the future site and its benefit will extend to the whole city as well

To evaluate the success rate of applying MaaS in the future site and whether it can extend its mobility benefits to the city, developers must consider the current transport modes available in the city. As of 2021, Hong Kong's public transport system comprised railways, trams, buses, minibuses, taxis, and ferries. These account for around 10.6 million passenger journeys in a day (Transport Department, 2021). This suggests that Hong Kong's existing transport system is capable enough to provide the foundations for developing MaaS. Nevertheless, developers must still invest in the resources needed to manage operations and additional facilities that come with MaaS.

The new infrastructure must also be safe and comfortable enough to promote a transition away from private vehicle use among citizens. From passengers' point of view, the key factor which can increase their willingness to use public transport is the quick and easy switching between different transport modes and the decrease in time wasted waiting for a particular mode of transport to arrive (Dysten, 2021). Investing in the development of interchange hubs which are linked to the MaaS platform is thus key to providing a seamless travel experience for passengers.

Enforcing data sharing

A robust MaaS platform requires an adequate database comprising traffic, transport service, and geographical data as well as user demographic information. This data can then be exchanged across operators within the platform to efficiently predict capacity requirements in the next hour and plan trips accordingly.

At present, the Transport Department initiated an ITS Strategy Review for Hong Kong in 2001 to promote the traffic operations on major highways, urban roads, and road tunnels (Transport Department, 2019). ITS enables data sharing across key stakeholders to optimise the transport system's performance and potentially transform the way the government manages and operates the city's mobility networks. However, the system must also have a regulatory framework in place to ensure the security of the data being shared. Additionally, there must be a control feature to ensure the data exchange is coordinated, synchronised, and standardised. Integrating ITS into MaaS will help optimise the platform's performance.

Another data-dependent feature in MaaS is the integrated payment for various transport modes. Today, in addition to card-based payment, digital wallets (e.g., PayMe, AlipayHK, WeChat Pay, Tap & Go, and O! ePay) emerge as an alternative payment method in Hong Kong. Among them, AlipayHK developed EasyGo technology in collaboration with MTR, Long Win Bus (LWB), Citybus, NewWorld First Bus (NWFB), designated routes of Kowloon Motor Bus (KMB), green minibuses, and ferries to promote smart mobility.

In the future, MaaS will provide a complete travel package which includes booking and ticketing. Payments must be fast and convenient to encourage users to adopt the MaaS application. To achieve streamlined payments, MaaS providers should build strong relationships with all relevant stakeholders (i.e., transport operators, banks, and Octopus card payment providers) and data providers.

Building a culture of car sharing

Travellers in Hong Kong prefer using cars to cut travel time. However, owning a car comes with additional expenses on maintenance and insurance on top of the purchase cost. And while owners are investing this much on their vehicles, they are using them for a mere fraction of the time. Studies over the past years have found that most cars worldwide are parked 90% of the time.

Fortunately, there are emerging transport models aiming to address this issue: car-share and rental services. Car-sharing is an on-demand service that enables users to reserve vehicles through a mobile application. Users are then charged by either time or distance (Marsh & McLennan Companies, 2020). Automotive manufacturers such as Daimler, Ford, and General Motors are realising the potential value of this model that they are now exploring integrating this model into their product offerings. Apart from shared bicycle schemes, car sharing is another flexible and tailor-made transportation mode which can solve the first mile/last mile problem.

The first mile/last mile problem, at its core, reflects the fact that public transport cannot take exactly where citizens need to go. Sometimes, the infrastructure of parking is not always available, and walking is not the most convenient way to move between the station to the residential areas. However, buying more cars is not the solution to the urban travel difficulties and will increase pollutions in the city. Better bicycle infrastructure, ridesharing can be alternative options that are more sustainable to tackle the “first mile/last mile” problem.

As illustrated in Table 2, Hong Kong has the potential to integrate MaaS into the city’s transport system and improve the urban mobility situation. The current wave of digitisation, Hong Kong’s sufficient transport supply and management, and the development of digital wallets and e-payment options provide favourable conditions for the development of MaaS. However, potential data hacking and unhealthy competition among stakeholders pose challenges to the development.

Table 2 SWOT analysis on MaaS implementation in Hong Kong

Case Study
Whim, a multimodal mobility app

Whim, developed by MaaS Global with an investment of EUR14 million, is the first all-inclusive MaaS solution commercially available on the market (Whim, 2019). MaaS was trialled in Sweden in 2015 and has been used in Helsinki since 2016. Residents use the app to plan and pay for transport modes within the city. These ride options range from train, taxi, and bus to car-share and bicycle. In April 2021, Whim expanded its services to cities outside Finland and is now available in Antwerpen, Turku, and Vienna, as illustrated in Table 2 (Finnoy Travel, 2020).

City	Services
Helsinki	Public transport, taxis, rental cars, city bikes and scooters
Turku	Public transport, taxis, rental cars, city bikes and scooters
Antwerpen	Public transport, trains, taxis, rental cars, city bikes and scooters
Vienna	Public transport, taxis, rental cars

Table 3 Current service range of Whim

MaaS is a win-win for local authorities and passengers

Data is crucial to the success of MaaS. In different cities, the connectivity between transport operators is always at varying levels based on data availability. The implementation of Whim relies on the support of local authority. In Finland, MaaS pilots are being led by players from the public sector, including local authorities, regional transport partnerships, and Finnish Ministry of Transport and Communications.

Whim is changing individual travel behaviours, as it encourages users to transition away from private vehicles and onto greener modes of transport. The ease of access to mobility services and customised trip option is earning the app more subscribers. Because it provides real-time information, the app enables users to better plan their trips and choose the means of travel that best suits their needs. At the same time, through the data generated by its growing customer base, the app is able to use this data to continuously improve its services and better meet the mobility needs of the city.

According to Sampo Hietanen, the visionary behind Whim, “We want to prove that we can beat the service level of a car. Or at least be comparable to it. We want to show that people want it, not just that we can do it.”

Key takeaways

MaaS plays a crucial role in providing sustainable and people-centric mobility solutions for the future occupants of Lantau Tomorrow. The successful implementation of MaaS largely relies on the collaboration of key players in the government and private sectors. This will enable seamless data sharing that, when properly executed and managed, will inform the planning and continuous improvement of the transportation services in the area. With the rate of today’s technological advancements, it is also highly possible that Lantau Tomorrow will also see the deployment of autonomous vehicles and other emerging technologies. These factors paint an exciting future for the new home of Hong Kong’s citizens.

3.5.3 HOW can we use MaaS in Lantau Tomorrow Vision?

Without MaaS, transportation resources in the site will be limited, especially during the early stages of the project development. This leads to unequal mobility options for the future occupants, impacting the quality of life in Lantau Tomorrow.

> ***The participation of private sector transport operators is helpful to accelerate MaaS uptake and improve its financial sustaonability.***
>
> ***Prof. Hong LO***
> *Director of GREAT Smart Cities Institute*

To address these challenges, project developers must consider the implementation of a robust MaaS platform that caters to the specific needs of the future residents. The following steps can help accelerate the delivery of solutions that MaaS can offer to its users and optimise the overall mobility in the area:

Tapping the private sector

The modes of transport that private stakeholders can bring to the table will diversify mobility options through the MaaS platform. At the same time, private sectors will also unlock the potential of boosting their profitability by participating in the platform.

Leveraging the user-centric features of MaaS

MaaS provides tailored transportation solutions to its users. This means the platform can be designed to specifically cater to the needs of Lantau Tomorrow's future occupants, especially its ageing population. For example, minibuses and small vans with assisted mobility features such as wheelchairs and sick bags can be added to the options available through the platform. Other features can be added to further ensure a comfortable travel experience as well as the reliability and affordability of the services for the intended users.

Ensuring data security

Because MaaS offers customised services, it has no one-size-fits-all solution. Like other new mobility programs, MaaS operates based on user data. It then uses this data to inform how it matches supply with demand, addresses first mile/last mile problems, and customise its other service features to meet the users' needs. However, this accessibility to users' information poses a potential risk to data security and privacy and challenges current regulations on transportation. Hong Kong's government must strive to address these risks by enforcing strict policies on data protection once MaaS becomes available to a wide range of service providers.

Adding robo-taxis as an alternative mode of transport through MaaS platform

Users' ride experience can be made safer, more cost-effective, and frictionless through the addition of robo-taxis to the options available through MaaS. Robo-taxis are electrified autonomous vehicles that riders can hail and share with other passengers. Because they use electricity as fuel, robo-taxis help reduce carbon emissions that impacts air quality. Robo-taxis also help reduce the number of vehicles on the road since they can serve multiple passengers at a time through its ride-sharing option. Major players in the transportation industry are seeing the potential value of robo-taxis that a number of companies have already announced plans to introduce large fleets of autonomous taxis, including General Motors (Anderson, 2019).

Encouraging users to adapt MaaS is a long-term endeavour. Key players of Lantau Tomorrow Vision must develop a deep understanding of the existing travel behaviours and mobility needs of Hong Kong's citizens and then develop ways to support the future site's residents as they transition to the new ways of travel through MaaS.

4 DRIVING EFFICIENCY-FOCUSED POLICY

4.1 Overview

This section outlines key findings for how Lantau Tomorrow can be designed to drive efficiency-focused policy by enhancing efficiency in approval processes and considering value-adding procurement strategies.

4.2 Enhance efficiency of approval process

4.2.1 WHY do we need a more efficient approval process?

The current system for approving construction projects in Hong Kong entails a complex process. An underlying factor is the fact that Hong Kong's construction law comprises several other laws and regulations. These are:

- Contract law—governs agreements between parties
- Tort law—addresses and provides remedies for civil wrongs not arising out of contractual obligations
- Various ordinances and subordinate legislation (i.e., regulations)—governs the execution of construction operations
- Law of restitution—ensures the injured party is restored to the position they enjoyed prior to the contract's formation
- Criminal law—sanctions imposed for acts and omissions which constitute criminal activity.

These building control legislations seek to ensure the quality of the infrastructure and the overall built environment. Government departments set up comprehensive approval standards. Multiple departments also review and update subsidiary codes of practice, guidelines, standards, and technical specifications over time to align with the laws and regulations.

With different objectives and control regimes, the process of obtaining the necessary vetting and approvals becomes even more challenging and time-consuming since it requires approvals from various departments (PlanD, LandsD/DLOs, BD, FSD, CEDD, WSD, HyD, TD, EMSE, EPD, etc.). The approval or disapproval process for the first submission of plans and major revisions, for example, takes approximately 60 days (Buildings Department, 2018).

Additionally, regulatory departments are struggling to handle peaks in submission workload due to fixed staff resources. These issues have led to an industry-wide demand for improving the existing approval process. The government if faced with the challenge of streamlining and simplifying the process without compromising public safety and health.

> ***The consultation process is long, and the interim results often require significant amendments.***
>
> ***Sir Gordon WU***
> *Chairman of Hopewell HK Properties Ltd.*

Following the Chief Executive's Policy Address in 2017, the government has set up the Steering Group on Streamlining Development Control under the Planning and Lands Branch (PLB) of the Development Bureau. The Steering Group will consolidate and rationalise standards and definitions adopted by the Planning Department (PlanD), Lands Department (LandsD), and Buildings Department (BD) in scrutinising development projects. The group will also seek to streamline the approval process without prejudicing the relevant statutory procedures and technical requirements (Development Bureau, 2019). The goals are summarised into five major objectives:

- Align technical definitions and approval standards
- Remove duplicate control under different regimes
- Enhance transparency and certainty in processing proposals
- Consolidate approval authority and procedures
- Streamline processes and shorten processing time.

Currently, the Steering Group has already promulgated batches of streamlined control measures covering the following topics:

- The building height restriction
- Site coverage on greenery
- Landscape requirements
- Building separation and building setback in the Sustainable Building Design Guidelines
- The application of design and disposition clause under lease
- Non-building areas
- Site coverage restriction through the joint practice notes, departments' practice notes, and documents.

Streamlining the approval process through digitised documentation and a shared database across departments may require investment on personnel training as well as incentives for developers and construction players, as illustrated in Table 4.

Table 4 SWOT analysis on streamlining the approval process in the construction industry

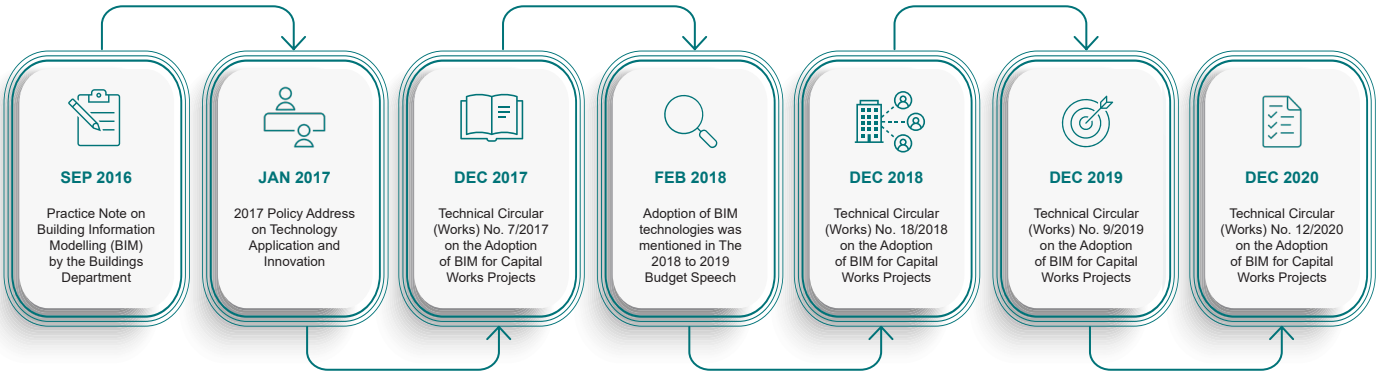
4.2.2 WHAT are the key attributes of an efficient approval process?

Digitising the documentation process

Building information modelling (BIM) has been making waves in the construction industry. As a collaborative and digitised approach to planning, designing, and managing projects, it helps streamline processes not just for the project stakeholders but also the regulating parties reviewing and approving the project. There is a stark contrast in the process and information flow between BIM and the traditional practice. In the latter, teams move from one phase to another and work in silos, posing a potential risk for data loss and communication gaps. Through BIM, information is collected digitally and is available to any project stakeholder, enabling a continuous flow of information in every phase, thus leading to better efficiency, accuracy, and collaboration.

Such is the value of BIM that the construction industry is adopting it on a global scale, with the market for BIM seeing an estimated compound annual growth rate (CAGR) of 12.5% by 2026 (MarketsandMarkets, 2021). The Hong Kong government has also taken its own initiatives to accelerate BIM adoption in the local industry. Figure 7 illustrates the milestones of BIM policy in Hong Kong.

Figure 8 Milestones of BIM policy in Hong Kong (Construction Industry Council, 2020)



The Chief Executive's 2017 Policy Address stated that the government will require BIM adoption in major government capital works projects. Within the same year, the Development Bureau issued a Technical Circular mandating BIM adoption for capital works projects with budget estimates of more than HKD30 million. Circulars were also issued in 2018 and 2019 aiming to enhance the BIM implementation requirements and expand the scope of mandatory BIM uses, respectively. These were then reinforced by the more recent circular issued in 2020.

Additionally, Hong Kong formed the Housing Electronic Submission Plan (HePlan), its first electronic submission system for building control which receives submissions using BIM. It is also Hong Kong's first government-run system which applies digital signature with digital certificate to facilitate long-term documentation of plans. HePlan streamlines the approval process for submissions from contractors to the Housing Authority (HA) and enables the Independent Checking Unit to conduct record management, filing, and internal workflow. Future versions of this system will enable the downloading of plans onto mobile platforms, thereby facilitating digitisation of site-monitoring works.

To encourage BIM adoption, BIM submissions to the Building Department (BD) are incentivised along with the 2D plans generated from the BIM models. This is patterned after Singapore's BIM e-Submission System (see details in case study 1). The BD may still require and process 2D drawings under the existing Buildings Ordinance, whether generated from BIM models or not, as well as the voluntary BIM submissions as supplementary information to facilitate BD's plan processing. Table 5 outlines a proposed action plan for incentivising BIM submissions in the short and medium term.

Table 5 Incentivising BIM submission to BD

Incentivise BIM Submissions to BD	
Short-term actions	• CIC's Task force on BIM Submissions to BD to conduct a study to define the requirements for BIM submissions to BD. The study should collect the views of industry, BD and quasi-Government clients, e.g., HKHA, HKHS, MTR, AAHK, URA, Hospital Authority and WKCDA • BD, in consultation with CIC's Task Force on BIM Submissions to BD, to identify and develop an implementation plan, in line with their current plan on ESH implementation and rollout, as well as to prepare guidance notes on best practice for reference by industry
Medium-term actions	• CIC Taskforce on BIM Submissions to BD, to work with BD and industry stakeholders, and rollout a BIM capability building plan for Government staff in line with the development of BIM submissions, and to consider, expanding the provider pool for BIM training to external educational institutions, in order to expedite city-wide capability building • BD to consider to incentivise and utilise BIM submissions for sizeable projects • BD to make use of automated checking tools as first screening on BIM submissions • BD to review the performance of the BIM submissions and automated checking tools to identify improvement areas and assess whether expansion of functions is required with consideration of industry feedback and opinions on a regular basis
Potentially streamlined submissions	**Design stage:** • Statutory Plan submissions • Application for Consent
Reference to evidence	• Singapore B e-Submission and CORENET • Housing Authority HePlan

In time, BD will stop accepting drawings other than those generated from BIM. This will accelerate the checking and approval process, especially if assisted by approved automated checking tools. It will also maximise the synergy between the Lands Department (LandsD) and Planning Department (PlanD) in building 3D digital maps for the development of Hong Kong's smart cities.

Accelerating response time from key departments

Currently, BD acts as the central governing body that circulates plans and collects feedback from other departments for submission approvals. However, the feedback from the departments often takes more than 60 days and are not bound by a statutory requirement (Buildings Department, 2018). Government agencies have also historically struggled with manpower shortage when collecting and consolidating feedback from departments, often delaying the response time to the construction developers. The prolonged review and approval processes also escalate the financial pressure on private developers. This high cost could potentially trickle down to the end users.

To address this, a performance pledge has been promulgated among all government departments to provide services for the public as well as bureaux/departments serving internal clients, including PlanD, LandsD, and other departments consulted for feedback. The pledge generally comprises a percentage-based KPI to measure the compliance rate and performance of regular public service providers. The assessment is then published annually (Water Supplies Department, 2020). Performance targets are also reviewed from time to time. Since its implementation, the performance pledge has affected consistent improvement in operational performance (Water Supplies Department, 2015).

A similar performance pledge can then be introduced to large-scale projects such as Lantau Tomorrow to regulate the complex process and incrementally improve the efficiency of interdepartmental operations. This strategy helps streamline the approvals by:

- Reviewing existing approval systems and setting KPIs with a shortened approval time
- Enhancing communication between government regulators, consulted departments, and key players in the industry
- Establishing comprehensive KPIs for all government departments.

Case Study
Singapore's BIM e-submission

To reduce the number of foreign workers and improve productivity in Singapore's construction industry, BCA introduced the BIM Roadmap in 2010, with the aim of achieving an 80% level of BIM usage in the construction industry by 2015.

As BCA understands the challenges that businesses face in considering the application of a new technology in their operations, BIM e-submission has been introduced and mandated in a phased approach (see Figure 8 below).

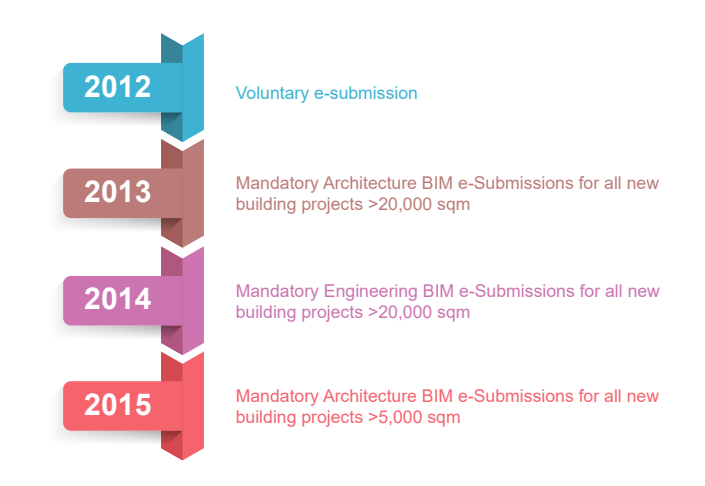


Figure 9 Schedule of BIM submission for regulatory approval in Singapore

Currently, BIM e-submissions are done in Lightweight file formats—compressed versions of Native files—in order to manage the file size. The challenge associated with BIM processing is that the industry must reinstate 2D annotations manually onto the 2D plans to supplement the plan for regulatory submission. To address this, BCA has been accepting voluntary BIM e-submissions in native BIM format since October 2016 (for architectural plans) and October 2017 (for C&S/MEP engineering plans). In parallel, BCA has been working with industry stakeholders to explore the feasibility of BIM submissions in Open BIM format.

Regarding the requirements of BIM submission, BCA has issued a Code of Practice which sets out the requirements and guidelines on the creation of models with specific object types, associated properties, and presentation format for regulatory BIM e-submission. Once the models are submitted to the Construction and Real Estate Network (CORENET), the respective regulatory agencies will conduct compliance checks on the 2D and 3D views generated from Revit/ArchiCAD and other original BIM software formats submitted under the BIM e-submission requirements. BIM e-submission is now fully rolled out in Singapore regulations. This phased implementation plan has allowed the industry practitioners adequate time to build up their capability. It also allowed the industry to understand and buy into the benefits of the BIM technology.

Case Study
CORENET, Singapore's e-government initiative

Construction and Real Estate Network (CORENET) was first introduced in Singapore in 2001, serving as the main submission system for building works approval. This e-submission system (eSS) enables automated conformance checking and facilitated approval on applications made to over 16 government agencies from nine different ministries covering planning approvals, structural approvals, building approvals, certificate of statutory completion (CSC), temporary occupation permit (TOP), and fire safety certificate (FSC).

The Building and Construction Authority (BCA) outsourced the implementation, management, and operation of the system to a third-party operator for approximately SGD4.8 million for over a contractual period of five years with an option to further extend for five years (Nova Group, 2007).

Outcome highlights of eSS:

- The eSS reduces time in securing a construction or related permits by 80%. It also reduces the number of application forms by 73% from 845 to 231 and facilitates a shift from physical submissions to electronic submissions (Nova Group, 2017).

- The eSS results in operational savings of USD150 million per year and other savings of USD1 billion per year related to investor risk and capital.

- The "total construction permitting time" is shortened from 102 days to 38 days between 2008 and 2009 (Asia-Pacific Economic Cooperation, 2012).

The centralised digital platform integrates the digital solutions such as automated design checking, e-inspection tool, and data collection and processing. These features can also be applied in the development of Hong Kong's Electronic Submission Hub to review the submission of design plan, identify the action plans for each digital tool, and explore the synergistic effect between the tools to ultimately streamline approval processes by means of digitalisation and the formation of a digital ecosystem.

Key takeaways

Long lists of documentation required by statutory and contractual controls impact the approval process of building developers. Digitisation through BIM will significantly reduce the paperwork and speed up the process, enabling construction industry players to increase their productivity. Based on local projects led by the HA, the use of BIM also helps minimise planning errors, efficiently detect issues, and ensure accurate calculations, thus further improving the approval process. With BIM informing more construction planning in the future, this new approach will also become a standard in the decision-making process of on-site stakeholders.

Singapore's initiatives and existing local performance pledge practices have informed the Hong Kong government's decision to implement a performance-based service standard within regulatory agencies. This will ensure continual improvement in the approval process for the construction industry players.

4.2.3 HOW can we use efficient approval process in Lantau Tomorrow Vision?

The boom in digital technology has gradually changed the way stakeholders engage in a construction project. The COVID-19 outbreak also forced the industry and the government to embrace digital solutions in their operations. BIM and other digital applications are providing a seamless digital asset management solution as well as clear and consistent acceptance criteria without compromising the quality of the built asset. The automation that comes with these applications along with the secure distribution of important documents all contribute to the efficiency of reviewing and approving the project.

At present, government departments and individual public and private organisations collect and maintain their own independent sets of spatial data. Through collaboration and continuous communication across all the government departments involved, an integrated platform can be built to achieve seamless data sharing (Construction Industry Council, 2019). This helps eliminate bureaucracy, enabling teams to focus less on the administrative requirements and more on the essential aspects of the project.

Challenges

Adopting new technology requires a major transformation from a government to an organisational level. Because the traditional system has been embedded in many governments and organisations today, full adoption of the new practices may take a while. Senior leadership must thus acknowledge the importance of their role in supporting all players through this transition.

4.3 Value-adding procurement strategies

4.3.1 WHY do we need value-adding procurement strategies?

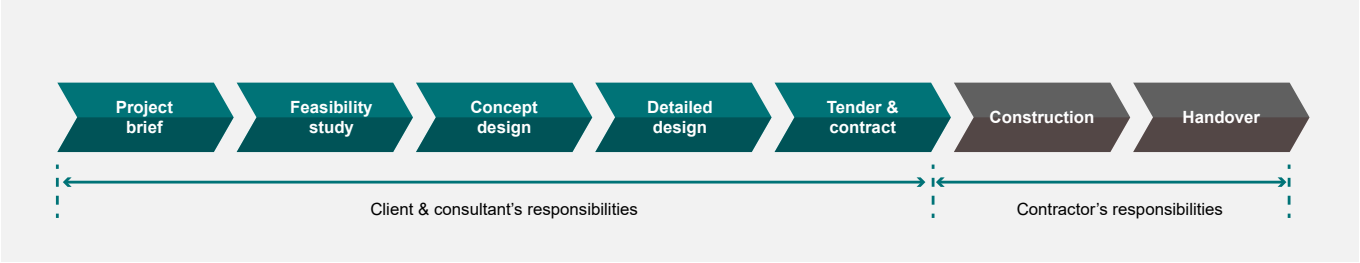
Procurement needs to consider multiple factors, including timeline, budget, and quality, and it should also be competitive, fair, and transparent to deliver value. Procurement processes are time-consuming and can lead to disputes with significant expenses involving middlemen (Perera, 2021). That is why procurement needs to be strategic to maximise efficiency. In Hong Kong's construction industry, these challenges to procurement are further compounded by the industry's complexity and fragmentation related to supply chains, products, etc.

There are typically two different procurement routes used today: the traditional procurement method that is commonly used in construction and digital procurement that is supported by cloud computing and system-to-system communication.

Current procurement method

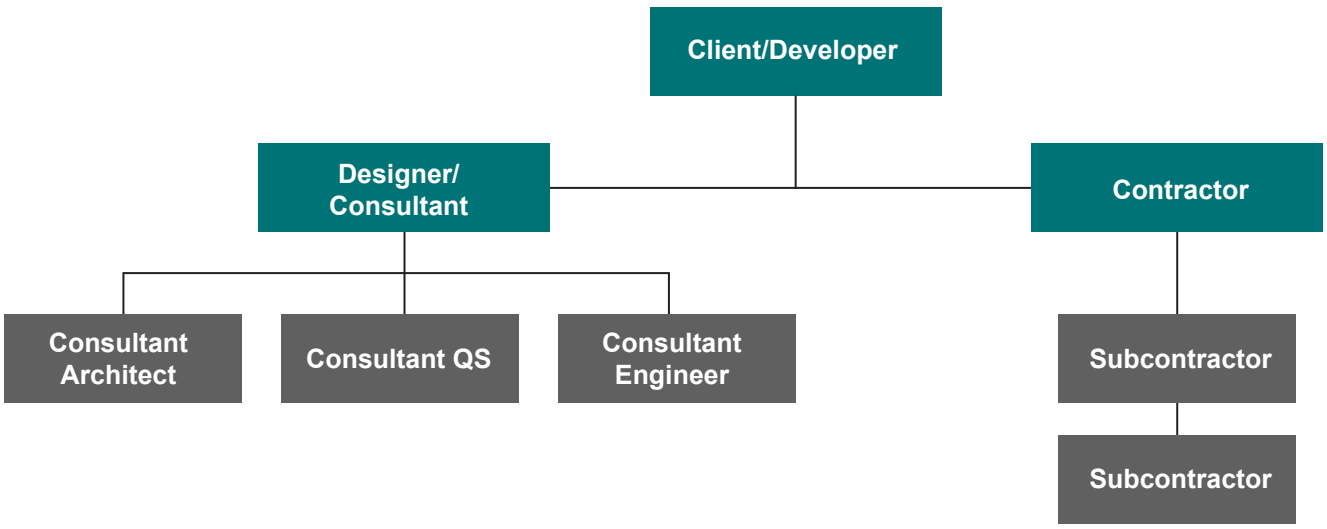
Traditional procurement, which remains as the most used method for procuring building works, has three stages: design, bid, and build. In this process, the design work is separate from construction, as illustrated in Figure 9. The client appoints consultants to design the project in detail, ensure cost control, and inspect the construction works as they proceed. Contractors are invited in the next stage to submit tenders for the construction of the project (Designing Buildings, 2021).

Figure 10 Sequential process of traditional procurement method



Traditional procurement can produce high quality works because the client has control over the works by applying the linear model, as illustrated in Figure 10. This method is also easier to be adopted because both contractors and consultants are familiar with this process since it has been in practice for a long time. However, since procurement starts after the design stage, traditional procurement requires longer period. It is also typically challenging to capture, store, process, and transmit data via traditional procurement, as large volumes of data are generated in procurement activities which can lead to inefficiencies, errors, and reduced trust (Srinath, 2021).

Figure 11 Contractual relationship between client and other duty holders



4.3.2 WHAT are the key attributes of a value-adding procurement strategy?

Adopting early contractor involvement (ECI)

ECI is an approach where contractors are engaged early in the design stage to integrate the design and construction processes by collaborating with other duty holders (Building and Construction Authority, 2020). At the time of entering a contract, construction cost is still unknown due to incomplete design or undefined price. The adoption of ECI can:

- Encourage innovation by gaining input from the contractor/construction manager on design development
- Deliver greater transparency in pricing when subcontractors are involved
- Enhance the level of safety by reviewing the design's buildability and identifying significant construction risks early on
- Help complete the project faster and minimise construction delays.

Case Study
Application of ECI on Lichfield Bridge demolition

The project was jointly funded by Staffordshire County Council (SCC) with Liberty Property Trust UK as the fund for the Business Park. Network Rail (NWR) was also heavily involved, as it owned the bridge which needed to be transferred to SCC. To avoid delays, the first objective was to gain NWR permission and procure/secure subcontractors for the demolition of the existing bridge deck and abutments within a 54-hour rail possession (Midland Highways Alliance Plus, 2015).

Rail specialists suggested the use of ECI services to achieve project goals and resolve NWR's concerns regarding delays in appointing a contractor. The application of ECI resulted in:

- Effective collaboration with stakeholders in coming up with a safe demolition strategy and dismantling the structure within the busy Christmas window.
- Exploring and refining several value engineering options, including a slight redesign/reduction of the bridge's width and angle of skew.
- Removing significant risks in an early stage. Contractors designed out the retaining wall to the northeast corner of the bridge and replaced it with an embankment, which removed the major risk interface between the retaining wall at the greatest height and the high-pressure water main (Midland Highways Alliance Plus, 2015).

Key takeaways

Investment in ECI can add value to construction projects by aligning stakeholders' perspectives, sorting out priorities, and coming up with a balanced solution. In addition, ECI services can enhance decision making throughout the process.

Digitising the procurement process

E-procurement offers a viable electronic alternative to paper-based method. In e-procurement, the processes including approvals happen on a cloud environment within specific pre-set conditions, making it less time-consuming.

Implementing e-procurement makes it easier to catch errors when tendering documents and references from past orders to better manage and monitor spending. By digitising the procurement process, clients can strategically source suppliers, implement better management, and have better visibility on spending thus achieving financial goals.

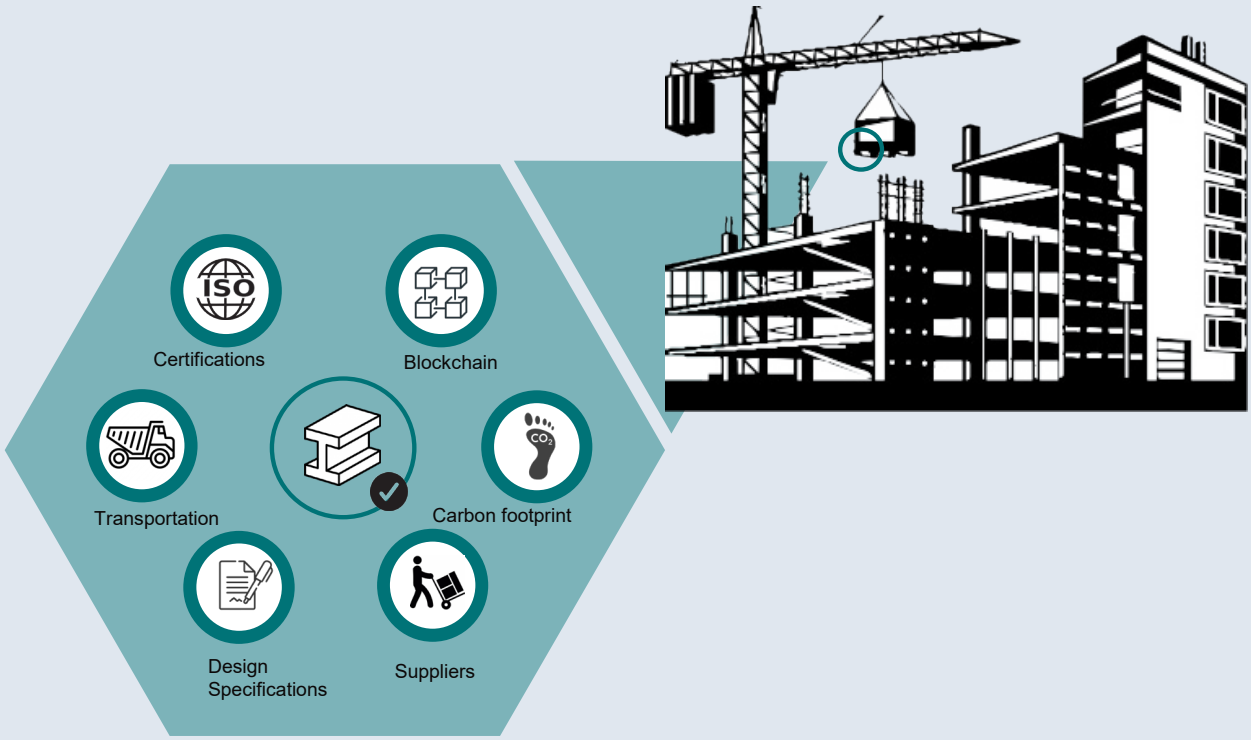
Blockchain-based e-procurement solutions mark a new era of e-procurement. Smart contracts in construction are verified by a computerised protocol and stored on a blockchain that facilitates greater visibility and trust and ensures transparency at every stage. These solutions are typically used to automate the execution of an agreement when predetermined conditions are met. In the UK, Digital Built Britain recommended the use of smart contracts for construction procurement in level 3 BIM as a replacement for paper-based contracts (Designing Buildings, 2020).

Case Study
Application of smart contracts in Tata Steel

Most manufacturers store and retrieve procurement information and supporting documentations on a per-request basis rather than linking those information and documents to a product's digital data. Tata Steel initiated a pilot programme that uses smart contract to follow a steel beam from production through to its reuse or recycle.

The digitisation programme allowed the company to track every beam using a unique ID which is registered on a blockchain system. Through this digital identification (also called digital passport of materials) all fabrication and design specifications become readily available, and transportation details can be added to the blockchain associated to the beam (Institution of Civil Engineers, 2018), as illustrated in Figure 12. This way, the beam becomes a tagged asset that can be added to a BIM model and has shareable production and procurement details.

Figure 11 Contractual relationship between client and other duty holders



Key takeaways

The implementation of blockchain technology has the potential to improve order management and establish verifiable audit trails of all products which can be tracked from source to delivery.

4.3.3 HOW can we use value-adding procurement strategy in Lantau Tomorrow?

Blockchain technology can mitigate human errors and disputes in a complex supply chain, improve transparency, and ultimately save costs throughout a project's life cycle. Some key technologies, such as BIM and, recently, blockchain technology, have given rise to the concept of smart buildings and smart cities that are aligned with the ultimate goal of Lantau Tomorrow. However, the fragmented nature of the construction industry poses safety risks and legal liabilities even with the automation of construction technologies. This can be addressed with a blockchain-enabled procurement strategy that will improve the risk management and transparency of the supply chain.

5 ACCELERATING GREEN TRANSITION

5.1 Overview

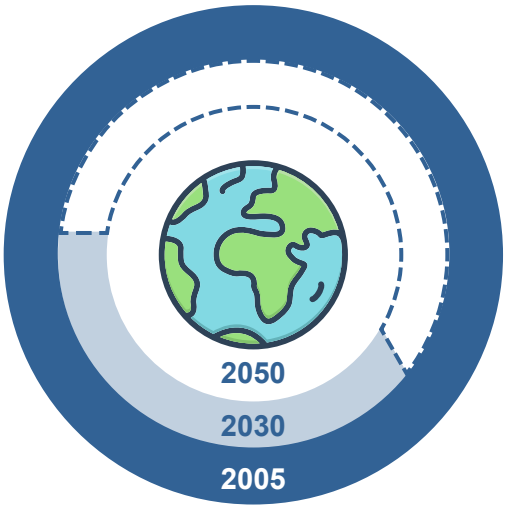
This section outlines key findings for how Lantau Tomorrow can be designed to accelerate the green transition through green transport and climate readiness.

5.2 Green Transport

5.2.1 WHY do we need green transport?

Motor vehicle exhaust is the main cause of urban air pollution. In Hong Kong, the transport sector, including road and marine, is the second largest air pollution source, accounting for about 53% of the local fine suspended particulates, 57% of nitrogen oxides and 53% of sulphur dioxide. The sector is also responsible for about 18% of local greenhouse gas emissions (Environmental Protection Department, 2017). As society shifts towards sustainable living, a cleaner and greener transport becomes a core theme of urban development. As set out in the "Hong Kong's Climate Action Plan 2030+" (The Government of The Hong Kong Special Administrative Region, 2020).

Figure 13 Hong Kong's carbon emission reduction target



65-70%

Using 2005 as the baseline, Hong Kong is moving towards a target of 65–70% carbon intensity reduction by 2030 and carbon neutrality by 2050.

5.2.2 WHAT are the key attributes of green transport?

Sustainable transport in Hong Kong

To achieve lower emissions and greater transport efficiency, the government put in place an HKD 300 million Pilot Green Transport Fund which was renamed to the New Energy Transport Fund (NET Fund) in September 2020. Through the NET Fund, the government aims to encourage the public transport sector to test out green and low-carbon transport technologies. The initiative prompted franchised bus companies to use electric buses on a much larger scale.

At the 2018 Hong Kong Awards for Environmental Excellence, the government presented the Gold Award in the Transport & Logistics Sector to Kowloon Motor Bus (KMB) for its advanced green technologies. KMB had initiated the installation of more solar panels on the roofs of its double-decker buses (The Government of The Hong Kong Special Administrative Region, 2019). This highlights the rise in opportunities for public transport to make positive changes.

Facilities and manpower shortage

As illustrated in Table 4, there are barriers to promoting green transport in Hong Kong even today. Basic infrastructure such as bicycle paths, pedestrian walkways, bridges and roads are a large component of Hong Kong's transport infrastructure. However, not all these were designed as green infrastructure. Trails with permeable surfaces are an example of green infrastructure. Secondly, constructing these can be costly. For example, electric vehicle (EV) charging stations require developers to first locate a site with sufficient grid capacity. This can take months and can thus incur costs on top of the installation and other costs associated with the delay in construction (Nelder, 2020).

To accelerate the adoption of green transport, the government set out a long-term policy through the Roadmap on Popularisation of Electric Vehicles published by the Environment Bureau in March 2021. The roadmap outlines plan to expand the city's charging network by providing up to 5,000 public EV chargers by the year 2025. The plans also include increasing charging facilities in private buildings by around 150,000 (The Standard, 2021).

Once the facilities are deployed, the government must also ensure the safety of citizens using these facilities. Adequate manpower will be needed to provide facility maintenance services. Along with the required investment in personnel training, the government must also take the subsequent costs into account.

Table 6 SWOT analysis on green transport in Hong Kong

Zero-emission vehicles in Hong Kong

Zero-emission vehicles are technology-driven key components of Hong Kong's green transport programme. To meet its long-term decarbonisation goal, the government set out to reduce petroleum use in public transport and has invested in a series of funding opportunities to support low- and zero-emission transport projects. The first of these is a HKD80-million pilot programme for electric minibuses for 2023.

The government also announced a HKD200-million Green Tech Fund to support the research and development of green transport projects such as EVs. In order to promote the smart power services, HK Electric provides EV charging service that allows users to locate an EV charging station within 15 minutes of driving distance across Hong Kong Island (HK Electric, 2021).

Green transport plans for Lantau Tomorrow

In January 2015, the Development Bureau issued a report on the provision of green transport by franchised buses and taxis in Lantau (Development Bureau, 2015). It states that Euro V buses are required to comply with the latest European emission standards. In-service Euro IV or earlier franchised buses must also have environment-friendly devices installed.

The government also fully subsidises the procurement of six hybrid buses, eight supercapacitor buses, and 28 battery-electric buses for a trial run on several bus routes across the future Lantau Tomorrow site. Six battery-electric buses are also being deployed to different bus routes to test the feasibility of operating these buses in Lantau Tomorrow.

Case Study
Transitioning to zero-emission transport in the UK

The UK government is prioritising the decarbonisation of its transport sector. In The Ten Point Plan for a Green Industrial Revolution, the government committed to prohibiting the sale of new petrol and diesel petrol as well as diesel vehicles by 2030 and requiring all new cars and vans to be carbon emission-free by 2035. The government also invested GBP120 million in 2021 to begin the introduction of at least 4,000 more British-built zero-emission buses (HM Government, 2020).

The EVs will be plugged into national power grids and will be fully emission-free. The UK's goal also envisions the use of hydrogen-powered vehicles as alternatives to EVs. However, the green hydrogen supply in the UK is currently too low to support a mass uptake of hydrogen vehicles.

To start a market for yet another EV alternative, the fuel cell electric vehicles (FCEV), the government provided a total of GBP23-million funding from 2017 to 2022 supporting the uptake of the FCEVs and the construction of 65 publicly accessible hydrogen refuelling stations across the UK.

Aberdeen is one of the UK's early adopters of FCEVs. Through a GBP19-million project, the city has deployed 10 fuel cell buses on operational routes across Aberdeen and installed a refuelling station at the centre of the city. Hydrogen is produced on site by three electrolysers capable of producing 360 kilograms of hydrogen per day, enough to power 10 buses. Refuelling takes only 10 minutes, and the only emission is water vapour. These buses also run more quietly than most vehicles.

Figure 14 Hydrogen-powered bus in Aberdeen City

In September 2020, the UK reached another milestone through the test run of its first hydrogen-powered trains along its mainline. The initiative was supported by the Department for Transport through a GBP750,000 grant and an investment of more than GBP1 million by Porterbrook and the University of Birmingham (Institution of Mechanical Engineers, 2020). The hydrogen-powered trains use hydrogen and oxygen to produce electricity, water, and heat, emitting pollutant-free gases in the process. The technology used for the trains is expected to be available for use by 2023 to retrofit current in-service trains and decarbonise the rail network.

Key takeaways

Through technologies behind the green vehicle alternatives are at varying stages of development, EVs, FCEVs, and hydrogen-powered vehicles are on their way to replace fossil fuel vehicles in the future. EVs can be charged through the electrical grid via charging stations, and hydrogen-powered vehicles can be filled up with hydrogen fuel produced on site via electrolysers. Compressed or liquid storage technologies also provide cost-effective energy storage solutions for future green transport networks.

Case Study
Transitioning to zero-emission transport in the UK (Cont'd)

In China, hydrogen energy production is seeing considerable progress. The country has long seen the potential value of using hydrogen as fuel and has invested heavily in the development of green hydrogen. SAIC Motor, a Shanghai-based automotive company, is taking the lead in this space through the release of its hydrogen strategy plan (Association of German Chambers of Commerce and Industry, 2020). Meanwhile, Hong Kong's land shortage issue is limiting its ability to adopt hydrogen locally, owing to the lack of space that can accommodate hydrogen plant facilities. Additionally, the government has no policies in place yet related to hydrogen adoption. Hong Kong will need to import hydrogen from the mainland, as it shifts towards a hydrogen economy in the future.

Active transport in Hong Kong

Cycling has been gaining popularity in many urban communities. This emission-free mode of transport involves docked and dockless bicycle-sharing schemes. As illustrated in Figure 8, docked bicycles have secure docking areas at designated on-street docking stations or kiosks, while dockless bicycles have none.

Figure 15 Docked bicycles vs. Dockless bicycles

Docked bicycles

Dockless bicycles

Bicycle sharing offers several benefits. It addresses the first mile/last mile problem through transit connectivity and provides a more convenient and affordable alternative for short trips than walking or using a car. It also promotes a cycling culture that enables citizens to enjoy sustainable and healthy urban living.

In Hong Kong, Gobee Bike, private operator, launched bicycle sharing schemes in April 2017. This prompted the entry of several competitors in the market within the following months. However, due to potential road hazards coupled with the lack of comprehensive cycle tracks and on-street bicycle parking spaces, the government is implementing strict policies to regulate the use of bicycles along Hong Kong's busy urban roads.

City planners must consider using physical barriers to provide dedicated and safer lanes for bicycle users. Public bicycles must also be regularly checked for repairs and maintenance to ensure safety for its users. (Transport Department, 2018).

Parking also presents challenges to bicycling implementation in urban areas. In Hong Kong, widespread illegal parking has proven to be the most pressing issue associated with bicycle parking. Between April 2017 and July 2018 alone, city officials received around 800 complaints related to illegal parking, and a total of 84,668 notices were issued to remove illegally parked bicycles. Of these, a total of 18,948 bicycles were removed, and 2,051 of which were dockless bicycles. In 2018, the Transport Department implemented a code of practice to promote self-regulation and sustainable operations for dockless bicycle-sharing. TD also banned dockless bicycle-sharing in urban areas (Legislative Council Secretariat, 2018).

Case Study
Transitioning to zero-emission transport in the UK (Cont'd)

Figure 16 Crowded parking area for shared bicycles

Meanwhile, tech experts have been working towards smart solutions to promote safety for bicycle users. The industry introduced pedal-assist electric bicycles with speed and torque sensors to measure the rotational speed and power. The bicycle can be set on safe riding mode to limit the user's speed and help avoid accidents on the road.

These smart solutions, coupled with a well-managed parking infrastructure and effective regulations are key in successfully implementing bicycle sharing and promoting sustainable active mobility in the urban areas.

Case Study
National cycling plan of Singapore

In 2013, Singapore released a National Cycling Plan with the goal of promoting bicycling in the city through a well-connected infrastructure set to be completed by 2030. The plan is to develop a comprehensive network of cycling paths over 700 kilometres long to connect residential areas, key amenities, major employment centres, and other modes of transport. Singapore's Land Transport Authority is working with the Urban Redevelopment Authority to establish guidelines that will encourage developers to provide bicycle parking (Ministry of Transport, 2013).

The cycling infrastructure will also include off-road cycling paths, road markings, and information signs as well as bicycle crossings and ramps. By 2015, around 240 kilometres of off-road cycling path networks in Tampines, Sembawang, and Pasir Ris have been completed (Ministry of Transport, 2013). Bicycle sharing began taking off across Singapore in 2017. During the same year, an Active Mobility Act was passed in Parliament to establish public paths for walking, cycling and other active transport, illustrated in Figure 9 (Singapore Statutes Online, 2017). The cycling culture peaked as nine cycling companies began operations—oBike, ofo, Mobike, SG Bike, GBikes, ShareBikeSG, Baicycle, Anywheel and Moov Technology—accounting for more than 200,000 shared bicycles deployed across Singapore.

Figure 17 Public paths for walking and cycling in Singapore

With the boom of Singapore's bicycle-sharing, the government sought to build better bicycle parking facilities around MRT stations and bus interchanges as well as public housing estates, amenities, schools, and other areas. Currently, there are around 174,000 bicycle parking lots in Singapore, of which 17,500 are strategically located at MRT stations (Legislative Council Secretariat, 2018).

Singapore's cycling industry demonstrates the importance of bicycle-sharing schemes to citizens who have no access to personal bicycles and are looking for a practical means of travel for daily short trips from home to transit hubs and vice versa.

Key takeaways

Cycling is a practical alternative means of travel that can complement public transport systems. Bicycle sharing schemes have been successfully implemented in Singapore, Netherlands, Japan, and other developed countries. To promote cycling in urban areas, city planners must consider building a network of cycling paths that connects various residential areas to key amenities across the city. In the future, city planners must also provide ways for riders to enter train stations and underground stops through a designated and visible bike path. Parking infrastructure and associated facilities must also be enhanced to add convenience and ensure safety for riders. For example, Japan has over 50 automated underground parking stations for bicycles strategically located near public transport facilities (DesignBoom, 2017). The Netherlands has dedicated cycling lanes and facilities such as showers and dressing rooms available to cyclers (Bicycle to Everything, 2018). These facilities are also part of the multimodal transportation system where diverse transportation options and efficient land use are key considerations.

The Hong Kong Cycling Alliance, a local non-profit organisation, is expecting that the government will be providing more bicycle parking spaces in the future to eliminate illegally parked bicycles in the city.

5.2.3 HOW can we use green transport in Lantau Tomorrow?

Hong Kong is pursuing various projects and strategies to develop green transport and e-mobility as part of its long-term sustainability goal. These will lay the foundations for creating a thriving living environment for the future residents of Lantau Tomorrow. Hong Kong's mobility goals for the future site include:

- Improved air quality in Lantau. Green transport helps decrease the number of pollutants released to the environment and aligns with the environmental protection. The Government has been encouraging the public transport sectors to use more environment-friendly vehicles in Hong Kong. Besides Hong Kong has previous experience in building multi-modal transport infrastructure where the pedestrian paths, bicycle paths and bus lanes are separated for safety considerations.

- Healthier lifestyle. Bicycles or scootering encourages physical and mental wellness. The objective of building a sustainable Lantau Tomorrow includes better living conditions and improved health and wellness by getting close to nature. The adoption of green transport is incorporating sustainability into the lifestyle.

Challenges

- **Risk of cost overrun.** Upgrading the infrastructure (i.e., the installation of EV charging facility in the commercial and residential buildings with higher safety standard) is identified as one of the causes of cost overrun.

- **Regulatory support.** Transport Department of Hong Kong also reminds the cyclists of the safe riding by mentioning the skills of controlling the cycle, such as balancing, steering, starting and stopping, but also the awareness of pedestrians, traffic signals and road surface, and the anticipation of hidden dangers on the street as well (Transport Department, 2021). These friendly reminders to the cyclists are expected to be written into laws if Lantau Tomorrow includes it into the construction.

5.3 Climate Readiness

5.3.1 WHY is climate readiness urgently needed?

- **The climate emergency:** Climate-adapted land use and urban design help protect the lives and livelihoods of urban residents. Cities must adapt and improve their resilience to current and future climate impacts (European Environmental Agency, 2020). Systemic resilience also includes increasing awareness of physical climate risks, incorporating risk management into city processes, optimising emergency response and enhancing financial and insurance programmes (C40 Citis & McKinsey Sustainability, 2021).

- **Climate risk factors for cities:** Heatwaves, storms, flooding, and droughts will remain the most critical factors. Risks such as wildfires and vector-borne diseases are also rising (European Environmental Agency, 2020). Compared to inland developments, artificial islands may face more challenging extreme conditions and sea level rises. Without climate-resilient design,

any new development will face enormous climate change-induced disturbances that will affect every aspect of life.

- **Extreme temperatures:** The very young, the elderly and those with pre-existing medical conditions are especially vulnerable to extreme temperatures. Health systems will be affected to re-design or upgrade energy and transportation systems that tend to fail during heatwaves. Cities in Asia, especially eastern China and the Middle East, are already dealing with extreme heat on a regular basis (CDP, 2021).

- Drought and water scarcity: While annual rainfall in Hong Kong is projected to increase, year-to-year variability in rainfall is also expected to increase. Years of low rainfall will also increase pressure on water resources. Many rivers in China are already facing serious water shortages from increased population, urban development and large-scale water-intensive manufacturing activities (Ma, et al., 2020).

- Flooding and severe storms: Hong Kong is prone to tropical cyclones and receives an average rainfall of 2400mm per year. The Hong Kong Observatory (HKO) has no definitive answer as to whether tropical cyclone activity has increased or will increase due to global warming, but the average intensity of tropical storms is growing. The HKO currently projects average annual rainfall to increase by about 11% by the end of this century (Hong Kong Observatory, 2021).

- Sea level rise. Coastal areas flood due to storm surges, tidal flooding and the effects of climate change (Stocker, et al., 2013). In Hong Kong, tidal records show that the level of Victoria Harbour rose at 3cm per decade between 1954 and 2017. Other parts of Hong Kong experienced a similar rate of sea level rise. Climate projections show sea levels in the vicinity of Hong Kong are expected to rise by between 63cm and 140cm by 2100 (Chan, 2019). Apart from climate change, Victoria Harbour experienced a high tide of 3.57m during storm Hato in 2017 (Hong Kong Obervatory, 2018). According to China Water Risk's New Base Case Scenario, Hong Kong could see storm tides of 5.87m as early as 2030, a level that would impact large areas of Kowloon and Hong Kong Island (China Water Risk, 2019).

> ***[We are in a] 'Code Red' climate emergency. Lantau Tomorrow should be a natural, net-zero development and not harm biodiversity.***
>
> ***I think [we are] building for future generations, we are not building for ourselves. [This] is the most important especially … when we consider climate action requires us to ensure that we are leaving a better world for future generations.***
>
> ***Donald CHOI***
> *President of Hong Kong Institute of Architects*

> ***Lantau Tomorrow can serve as Hong Kong's role model for carbon- neutral development. It should be a connected and engaged community for people to live, work, and play … Carbon neutrality in the development can be achieved by mobilizing such smart technology and design strategies as natural ventilation, maximizing renewable energy generations, microclimate design and so on.***
>
> ***Albert CHEUNG***
> *Chairman of Hong Kong Green Building Council*

> ***Lantau Tomorrow should embrace future ready digital solutions and become resilient to unprecedented environmental, social and economic challenges. Together we shall foment the design of more resilient communities empowered by blockchain, tokenisation, AI, Big Data, future mobility solutions and new material technologies to address these challenges.***
>
> ***Bryant LU***
> *Founder and Chairman, Behave*

5.3.2 WHAT are the key attributes of climate readiness?

- There are three key attributes of climate readiness for sub-tropical cities:
    - Adapting to extreme heat
    - Adapting to flooding and severe storms
    - Adapting to sea level rise
- Climate risks are location-dependent, meaning that local climate risks and vulnerability assessments, supported by high-quality data, are key to understanding current and projected impacts.
- Existing evidence suggests that awareness-raising and early warnings are highly cost-efficient and effective in reducing climate impacts. Nature-based solutions are also effective, especially as they provide multiple benefits.
- Cities can identify a mix of reactive, preventative and transformative adaptation strategies to reduce climate risks and impacts as recommended in the Climate Action Planning Guide (C40 Cities Climate Leadership Group; C40 Knowledge Hub, 2021):

- **Reactive adaptation** fights immediate negative impacts, protecting lives and city systems during climate-related disasters and restoring them afterwards. Examples include temporary increases in the capacity of hospital services during a heatwave or providing sandbags to divert water in a flood.

- **Preventative adaptation** reduces negative impacts by preventing climate events from becoming disasters. Examples include the construction of coastal protection devices, installing energy-efficient air conditioning systems in buildings and water rationing.

- **Transformative adaptation** addresses the causes of climate risk, making impacts less likely and less severe. Examples include expanding a city's green infrastructure, developing water reuse systems and making changes to a building code.

- **Adapting to extreme temperatures.**

  - Hotter outdoor air leads to heat stress and heat-related mortality. It also leads to higher thermal transfer through building envelopes, leading to hotter building interiors and higher overall cooling demand.

  - Urban and building design play an important role in mitigating the adverse impacts of extreme temperatures through strategies like natural ventilation optimisation, urban shading enhancement, reduced ground coverage of buildings, and controlled and minimised anthropogenic exhaust.

- **Adapting to flooding and severe storms:**

  - Heavy and prolonged rainfall produces excess runoff which increase the risk of flooding and landslide damage. This impacts buildings and infrastructure and causes disruption to business activities, as we saw during Typhoon Hato (2017) and Typhoon Mangkhut (2018) (HKSAR Environment Bureau, 2021).

- **Adapting to sea level rise:** Higher sea levels mean-

  - Coastal ecosystems erode and lose their ability to adapt to climate change, so their effectiveness as protective barriers diminishes.

  - Impacts will be worse in areas of reclaimed land, where barriers prevent the inland migration of marshes and mangroves and limit the availability and relocation of sediment.

  - Exacerbated by trends in coastal development, expected annual flood damage will increase by two or three times by 2100.

  - During high tides, flooding further reduces the efficiency of stormwater drainage and wastewater outfall. Flooding can also introduce new or exacerbate existing salinisation. Both groundwater and surface water sources are at risk.
    (Oppenheimer, et al., 2019; China Water Risk, 2019)

Designing nature-based solutions

These are critical to adaptation and produce other benefits related to carbon sequestration, health and wellbeing and economic diversity. Solutions are grouped into several categories:

- Green infrastructure, such as trees, green roofs, green corridors, and permeable pavements.
- Blue infrastructure, including drinking fountains, water cooling, public swimming pools, fountains, and water bodies.
- Beaches and dunes, which reduce the impact of storm surges, while sand can be added to widen beaches and prevent erosion.
- Natural structures such as barrier islands, oyster and coral reefs, mangroves, seagrass, and salt marshes – these work alone or in tandem with built infrastructure like seawalls to absorb storm surges.
- Better building design, including passive cooling and natural ventilation – this is a central part of adaptation strategies.
- Community outreach also helps, including the provision of cooling centres and communications campaigns.
- Urban development strategies such as urban massing geometry, building materials, district cooling, and cool pavements.

  (European Commission, 2015; Seddon, et al., 2020)

Designing with water

As peak runoff flows increase and intensify, it is prudent to slow them down and gain benefits through greening, increased biodiversity and amenities (HKSAR Environment Bureau, 2021). Examples include:

- Sponge city features, which can be implemented at the building, campus and neighbourhood scales;
- Vertical sponge city infrastructure, which can be an alternative or additional tool to minimise storm damage at the building scale;
- A combination of traditional sponge city and vertical sponge city features in high-rise buildings, which may help create social infrastructure to make workplaces more human-centred and productive; and
- A diversity of natural features and processes that can be integrated into cities, landscapes and seascapes, through locally adapted, resource-efficient systems.

> ***We talk about the future, which is very difficult to forecast. We need to have an open mind and see the possibilities. For example with climate change: are we going to build buildings on top of water? Can we reach out into space? How open should our buildings be? The ability to cater [architecture] to a changing world – that's what I see as the most important.***
>
> ***Gregg LI***
> *Chairman of OASA*

> ***The challenge in climate readiness is how to make the best use of natural resources: light, air, solar power, wind, and greenery, turning waste into energy or recycling, rainwater harvest and management, and preservation of existing waterways. To achieve climate resilience, health and wellbeing in the light of recent pandemic, we should design for sea level surge, extreme rain management, maximizing natural ventilation, and better building and district drainage system and their maintenance.***
>
> ***Albert CHEUNG***
> *Chairman of Hong Kong Green Building Council*

5.3.3 HOW can we use climate readiness in Lantau Tomorrow Vision?

A. Extreme heat solutions for the urban microclimate

To understand heat risks, communities first need to measure urban heat and identify the most vulnerable groups, then develop a heatwave response plan to reduce the urban heat island effect (Osmond & Sharifi, 2017). Solutions could include:

- Cool roofs and façades with a lower albedo colour;
- Cool and permeable pavements and road surfaces;
- Green roofs and walls with enhanced insulation to reduce energy loss or heat gain;
- Trees and urban vegetation for shading and evapotranspiration cooling;
- Improving urban air ventilation by designing adequate breezeways, air paths, non-building areas, and building porosity and setback;

- Alternative shading and cooling methods including canopies and water features such as “spray parks”;
- Designing pedestrian routes to provide environmental diversity and choices of routes;
- Creating cool spots, or “urban oases” for pedestrians by providing shading, greenery, and ventilation; and
- Prioritising heat-sensitive urban planning like linear parks and green corridors that help enhance ventilation, and ensuring a high “sky view factor”, which cools cities by enabling the release of trapped heat into the sky. Reducing anthropogenic heat discharges at low levels can also reduce heat trapped at the pedestrian level.

Leading examples of climate adaptation

Singapore: “Cooling Singapore”, a research project aiming to combat the urban heat island effect, collated 86 cooling measures based on vegetation, urban geometry, water features, materials, shading, transport, and energy (NUS, TUMCREATE, Singapore-ETH Centre and SMART, 2021). Singapore also pioneered the concept of district cooling in the Marina Bay district. By centralising cooling plants, the network can reduce electricity consumption by 40% when compared to traditional air conditioning (Mokhtar, 2020).

Antwerp: This city modified its building code and now requires heat resilience to be incorporated into building work.

Los Angeles: The Sustainable City pLAn 2019 aims to reduce the urban heat island effect by lowering urban and rural temperatures and has set targets to use cool roofs and pavements.

Melbourne: The Urban Forest Strategy will cool the city by 4°C by 2040 by doubling the tree canopy, with at least 3,000 trees planted annually.

B. Sponge city (SCC) and vertical sponge city (VSC) concepts

- In China, SCC was proposed as a solution for urban water management in 2012, in response to disasters caused by extensive storm flooding and water shortages during dry seasons. City-wide SCC infrastructure is scheduled for implementation in 80% of cities by 2030. With one change to the design of open space, SCC delivers many positive outcomes. By making the ground more permeable to mimic natural surface runoff processes, SCC concepts:
    - Detain, filter and infiltrate runoff to relieve strained storm drainpipes from consistently torrential water volumes, allowing soils and plants to clean pollutants carried by the runoff from the water;
    - Allow infiltration which restores waterbodies and replenishes aquifers;
    - Allow the filtered chemicals to be absorbed by plants, aiding their growth; and
    - Allow excess runoff to be released as evapotranspiration to cool the air.

Examples of SCC and VSC in action

China – Tianjin Eco-City: The main objective of this project was to improve the environmental and ecological restoration of waterbodies. The construction of SCC facilities faced serious constraints due to high groundwater levels and soil salinisation. The overall construction strategy involved combining small-scale decentralised measures with large-scale regional measures. The small-scale measures included green roofs, rain cisterns, ecological ponds, permeable pavements, vegetated swales, and rain gardens. These achieved a runoff control rate of 80%, with pollutants reduced by 40%.

Singapore – Punggol Waterway Ridges: This is Singapore's first public housing development to use water-sensitive urban design on a large scale. Four types of features were integrated: bioretention basins and rain gardens, bioretention lawns, vegetated swales, and vegetated swales with a gravel layer. The development's innovative design has achieved an effective runoff control of 46.7%, with pollutants being reduced by between 45% and 80%, depending on rain event.

New York – Hunter's Point South Waterfront Park: This multi-use grassy oval is framed by a continuous path and a pleated steel roof shade pavilion. It holds a play area but is also designed to handle storm surges on this flood-prone site. The park's perimeter has a bioretention strip and filters stormwater from the surrounding streets using a 230 m biofiltration swale, a gabion wall running along the length of the park and permeable paving throughout the site. A total of 72.77% of annual rainfall is intercepted, infiltrated and evaporated.

> ***The development of Lantau Tomorrow should follow scientific principles. For example, the reclamation has been backed by studies on ecology, project phasing and waste management. Furthermore, Lantau Tomorrow's development should incorporate new building strategies, for instance common utility channels.***

Prof. KK LING
Director of Jockey Club Design Institute for Social Innovation at The Hong Kong Polytechnic University

> ***Lantau Tomorrow can be the beacon for deep decarbonisation and adaptation of a vertical city. The project opens many doors to unique sustainable design opportunities of a vertical compact city to achieve carbon neutrality and climate resilience. To stand out as a world-class future-ready development, a whole life carbon perspective and aspirational benchmarks shall be adopted to drive innovation.***

MK LEUNG
Principal Behaviourist, Behave

C. Sea defences

- Seawalls are built 1.5-2m above sea level and can cost between US$200 and $625 per metre. Seawalls age or become damaged from salt water and waves and need to be replaced. They will also need to be replaced or built higher, given the continually rise in sea levels.

Example: The BIG U, New York

The BIG U was developed to protect Lower Manhattan from flood waters, storms and other impacts of a changing climate. It is a continuous 16km seawall tailored to each neighbourhood's typology and incorporating amenities desired by the community. The Bridging Berm, a large soil-based barricade, provides robust vertical protection for the Lower East Side from future storm surges and rising sea levels. The berm also offers pleasant, accessible routes into the park, with many spaces where people can rest, socialise and enjoy views of the park and river. Both berms and bridges are wide and planted with a diverse selection of salt-tolerant trees, shrubs, and perennials, creating a resilient urban habitat (Rebuild by Design, 2019).

D. Floating Structures.

- One of the key advantages of floating architecture is its sustainability compared to land reclamation, which can displace natural sediments and cause irreparable harm to the marine ecosystem. Floating buildings can create artificial reefs, providing food and shelter for marine life and come in two types: semi-submersible buildings or buildings with foundations on the seabed, like oil rigs. There are also pontoon buildings, such as the floating homes in Ijburg, Amsterdam, which fully float on the water's surface and are kept stable by mooring systems. Very large floating structures are becoming common in airports, storage structures, wind farms, and solar farms.

Ocenix City, Busan

Oceanix City in Busan, Korea is a prototype of a floating, sustainable city based on a pontoon structure. This design restricts it to shallower waters and requires breakwaters to limit the impacts of waves. This sort of structure could serve as an extension of a coastal city or as a "life raft" for island communities (Mezza-Garcia, 2019).

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