CHAPTER SAMPLER

Sustainable Cities

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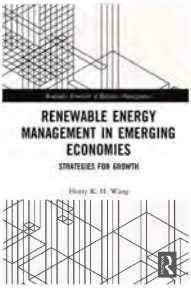
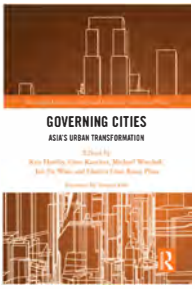
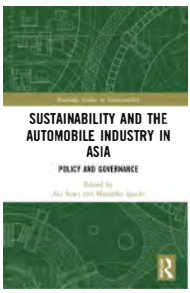
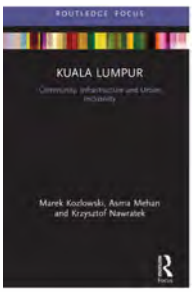
Contents









8 Smart city renewable development management

逆境出人才
Nì jìng chū rén cá
Difficult situations force people to rise to the challenges.
Crisis breeds wisdom.

Executive overviews

Climate change and global warming have posed essential and major challenges to leading cities around the world. Different extreme weather events induced by climate change and global warming have caused serious damages and disruptions to major cities, especially those in emerging economies. These events include hurricanes, typhoons, extreme heat summers, freezing cold winters, extreme heavy downpours, flooding and droughts. In addition, the rising urbanisation, population growths and increasing pollutions have put more pressures on cities globally. As a result, new green smart city designs and transformations, with clean renewable energy applications and energy-efficient green buildings, have been important priorities for leading cities globally. These various new smart city developments with renewable energy integrations will be discussed further in this chapter, together with city examples.

Climate change threats and challenges to global cities

Climate change and global warming have serious implications for all the major cities around the world, especially for those in the emerging economies. Some of most serious negative impacts and damages on leading cities around the world have been caused by the various extreme weather events induced by climate change and global warming. These have included hurricanes, typhoons, extreme heat summers, freezing cold winters, extreme heavy downpours, flooding and droughts. These extreme weather incidents have caused serious damages to various cities across the world with heavy financial cost damages, especially those in emerging economies.

In addition, climate change and global warming have led to rising sea levels globally. Scientists have measured that the average sea levels around the world

have risen by about 8 inches or 20 cm in the past 100 years. Looking ahead, climate scientists are expecting sea levels to rise further at faster rates in the next 100 years. These will be driven by climate change and global warming causing the accelerated melting of the polar ice caps and sea warming. Ocean scientists have conservatively estimated that sea levels globally could potentially rise by a further 1–4 feet, or 30–100 cm by 2100. These high sea level rises will be large enough to flood many coastal cities plus various small Pacific island states, such as Vanatu. Examples of cities facing serious flooding risks in developed economies included Boston, New York, Hilton Head, Miami, London, Hong Kong, etc. Major cities in emerging economies facing serious flooding risks include Bangkok, Jakarta, Manila, etc. These cities have all been forecasted to experience much more frequent and serious flooding risks by 2100.

Looking ahead to 2050 and 2100, many coastal and low-lying cities around the world will be seriously affected by rising flooding risks and incidents. These cities will have to invest heavily on various flood defences, such as seawalls and catchment ponds, so as to survive and control these potential serious flooding events.

Major cities around the world are also going green and actively transforming their energy mix as part of their commitments to the Paris Agreement. Many leading cities globally have been transforming their total energy mixes and energy consumptions away from fossil fuels to use more clean renewable energies, such as solar, wind, hydro, bioenergy and geothermal. These clean renewable energy applications will help these cities to better meet their rising future energy requirements generated by their growing populations and economic growths. In addition, these clean energy transformations should help these cities to reduce pollution and greenhouse gas emissions plus minimise their climate change and global warming impacts. Some of the top green cities in the world included Copenhagen in Denmark, Amsterdam in the Netherlands, Stockholm in Sweden, Vancouver in Canada, Curitiba in Brazil, Reykjavik in Iceland, London in the UK and San Francisco in the USA. Looking ahead, experts have forecasted that over 100 cities across the world in both developed countries and emerging economies, ranging from Addis Ababa to Auckland, will be using more than 70% renewables in their future energy mixes (ADB, Green Cities, 2012).

Many governments and cities have recognised the serious threats of climate change and global warming. They have agreed to work together to achieve their Paris Agreement commitments. They have also agreed in the COP24 meeting in 2018 to try to limit their emissions so as to reduce global warming to below 2°C and then further to 1.5°C as proposed in the IPCC 1.5C report. In line with these new global consensus and agreements, many city leaders and municipal governments have been improving their environmental management and setting new firmer emission reduction targets plus enacting new municipal renewable policies.

A good example is that in the USA, some 58 cities and towns, including Atlanta and San Diego, have committed to move to 100% clean energy in future as part of their climate change and clean renewable energy drives. Meanwhile,

Burlington in Vermont has claimed to be the first US city to get its energy from entirely renewable sources. Another good emerging economy example is in Latin America where almost half of Brazil's major cities have been powered entirely by hydropower and clean renewable power sources.

There are large variations in how various cities, in developed countries and emerging economies, are transforming their energy mixes with renewable energy applications. A good example is that most of the 100 leading cities in North America, which have been reporting their energy mixes, have been shown to be using less than 70% clean renewable energy in their city's energy mix. However, some of the leading cities in emerging economies have already been using more than 70% renewable energies in their energy mixes. Another good example is that a majority of Latin American cities, which have been reporting their energy mixes, have reported that they have already passed the 70% threshold and are using more than 70% renewable energy in their energy mixes.

Energy experts analysing these different city energy transformation trends have found that many leading cities in the developing world and emerging economies have been actively supporting their clean energy transformations by capitalising on their local natural resources and maximising renewable energy applications. The pioneering clean energy transformation activities in these major cities in the emerging economies have been largely driven by local economic needs plus the political commitments of their local and national governments.

Climate change and global warming are also imposing serious challenges to the availability of clean renewable energies to different key cities of the world. A good example is that in Latin America the production of green electricity from hydropower has been changing drastically between years due to the extreme droughts being caused by climate change in some key Latin American regions. These serious droughts have seriously affected the functioning of some hydropower plants. Looking ahead, cities in the emerging economies, especially in Latin America, have to further diversify their energy mixes into different clean renewable energy sources, including solar, wind, hydro, geothermal, bioenergy, etc. This should then help to provide more sustainable and continuous clean power generation, which should then help to provide good energy security for their local population whilst maximising renewable applications and minimising environmental pollutions (CDP, Global City Report, 2016).

Smart low-carbon green city global developments

Globally, there has been rising urbanisation in recent years, leading to almost half, about 50%, of the world's population now living in urban cities globally. Looking ahead to 2050, experts have projected that the city populations globally could rise significantly to 75% of total population. These are driven mainly by high rural to urban migrations and high urbanisation rates.

City planners globally have been advocating that it would be important to design and transform current cities to become smarter low-carbon cities with renewable applications and green environment to better accommodate the rising

city population, in both the developed countries and emerging economies, on a sustainable basis. It is also important to retrofit and improve older cities so that they can become smart low-carbon cities. The potential key challenges and improvements required for smart low-carbon cities are discussed below (BBC, Future cities, 2013).

Smart city researchers in leading institutes globally have been working together via various international alliances on new smart city designs. A good example is the Imperial College London Digital City Exchange. Its research of leading cities globally has shown that many large cities worldwide will soon be reaching breaking points. The serious problems that many leading cities of the world are facing have included worsening traffic jams, longer queues, delays on public transports, power outages, worsening pollutions, rising congestion and crime levels, etc. In addition, the air qualities and environmental pollutions in many major cities globally are getting to such poor levels which have become hazardous for the health of their populations. These reinforce the essential needs for the major cities in the world to prioritise their efforts to accelerate their clean renewable energy transformation and to achieve the large reductions in GHG emissions to meet their Paris Agreement commitments (Imperial College's Digital Economy Lab, Digital City Exchange, 2019).

There has been widespread recognition internationally that the commitments made by national governments under the Paris Climate Agreement would be very difficult to achieve without concerted action by major cities globally. Many mayors of leading cities around the world have shown strong commitment to tackle climate change and pollution. They have also shown good willingness to collaborate internationally to improve their cities and achieve the strict climate goals. A good example is the new C40 Cities network. This is a global network of the mayors of 40 world's megacities. They have agreed to work together to address the key climate change challenges to cities globally and to meet their Paris Agreement commitments. The C40 City group has published its analysis report titled "Deadline 2020," on the potential emissions-reduction pathways that their cities would need to achieve as part of their contribution to keeping the global average temperature rise within the safe limits of below 1.5°C as advocated in the IPCC 1.5 Report (C40, 2020 City Report, 2018).

Climate experts globally have predicted that whilst the technologies and expertise may exist to limit the potential temperature increase to 1.5°C globally, there are likely to be significant challenges plus high resistance from some governments and corporations. With major cities already stretched to meet multiple competing priorities, the city leaders must determine the critical policies and actions which they will need to take to improve their worsening environment and emission trajectories. They will have to work proactively with their stakeholders and communities to build and invest in the appropriate new smart low-carbon infrastructures. City leaders have to enact suitable municipal policies and incentives to make significant progress towards achieving their green city targets. City leaders will also need to prioritise appropriate climate actions around key initiatives that would catalyse systemic changes. Their key priority actions should

include greenification, decarbonisation, building energy efficiencies, waste recycling, energy management improvements, etc. These key areas will be described in more detail in the sections below with relevant examples (Mckinsey, Climate actions in cities to 2030, 2018).

Greenification will be very important for future smart low-carbon city designs and developments. Sustainability experts have predicted that future smart cities would need to transform quickly to become green carbon-neutral cities. The future green carbon neutral cities will need to undertake significant energy transformation by reducing their fossil fuel consumptions and promoting renewable applications. Low-carbon transportation will be an essential part of the future smart cities. These should include electric vehicles, zero-emission vehicles, green public transport, bike-sharing schemes, etc. The future green cities should also include new smart buildings and green skyscrapers where living and office space will be designed together with various green features. These should include solar roofs, urban greenhouses, high-rise vegetable patches, heat pumps, etc. These city greenification improvements should help to reduce greenhouse gas emissions and lower pollution. These should help to improve the city's air quality significantly whilst improving the living standards for the city residents.

Decarbonising the electricity grid and power supplies for cities around the world will also be an important requirement for cities to achieve the new UNIPCC targets. These should include a massive expansion of large-scale renewable power generation and phasing out of fossil fuel power generation. These should help to decarbonise the city electricity grid and power supplies globally. Major cities and their urban residents are normally the key customers for major electric utility and generators globally. This should give them significant leverage to shape and choose the future energy profiles of the electricity that are being generated for their consumption within their metropolitan areas. A good urban example is that some leading utility companies in the UK have already been offering their customers the choice of buying 100% green electricity, generated totally from renewable sources, when they set up their electricity supply contracts to their residential home.

Experts have advised that capturing these city greenification opportunities will not be easy. Municipal city administrations will have to work closely together with various key stakeholders to achieve these goals. Utility companies and regulators will need to play their roles in ensuring that the optimal mix of renewable energy applications should be applied at the city level. In addition, the application of new advanced components, such as energy storage and smart grids, should be encouraged so as to achieve the required electricity grid flexibility and reliability. City leaders and municipal governments will also have essential roles to set clear new decarbonisation and emission goals and targets. These would be key for aggregating energy demands for renewables plus promoting energy efficiency. In addition, municipal city governments should shift more of the future urban energy consumptions into electricity especially in the transportation plus the heating and cooling sectors in their cities. Through focused

acceleration, and close collaboration between utilities and regulators, city experts have forecasted that major cities globally should be able to achieve an optimal grid mix of 50–70% of clean renewable electricity. The renewable sources should include solar and wind, together with other zero-emission clean energy generation sources such as hydropower. These future clean renewable energy transformations in cities could help to capture 35–45% of the total emission reductions required by 2030. In addition, the predicted future cost reductions in renewable energy generation should help to maintain electricity costs to as low as $40–80 per megawatt hour for smart cities (IRENA, 2018).

A major area of improvement in smart cities is to improve and optimise the energy efficiency of buildings in the cities. Experts have estimated that for buildings around the world, heating and cooling have accounted for 35–60% of their total energy demands. These heating and cooling energy requirements have also produced nearly 40% of the greenhouse gas emissions from buildings.

Looking ahead, reducing energy uses and emissions from buildings will not be easy. These will require significantly more focused effort than most cities have currently been taking. The improvements should include raising building standards for new construction, retrofitting building envelopes, upgrading HVAC and water-heating technology, implementing lighting, appliance and automation improvements, etc. To realise good progress in these various areas will require city leaders and urban planners to work closely with building owners, both residential and commercial, plus real-estate developers and building occupants. Combined actions by all parties should help to reduce building energy costs as well as providing more resilient, comfortable spaces to live, work and play for future smart city residents through to 2050 and beyond.

Another major area for future smart city improvements will be in the field of transportation and enabling the next generation of smart mobility in cities globally. City leaders have access to a wide range of mobility and transportation options. These include public–private transportation mix, bike-sharing schemes plus hybrid and electric vehicles, etc. City administrations and urban planners should apply appropriate urban mobility and land-use planning to transform the transportation systems around their cities. The key to reducing emissions through various transportation modes will be to ensure that all residents will have access to a variety of attractive, affordable low-carbon mobility options. Public transit-oriented transport developments can help to promote smart densification through better land-use planning. These should also help to lay the foundation for more multi-modal transportation systems and reduced carbon emissions in the long term. Urban initiatives to encourage walking and cycling around cites can help to improve city life and transportation. Targeted enhancement of mass transit, such as the introduction of bus rapid transit (BRT) in main urban arteries, should help to reduce traffic jams plus lower GHG emissions. In addition, cities can accelerate emission reductions by enabling the uptake of the next-generation clean vehicles, including electric vehicles and new energy cars, via appropriate licensing and registration incentives. New autonomous digital technologies can also be used to optimise freight transport and delivery in

cities. Experts have forecasted that suitable focused acceleration in appropriate urban transport action areas should contribute to urban emission reductions of 20–45% of the 2030 targets. These emission reductions will be dependent on various factors, including urban income levels and population density. These improvements can also help to promote sustainable city economic developments and GDP growths, by reducing congestion and improving city efficiencies. In addition, these should help to improve the quality of life for residents by alleviating local air pollution and improving equitable access to mobility options in cities.

Future smart cities will also need to tackle waste recycling and emissions in resource-effective ways. Urban planners should adopt a prioritised approach involving the "highest and best use" approach. It would involve first reducing waste upstream and re-purposing as many useful finished recycled products as possible. There should be increased recycling, composting and recovering waste materials for useful purposes. Cities will also need to manage waste disposals to minimise emissions of the remaining organic waste materials. Methane emissions from waste landfill site could potentially have very high impacts on the near-term global warming as methane is a strong GHG. Reducing wastes should help to reduce GHG emissions and improve energy efficiencies. Innovative models for waste management can help cities rethink their need for traditional waste collection and disposal infrastructures.

Some forward-looking cities are already going further and planning their transition to a full "circular economy" model. This will involve shifting resource consumption from linear flows to continuous reuse and recycling. Waste experts have estimated that waste-management improvements could help to achieve up to 10% of the emission reductions needed by 2030. These improvements will also provide additional benefits including improved local resource resilience, waste reductions and improved energy efficiencies.

One innovative urban circular economy development is the integrative use of urban waste recycling and incineration system together with new urban district heating systems. A good example is that the utility company EON in the UK has developed and implemented new district heating systems, which are powered by the urban waste recycling and incineration stations in London, for some new residential developments in Greenwich in London (*Guardian*, London District Heating Systems, 2017).

Asia's smart city developments and challenges

In Asia, the combination of high economic growth rates and rising urbanisation together with the fast-growing urban populations has brought serious environmental challenges to their major cities. Asia is already home to over half, about 53%, of the world's urban population. This is followed by Europe with 14%. Hence, there are particular pressing needs to harness businesses, citizens and policy makers to improve urban planning and the design of future green smart low-carbon cities in Asia.

As more people are moving into Asia's cities to live, work and play, the number of motor vehicles, motorcycles, bikes and trucks have also risen significantly in the cities. These have caused heavy traffic jams and gridlocks in many cities globally. In addition, the running and idling car engines, during traffic jams, would be generating more GHG emissions and causing heavy air pollutions in some of the world's most congested and polluted metropolises.

At the last World City summit, held in 2016 in Singapore, many city mayors and urban leaders have identified transport planning and management as one of the biggest challenges facing cities. Various serious city challenges have also been covered in many future energy scenarios published by energy experts. A good example is the Shell Sky Scenario which covered potential future transport improvement options for key Asian cities. These scenarios have shown that changing and improving the modes of transportation for people and goods in cities could be one of the crucial steps for many cities around the world to meet the goals of the Paris Agreement (World City summit, Innovative Cities of Opportunity, 2016).

Asian cities have many opportunities to be innovative and bold with improving their transportation systems and models. Building new compact low-carbon cities that will efficiently integrate the public and private modes of transport together with key technology innovations will be very important. Looking ahead, electrification is likely to be a very important area for transport improvements and innovations in the smart cities in Asia and globally. The use of electric vehicles has been rising globally but there are still many hurdles, including customer preference, battery life, travel ranges, etc. (Shell, Shell Sky Scenario, 2018).

A good country example is that China has been leading the world in promoting electric vehicles. In Beijing, despite the government cutting EV subsidies by as much as 40% in 2017, the sales of electric vehicles have still been increasing. These have been largely driven by consumer preferences and demands. These rising electrification trends have shown the importance of customer preferences as an important driver for electric car sales. Currently, electric vehicles have made up only 0.3% of China's total vehicle fleets. As China's economy continues to grow, its cities should continue develop fast with high urbanisation rates. These are mainly driven by the continued high migrations from rural to urban districts in China. Currently, over half of China's population is still living in the rural areas. Looking to the future, experts have forecasted that many more in the rural areas will be migrating to nearby cities to seek employment and better lives. Transport experts have also forecasted that the number of electric vehicles in China would likely to continue to rise further. Looking ahead, it is likely that over 25% of China's passenger vehicle kilometres would be driven by electric vehicles in 2040. By 2050, it is expected that half of the cities in the world may be following China's suit with rising numbers of electric vehicles being driven on their city roads (Shell, Shell Sky Scenario, 2018).

In addition, the development and use of hydrogen in future smart green cities are likely to be very important for future green transportation developments in Asia and globally. Hydrogen vehicles do not produce carbon emissions and

will be important for future green smart cities to achieve their Paris Agreement commitments. A good example is that Japan has been a leader in hydrogen applications for smart cities. Japan has already released in 2017 a blueprint towards a possible "hydrogen society" by 2040. Cars running on hydrogen do not produce carbon emissions from the tail-pipe. Buses powered by hydrogen fuel-cells have already been running in Tokyo. The Japanese government is planning to use the Tokyo Olympics and Paralympics in 2020 to showcase hydrogen technology in their Olympic athletes' villages. Today, out of Japan's 70 million vehicles, only 2,200 are fuel-cell cars. Looking ahead, the Japanese government is aiming to increase the number to 40,000 by 2021. It is also planning to increase the number of hydrogen-filling stations in Japan from 91 to 160 in the same period (Japan, Blueprint hydrogen society by 2040, 2017).

Looking ahead to 2070, different cities across the world will need to improve their designs and performances, including their transport systems. These will be essential to achieve their net-zero carbon emission targets in line with the latest UN IPCC recommendations and to meet their Paris Agreement commitments. Looking ahead, transportation experts have predicted that over half of the world's total vehicle and freight kilometres could be driven by new electricity or hydrogen vehicles in the green smart cities in Asia and globally in future (Toyota, Sustainability Environment report, 2018).

Smart cities' digital and big data developments

Looking ahead, future green smart cities will have to apply advanced big data systems plus new internet of things (IOT) techniques and digital IT systems to improve their various city operational performances. An important area of digital IT application will be in traffic management systems, as many cities will need to make their traffic systems smarter so as to improve traffic management and reduce traffic jams. A good example will be to use a network of advanced sensors around the smart city which will then provide a host of data about how the city is performing. This will allow different city systems to be linked up and optimised so that they can ultimately all work more efficiently together with advanced digital big data analysis systems.

Many technology companies, including Siemens, IBM, Intel and Cisco, have been working on smart city IT applications plus investigating how best to hook up smart cities into smart networks. A good business example is that IBM currently has 2,000 digital projects ongoing in various cities around the world. Good examples included crime prevention analytic systems in Portland, Oregon and advanced water databases in California. It has also been working on smarter public transport management systems in Zhenjiang in China.

An exciting smart city big data development is that in Rio de Janeiro in Brazil, IBM has built an advanced city operation centre. This has been described as the new digital "nerve centre" of the city. It was built initially to help to deal with the floods that had regularly threatened the city. Further developments have enabled the centre to effectively co-ordinates some 30 different government agencies.

The centre has also generated special mobile apps for the citizens, which will help to keep them updated on potential accidents, traffic black-spots and other essential city updates.

Another good example of smart city big data development is the new City Pulse System. The US Silicon Valley firm Screampoint has developed a new City Pulse System which is a new form of city performance digital dashboard. The new big data system with many smart sensors will take various key digital inputs or pulses of the city from various key data sources or sensors. These would include energy usage, waste management, number of jobs available, etc. Kansas in the USA has already installed one of these new City Pulse Systems. Amsterdam and Barcelona are also considering installing one of these new City Pulse Systems.

Smart cities can also use big data to predict crime and improve security for their residents. A good example is that the security firm AGT has been working with cities around the world to create an overall digital picture of how safe a city is at any given time. These new security systems will use city-wide data and predictive algorithms to generate security updates for residents and communities on the latest city crime and security situations. Then police and communities can use these new systems to help to prevent crime and improve security around the smart city.

Crowd sourcing has also becoming very important consideration for the design of future smart cities. Leading researchers, including those at Columbia University Committee on Global Thought, have advocated that it would be important for city leaders and urban planners to recognise that the behaviour of a future smart city will be driven by the behaviour of its citizens. It is also very important to realise that advanced IT systems will be playing increasingly important roles in the lives of its citizens. Hence, it should be important for various corporates working on smart city designs to undertake adequate consultations with citizens, community groups, stakeholders, city councils, etc. In addition, urban data-collecting schemes and surveys will require the consent of various citizens and stakeholders to make these meaningful (Columbia, Committee on Global Thought, 2019).

A good example is the new IBM water project in Dubuque, Iowa, USA. The company has offered various households in the city access to digital information about their water consumptions. The majority of citizens then quickly changed their habits and saved more water when they were given access to their water use data. Interestingly, the citizens who were also given access to their neighbour's water use information were found to be twice as likely to make changes to save water.

Many leading smart city researchers, including the MIT Sense-able Cities Lab, have highlighted that the powers and opinions of the crowd and communities in future cities would be crucial for the development of smart cities of the future. Experts have predicted that there might be some conflicts of interests in future between what big corporations may want to sell to cities and what the citizens would actually need. Experts have generally forecasted that the power of the

crowd and what they want will become more important as cities get smarter. A good example of citizen consultation and crowd sourcing is the Honolulu crowd-sourcing scheme. The city has undertaken survey and collated data from citizen where all the defibrillators should be located in different buildings around the city. This has helped to optimise the defibrillator locations so that these should offer the best immediate help to patients if someone has suffered a heart attack in the city (MIT, Senseable Cities Lab, 2019).

Climate flooding risks and future sponge city developments

Climate change and global warming have led to rising sea levels globally. Looking ahead, climate scientists have predicted that sea levels globally will rise more rapidly in the next 100 years with the melting of the polar ice caps induced by global warming. Ocean scientists globally have estimated that the sea levels could potentially rise by a further 1–4 feet, or 30–100 cm. These high sea level rises could bring serious flooding risks to many major coastal cities globally. There will also be widespread flooding of many small Pacific island states, such as Vanatu.

Hence, many coastal and low-lying cities around the world will have to start to prepare for these rising flooding risks. These cities will have to invest heavily to install the appropriate flood defences, such as seawalls plus catchment ponds, so as to handle and control these expected serious flooding events.

City planning experts have proposed that major cities in future should combat these floods by transforming themselves into "green sponge cities". The general idea is that a modern sponge city can better utilise its wetlands and wet areas, such as marsh, swamps or shallow ponds as well as green spaces and floodplains, to absorb large amounts of water before the flood water would flood and submerge the streets in the city. City planning experts predicted that if cities could reconsider the power of their wetlands and other natural infrastructure, then it would be possible for new sponge city designs to help modern cities to protect themselves better from the growing risks of urban floods caused by climate change and global warming. Good city flooding examples include many cities in Thailand that have suffered flooding regularly during monsoon season. In 2011, Bangkok suffered serious major flooding and it was estimated to have costed damages of some USD41 billion.

In recent years, high economic growths and rising migrations from rural areas have led to rapid population growths in many Thai cities like Udon Thani. The rising urban migration and growths in urban population have contributed to serious changes in urban land use in the city. These urban changes had exacerbated the flooding risks by increasing the area covered in concrete, asphalt and other impervious surfaces. These new expanded impervious surfaces would prevent rainwater seeping into the ground. All these would reduce water runoff leading to excessive water build-ups, which resulted in more frequent flooding in the cities.

A good example is Udon Thani which is one of the major cities in the northeast region of Isan in Thailand. It has been particularly negatively impacted by rising population and flooding incidents. During the Thai monsoon season every year, the city's drainage systems have been seriously overwhelmed. These have resulted in large areas of the city being flooded and inundated. Many homes and buildings were flooded plus many roads became impassable. In addition, there were serious health risks generated by raw sewage mixing with flood waters. All these have led to serious hazards to the city residents plus generated serious damages with high financial penalties.

As Udon Thani has been growing rapidly, the city leaders have to find suitable solutions urgently to alleviate the increased flood risks. So the Udon Thani municipal city government has decided to adopt plans to transform its city into a "green sponge" city. These transformations should help the city to better mitigate flooding by using "natural infrastructure," including wetlands, trees and parks. The Udon Thani Green Infrastructure Master Plan proposed combining natural and built infrastructure systems for the Udon Thani city regions. Landscape architects, engineers and scientists worked together to test the feasibility of natural infrastructure to soak up excess water so as to minimise flooding incidents. They used a hydrological model, in combination with advanced city design and engineering tools. They managed to design a natural infrastructure network which would link up various green areas across the city. Their computer simulation work shows that these wetlands and green areas would help to buffer water flows. These should then help to reduce flooding by slowing water flows during storms with increased infiltration. In essence, these would act like sponges to soak up water in the city to minimise the risk of a serious flood in the city. As part of its new plans, Udon Thani has been working to protect the existing wetlands, but also to restore lost and create new wetlands, along with other natural infrastructure. These will all contribute to the overall aim of protecting the city from future flooding. In addition, these will help to provide additional benefits for the citizens, such as more green and recreational spaces in the city. There are plans for a new park on a canal in Udon Thani which will create a new wetland in the city. This will help to slow the speed of water during storms plus increase infiltration during both dry and monsoon seasons (Cgiar, Fighting Floods by Sponge Cities, 2018).

The new green sponge city concepts have shown that careful city planning using wetlands and other natural infrastructure to create a new green sponge city is important. These should help to create greener, healthier and less flood-prone cities for the future.

These new sponge city concepts are now being adopted by more leading cities in Asia and around the world. Research in Asia by the International Water Management Institute (IWMI) has also highlighted the value of urban wetlands in India both for the urban poor and for flood minimisation. A good example is that the wetlands within the city of Hyderabad in India have supported the growing of rice, vegetables and cattle fodder that have been sold in the city markets. These have been a major contribution to the livelihoods of many

subsistence farmers in the cities plus helping to reduce flooding risks in the city. Similarly in India's northeast, the wetlands of Kolkata have not only helped to reduce flooding in the city, but also helped to support 32,000 residents who are fishing for a living. In addition, these have helped to treat the city's rising sewage outfalls.

Both cities have also been working to control the haphazard urban sprawl that has caused degradation and minimise the loss of their valuable wetlands. In Kolkata, the loss was particularly serious at up to 50% between 2000 and 2012. These have posed serious threats to the poorest residents who have also been most dependent on the benefits that the wetlands would provide. These wetland degradations in Kolkata have also seriously increased the flooding risks in the city.

The Sri Lankan government has also recognised the vital benefits of urban wetlands and sponge city. It is working hard to conserve and enhance its wetland potentials, including flooding mitigations. Colombo is aiming to be one of the first official "Wetland Cities" with the new sponge city concept, which is accredited by the Ramsar Convention. City planners have forecasted that these new sponge city transformations will not only improve flood protection, but also help to create more competitive and liveable international cities in future.

The UN has also just announced its plans to develop new floating cities as an innovative approach for future urban design to combat climate change and global warming. The UN-Habitat team has just announced its new partnership with the Massachusetts Institute of Technology Center for Ocean Engineering, The Explorers Club and the floating cities non-profit group Oceanix to jointly develop designs for new floating cities. They have just started work and have forecasted that their new designs should benefit existing cities in their fight against climate change and global warming (UN, Floating City to fight Climate Change, 2019).

Smart low-carbon green city economic benefits

There have been many questions on what are the potential economic benefits and payoffs for green smart low-carbon city developments. Many stakeholders have questioned what are the major economic benefits to cities and urban residents from the push by many cities in their transformation to become smart low-carbon green cities. We shall analyse the transformations undertaken by some of the leading cities around the world and discuss various major benefits below.

A good smart city benefits' case study example is Copenhagen in Denmark. The impetus for Copenhagen's climate plan and drive for carbon neutrality started when Copenhagen hosted the COP15 global climate conference in 2009. The Copenhagen city leaders believed that they should walk the walk and talk the talk, plus set an example for other cities. There have been lots of obstacles and challenges plus setbacks during their transformation journey. Copenhagen is now well on its way of becoming carbon neutral by 2025.

Copenhagen has been undertaking extensive clean energy transformation, by reducing its fossil fuel consumption and promoting clean renewable energy applications, as part of their transformation plans. These have helped to create new jobs, new economic activities and new businesses in the city. The city government of Copenhagen has been moving rapidly towards meeting the goals of its 2025 Climate Plan to become the world's first carbon-neutral city by 2025. It has been working hard to reduce and offset carbon emissions with extensive clean energy transformations. Copenhagen city officials have reported that the same policies that have protect the city's environment have also helped to improve sustainable economic developments and global competitiveness in the Denmark capital city. By focusing on reducing carbon emissions and becoming more sustainable, the city is helping to enhance their citizens' health, well-being and comfort, plus also improving their economies and employment (Berger, Copenhagen: Economic Payoffs, 2017).

Economists have estimated that each time Copenhagen spends $1 on its climate plan, it would help to generate $85 in private investment elsewhere in the city. Economic studies have shown that the Copenhagen climate plans and actions would be generating an economic surplus of almost $1 billion over its lifetime which is a very significant economic benefit. In addition, there are significant additional intangible benefits which include improving living standards, better environment, improved air qualities, etc.

In line with the Copenhagen 2025 Climate Plan, the city government is aiming to reduce Copenhagen's carbon emissions by 37% with new energy policies and targets. After that, the city will purchase additional carbon offsets via the Carbon Emission Trading Schemes CETS so as to achieve the remaining 63% of carbon reductions that would be required to become carbon neutral. It is recognised that although the purchased carbon offsets will, in principle, result in zero-net carbon emissions, the local effects of residual carbon emissions would still be felt.

Copenhagen has succeeded in reducing its carbon emissions by more than 40% since 1990. This is despite the fact that its population have grown by over 50% in the equivalent period. The city is now home to nearly 600,000 people, with greater Copenhagen comprising two million people. As the city's population increased between 2005 and 2014, its economy also grew by 18%. In contrast, its per capita CO_2 production fell by 31%. These reductions have been achieved mainly due to the city's massive climate protection efforts. The city has managed to hold onto its various climate change improvements and gains. The residents of Copenhagen have become the Danes that are producing proportionately less carbon than other Danes elsewhere in Denmark. With 40% of Denmark's population living in greater Copenhagen, the city is only emitting 30% or a per capita emission of 2.5 tons per person, of the whole nation's carbon emissions.

These notable accomplishments in carbon emission reductions have been achieved by various hard works. Copenhagen has been transforming its private and public transport systems. It has been encouraging its residents to use low-carbon transport. This has led to about 45% of all road trips now being

made by bicycle. Over 75% of the cyclists have also been riding their cycles all year-round despite the cold winters. The city has put in place a good bike-sharing system with dedicated bike lanes plus cycle routes where cyclists could travel safely at designated speeds.

The city government has also increased the proportion of its cars running on electricity, biofuels or hydrogen to 64%. The city has established the goal of having all city vehicles converted to run on clean renewable energy by 2025. It has also been implementing carbon-neutral bus service to replace its existing bus fleet which have been running on diesel.

Copenhagen has also been improving its energy efficiencies with major investments. Energy-efficient district heating systems have been used to heat approximately 98% of the city. All the heating in the city is planned to be done by energy-efficient district heating systems by 2025. Architects have predicted that there would be no chimneys on the roofs of house in Copenhagen as there would be no individual heating in the houses or flats in Copenhagen in future.

The improvements in energy efficiency in Copenhagen have resulted in significant savings to consumers and businesses in the city. The adoption of innovative energy efficiency technologies has helped to bring new green products and technologies to the market. The energy efficiency improvements have also helped to lower production costs which have made the city's economy more competitive.

Copenhagen city government has also developed specific new investment strategy for its low-carbon transformations. To reduce the emissions from its district heating systems, Copenhagen has been producing heat from recycled municipal wastes. It is building a biomass-fuelled power plant named BIO4 at Amagerværket to replace a 600-MW coal power plant. The new waste to power plant is scheduled to be ready by 2020. The new electricity generation plant has been designed to reduce CO_2 emissions by a big 1.2 million tons per year.

Copenhagen's clean energy transformation and smart city transition have demonstrated that these can help to reduce GHG emissions plus generating significant economic benefits. Copenhagen city leaders have said that it has not been expensive for Copenhagen to go green. In addition, it has helped to generate better environment and created new low-carbon employment for the city residents. City officials have reported that going green has been very good for the local economy and has helped to create more new local jobs for the residents. It has also helped to create a more vibrant city which is more liveable for its residents. These are key components for a world-class competitive smart low-carbon city which is a good role model for other major cities globally.

Smart city, clean energy and smart grid developments

Major cities around the world have been transforming their energy mix by reducing their use of fossil fuels and promoting clean renewable energy applications, including solar, wind, hydro, bioenergy and geothermal. These fossil to clean energy transformations should help these cities to better meet their rising energy requirements as well as reducing pollutions and CO_2 emissions. Some

leading cities have also committed to move to 100% clean energy in future as part of their Climate Action Plan. A good example is Copenhagen in Denmark which has committed to become carbon neutral by 2030, which we have discussed earlier in the smart city benefits' case study, in this chapter.

Many major cities in the developed countries and emerging economies have been actively supporting their fossil to clean energy transformations. These transformations have largely been driven by local economic needs and the political commitments of the local and national governments. The clean energy transitions should help them to capitalise on their available local natural resources plus maximise the use of available clean renewable energies whilst minimising the import of expensive fossil fuels, such as crude or natural gas.

Decarbonising the electricity power generation and electricity supply grid of major cities around the world is an important requirement for these cities to achieve their clean energy transformation and achieve the UNIPCC targets. Power generators, utility suppliers, regulators and grid companies have to work together to ensure that the overall mix of clean energy should be appropriately balanced together with reliable supply security to all the customers in their cities. In addition, critical components such as energy storage and smart grids should be in place to ensure grid reliability and efficiency.

A good example is that in the UK the electricity and energy systems in the major cities have been changing to maximise economic benefits for businesses and households. Over a quarter of the UK's electricity is now being generated by renewables, including wind, solar and waste. New energy storage technologies are being applied. The costs for future advanced energy storage systems have started to decline significantly with technological innovations and cost reduction measures.

In 2017, UK Government Ministry BEIS and Ofgem have put forward new plans to upgrade the UK smart grid and clean renewable energy systems so that consumers in its major cities will have more control over their energy uses using innovative new technologies. The UK government has also launched its £246 million Faraday Challenge to boost technological innovation and developments of new battery and energy storage technologies. These should help to develop a smarter, more flexible energy system with new smart green battery and energy storage technologies (UK BEIS, Smart City & Grid Report, 2017).

There has also been good international co-operation on new smart materials and clean battery research and innovations. A good example is that the UK and China have been cooperating on new battery and new material research works particularly on graphene. Graphene is seen by many researchers as one of the world's thinnest, strongest and most conductive material. Scientists have been forecasting that graphene could revolutionise aircraft and car designs, plus create new battery and new material applications. Graphene was first isolated from graphite mineral by Andre Geim and Kostya Novoselov at the University of Manchester in 2004. They were awarded the Nobel Prize for Physics in 2010. China has included graphene as one of the strategically important new material in its 13th Five-Year Plan (2016–2020). A new five-year UK-China

research programme between China's Beijing Institute of Aeronautical Materials (BIAM) and the National Graphene Institute (NGI) at the University of Manchester, UK has been established. The research co-operation agreement was signed during a special visit by PRC President Xi Jinping to the NGI at Manchester during his state visit to the UK. The key objectives of the joint research are to develop new graphene-based polymers which can be used in a variety of applications, including new battery, new aircraft plus high-speed trains and vehicles. It is expected that the new graphene material will contribute to light weighing of new auto vehicles, i.e. making them lighter in weight and thereby improving their fuel efficiencies. In addition, the material will improve robustness and performance. In particular, the researchers will be focusing on developing new graphene-based composites with enhanced mechanical and conducting properties, together with improved electrical and thermal conductivities. These new materials will be very important for new applications in new smart grids, new EV charging stations, and new battery and new energy storage system designs.

China's smart city and clean energy development case study

The People's Republic of China (PRC) economy has been growing fast in the last few decades. These high economic growths have also generated some serious problems including pollution, climate change and environmental damages. China has been changing its economic growth model and its policy focuses on its latest 13th Five-Year National Plan. In the past, China has primarily focused on economic growths and GDP rises. However now, China is more focused on climate change and green economy plus green developments. This is a big policy shift and has major implications both nationally and globally. A good example is that the PRC Central and local government officials have now to perform well on environmental protection and climate change, as well as on economic developments.

China's future development strategy is closely linked with climate change, environmental improvements and green developments. The Chinese government has elevated climate change and sustainable economic developments to be key national strategies in their 13th Five-Year Plan. The Chinese government has also started to implement its new national environmental concept of "ecological civilisation." There is a famous motto by Chairman Xi Jinping who has said: "The Green Mountains and Green Rivers are as valuable as Mountains of Gold and Rivers of Silk." In China, it is common to describe healthy rivers and water in shades of green.

The PRC government's National Energy Agency (NEA) has also announced that China is planning to invest 2.5 trillion yuan or over USD360 billion into China's renewable energy sector. It has also announced that China, which is now the world's largest energy market, will continue to shift away from coal power generation towards cleaner fuels and renewable power generation.

The PRC government's National Development & Reform Commission (NDRC) has also predicted that these clean renewable energy and low-carbon economy investments in China will help to create more than 13 million new jobs in China. It has also forecasted that the total installed renewable power generation capacities in China, compromising of wind, hydro, solar and nuclear power together, should be contributing to about half of the new electricity generation capacities in China by 2020–2030.

The NDRC has also announced that the solar power sector in China will be receiving some one trillion yuan or over USD140 billion of new investment. Looking ahead, China is planning to increase its solar power capacity by five times. This is estimated to be equivalent to adding about 1,000 new major solar power plants across China. In addition, new investments of some 700 billion yuan or USD100 billion are planned to go into new wind farms across China. New investments of another 500 billion yuan or over USD70 billion are planned to go into new hydropower stations across China. New investments by China into new tidal and geothermal power generations are also being planned.

There is also growing international co-operation in renewable and clean energy by leading international clean renewable energy companies with leading Chinese energy companies. A good example is that the Asian Development Bank (ADB) has recently signed a loan agreement to provide a loan facility of $250 million to a new Icelandic-Chinese Joint Venture. The joint venture partners are Arctic Green Energy Corporation (AGE) and Sinopec Green Energy Geothermal Company Limited (SGE). They will both be working together to expand geothermal district heating systems in China. These will replace coal-based district heating systems which have been one of the major causes of air pollution in the PRC, particularly in the Beijing-Tianjin-Hebei region. The funding from the ADB will enable AGE and SGE to significantly expand their operations to support the smart cities in the PRC to improve their environment plus reduce pollution, whilst providing much needed clean district heating to key smart cities in the PRC.

AGE is based in Iceland and is a leading global developer and operator of renewables, including geothermal technology and energy efficiency projects. SGE was established in 2006 and is the world's largest geothermal district heating company in terms of service area. The new joint venture between AGE and Sinopec Star of the Sinopec Group should provide good synergies in both advanced technology transfer and new market developments plus support smart city developments in the PRC and globally.

There are also important smart city transformation plans and developments being implemented for key economic regions in the PRC. China has some of the largest cities in the world. Good examples include Beijing with an urban population of 25 million and Shanghai with an urban population of 34 million. These have made them two of the largest cities in China and amongst some of the largest cities globally. The urban population in China is currently representing 57% of the total population of 1.38 billion. Looking ahead to 2020–2025, it is expected that rising urban migration should increase the urban population

in China to about 60% by 2020–2025. It is estimated that around 250 million Chinese farmers and peasants will be moving from rural regions to urban cities as part of their move to become seasonal migrant workers in the big cities and to seek employments.

Putting this PRC rural urban migration into the global perspective, the Global Commission on the Economy and Climate has forecasted in its recent report that more than two billion extra people are expected to be moving into different cities globally in the coming decades (Global Commission on the Economy and Climate Report, 2018).

China is also in a period of transition with new urban smart cities being planned and implemented. A good example is Xiongan which is a new state-level special economic area in the Baoding area of Hebei, China. It is situated about 100 km southwest of Beijing and active urban developments are ongoing. Xiongan is part of the new green low-carbon smart city development master plan for the Greater Beijing region in China. Xiongan represents a fundamental change in China's national strategy and its long-term city planning strategy. It will share some functions with the capital but it will also take over some tasks from Beijing. A lot of non-core capital and municipal government functions and administrations in Beijing will be moved out to Xiongan. A good example is that Peking University has planned to invest and move some of their research functions from Beijing to Xiongan. The main functions of Xiongan will be to serve as the new development hub for the Beijing-Tianjin-Hebei economic triangle. The implementation of this new smart city project will include significant green sustainable developments. A good example is that the central government of the PRC has forbidden some polluting industries from entering the new area. In addition, some real estate development projects have been stopped until the detailed planning and reviews are finalised and approved by relevant government agencies. Xiongan will also include new smart city designs with advanced modern technologies including smart highways, subways, green buildings and green transportation (Xinhua, Xiongan New Area in Hebei, Beijing, 2017).

There are also ongoing good international exchanges and co-operations between some key Chinese city mayors with other international city mayors plus urban designers. A good example is that the British Town and Country Planning Association (TCPA) experts have been discussing with China city mayors and urban designers about new low-carbon smart city designs. They have been exchanging views and learnings on various new potential city and urban designs with low-carbon buildings and smart public transport systems. These international exchanges and co-operations should help China's major cities in their smart city transformations plus ease their severe traffic jams and improve air qualities. The clean energy transformations in the key Chinese smart cities should also help to reduce pollution and carbon emissions (Wang, Sino-British Summit Paper, 2017).

The PRC government has been supporting electric vehicle and new energy car developments and deployment in various cities of the country. The PRC government has extended its China New Energy Vehicle Program to 2020.

In June 2012, the PRC government first issued its New Energy Car Program to support the domestic electric car and new energy vehicle industries. Its programme had set a sales target of 500,000 new energy vehicles by 2015 which would then rise to five million by 2020. In September 2013, the PRC government introduced a New Energy Car Subsidy Scheme which provided a maximum subsidy of USD9,800 towards the purchase of a new electric passenger vehicle in China, and up to USD81,600 for a new electric bus in China.

The PRC government's support for New Energy Vehicles should help to create a new world-class new energy and electric car industry in China that would help to create new jobs and exports. A good example is that the Chinese new energy and electric car company, BYD Auto, has overtaken both Mitsubishi Motors and Tesla Motors to become the world's second largest plug-in electric passenger car manufacturer, after Renault-Nissan. In addition, these new electric cars should help to reduce China's fossil oil consumptions and lower the fossil imports. New electric cars will also help to reduce air pollution and GHG emissions in China.

China currently already has the world's largest fleet of light-duty plug-in electric vehicles. China has also overtaken both the USA and Europe in the cumulative sales of electric vehicles. In 2015, China was the world's largest plug-in electric car market, with a record annual sales of more than 207,000 plug-in electric passenger cars which represented over 34% of global sales. China has also become the world's largest electric bus market with over 173,000 plug-in electric buses. Looking ahead, China is expected to account for more than 50% of the global electric bus market by 2025. These rising number of electric vehicles in China should reduce GHG emissions in various cities and help to meet China's Paris Agreement commitments.

2 The smart city as layered policy design

Singapore's Smart Nation initiative

Jun Jie Woo

The growing application of advanced information and communications technology (ICT) to urban governance and policymaking has led to the emergence of the "smart city" as an urban policy innovation capable of addressing the increasingly complex policy issues faced by city governments. More than simply applying new technological tools and solutions to urban problems, smart cities have given rise to new and more responsive modes of urban governance. This chapter will take a policy design approach to understanding urban governance in a smart city. Focusing on Singapore's Smart Nation initiative, the chapter identifies the various design components and dynamics of the initiative that have influenced Singapore's development as a smart city. I argue that the Smart Nation initiative constitutes an act of "policy layering", where new policy elements that are related to the smart city are layered upon Singapore's existing developmental approach to governance and policymaking. The result of this is an increasingly complex urban policy mix that features new interconnections between novel policy instruments and old policy goals.

Introduction

The advent of advanced information and communications technology (ICT) and the growing prominence of data analytics as a possible tool for policymaking have led to the emergence of the "smart city" as an urban innovation deemed capable of addressing increasingly complex policy issues through the application of advanced ICT and digital technologies (Batty, 2013; Crivello, 2015; Gil-Garcia et al., 2016; Goldsmith and Crawford, 2014; Goodspeed, 2015; Townsend, 2014). Indeed, urban policymakers are increasingly focused on establishing the infrastructure necessary for smart city formation (Bakıcı et al., 2012; Crivello, 2015; Lee et al., 2013; Zygiaris, 2013), with the "smartness" of a city seen as part of a broader set of urban strategic agendas aimed at addressing emerging and increasingly complex urban issues and problems (Gil-Garcia et al., 2016: 2). As Gil-Garcia et al. further point out, a city's "smartness" tends to be determined by the extent to which it uses ICT in urban policy and governance.

Beyond this focus on the application of ICT and digital technology, however, smart cities continue to be plagued by a lack of definitional precision and

universality, with understandings of the socio-political and policy processes underlying smart city formation particularly fuzzy (Albino et al., 2015; Hollands, 2008; Neirotti et al., 2014). Nonetheless, there is emerging interest in the various "smart governance" mechanisms and institutions that determine the emergence and success of smart cities (Calder, 2016; Gil-Garcia et al., 2016).

This chapter aims to continue on this trajectory by taking a policy design approach to understanding the policy initiatives and dynamics that have driven the formation and governance of Singapore as a smart city. In doing so, it seeks to provide a design-centric approach to understanding urban governance in a smart city. More than simply a case study of smart city formation in Singapore, the findings of this chapter have significant implications for other emerging smart cities in Asia.

The choice of Singapore as a case study is by no means arbitrary. First, Singapore is known to be a leading proponent of the smart city movement (Infocomm Development Authority of Singapore, 2014; Mahizhnan, 1999; Watts and Purnell, 2016; Woodhouse, 2016), beginning with its early efforts at implementing e-government initiatives (Chan et al., 2008; Sriramesh and Rivera-Sánchez, 2006). In 2016, Juniper Research named Singapore the top smart city of the world, ahead of Barcelona, London, San Francisco, and Oslo (Juniper Research, 2016).

Furthermore, Singapore's status as one of the world's few functioning city-states also suggests that its approach to transforming itself into a smart city differs from those of other cities. Unlike other cities that exist under the aegis of a larger nation-state, smart city initiatives in Singapore tend to be elevated to the national level. As Calder (2016: 3) notes, Singapore's dual identity as city and state allows for the "pragmatic, flexible, nonideological domestic politics characteristic of cities", even as "national standing provides the legitimacy and resources required to play credibly on the international scene". Evidence of this can be found in its Smart Nation initiative, a suite of smart city policies that were introduced in 2014 as part of the government's efforts to address complex urban issues through technological means. While the initiative is centrally developed and administered by a Smart Nation Programme Office (SNPO) situated within the Prime Minister's Office, it also involves public agencies that deal with citizens at the grassroots level, such as the Housing Development Board or Municipal Services Office (Ministry of National Development, 2015; SNPO, 2017a).

This chapter will discuss Singapore's Smart Nation initiative as policy design, identifying the various design components of the initiative as well as the design dynamics that have influenced its development. In so doing, I argue that the Smart Nation initiative constitutes an act of "policy layering", where new policy elements that are related to the smart city are layered upon Singapore's existing developmental approach to governance and policymaking. The result of this is an increasingly complex urban policy mix that features new interconnections between novel policy instruments and old policy goals.

The findings of this chapter suggest that there is much scope for taking a policy design-centric approach to understanding urban governance. While the policy

design approach has often been applied to policy domains such as economic development, healthcare, and climate change, efforts to draw on the insights of policy design in urban policy are much harder to come by. Conversely, smart city governance tends to emphasize the incorporation of smart technologies in decision-making and policy implementation (Meijer and Bolívar, 2016) without sufficiently addressing the macro-level policy design processes.

The following section will provide a brief overview of the existing literature on smart cities and, at the same time, provide a broad introduction to Singapore's Smart Nation initiative. I will then discuss the Smart Nation initiative in the context of policy design. This is followed by a discussion of the design dynamics that underpin the initiative, before concluding with theoretical implications and potential avenues for future research.

Of (smart) cities and (smart) nations

As a concept and in practice, smart cities emerged from and continue to exist at the intersection of advanced ICT and data technology with increasingly complex urban problems. Fundamental to the concept of a smart city is the assumption that complex "wicked" problems – urban transport, crime, healthcare, and education, among others – can be addressed through the use of data analytics and sensors that allow for more effective information collection and management (Batty, 2013; Goodspeed, 2015; Kitchin, 2014; Perera et al., 2014; Stimmel, 2015).

This notion of a smart city as source of policy solutions has become increasingly prominent over the past decade, with cities across the world seeking to utilize data analytics to address urban and municipal issues (Batty, 2013; Goodspeed, 2015; Kitchin, 2014; Stimmel, 2015; Townsend, 2014). This often involves the use of data-sharing platforms (Goldsmith and Crawford, 2014; Misuraca et al., 2014; Noveck, 2015), "city dashboards" (Dameri, 2017; Kitchin and McArdle, 2016), as well as networks of sensors and the "internet of things" (Bakıcı et al., 2012; Filipponi et al., 2010; Gubbi et al., 2013; Perera et al., 2014; Zanella et al., 2014).

More than simply a matter of establishing the necessary ICT infrastructure, however, smart cities have also been associated with new approaches to urban governance. While initial understandings of such smart governance focused on governments' ability to "cope with the conditions and exigencies of the knowledge society" (Willke, 2007: 165), the increasing application of data analytics and "sensible" technologies to policymaking has led to a stronger focus on responsive urban governance, through the effective collection of policy feedback and data (Goldsmith and Crawford, 2014; Greco and Bencardino, 2014; Perera et al., 2014; Resch et al., 2012). More importantly, this emphasis on "responsiveness" places a stronger focus on citizens and communities, with new digital tools and platforms facilitating civic engagement and policy collaboration with industry and societal actors (Bakıcı et al., 2012; Goldsmith and Crawford, 2014; Townsend, 2014). As Meijer and Bolivar point out, "smart city governance is about crafting new forms of human collaboration through the use of ICTs to obtain better outcomes and more open governance processes" (Meijer and Bolívar, 2016: 392).

Indeed, it is this focus on open collaboration and civic engagement that separates these studies of smart cities from a pre-existing e-government literature that emphasizes a one-way delivery of public services through online mechanisms and platforms, with limited scope for interactivity (Meijer and Bolívar, 2016; Norris and Reddick, 2013). Furthermore, e-government is associated with incremental changes in policy processes and outcomes (Norris and Reddick, 2013). In contrast, smart cities tend to be associated with more integrated approaches to urban governance that emphasize the responsiveness and transparency of a city's policy processes (Gil-Garcia, 2012; Goldsmith and Crawford, 2014; Meijer and Bolívar, 2016; Noveck, 2015).

As the world's only "fully-functioning city-state" (Long, 2015), Singapore's approach to establishing itself as a smart city differs from that of other cities. In particular, the conflation of city and state in Singapore suggests the convergence of a national–local divide in smart city strategies (Angelidou, 2014) and an elevation of urban and municipal issues to the national policy agenda, allowing for greater policy expediency when compared to countries with more layers of government (Balakrishnan, 2016; Lim, 2016). As a consequence, its smart city initiatives tend to be more centralized and far more extensive that those implemented in other cities (Watts and Purnell, 2016). This is further encouraged by the relatively high level of political and administrative centralization in Singapore,[1] which allows for swift decision-making and hence the ability to quickly implement large-scale policy changes (Low, 2006; Tan, 2012; Woo, 2016a). The following section will take a policy design approach to understanding Singapore's smart city policies, which are collectively known as the Smart Nation initiative.

The Smart Nation initiative as policy design

Originating from the seminal work of Harold Lasswell, the fundamental precept of policy design is that the policy process comprises policy means (instruments) and ends (goals) (Lasswell, 1951, 1971). Under this design orientation, policy instruments are essentially the tools, techniques, or mechanisms that governments use to achieve policy goals, usually by giving effect to public policies (Bressers and Klok, 1988; Howlett, 2011; Howlett and Rayner, 2007; Woodside, 1986).

While early policy design studies had sought to build up comprehensive typologies of policy instruments and their varied functions and effects (Bemelmans-Videc et al., 1998; Elmore, 1987; Grabosky, 1995; Hood, 1986; Howlett, 2000; Woodside, 1986), subsequent efforts would seek to develop a deeper understanding of how instruments tend to be "packaged" within larger "policy mixes" (Doelen, 1998; Gunningham et al., 1998; Howlett, 2004) or "new governance arrangements" (Howlett and Rayner, 2007; Rayner and Howlett, 2009). Often taking a portfolio approach to understanding policy mixes, these studies seek to understand the relationships between policy instruments within a given policy mix, paying particular attention to the dynamics that arise when new instruments are added to a mix or existing instruments omitted or changed (Howlett and Rayner, 2013a, 2013b). This has allowed for the identification and categorization of the different

		Instrument Mixes	
		Consistent	**Inconsistent**
Multiple Goals	**Coherent**	Integration	Drift
	Incoherent	Conversion	Layering

Figure 2.1 Policy Mix Dynamics

dynamics that emerge when new instruments and goals interact with existing ones within a given policy mix. Four main dynamics have been identified in the literature, with each dynamic associated with the extent of policy goal coherence and policy instrument consistency within a policy mix, as illustrated in Figure 2.1.

While "policy layering" has been taken to mean the adding of new policy goals and policy instruments onto an existing regime without removing previous ones, "conversion" involves changes to policy instrument mixes without any change to policy goals (Béland, 2007; Rayner and Howlett, 2009; Thelen, 2004). "Policy drift" occurs when policy goals are changed but not the instruments used to attain them (Hacker, 2004; Rayner and Howlett, 2009: 103). Dynamics of layering, conversion, and drift are fundamentally rooted in the assumption that policy mixes ought to be designed in such a way that policy instruments support, rather than undermine, each other, i.e., to ensure *coherence* in policy goals and *consistency* among policy instruments (Howlett and Rayner, 2007: 7). As Figure 2.1 shows, an ideal situation of integration occurs when instrument mixes are consistent and policy goals are coherent. In contrast, the addition of new instruments and goals without sufficient consideration of existing ones may result in mismatches between goals and instruments. Lastly, conversion reflects a more systematic attempt to change the policy instrument mix in order to meet new policy goals. These dynamics of policy design can provide a useful framework for understanding new policy initiatives such as the Smart Nation initiative and interactions between components of these new initiatives and the existing urban policy milieu.

Launched in 2014, the Smart Nation initiative aims to harness data and technological solutions to address urban policy issues (Lee, 2014). According to the SNPO, the Smart Nation initiative aims to "support better living, stronger communities, and create more opportunities, for all", with a focus on "how well a society uses technology to solve its problems and address existential challenges" (SNPO, 2016). The initiative places a strong emphasis on five key domains: transport, home and environment, business productivity, health and enabled aging, and public sector services.

In terms of policy instruments, the Smart Nation initiative relies on a set of "enablers" (SNPO, 2016), which include:

- Test-bedding and collaboration with industry and research institutions
- An open data portal and a Smart Nation Platform that allow for the consolidation and sharing of government data
- Investments in Research and Development (R&D)

- Laboratories for the development and piloting of technological solutions
- Start-up accelerators to nurture creative start-ups and innovations
- Cybersecurity measures for the safeguarding of data, systems, and networks
- Building computational capabilities among citizens through educational programs at various levels, including young children, secondary school students, and working professionals.

The policy goals and instruments that the Smart Nation initiative has articulated differ from those of Singapore's hitherto development-oriented approach to governance or the Asian "developmental state" model (Huff, 1995; Low, 2001; Perry, 1997). The developmental state model generally emphasizes policy goals of economic growth and industry development, with policy instruments typically including subsidies, incentives, government investments in economic and physical infrastructure, and direct market interventions by the state, most notably through state-owned industries and other quasi-governmental organizations.

Although developmental goals are also emphasized in the Smart Nation initiative, there appears to be a clear focus on citizens and communities in the initiative's policy goals, with these goals broadly emphasizing stronger communities, greater policy collaboration with businesses and citizens, and the nurturing of a culture of innovation and experimentation. As the SNPO emphasizes: "(c)itizens are ultimately at the heart of our Smart Nation vision, not technology!" (SNPO, 2016). By providing a list of the policy goals and instruments that are associated with the development state model and the Smart Nation initiative, Figure 2.2 highlights the significant differences between the two approaches.

	Developmental State	**Smart Nation**
Policy Goals	Development-driven • Economic growth • Industry development	Citizen-centric • Stronger communities • Policy collaboration • Innovation and Experimentation Development-driven • Creation of new opportunities
Policy Instruments	Developmental • Subsidies • Incentives • Government investments • Market interventions	Enabling • Test-bedding • Open Data Portal & Smart Nation Platform • Laboratories • Start-up Accelerators • Cyber Security • Computational Capabilities Developmental • Investments in R&D

Figure 2.2 Policy Design Elements

These differences are particularly distinct in terms of policy instruments. In thinking about the policy instruments employed by the two approaches, it is useful to think about "developmental" versus "enabling" instruments (Woo, 2015, 2016b). Where the former involves the allocation of state and societal resources toward the attainment of developmental goals (Chang and Grabel, 2004; Murinde and Mlambo, 2011; Stiglitz et al., 1993), the latter is associated with "the creation not merely of incentives but of those conditions that allow activities to take place" (Baldwin et al., 1998: 4). As Figure 2.2 shows, the developmental state model emphasizes developmental instruments that involve the mobilization of resources toward the stimulation of economic growth and industrial development. In contrast, the Smart Nation initiative favors instruments that establish the enabling conditions and infrastructure necessary for the development and operations of innovation start-ups. Calder (2016: 61) describes this as "minimalist, enabling governance".

However, it is important to note that the design of Smart Nation policies – or any instance of policy design for that matter – is not a static process. As discussed earlier, policy design tends to be an iterative process that involves the inclusion (or exclusion) of policy instruments from an existing policy mix or portfolio over an extended period of time. There is, in other words, no tabula rasa in policy design – but legacies of urban policies and design processes past. What then, are the dominant design dynamics – whether layering, conversion, drift, or integration – involved in the Smart Nation initiative?

Layered hybridity: a developmental smart city?

Despite its focus on citizen- and community-centric policy goals, as articulated in official documents and reports, the Smart Nation initiative retains a strong emphasis on goals and objectives associated with economic development. These range from ensuring greater efficiency in its ports to exporting data-related products and services or smart city solutions as potential streams of trade revenue (Bhandari, 2017). Indeed, the Smart Nation initiative has often been evaluated in economic terms, such as its ability to generate employment, create new business opportunities for firms, and create value for consumers (Chng, 2016).

As Prime Minister Lee noted in a speech in 2014, the advanced data and IT technologies that may emerge from the Smart Nation initiative can contribute to greater economic productivity and generate business opportunities (Lee, 2014). This linkage between the Smart Nation initiative and economic development is further emphasized by Vivian Balakrishnan, the initiative's Minister-in-Charge:

> It is technological advancement that leads to economic development, and ultimately economics determines political outcomes. In other words, it is technology first, then economics, and finally politics. If you get it wrong and put the cart before the horse, you get a very confused world that is unable to solve the existential challenges. And more importantly, a world unable to capitalise on the opportunities that these technological advancements present.
>
> (Balakrishnan, 2016)

Fundamental to the Smart Nation initiative, therefore, is the primacy of economic policy goals and the assumption that the various technological tools and innovations associated with the Smart Nation initiative should be geared toward the attainment of these economic goals. The Smart Nation initiative's direct predecessor, the "Intelligent Nation 2015", had already placed a strong emphasis on the transformation of key economic sectors (Angelidou, 2014: S8).

As Minister Balakrishnan has pointed out, the government's investments in data-related R&D aim to "improve the quality of life and to enhance economic opportunities and provide good jobs for our people" (Balakrishnan, 2016). The economic value of such R&D activities is underscored by the Minister's assertion that:

> data (and nowadays the term big data is in fashion) is the new currency, but raw data is commoditised, everyone has access to it. The real value is in insight and the ability to synthesise and generate new perspectives and the ability to exercise judgement and wisdom to create new ideas, products and services.
>
> (Balakrishnan, 2016)

Perhaps most tellingly, the Economic Development Board (EDB), which has been Singapore's de facto "pilot agency" under its developmental state approach, remains the lead agency for the development of the various smart or knowledge sectors associated with the Smart Nation, such as real-time data solutions (Calder, 2016: 92–97; Economic Policy Board, 2016). Furthermore, the EDB's role often extends beyond economic or sectoral development to include other aspects of the smart city. For instance, the EDB has recently signed a memorandum of understanding with MasterCard to develop new technological solutions for both business development and urban mobility, with a further aim of potentially exporting these solutions (MasterCard, 2016). The Smart Nation initiative therefore continues to emphasize economic development goals, whether in terms of enhancing business and economic activity through technological solutions or even potentially exporting these urban-technological solutions. As Angelidou (2014: S8) has noted, Singapore's smart city initiatives tend to be economic sector-based rather than geographically or spatially based.

This addition of new policy instruments (smart city policies) and policy goals (citizen and community development) to an existing mix of development-oriented policy instruments and goals suggests a significant degree of policy layering. Indeed, as the previous discussion has shown, there are numerous cross-linkages among these new policy instruments and old policy goals, with new Smart Nation initiatives emphasizing the attainment of economic policy goals. While the Smart Nation initiative has sought to recast Singapore as a 21st century smart nation, vestiges of its old developmental state persona remain. Rather than a transformation into a smart city or smart nation, Singapore's efforts have culminated in the hybrid form of a "developmental smart city".

Where collaborative opportunities are discussed, these tend to be top-down and state-centric, with potential collaborations taking place on state-owned platforms and institutions such as the Smart Nation platform or government-owned start-up accelerators. Furthermore, many of the smart city solutions that aim to

improve the quality of life of citizens, such as the introduction of smart home technologies, tend to be associated with or developed by public agencies, in this case, the Housing Development Board (SNPO, 2017b). There is, in short, a continued prevalence of both developmental policy goals and state-driven solutions in Singapore's approach to developing a smart city, with new smart city initiatives layered upon an existing legacy of development-oriented policy instruments, goals, and logics.

While the conventional wisdom in policy design would suggest that such policy layering may give rise to incoherent policy goals and inconsistent policy instruments (Rayner and Howlett, 2009), the policy outcome of the Smart Nation initiative remains to be seen. All we can say at this point is that the Smart Nation initiative is either a bold act of policy innovation, with the possibility of achieving both economic and societal policy goals through one set of policy instruments, or a potential risk, with linkages between policy instruments and policy goals not clearly explicated (or, indeed, explicable) and hence leading to some degree of confusion and complexity.

Conclusion

This chapter has sought to understand Singapore's Smart Nation initiative through the lens of policy design. In doing so, it has found that the initiative constitutes an act of policy layering, with new policy instruments and goals associated with smart city formation layered onto an existing legacy of development-oriented policy instruments and goals. What has emerged, as a result, are cross-linkages between new policy instruments (smart city initiatives and solutions) and old policy goals (new economic opportunities and sectors associated with the application of smart technologies).

While the rhetoric in many smart cities, Singapore included, has been the need for a transformation into a 21st-century smart city that not only relies on advanced digital and data technologies for the development of urban policy solutions but also involves new collaborative approaches to urban governance, the case of Singapore's Smart Nation initiative suggests that such a transformation may not necessarily give rise to a state of tabula rasa for urban policymakers and designers. The reality is that new urban policies and interventions tend to be layered upon existing policy legacies. In other words, the emergence of a smart city depends not so much on a large-scale transformation but on an ongoing process of incremental layering and policy adaptation.

As Shelton et al. (2015: 14) have noted, "smart city interventions are always the outcomes of, and awkwardly integrated into, existing social and spatial constellations of urban governance and the built environment", with "greenfield smart cities . . . the exception rather than the rule". The successful formation of a smart city therefore hinges upon urban policymakers' ability to successfully integrate new policy measures, goals, and models with existing ones. As the policy design literature has pointed out, an inability to do so can result in incoherent policy goals and inconsistent policy instruments.

In framing Singapore's Smart Nation initiative as policy design, this chapter hopes to provide a useful starting point for further explorations into the integration of urban policy and policy design. Indeed, the incorporation of policy design into urban policy processes can provide policymakers with a powerful set of tools for assessing existing urban policy efforts and planning future urban policy interventions in a more integrated manner, considering and addressing existing policy legacies that may otherwise adversely impact new policy interventions.

Future research directions may therefore focus on further conceptual explications of the linkages between policy design and urban policy. These efforts may also involve the application of any potential new theoretical insights to other smart cities. The continued proliferation of smart cities across the world – and the potential impacts that smart city initiatives can have on their inhabitants – suggest an urgent need for closer attention to and research on the policy processes involved in the design, formation, and governance of a smart city.

Note

1 The ruling People's Action Party (PAP) has consistently won a comfortable majority in all general elections since independence.

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2 Transport issues and challenges in Asian cities and their socioeconomic and environmental implications for achieving the Sustainable Development Goals

Ganesh Raj Joshi

Introduction

Cities are at the center of the majority of human activities and a key source of global prosperity, and as such are driving engines of economic growth, innovation and technological advancement. Worldwide, urban areas accommodate more than half of the global population, and generate almost 82 percent of global Gross Domestic Product (GDP) (CCFLA, 2015; UN, 2018). Today, Asia is the most quickly urbanizing region in the world, and with increasing economic growth, demand for urban mobility and transport has intensified significantly in Asian cities. To fulfill this demand, most of the cities in developing countries are promoting private vehicles, expanding their road networks and highways, and supporting the establishment of domestic automotive industries. As a result, the majority of Asian cities are trapped in the vicious cycle of excess motorization that leads toward traffic congestion, air and noise pollution, road accidents and fatalities, urban sprawl and GHG emissions, which pose severe socioeconomic and environmental challenges. In order to tackle these urban challenges, it is important for cities to address the root causes of these problems.

A focus on building safe, resilient, liveable and sustainable cities and communities stands as a viable approach to overcoming a range of existing and future urban challenges. Liveable and sustainable cities promote low-carbon and sustainable urban growth, achieve improved air quality and public health, enhance safety and security, and improve mobility and accessibility, thus avoiding the cost of sprawl by reducing unnecessary urban growth.

To reduce automobile dependency and increase the sustainability of the cities, Environmentally Sustainable Transport (EST) can play a key role. It offers cost-effective, low-carbon and sustainable transport solutions that provide high levels of mobility and accessibility without the intrinsic problems associated with automobile-dominated cities (Wright, 2010; Newman and Kenworthy, 2015). EST further prevents the negative impacts of motorization and improves the quality of life of urban dwellers through providing a framework for robust infrastructure and people- and environment-friendly, low-carbon transport solutions.

The 2030 Agenda for Sustainable Development also highlights the importance of sustainable transport for achieving the Sustainable Development Goals (SDGs) and related targets. SDG 11 particularly calls for concerted actions at local, national and international levels to make cities and human settlements inclusive, safe, resilient and sustainable (UN, 2015). In order to achieve the SDGs, it is essential to implement better policies, planning and management strategies, which could be supported by state-of-the-art technologies, innovative financing mechanisms, and improved institutional arrangements through good governance.

This chapter articulates the key transport-related issues and challenges posed by increasing numbers of automobiles and unsustainable urban growth in Asian cities. It further analyzes transport-related problems such as traffic congestion, air and noise pollution, transport-related collisions, fatalities and property damage, GHG emissions and climate change, and their socioeconomic and environmental impacts. Finally, it recommends an appropriate set of policy solutions and measures to overcome the existing and future transport-related urban issues and challenges for achieving the SDGs and related targets by 2030.

Current megatrends and future of Asian cities

Megatrends are global forces of development that have enormous influence on cities and communities over a long period of time, eventually shaping their socioeconomic and environmental conditions locally and globally. Cities are highly affected by these megatrends such as rapid population growth, increasing pace of urbanization and motorization, rural–urban transition, frequent occurrence of natural disasters, global warming and climate change, as described here, among others.

Rapid population growth

The global population has been increasing rapidly in recent decades. In 1950 the global population was about 2.5 billion, which increased to 6 billion in 2000, and eventually in 2019 it reached about 7.7 billion (UN, 2019a). This rapid population growth is a key driver of increased global urbanization. In 1950, only 30 percent (751 million) of the world's population lived in cities, whereas in 2018 that proportion reached 55 percent (4.2 billion). It is estimated that an extra 2.4 billion people will be added to the world's cities by 2050, with an urban population of up to 68 percent (UN, 2018).

With this fast population growth in cities, demand for transportation has increased manifold worldwide. Studies show that by 2030, annual passenger traffic will exceed 80 trillion passenger kilometers, which is almost a 50 percent increase; and global freight volumes will grow by 70 percent (IEA, 2017). It is predicted that by 2050 the global passenger demand will double, and global freight will increase by 150 percent (OECD, 2015). Travel demand is mainly increasing in the developing countries in Asia, particularly in emerging economies

like India and PR China. As an example, travel demand in India increased eight-fold between 1980 and 2017 (Chin et al., 2017). However, in most of the developing countries, transport infrastructure has lagged far behind compared to transport demand. As a result, most of the cities in developing countries are facing serious transport-related socioeconomic problems.

Urbanization and motorization

The global urbanization rate is different across the regions. Asia is urbanizing faster than ever and this trend is projected to continue in the coming decades. According to the United Nations, approximately 54 percent of the world population lived in urban Asia in 2018, and the urban population will reach up to 8.5 billion by 2030. It is predicted that by 2030, a billion people will be added to Chinese cities (Bloomberg Philanthropies et al., 2016). The speed of urban growth in Asian cities is much faster compared to other parts of the world. Studies show that while London took about 130 years to grow from 1 million to 8 million people, Bangkok took 45 years, Dhaka 37 years and Seoul took only 25 years (Giraud & Lefèvre, 2006; Yves Boquet, 2013). In this short time span, some Asian cities were better placed to manage the growth of automobile use, whereas other cities found it difficult to accommodate the increased number of automobiles, leading to their rapid development being largely unplanned and implemented in a haphazard way. Currently, the Asian region is home to 17 megacities, including the world's three largest cities, Tokyo, Delhi and Shanghai. The UN projection indicates that by 2030, out of the 43 megacities, the Asian region will have 22 megacities with more than 10 million inhabitants. This has significant implications for urban mobility and transport demand, presenting a new set of challenges and opportunities for cities and communities.

Most of the developing countries in Asia are expanding their road networks and building new highways to accommodate existing and future transport demand, and promoting private operators to run vehicles in urban areas. As a result, the number of private vehicles has been increasing rapidly in Asian cities, leading toward unsustainable levels of motorization. According to the Asian Development Bank (ADB), nearly half of the world's projected 1.5 billion vehicles will be in Asia by 2030 (ADB, 2013). Increasing pace of urbanization and motorization leads to the expansion of cities and promotes urban sprawl, which has a negative impact on the sustainability of cities and communities, with disproportionally high impacts on lower socioeconomic communities.

Natural disasters

The Asia Pacific region is extremely prone to natural disasters. The region is hit by a number of natural disasters each year such as cyclones, storms, floods, landslides, debris flows, avalanches, earthquakes and droughts. The region accounted for 91 percent of the world's total deaths and 49 percent of the world's total damage due to disasters in the last century (UNCCD, 2009). In

the last 45 years, approximately 2 million people lost their lives, 6 billion people were affected and almost US$1.15 trillion of economic loss occurred in the region, which is more than 40 percent of the global total (UNESCAP, 2015). Almost 90 percent of those deaths occurred in low- and middle-income countries in Asia.

Most of the developing countries in Asia lack adequate early warning systems, strong enforcement of building codes, land use and transport planning, and climate- and disaster-resilient transport infrastructure and services (UNCRD, 2018). Therefore, human and economic losses from natural disasters in Asia have significantly increased in recent years. For example, between 2014 and 2017, the Asia Pacific region was hit by 55 earthquakes, 217 storms and cyclones and 236 cases of severe flooding, resulting in 33,000 people killed and 650 million displaced (UN OCHA, 2019). Flooding is the dominant disaster in the region, and the economic costs of the flooding are very high. For example, in 2015, a massive flood-hit Chennai city, India, due to heavy rainfall, killed more than 500 people and displaced over 1.8 million. According to Swiss Re, the economic loss from such flooding was equivalent to US$2.2 billion (Hindu Business Line, 2016).

Many Asian cities, such as Islamabad, Delhi, Kathmandu, Beijing, Taipei, Jakarta and Manila, are situated along earthquake-prone zones. Most of these cities have fragile and old infrastructures, lack proper earthquake warning systems and have weakly enforced building codes. Therefore, these cities could sustain unprecedented damage in case of earthquake events. As an example, in 2015, Kathmandu was hit by a devastating earthquake of magnitude 7.9, which caused immense loss of life and property damage. Almost 8,659 people were killed, 21,952 injured, and the overall damage was estimated at up to US$10 billion, which is nearly half of the country's GDP (Nepal Government Planning Commission, 2015).

Acknowledging the important role of state and city governments in reducing disaster risk, the Sendai Framework calls for collective effort and action to make the world safer from the risk of disasters in the decades to come for the benefit of present and future generations (UNDDR, 2015). Therefore, developing countries and cities in Asia need urgent attention and action to build better policies, better planning and development strategies for achieving disaster risk reduction, and better rebuilding after disaster events, helping to reduce the loss of lives and assets.

Climate change impacts

The transportation sector is one of the largest sources of greenhouse gas (GHG) emissions, responsible for approximately 23 percent of CO_2 emissions in 2010, and 40 percent of total energy consumption in the transportation sector occurred in cities, making a substantial contribution to global warming (Sims et al., 2014). Consequently, urban transportation has emerged as one of the key climate issues that must be addressed, with a priority on controlling global warming and climate

change impacts. Despite advances in vehicle technology, fuel efficiency, electric mobility and hybrid cars in recent years, fossil fuels remain the primary energy source in the transport sector. According to the IEA, in 2018 transport was responsible for 24 percent of direct CO_2 emissions from fuel combustion, which is expected to increase significantly by 2035 to 46 percent of global emissions, and by 2050 it could reach up to 80 percent if nothing is done about it (IEA, 2016). According to the World Meteorological Organization, if the current emission trends continue, the resultant increase in average global temperature could exceed 4°C by the end of the century (New Climate Economy Report, 2014). Subsequently, most of the world population will be exposed to an increase in temperature, resulting in impacts such as melting of glaciers, which is the major driving force of sea-level rise; changing weather patterns, with increasing numbers of warm days; and greater flooding in some areas and droughts in others, which will have an adverse impact on global security, the economy and people's livelihoods.

The recent report published by C40 cities warned that over 800 million people living in 570 coastal cities will be at risk from sea-level rise and coastal flooding (C40, 2019). In the business as-usual scenario, global economic losses from coastal flooding may exceed US$1 trillion annually by 2050 unless the major coastal cities prepare for it (Hallegatte et al., 2013). As most of the megacities in Asia are located along the coastline, they are at high risk from global warming and sea-level rise. Predictions indicate that if there is a 3°C rise in global temperature, the majority of coastal cities in Asia will be flooded (Holder, Kommenda and Watts, 2017), and many low-lying areas will be submerged. In addition, many developing countries in Asia lack robust climate-resilient infrastructures and services, which are essential to mitigate climate change impacts. Thus, these countries will suffer the most. For example, new estimates warn that South Asia could lose about 1.8 percent of its annual GDP due to climate change impact by 2050 (ADB, 2014), progressively reaching up to 11 percent by the end of the century under the business-as usual scenario (ADB, 2015).

Acknowledging the urgency to address climate risks and work collectively toward climate mitigation action, the Paris Agreement was signed by UN member countries in 2015, which aims to keep the global average temperature to well below 2°C above preindustrial levels; and to limit global warming to 1.5 °C, in an attempt to reduce the climate change impacts. However, a recent report published by the United Nations Intergovernmental Panel on Climate Change (IPCC) in 2018 warns that even if we succeed in achieving all the goals of the Paris Agreement, the global temperature will rise by 1.5 °C by 2030 (IPCC, 2018), having a devastating impact on land areas, ecosystems and the socioeconomics of the least developed and the small island countries (ADB, 2017).

Therefore, countries and cities need to significantly reduce the use of fossil fuels across their economies, including the transport sector, and to develop people- and environment-friendly sustainable cities and communities which are less dependent on automobiles (Newman, Beatley and Boyer, 2017). It is equally important to implement state-of-the art, low-carbon transport solutions that considerably

support the reduction of GHG emissions and help to achieve the targets of the Paris Agreement, and thereafter reduce the impact of climate change.

Impact of global warming on Asian cities

Asia is already confronting the threat posed by global warming. For instance, southeastern India, western Sri Lanka, northern Pakistan and eastern Nepal have all experienced a rise of average temperatures from 1.0°C to 1.5°C between 1950 and 2010 (Mani et al., 2018). On the other hand, many cold regions of Asia are suffering from more severe winters where the average temperature is decreasing significantly. Increasing average temperatures during summer in hot regions and decreasing average temperatures during winter in cold regions have adverse impacts on human well-being. For example, in the year of 2017 alone, 54 million people across Asia were affected by intense monsoon rain and flooding, affecting approximately 40 million people in Bangladesh, India and Nepal (UNOCHA, 2017), costing around US$1.2 billion (Benfield, 2017). Likewise, after long drought in 2016 in Mongolia, heavy snowfall occurred earlier than usual, and the temperature dropped below -40°C, affecting almost 265,000 people and killing about 165,000 animals (UNOCHA, 2017).

Global warming has an adverse impact on regional water bodies, worsening water security and affecting many urban dwellers in South Asia and East Asia. For example, after heavy flooding in 2017 in many parts of India, about 42 percent of India's land area was hit by drought in early 2019, and rainfall in India has decreased by 36 percent (Gogoi and Tripathi, 2019). As a result, groundwater levels have been reduced considerably and water supply has been affected in many major cities of India, including Delhi, Bengaluru, Hyderabad and Chennai. Climate change has a considerable economic impact on India and other countries in the region. In the case of India, economic losses of about US$13.8 billion annually due to climate change are predicted (Eckstein, Hutfils and Winges, 2019). Likewise, Southeast Asia could suffer bigger losses than most of the other regions in the world. In the business-as-usual scenario, climate change could reduce the region's GDP by up to 11 percent by the end of the century (ADB, 2015).

Risk of sea-level rise for Asian cities

Asia is the most populated region in the world, and it is estimated that 54 percent of the Asian population live in low-lying coastal areas. As most Asian megacities, such as Mumbai, Chennai, Kolkata, Dhaka, Shanghai, Guangzhou, Bangkok, Ho Chi Minh, Hong Kong, Jakarta, Tokyo and Manila, are located along the coastline, these cities are at high risk from sea-level rise and coastal flooding. Studies predict that sea-level rise will have catastrophic consequences for many Asian cities. The recent IPCC report highlighted that even just a 1.5°C increase of temperature will generate a sea-level rise up to 0.8 meters by the end of the century (IPCC, 2018). Even if the Paris Agreement is fully implemented, it is anticipated

that sea-level may rise up to 0.65 meters by 2100 (ADB, 2017). Studies have projected that in a business as-usual scenario, over 570 low-lying coastal cities will be impacted by 0.5 meters of sea-level rise by 2050. As a result, most of the coastal population will be displaced, millions of square kilometers of coastal land will be submerged and disappear, and that could cost the world economy about US$1 trillion by 2050 (C40, 2019). To exacerbate this situation, heavy rainfall during the monsoon period, powerful storm surges, unmanaged urbanization and insufficient drainage will result in increased flooding, having devastating impacts on communities.

A World Bank study warns that in the case of a sea-level rise of one meter, approximately 32,000 square kilometers of coastal area will be flooded and more than 23 million people will be affected in PR China alone. A one-meter rise would inundate more than 13,800 square kilometers of land and might displace 2.8 million people in Indonesia (Dasgupta et al., 2007). Due to sea-level rise some Asian cities are already experiencing submersion from ocean waters. For example, Jakarta, the capital city of Indonesia and home to 10 million people, is sinking at an alarming rate, and could be underwater by 2050; in some parts of Jakarta, ground level has sunk as much as 2.5 meters in the past decade (Lin and Hidayat, 2018). Recent studies predict that the combination of climate change and urban development will amplify the risk of future flooding in Jakarta by 322–402 percent by the middle of the century (Januriyadi et al., 2018). In the case of Vietnam, if sea levels rise by one meter, about 11 percent of the country's population could be affected by inundation risk (Dasgupta, 2018). Likewise, due to the impact of rising sea level, numerous islands in the Maldives could be made uninhabitable within a decade, and by the end of this century, most of the land area of the country will be submerged (Anthoff, Nicholls and Tol, 2010).

Building climate- and disaster-resilient infrastructures and low-carbon transport services could be the one of the best approaches to reducing sea-level rise and coastal flooding. Therefore, cities and communities need immediate action on low-carbon transport and green growth development to address global warming and sea-level rise.

Key transport-related issues and challenges in Asian cities: a rapid review

Cities account for 80 percent of global economic output (Seto and Dhakal, 2014), with just 150 major cities in the world producing 41 percent of global GDP (Floater et al., 2014). Rapid urban population growth, continued growth in automobile dependence and a lack of proper urban planning and management are major concerns for Asian cities. Due to rapid urbanization and automobile dependence, most Asian cities face numerous transport-related socioeconomic and environmental problems such as traffic congestion, air and noise pollution, road accidents and fatalities, and GHG emissions which lead to climate change and global warming.

Traffic congestion and associated socioeconomic challenges

A number of researchers have provided different definitions of traffic congestion based on demand capacity, delay-travel time and cost (Aftabuzzaman, 2007). However, it is difficult to find a universally accepted definition of traffic congestion (Downs, 2004). In general, traffic congestion refers to the incremental delay caused by interactions among vehicles on a roadway, particularly as traffic volumes approach a road system's capacity, that results in incremental costs and other impacts (Litman, 2013). The congestion level is influenced by the state of the economy, demography, the growth rate of the city, technological development, traffic management skill and the effectiveness of the implementation of policy actions and measures, among other factors. Usually, congestion is mainly the result of inadequate transport infrastructure, absence of adequate public transport services and lack of smart policy enforcement and traffic management. However, congestion is also contributed to by poorly designed or maintained transport systems, the behavior and habits of drivers and passengers, weather conditions and rainfall levels, and a lack of a unified city traffic management system, among other factors.

In general, traffic congestion has a negative impact on the economy, public health, society and environment of a city. Traffic congestion is a major problem in most Asian cities, but the congestion level in these cities is vastly different. Some cities such as Singapore, Hong Kong and Tokyo have effective traffic management systems and public transit systems to alleviate traffic congestion, while many other Asian cities are unable to manage their congestion problem. As a result, these cities are suffering from severe traffic gridlock, which imposes a range of social, economic and environmental costs. According to the Asian Development Bank, road congestion costs Asian countries between 2 and 5 percent of their GDP per year due to time delay, waste of fuel and higher transport costs (ADB, 2019). This cost could be even higher if indirect costs such as loss of opportunity, work time loss, air pollution costs and costs due to vehicle collisions, injuries and fatalities are considered.

Traffic congestion is imposing a lot of socioeconomic challenges to South Asian and Southeast Asian countries. During peak periods, the level of congestion experienced within the major cities in the region such as Delhi, Dhaka, Bangkok, Jakarta or Manila is quite serious and the traffic flow becomes almost impossible. The recent report 'Unlocking Cities: The Impact of Ridesharing across India' revealed that travelers in India's biggest cities (Delhi, Mumbai, Bengaluru and Kolkata) spend 1.5 hours more on their daily commutes than their counterparts in other Asian cities, which costs an estimated US$22 billion annually (Chin et al., 2018). The report further highlighted that the annual estimated congestion cost of Delhi is approximately US$9.6 billion, which is equivalent to approximately 12 percent of its GDP. The prediction shows that traffic congestion costs for Delhi will be up to US$14.66 billion per year by 2030 (Davis et al., 2017). The traffic congestion in Dhaka costs the Bangladesh economy approximately US$4.3 billion a year (*Dhaka Tribune*, 2018). Likewise, the cost of traffic congestion in

Karachi, Pakistan, was about US$688 million in 2013, which is equivalent to 2 percent of Pakistan's total GDP (Ali and Muqeem, 2016).

Similar congestion problems have also occurred in Southeast Asian countries. For example, an average citizen in Bangkok, Thailand, spends 72 minutes in gridlock per day, which is followed by Jakarta, Indonesia, at 68 minutes, Metro Manila, the Philippines, at 66 minutes, and the average resident of Kuala Lumpur spends 53 minutes per day in gridlock (Chin et al., 2018). A World Bank report revealed that in 2014, estimated economic loss due to traffic congestion in Greater Kuala Lumpur was RM54 million every day or US$20 billion a year (Gil Sander, Blancas Mendivil and Westra, 2015). The majority of this cost is associated with lost productivity, wasted fuel and environmental damage. Meanwhile, Kuala Lumpur is also wasting 1.2 billion liters of fuel in traffic congestion, which is almost 2 percent of their GDP (Kim, 2017). The economic cost of congestion in Metro Manila is approximately US$6.8 million per day, and it may increase up to US$10.3 million per day by 2035 (JICA, 2017). Similarly, Jakarta's congestion is estimated to cost the Indonesian economy US$6.5 billion per year (*Diplomat*, 2019). Studies show that traffic congestion costs South Asian and Southeast Asian countries from 2 to 5 percent of their GDP.

Air pollution and its socioeconomic consequences in Asia

Air pollution is defined as a degradation of air quality caused by smoke or other harmful gases or particulates released into the environment from either natural or man-made activities. A gas that absorbs and emits radiant energy within the thermal infrared range is referred to as a greenhouse gas (GHG). There are different types of GHG, including carbon dioxide, methane, nitrous oxide, chlorofluorocarbons (CFCs), hydrofluorocarbons and ozone, among others, which contribute to the greenhouse effect. Meanwhile, air pollution can be divided into two types: (a) outdoor air pollution, and (b) indoor air pollution.

Air pollution and GHG emissions are a worldwide problem. According to the 'State of Global Air Report', more than 90 percent of people worldwide live in areas with pollution levels exceeding the WHO guideline for healthy air. Consequently, air pollution contributes to almost 7 million deaths globally, and nearly 90 percent of air-pollution-related deaths occur in developing countries in Asia and Africa (WHO, 2018a). Exposure to air pollution cost almost US$5.11 trillion in welfare losses globally in 2015 (Roy and Braathen, 2017; WHO, 2018b). Without effective policy initiatives, it is predicted that one person will die prematurely every 5 seconds due to outdoor air pollution by 2050 (EU, 2016).

Air pollution has an adverse impact on public health and the well-being of people, particularly in low-income countries. For example, the death rate of children under the age of 5 due to air pollution in lower-income countries is more than 60 times that in high-income countries (World Bank, 2013). It is predicted that if current levels of air pollution persist, the global population would lose

about 12.8 billion years of life, thus reducing the life expectancy of the average person by 1.8 years (Greenstone and Fan, 2018).

The transport sector is one of the major sources of outdoor air pollution. Despite significant technological progress, air pollution from the transport sector could increase significantly in the middle of the century. As a result, the premature death toll worldwide from outdoor air pollution will rise from 3 million today to more than 4 million in 2040 (IEA, 2017). The annual global welfare costs associated with premature deaths from outdoor air pollution are projected to rise from US$3 trillion in 2015 to US$25 trillion by 2060 (Lanzi et al., 2016).

In the Asia Pacific region, about 4 billion people, i.e. approximately 92 percent of the population of the region, are exposed to levels of air pollution in excess of the World Health Organization (WHO) guideline (CCAC and UNEP, 2019). Emerging economies such as PR China and India are suffering the most as more than half of the world's air pollution deaths occur in these countries. Outdoor air pollution contributed to an estimated 1.6 million premature deaths in PR China and over 1.2 million in India in 2017 (WHO, 2019). The total economic cost of the health impacts of outdoor air pollution in these two countries was about US$1.9 trillion in 2010 (OECD, 2014).

Major Asian cities are seriously affected by air pollution, in particular Delhi, Beijing, Bangkok, Jakarta, etc. For instance, the total social cost of fossil-fuel-based transport, including air pollution and traffic congestion, costs Beijing up to 15 percent of its GDP (Creutzig and He, 2009). The World Bank estimates that the cost of air-pollution-related health damage is about US$1 billion a year in cities such as Bangkok and Jakarta. Health problems due to air pollution cost many Asian developing countries 2 to 4 percent of their GDP annually (Wismans et al., 2016). Air pollution has adverse impacts on other sectors like agriculture and tourism. Studies show that agricultural productivity is highly affected by high ozone concentrations that lead to reductions in agricultural produce. It further accelerates the rate of global warming, which has adverse impacts on overall life and ecosystems.

Asia's road safety problem and its socioeconomic consequences

Road traffic crashes, fatalities, disabilities and property damage are a major concern worldwide. Road collisions represent the eighth-leading cause of death globally. Every year about 1.35 million people lose their lives and up to 50 million are injured on the road (WHO, 2018c). Road traffic injury is a leading cause of death globally especially for young people aged between 15 and 29 years. According to WHO, almost 50 percent of all crash victims are pedestrians, cyclists or motorcyclists. This percentage is even higher in some of the developing countries of Asia, with 20.7 deaths per 100,000 population. Low- and middle-income countries are the most vulnerable to the impact of road traffic injuries. With only 60 percent of the world's vehicles, 93 percent of the world's traffic fatalities occur in these countries (WHO, 2018a). In the least developed countries, with only

1 percent of the world's vehicle fleet, 13 percent of the total deaths occur, which is three times higher than death rates in high-income countries. According to WHO, road traffic collision cost most of the developing countries up to 3 percent of their gross domestic product. It is predicted that road traffic injuries will be the seventh-leading cause of death by 2030, marking a significant increase in the global burden of road traffic deaths and injuries.

The rates of road traffic death are among the highest in the world in the Asian developing countries. With only 16 percent of the global vehicle share, Asia accounts for almost 60 percent of the world's traffic fatalities per year (WHO, 2013). Emerging economies such as P.R China, India, Indonesia, Thailand, Vietnam and the Philippines are affected the most. For example, with about 1 percent of the world's motor vehicles, India accounts for almost 150,000 road fatalities annually, which costs the Indian economy over US$8 billion every year (Quartz India, 2016). Likewise, as a result of traffic accidents, more than 260,000 people are killed on Chinese roads annually, costing the Chinese economy billions of dollars (China Daily, 2016).

Considering the importance of road safety, the United Nations General Assembly Resolution A/RES/64/255 has established the 'UN Decade of Action for Road Safety 2011–2020', which calls for global action to reduce road traffic accidents and fatalities and improve road safety by 2020. Road safety is also acknowledged in the SDGs. Out of the 17 Goals, 2 are mainly focused on road safety. SDG 3.6 states: '*By 2020, halve the number of global deaths and injuries from road traffic accidents*', and SDG 11.2 states:

> By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

In the business-as-usual scenario, achieving these targets remains a key challenge for the developing countries in Asia.

Rural–urban transport disparity

Globally, about 45 percent of the world's population is living in rural areas, and nearly 90 percent of the world's rural population is living in developing countries in Asia and Africa (UN, 2018). Many of these rural communities are disconnected and isolated from public transport services. Forty percent of people in the Asia Pacific region lack direct access to an all-season road (UNESCAP, 2016). Inadequate public transport and poor infrastructure quality make finding solutions to the situation more critical. As a result, most of the time rural communities find it a problem to access jobs, markets, schools, hospitals, and other socioeconomic opportunities. On the other hand, Asian cities are overcrowded with automobiles and this is resulting in problems of growing traffic congestion, whereas rural areas are disconnected and isolated with very limited transport

facilities. This rural–urban transport gap promotes rural to urban migration, which has an adverse impact on rural economic development. Therefore, it is important to reduce the rural–urban disparity, and increase the transport connectivity between rural and urban areas. In this regard, countries should invest in rural transport to enhance rural–urban connectivity, which could provide many solutions in order to tackle various current urban issues.

Considering the importance of rural transport, member countries of the Regional Environmentally Sustainable Transport (EST) Forum in Asia have voluntarily adopted the *Vientiane Declaration on Sustainable Rural Transport* in 2017 in Vientiane, Lao PDR. The declaration acknowledges the importance of rural transport and the benefits of enhancing rural–urban connectivity for productivity, resilience and empowerment, along with changes to socioeconomic dynamics that support poverty eradication, hunger elimination, social integration, increased food security and improved supply chain logistics (UNCRD, 2017). In addition, rural transport connectivity provides a vital link in making meaningful contributions to achieve the 2030 Agenda for Sustainable Development (the SDGs). Thus, it is important for developing countries to improve rural transport infrastructure and services to fill the transport disparity gap.

Socioeconomic benefits of rural–urban connectivity

Poverty eradication

According to the United Nations, approximately 780 million people live below the poverty line, with about 11 percent of the world population living in extreme poverty (UN, 2019b). About 400 million people are estimated to live below the extreme poverty line in Asia and the Pacific (UNESCAP, 2018). To upgrade the economic status of these poor communities, it is essential to improve rural–urban connectivity by providing quality infrastructure and transport services that link rural areas with the urban centers. Improved rural transport considerably helps to increase the economic status of the rural community and creates numerous opportunities for new businesses, jobs and markets. As an example, the Rural Infrastructure Program-II in Bangladesh improved the rural road networks in some rural villages, which helped to increase household income by almost 197 percent (Sieber and Allen, 2016).

Improved health care access

According to the International Labor Organization, 56 percent of the world's rural population do not have access to health care facilities. Rural transport is a key driver for improving rural health, education and well being. Studies conducted in India reveal that rural road development projects could help to increase health care access by 30 percent (Khandker and Koolwal, 2014; Kanuganti et al., 2015).

Improved education facilities

According to the UN, about 263 million children and youths remain out of school. This includes 61 million children of primary school age, and more than 60 percent of them are girls in developing Asia. Improved rural–urban connectivity has a considerable impact on access to education, and supports an increase in school attendance by both teachers and students. A study conducted by the Asian Development Bank on road projects in India shows that primary school dropout rate among girls declined by 9.7 percent in communities with improved transport, compared to 7.2 percent in a village without new roads, and attendance of teachers also increased by 5.5 percent in villages benefiting from the road project compared to other villages (ADB, 2013).

Increased agricultural productivity

Better rural transport connectivity helps improve agricultural productivity. An example from the Philippines shows that about 1,417 kilometers of farm-to-market roads were improved or constructed in rural villages of the Philippines, resulting in average rice yield increasing to 4.6 tons per hectare, which is 31 percent higher than the average yield (ADB, 2012).

Limited urban infrastructure and transport services

With rapid population growth, increased urbanization and motorization, and a need to address global warming and climate change impacts, the demand for disaster- and climate-resilient transport infrastructure is rising significantly in developing countries. However, compared with demand, infrastructure development is lagging far behind in most Asian cities.

Global demand for infrastructure

According to an Organisation for Economic Co-operation and Development (OECD) report, the global infrastructure investment required to satisfy a low-carbon future scenario will amount to US$6.9 trillion per year by 2030 (Mirabile, Marchal, and Baron, 2017). The same report highlighted that the transport sector alone requires an estimated US$2.7 trillion in annual investment. However, global infrastructure investment is far less than what is required. The McKinsey Global Institute forecasts that estimated that US$57 trillion investment is required on infrastructure development between 2012 and 2030 (Dobbs, et al., 2013). The road transport sector alone requires US$2.1 trillion per year of investment. However, the real investment was far less compared to the worldwide demand. For instance, in 2015, worldwide transport infrastructure investment was only US$1.89 trillion, which is almost US$0.81 trillion less than the requirement per year. This massive infrastructure deficit is the major challenge for city authorities and governments to solve in order to address infrastructure shortfalls,

which have significant impacts on sustainable urban development and the future of cities.

The Global Commission on the Economy and Climate estimated that about US$90 trillion will need to be invested in infrastructure development globally by 2030 (GCEC, 2014). To address climate change and global warming, at least US$3.7 trillion per year will need to be invested in infrastructure up to 2035 to support economic growth and development. The total transport infrastructure investment in 2015 was US$1.189 trillion (McKinsey, 2017). Despite the considerable current investment, the infrastructure investment gap remains US$5.5 trillion globally between now and 2035.

Infrastructure demand in Asia

The Asian Development Bank estimates that developing Asia requires US$26 trillion in infrastructure development investment by 2030 with a rate of US$1.7 trillion per year to maintain economic growth, eradicate poverty and respond to climate change (ADB, 2017). South Asia needs the highest infrastructure development investment, equivalent to almost 9 percent of its gross domestic product (GDP) up to 2030 (ADB, 2018). At the same time, ASEAN requires an estimated US$2.8 trillion in infrastructure investment. Improving regional connectivity in Central Asia requires about US$38 billion worth of investment by 2030 (AIIB, 2019). A major portion of Asian infrastructure investment requirements is in PR China and India. A report published by Green Finance for Low-Carbon Cities estimated that PR China alone will require US$1 trillion over the next five years for low-carbon buildings, sustainable transport and clean energy in urban areas (PIEF, 2016). Similarly, the infrastructure sectors of India need an estimated US$4.5 trillion in investment by 2040 (Global Infrastructure Hub, 2019). The current level of Asian investment, estimated at US$881 billion per year, is far from sufficient for maintaining economic growth and addressing climate change impact in Asia.

The world needs to invest an average of US$4.7 trillion annually to meet the SDG goals by 2030, and 54 percent of this investment needs to be in Asia (Global Infrastructure Hub, 2019). Emerging economies such as PR China and India need 34 percent and 8 percent of the total investment, respectively. According to the Asian Development Bank, the financing gap in Asian cities is about US$459 billion a year (Ra and Li, 2018), which is equivalent to the GDP of Thailand. This massive infrastructure investment gap cannot be overcome only by government investments, and significant investment should be required from both the public and private sectors through innovative funding and financing mechanisms. To meet the infrastructure demand and fill the investment gap, it is essential for countries to mobilize finance from different sources. The Global Commission on Economy and Climate estimates that investing in sustainable urban infrastructures, including public transport, can reduce emissions and contribute approximately US$17 trillion to the global economy by 2050 (Gouldson et al., 2015). Therefore, countries need to increase their annual

investment in infrastructure development significantly to achieve the targets of the SDGs by 2030.

Importance of sustainable transport for achieving the 2030 Agenda and SDGs

This section highlights the importance of low-carbon sustainable transport solutions and other appropriate transport policy measures to address the existing and future transport-related socioeconomic and environmental challenges in Asian cities, and their implications for achieving the SDGs.

People- and environment-friendly, sustainable transport has significant implications for achieving the SDGs and related targets by 2030. Some SDG goals are directly linked whereas others are indirectly connected to sustainable transport, as highlighted by the 2030 Agenda for Sustainable Development. Particularly, SDG 11 calls for concerted actions at local, national and international levels to make cities and human settlements inclusive, safe, resilient and sustainable. Therefore, it is important to improve the quality of transport infrastructure and services for enhancing safety and security, mobility and accessibility, comfort and convenience, affordability and inclusiveness in the transport sector, in order to build cities and communities that are safe, smart, resilient, liveable and sustainable.

Policy measures for improving traffic congestion and air quality

There are numerous policies and strategies for reducing traffic congestion and air pollution in urban areas. These can be divided into two types: (a) temporary and short-term solutions, and (b) virtuous and long-term solutions. Temporary solutions are usually introduced for a short time period only, and are not suitable for long-term traffic alleviation: for example, widening roadways, which is a *short-term* solution to congestion relief. Roadway widening provides an additional capacity for traffic flow, and congestion will be managed for a while. However, eventually the new roadways will induce new demand for vehicles and private cars, and after some time the road will be full of vehicles and the situation will not be changed. Therefore, in the long run roadway expansion provides fewer congestion reduction benefits than predicted. Such policy measures could be worthwhile only for buying time for more radical policy interventions. Therefore, these short-term congestion and pollution reduction strategies should not be considered as permanent solutions. Usually, long-term strategies are people- and environment-friendly solutions, which encourage passengers to avoid driving fossil-fuel vehicles and promote sustainable low-carbon transport solutions (Table 2.1).

In contradiction to this logic, most of the developing countries are expanding the roadways and building highways as a solution to traffic congestion, which includes the expansion of roads, wider streets, use of flyovers, reducing cross streets and crosswalks, reconstruction of intersections, one-ways streets, etc. It is

Table 2.1 Co-benefits of congestion management policy measures and strategies on air pollution reduction and road safety improvement

Congestion management policy measures	*Congestion reduction*	*Air pollution reduction*	*Road safety improvement*
Improving public transport	✓	✓	✓
Alternative modes of transport options	✓	*	*
Non-motorized transport (walking and cycling)	✓	✓	✓
Integrating modes of transport	✓	*	✓
Transport pricing reform (such as applying congestion pricing, parking pricing, etc.)	✓	✓	x
Removing the fuel subsidies	✓	✓	x
Use of high-occupancy vehicles	✓	✓	*
Transit-priority traffic control system	✓	✓	✓
Use of state-of-the-art frontier technologies (ITS, GPS, automations)	✓	x	*
Integrated land use and transport planning	✓	✓	✓
Smart growth development	✓	✓	✓

✓= co-benefit; * = depending on the situation; x = no effect

therefore important to introduce better policies, planning and innovative congestion reduction strategies which help to reduce traffic congestion and maximize socioeconomic and environmental co-benefits.

It is crucial to improve air quality, which will bring various co-benefits to the largest sectors of society by improving people's health, productivity and well-being. Improved air quality has significant positive impacts on socioeconomic and environmental dimensions. For example, a US Environmental Protection Agency study highlighted that the total benefits of the 'Clean Air Act' programs saved the US economy up to US$22 trillion between 1970 and 1990 (USEPA, 1999). Implementation of low-carbon and sustainable transport systems not only improves air quality and human health through the reduction of air pollution and GHG emissions but also has significant complementary co-benefits, including the reduction of congestion, road accidents and fatalities, and also helps to reduce noise pollution (Table 2.2).

Integrating different modes of transport

Transport integration refers to the process of making journeys that use a range of transport modes, including rail, road, waterways and air, more efficient, convenient and well-connected and all operating and functioning as one 'seamless' system. It can facilitate intermodality in which passengers can use different modes of the transport system over one trip using a single ticket with an affordable fare.

Table 2.2 Co-benefits of air pollution management policy measures and strategies on congestion reduction and road safety improvement

Air pollution management policy measures	*Congestion reduction*	*Air pollution reduction*	*Road safety improvement*
Low-carbon transport development	*	✓	*
Use of non-motorized options	✓	✓	*
Use of hybrid and electric vehicles	✓	✓	*
Use of clean air technologies	x	✓	x
Use of clean and alternative fuels	x	✓	x
Improving the quality of fuel	x	✓	x
Emission standards and vehicle inspection and maintenance (I/M)	*	✓	✓
Eco-driving	✓	✓	*
Speed management	✓	✓	✓
Making cities greener (trees and vegetation)	x	✓	*
Traffic demand management	✓	✓	✓

✓= Co-benefit; * = depending on the situation; x = no effect

For example, in Japan bicycle, taxi, bus, metro and railways are well connected as one system, which usually provides door-to-door transport service, saving time and expense while reducing the use of private vehicles and cars.

Transport pricing reform

Acceptable levels of transport pricing or road pricing reform are necessary for reducing the traffic congestion in highly congested areas. Possible transport pricing reform includes congestion charges, parking fees, road tolls, fuel taxes, vehicle registration fees and roadway costs, which support congestion relief in the congested urban corridors. Studies show that the zoning price in London, congestion taxes in Stockholm, car registration price in China, electronic road pricing in Singapore and high parking fees in Beijing are good examples of transport pricing reform. These are effective solutions for reducing levels of congestion and air pollution in urban areas. It is important that these technologies are implemented electronically so that vehicles do not need to stop at toll gates or other payment points. Manual payment significantly increases traffic congestion.

Remove fuel subsidies

Fuel subsidies promote the use of private vehicles. Increased numbers of private vehicles ultimately contribute to traffic congestion, air and noise pollution and increased traffic-related incidents resulting in injuries, fatalities and property loss. Therefore, removal of fuel subsidies could help to control congestion, pollution and accidents. For example, Indonesia's fuel subsidy reforms have had

a significant impact on reducing traffic congestion. A study reveals that after the fuel subsidy was removed in 2014 in Indonesia, approximately 10 percent less traffic appeared on the roads compared with the fuel subsidy period (Burke, Batsuuria and Yudhistirab, 2017).

Use of high-occupancy vehicle lanes and intersections

High-occupancy vehicle (HOV) lanes reduce the amount of available road space for single-occupancy vehicles. When priority is given to HOVs at intersections, they may move more passengers smoothly and reduce stop-and-go traffic at lights, as well as urban congestion and air pollution (Litman, 2013). For example, Jakarta's 'three-in-one' policy shows that HOVs have significant positive impacts on reducing traffic congestion. In the case of Jakarta, the implementation of HOV policy considerably reduced the traffic congestion delay by 1 min/km in the morning and 2.5 min/km in the evening peak (Hanna, Kreindler and Olken, 2017).

Ridesharing programs

Currently, car-sharing, three-wheeler-sharing, motorbike-sharing and bicycle-sharing are common ridesharing programs in many cities in the world. These programs considerably help to solve traffic crises and reduce congestion levels, mainly in peak hours, particularly when these vehicles take more than one additional passenger. There may be problems with air pollution and the safety and security of these vehicles, so it is important to make sure that they use clean energy sources with better security options.

Policy measures for the improvement of road safety

A recent study conducted by the World Bank in PR China, India, Indonesia, Thailand and the Philippines predicted that reducing road traffic deaths and injuries by 50 percent in these countries could have significant positive impact on economic growth. It could generate income equivalent to 7.2 percent of GDP in the Philippines, 14 percent in India, 15 percent in PR China and 22.2 percent in Thailand. In addition, other economic and social welfare benefits can be generated up to 32 percent of their national GDPs over a period of 24 years (World Bank, 2017). Therefore, developing countries should introduce appropriate road safety policies and management strategies, and increase investment in road safety improvement and management to achieve greater socioeconomic benefits (Table 2.3).

Improving road safety and reducing risk of traffic accidents, injuries and casualties requires strong commitments and enforcement of road safety legislation. Millions of deaths and injuries from road accidents can be prevented if governments can enforce better road safety policy measures and strategies.

Table 2.3 Co-benefits of road safety improvement policy measures and strategies on congestion reduction and air pollution reduction

Policy measures for road safety improvement	*Congestion reduction*	*Air pollution reduction*	*Road safety improvement*
Prevent drinking and driving	✓	x	✓
Speed control	✓	✓	✓
Use of seatbelts	x	x	✓
Use of helmets	x	x	✓
Use of traffic lights	✓	x	✓
Use of CCTV to monitor road conditions	✓	x	✓
Use of intelligent transport systems (ITS)	✓	x	✓
Improving vehicle standards	✓	✓	✓
Improving bicycle infrastructures	✓	✓	✓
Improving pedestrian lanes and pedestrian crossings	✓	✓	✓
Improving public awareness of road safety	x	x	✓
Better emergency care and post-crash response	✓	x	✓
Better road design	✓	✓	✓
Ensuring safe driving practices	✓	x	✓
Traffic calming	*	✓	✓
Traffic safety insurance	x	x	✓

✓= co-benefit; * = depending on the situation; x = no effect

Road safety is a shared responsibility of national and local governments, road users, industries, international and national organizations, urban and transport planners, road and vehicle designers, law enforcement officials and traffic police, health professional and educators, politicians and all communities. Therefore, it is essential to engage all sectors of society for their collective efforts, but with differential roles and actions for improving road safety. It is equally important that the implemented policies and strategies should consider the needs of all road users, including vulnerable groups such as children, elderly, women and the physically disabled. The World Health Organization (WHO) has encouraged countries to prepare a road safety strategy that is multispectral and multidisciplinary, and recommended various road safety strategies outlined as twelve key actions around five pillars, which include (i) road safety management, (ii) safer vehicles, (iii) safer road users, (iv) post-crash response and (v) safer driving environment.

Many developing countries are enforcing different policy measures and strategies to improve road safety. However, implementation of the following strategies in a timely manner could significantly and quickly help to improve road safety in cities and urban areas.

Preventing drinking and driving

Alcohol is a major risk-increasing and contributing factor in road accidents and fatalities worldwide. It is estimated that up to 35 percent of all road deaths are reported as alcohol-related (WHO, 2018c). Data indicate that alcohol-related deaths among fatally injured road users could be approximately 273,000 people every year (Vissers, Houwing, and Wegman, 2017). Therefore, it is essential for governments to make strong legislations with effective enforcement against drunk driving, with sufficient punishment options.

Speed control

Speed has a direct connection with traffic road accidents and fatalities. With high speeds, the risk of a crash, injuries and death increases significantly. According to recent research published by the OECD, inappropriate speed is mainly responsible for up to 30 percent of all fatal road crashes (OECD, 2018). Thus, reducing speed on the road is an important factor in saving lives and controlling road accidents.

Better road design

Faulty road design creates more danger of fatal road accidents. Therefore, safe road infrastructure design is essential for improving road safety and minimizing traffic accidents and fatalities. Urban planners and road engineers can play a crucial role in designing and building safer road infrastructure. During road infrastructure development, it is important to use quality materials and people-friendly design with appropriate crossings, footpaths, gentle curves and inclinations: these always help to reduce the risk of road accidents. Traffic laws and regulations should be appropriate to local road design specifications, and should be enforced properly in order to ensure that design improvements actually improve road safety.

Other road safety strategies and measures

There are numerous other important road safety measures, which include use of seatbelts, helmets, traffic lights, CCTV and intelligent transport systems (ITS); improving vehicle standards, the design and quality of roadways and highways and non-motorized transport (NMT) infrastructures; well-planned and well-built pedestrian lanes and crossings; better emergency care and post-crash response; promoting traffic safety, road safety education and public awareness of road safety to ensure safe driving practices and traffic safety insurance.

Policy recommendations and conclusions

Safe, adequate, efficient, affordable, inclusive and people- and environment-friendly transport systems are important enabling conditions for economic

growth, resilience of cities and sustainable urban development. Transforming public transport and reducing the number of automobiles in cities helps considerably to tackle traffic congestion, air and noise pollution, road accidents, injuries and fatalities, and thereby decrease GHG emissions.

Sustainable urban planning, better roadway design and robust infrastructure development are key for the improvement of urban mobility and sustainable urban growth. This chapter makes up a set of policy recommendations to overcome the existing and future urban challenges in Asian cities, thus helping to achieve the SDGs and related targets by 2030 (Tables 2.4 and 2.5).

Table 2.4 Contributions of sustainable transport to SDGs and related targets

SDGs	*Related targets*	*Contributions of sustainable transport to the SDGs*
	*Target 1.1: By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than US$1.25 a day.*	Improving transport connectivity can reduce poverty and provide economic opportunities and basic services for all sectors of society.
	*Target 2.1: By 2030 end hunger and ensure access by all people, in particular the poor and people in vulnerable situations including infants, to safe, nutritious and sufficient food all year round.*	Improved rural transport infrastructure and services with better supply chain logistics can make food more accessible and affordable by reducing costs of agricultural products and thus reduce hunger.
	*Target 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents.*	Implementation of improved policies and regulations for road safety and development of safe and people-friendly transport infrastructure and services can help to reduce the number of global deaths and injuries from road traffic accidents.
	*Target 4.3: By 2030, ensure equal access for all women and men to affordable and quality technical, vocational and tertiary education, including university.*	Transport connectivity and enhanced rural–urban linkages provide better opportunities to access school and universities for all sectors of society.
	*Target 5.1: End all forms of discrimination against all women and girls everywhere.*	Socially inclusive transport systems open new opportunities for women and girls and improve access to better health, education, markets and employment opportunities.

(*continued*)

Table 2.4 Cont.

SDGs	*Related targets*	*Contributions of sustainable transport to the SDGs*
	*Target 6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all.*	Better transport options can assist in providing drinking water to areas of water shortage.
	*Target 8.5: By 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value.*	Sustainable transport infrastructure and services can increase access to markets, boost trade and commerce, and create new jobs. They further help the efficient movement of people and goods through better supply chains and logistics.
	*Target 9.1: Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.*	Robust transport infrastructure and services significantly help economic development and human well-being at both regional and local levels.
	*Target 10.1: By 2030, progressively achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average.*	Improved and affordable transport connectivity helps poor and disadvantaged groups access job and income generation opportunities which help to reduce inequality.
	*Target 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.*	Better transport systems can offer cost-effective, low-carbon and sustainable transport solutions that provide high levels of mobility and accessibility for the benefit of all.
	*Target 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.*	Improved transport accessibility and connectivity, and better freight and logistics, can increase food security and reduce food losses between farm and market.

Table 2.4 Cont.

SDGs	*Related targets*	*Contributions of sustainable transport to the SDGs*
	*Target 13.1: Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.*	Disaster- and climate-resilient transport infrastructure and low-carbon transport services can significantly enhance the resilience of cities and communities and help increase capacity to adapt to climate change.
	*Target 17.9: Enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals, including through North–South, South–South and triangular cooperation.*	International cooperation, collaboration, networking, knowledge-sharing and capacity-building among different stakeholders in transport sector help to make better partnerships for achieving the SDGs.

Table 2.5 Summary of social, economic, environmental and climate co-benefits from different sets of policy interventions and measures

Social benefits	*Land-use planning*	*Public transport*	*Non-motorized transport*	*Transit-oriented development*	*Transport demand management*	*Smart Growth*
Public health improvement	*	*	✓	✓	*	✓
Traffic road accident injury and fatality reduction	✓	✓	✓	✓	✓	✓
Convenience and comfort	✓	✓	✓	✓	✓	✓
Enhanced mobility and accessibility	✓	✓	✓	✓	✓	✓
Improved safety and security	✓	✓	✓	✓	✓	✓
Benefit to business	✓	✓	✓	✓	✓	✓
More attractive and dynamic	✓	✓	✓	✓	✓	✓
Gender equality promotion	*	✓	✓	*	*	*
Increased aesthetic value	✓	✓	✓	✓	✓	✓

(*continued*)

Table 2.5 Cont.

Social benefits	*Land-use planning*	*Public transport*	*Non-motorized transport*	*Transit-oriented development*	*Transport demand management*	*Smart Growth*
Economic benefits						
Congestion reduction	✓	✓	✓	✓	✓	✓
Reduced journey time	✓	✓	x	✓	✓	✓
Energy security and fuel savings	✓	✓	✓	✓	✓	✓
Employment creation	✓	✓	✓	✓	✓	✓
Productivity improvement	✓	✓	*	✓	✓	✓
Raising revenue from various taxes and fees	✓	*	*	✓	✓	✓
Environmental benefits						
Improved air quality	✓	✓	✓	✓	✓	✓
Particulate matter reduction	✓	✓	✓	✓	✓	✓
Sulphur oxide reduction	✓	✓	✓	✓	✓	✓
Carbon monoxide reduction	✓	✓	✓	✓	✓	✓
VOC reduction	✓	✓	✓	✓	✓	✓
Noise reduction	✓	✓	✓	✓	✓	✓
Climate co-benefits						
Greenhouse gas reduction	✓	✓	✓	✓	✓	✓
Improved resilience of cities	✓	✓	✓	✓	✓	✓
Help for climate mitigation	✓	✓	✓	✓	✓	✓

(✓= co-benefit; * = depending on the situation; x = no effect)

Key policies and strategies for congestion relief, improvement of air quality and road safety management

In order to address the existing and future transport-related socioeconomic and environmental challenges such as traffic congestion, air pollution and road accidents and fatalities in Asian cities, the following sets of key policy measures and strategies can be used.

Alternative modes of transport

Improving alternative modes of transport to personal cars is one of the significant ways to reduce congestion and improve mobility and connectivity. Better

public transport systems such as bus rapid transit (BRT), light rail transit (LRT), mass rapid transit (MRT) and non-motorized transport (NMT) help to improve mobility and connectivity, and provide transit for all sectors of society, including vulnerable groups. They further reduce the social costs of roadways and parking and provide support for compact and mixed urban development.

Improving public transport systems

Making public transport systems more safe, smart, efficient, convenient, punctual and affordable to all sectors of society, including the poor, women, children, youth, elderly and the physically disabled, will help to reduce the use of private cars and will eventually support reduced road congestion, air pollution and road accidents in urban areas.

Promotion of non-motorized transport

Non-motorized transport includes walking, cycling, three-wheelers and rickshaws, which can provide part of the solution to congestion. In most of developing countries, NMT is unsafe, uncomfortable and inconvenient to use. Improving the quantity and quality of pedestrian streets, footpaths, walkways, sidewalks, crosswalks, dedicated bicycle lanes, bicycle-sharing systems and bicycle parking facilities at bus and railway stations can be cost-effective methods to reduce traffic congestion and air pollution, and improve road safety and public health.

Emission standards and inspection and maintenance

Strengthening automotive emission standards and inspection and maintenance (I/M) systems are major components of overall strategies to reduce emissions and improve the safety of vehicles, drivers and road users. I/M is one of the most cost-effective ways of improving vehicle performance and efficiency and brings a higher return in safety and environmental benefits in the long run. Studies show that proper vehicle maintenance through a regular inspection and maintenance system can result in 3–7 percent lower fuel consumption and thereby reduce CO_2 emissions (Kolke, 2002).

Transportation demand management (TDM)

Transportation demand management, which is also known as traffic demand management or travel demand management, is the application of a broad set of policies, strategies and measures for reducing travel demand and managing vehicles in a particular place and time. TDM focuses on reducing traffic congestion and improving mobility options in a specific corridor within existing facilities by better balancing travel demand through cost-effective and improved transportation alternatives that reduce congestion levels, lower vehicle emissions and improve road safety. There is a long list of TDM measures, including congestion

charging, road pricing, fuel taxes, vehicle ownership fees, charging for vehicle licenses, parking fees, vehicle use restrictions and parking restrictions, among others.

Smart growth development

Smart growth is an urban planning approach and set of policies that promotes more compact, connected and mixed-use development patterns in walkable urban centers to avoid sprawl. Smart growth development places first priority on people rather than automobiles and discourages use of private vehicles, thereby reducing traffic congestion, air pollution and road accidents and casualties. Smart growth encourages high-density centers that allow the close proximity of business, offices, shopping centers, restaurants and bars, amusement and entertainment places, residential areas and public parks which are well connected with cost-effective public transport system.

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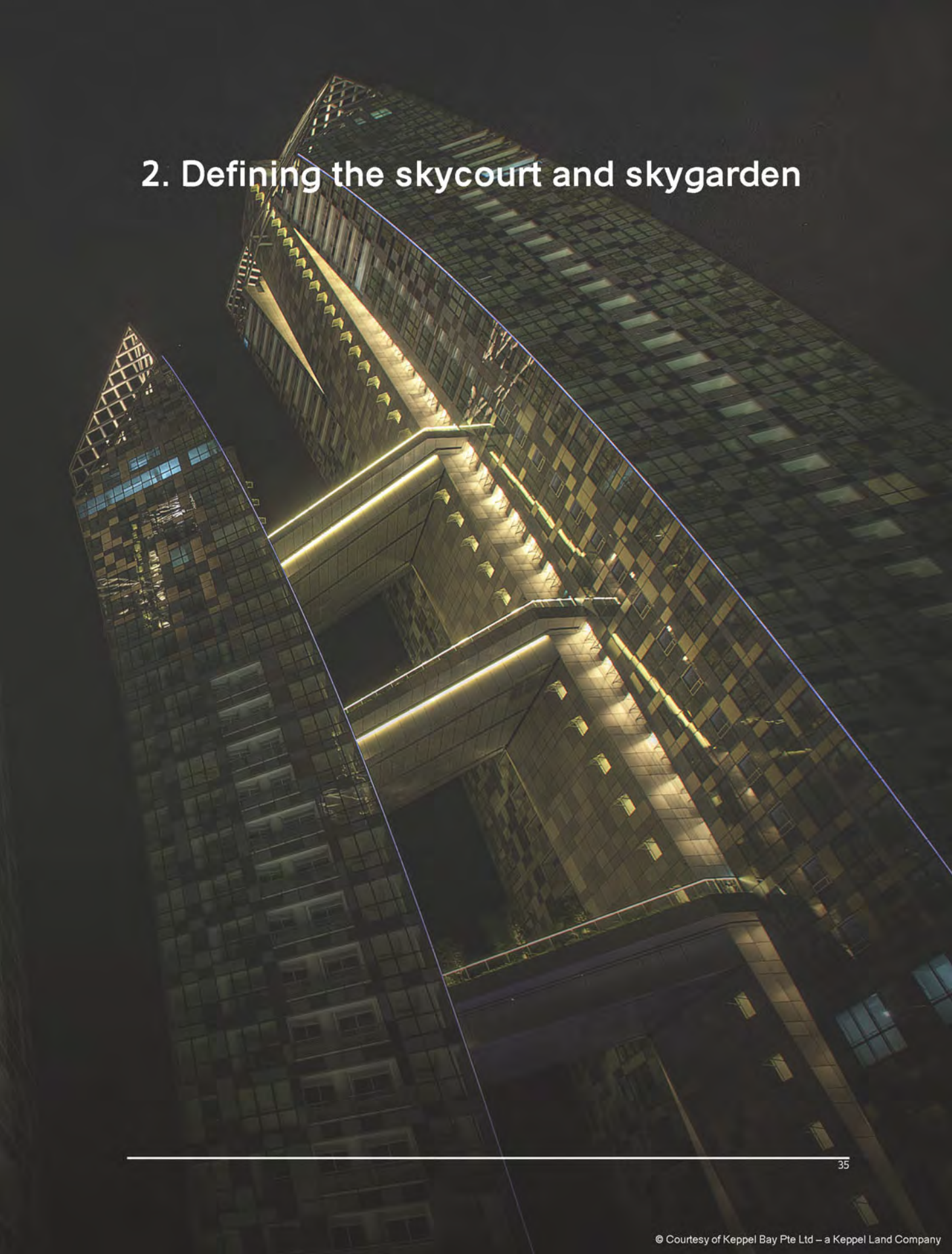
2. Defining the skycourt and skygarden



2.1 The skycourt and skygarden: a historical overview

There have been notable historical precedents that suggest skycourts and skygardens are not phenomenon only known in our lifetime, but can be found in the urban habitats of antiquity and the immediate past. We can trace the skygarden back to ancient civilisation's quest to integrate greenery into cities at height. The *Hanging Gardens of Babylon*, built by Nebuchadnezzar II for his wife Amyitis, were documented by the Greek historian Diodorus Siculus in the 6th century BC as being a series of planted terraces that were supported on stone arches 23 metres above ground. The Syrian King reputedly built the hanging gardens in an effort to please his homesick wife, who longed for her homeland of Persia. Trees were embedded into tiered stones terraces, with permanently green foliage made possible by a mechanical irrigation system from the Euphrates River.

Al-Fustat, an Egyptian city known for its shaded streets, gardens and markets that today forms part of Old Cairo, similarly incorporated skygardens. Modern archaeologists have recovered relics that came from as far as Spain, China, and Vietnam, providing evidence of the city's importance as a trade hub as well as being a production centre of Islamic art and ceramics. It was reputedly one of the wealthiest cities in the world and had an estimated population of 200,000 people (Mason, 1995). The Persian poet and philosopher Nasir Khusraw described the city as having a number of 14- storey high-rise residential buildings that were surmounted by recreational rooftop gardens that were customised by its inhabitants and irrigated by ox-drawn water wheels (Barghusen and Moulder, 2001; Behrens-Abouseif, 1992).

In Italy, hill towns such as Urbino and San Gimignano manipulated the natural topographic levels of their location to create urban settlements that were protected given their elevated position (Figure 22). During the Renaissance, steeply terraced gardens and green roofs were common in the city of Genoa. Raised piazzas, interconnected by steps to traverse the changes in level, permitted surveillance of the land beneath but also the environments for public events to take place (Peck *et al.*, 1999). At the private scale, the *Villa Giulia*, built between 1550 and 1555 by the architects Ammanati and Vignola for Pope Julius III, manipulated the natural topographic and man-made levels in order to allow the Pope and his entourage to enjoy views of the surrounding

Figure 22: *San Gimignano*, Siena: a lush and steeply terraced hill town in Italy with public spaces at multiple levels

landscape from its raised terraces and three-tiered covered loggias (Watkin, 2005).

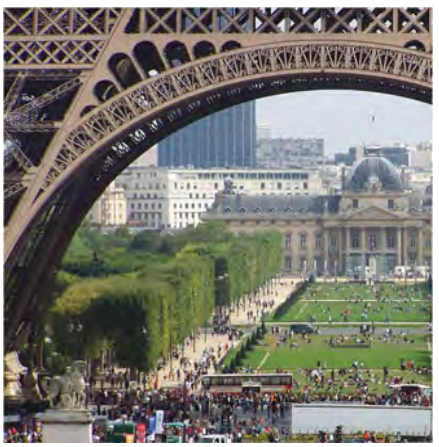


Figure 23: *The Eiffel Tower*, Paris: a structure that permits the democratisation of view for the fee-paying visitor

By the 19th century, the ability to glean panoramic views was no longer the realm of the privileged few. The democratisation of view from ever-increasing heights, made possible by the invention of the elevator, further challenged any exclusive preconceptions of elevated levels by providing opportunities for society to survey the city as a means of recreation and delight. The *Eiffel Tower* of the Paris exposition of 1889 stood as a testimony to human ingenuity and technological advancement in an industrial age (Figure 23). It provided a platform from which people could marvel at the Paris skyline for an entrance fee, and remains the most visited paid monument in the world. Its ability to provide a panorama as a sellable commodity and thus a means of income generation has since become a template for many an observation gallery in tall buildings within cities around the world.

Figure 24: *Unité d'habitation*, Marseilles: recreational space on the roof to supplement open space on the ground

By the 20th century, the influence of Le Corbusier and his manifesto of celebrating the rooftop as a further means of supplementing those open recreational spaces on the ground further spawned examples of planted and unplanted sky-rise social spaces within an increasingly object-driven modern city (Figure 24). Architects such as Ken Yeang went further to adopt the skycourt as an interstitial open space within buildings for its environmental as well as socio-economic benefits, and the skycourt has become an increasingly important part of a new architectural vocabulary within high-density urban environments (Pomeroy, 2012a) (Figure 25). Norman Foster's *Commerzbank* in Frankfurt aptly demonstrates their incorporation. The tall building was conceived as three 'petals' of triangular office floor plates, grouped around a central 'stem' formed by a full-height atrium (Figure 26). Sealed skycourts of four storeys high rise up through the height of the building, rotating every four storeys to the next face. The skycourts provide employees with an opportunity to view other skycourts above and below, as well as the cityscape beneath and the sky above. These spaces provide a social dimension for the office employees to use as places of meeting, events, lunches or remote working. They have been described as a social foci 'with coffee bars and seating tucked amongst the plants. They are

thus intrinsic to Foster's vision of the tower as a community of villages with each garden as a village square/green for the 240 employees who directly overlook it' (Davey, 1997).

Skycourts and skygardens continue to be part of the urban habitat today, and exist for the very same reasons that they did in antiquity. They are places of recreation for the individual or group, can afford a memorable view and vantage point, and can offer environmental as well as socio-physiological benefit. Yet despite such historical precedents and the important role that they play, little has been done to define skycourts and skygardens in terms of their spatial, social, economic, environmental, technological or cultural contribution, or the increasingly diverse role that they play within the urban habitat. The following sections will seek to define their multi-faceted nature.

Figure 25: *Menara Mesiniaga*, Kuala Lumpur: an early example of a tall building that incorporates skycourts for their social-environmental benefits

Figure 26: *Commerzbank*, Frankfurt: an exemplary environmentally responsive building that incorporates skycourts to form a vertical working village

2.2 The skycourt and skygarden: spatial morphology and perceived density

In urban terms, 'density' often carries the negative spatial and social connotation of the close proximity of buildings in one constrained location, or of cramped living conditions where there is a heightened proximity between individuals. According to the academic Vicky Cheng, perceived density refers to 'the interaction between the individual and the space, and between individuals in the space', which requires the concepts of spatial density ('the perception of density with respect to the relationship among spatial elements') and social density ('the interaction between people') to distinguish between the two different aspects of the former (Cheng, 2010). She points out that these definitions demonstrate how perceived densities straddle different disciplines under different contexts, and how urban density is intrinsically associated with the shaping and densification of urban morphology.

Society's aversion to urban density given pre-conceived notions that such environments lack space for interaction, or are homogenous environments that lack character, therefore requires careful consideration. This is because there are a myriad of high-density case studies that embody such attributes but are celebrated urban settings for their inhabitants and visitors alike (OECD, 2012). Hong Kong and Paris demonstrate this, and also how high-density urban habitats need not relate to just high-rise structures. An investigation into the spatial morphology of Hong Kong and Paris demonstrates that the iconic high-rise developments of the former may be perceived to be higher density than the lower-rise developments of the latter, and yet the reality is that Haussmann's 6–7 storey districts are in fact denser than a Hong Kong neighbourhood of 20 storeys (Figure 27). When comparing the two cities in terms of floor area ratio (FAR), Paris has an FAR of 5.75, whilst Hong Kong's is 4.32, demonstrating that higher densities can be achieved by alternative building forms to the high-rise typology, which can similarly reduce perceived densities (OECD, 2012) (Figure 28).

It perhaps comes as little surprise that the skycourt has become an increasingly important element within the architectural vocabulary of the world's tallest buildings and the densest environments as a means of reducing perceived densities. Skycourts can be initially defined in terms of their

Figure 27: Haussmann's Paris: a high-density environment of 6–7 storeys with an FAR of 5.75

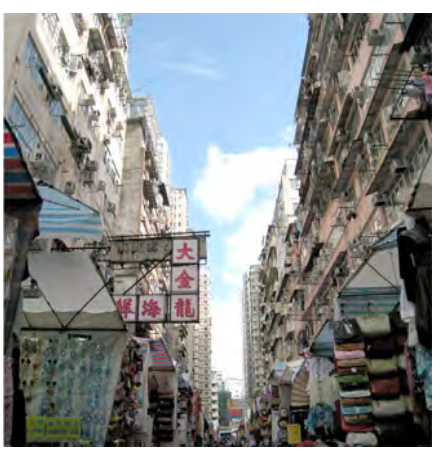


Figure 28: A Hong Kong neighbourhood: a high-density environment of 20 storeys with an FAR of 4.32

spatial morphology and how they can reduce the perceived densities of a tall building, or high-density development, by breaking the mass and potential monotony of repetitive floor plates by the juxtaposition of solid and void (Pomeroy, 2005; 2007). They have the ability to evoke the human scale and proportion of the traditional street by presenting themselves within high-density urban habitats and tall buildings as interstitial open or enclosed spaces that balance the figurative (semi-public) void within the solid of the (private) object.

As the word 'court' suggests, a sense of enclosure can be created by the void space being bordered by other buildings within the immediate urban context, or formed by its own internal façades. Skycourts are often located at the perimeter of buildings and are commonly three storeys or more to allow the benefit of greater light and ventilation to penetrate deeper into the structure – thus enhancing the internal environment (Figure 29). Such proportions also permit, depending on orientation and climatic factors, the incorporation of trees or extensive landscaping to further enhance the aesthetic, socio-physiological and environmental properties of these social spaces.

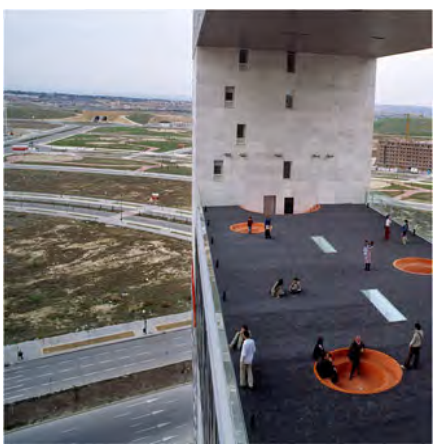


Figure 29: *Mirador*, Sanchinarro: a mid-level hollowed out skycourt as an interstitial space

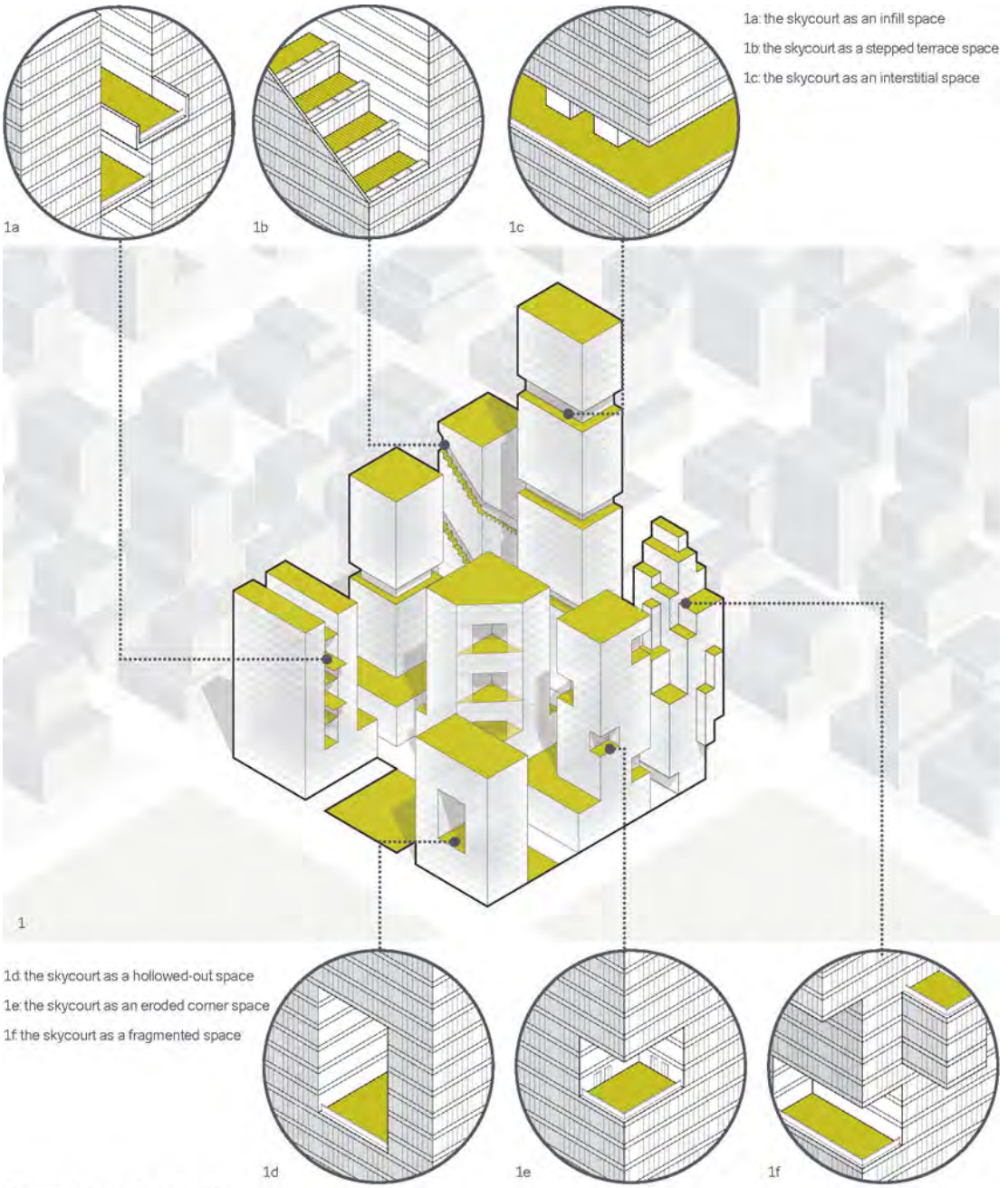
The rooftop garden has been defined as a landscaped environment built on the roof of a building that is strong enough to support the load, and is ideally suited to reinforced concrete and steel structures (Osmundson, 1999) (Figure 30). A skygarden, on the other hand, tends to refer to an open or enclosed landscaped open space that can be dispersed through the higher levels of the urban habitat or tall building, and has become a generic term that occasionally substitutes the terms skycourt and rooftop garden. As the name suggests, emphasis is often placed on the aesthetic qualities of the garden setting and its appeal to occupants. Just as one normally finds a proportion of open space to built-up area in ground-scraping mixed-use developments, skycourts and skygardens start to vertically balance open space to built-up area ratios within the tall building (Pomeroy, 2009).

Figure 30: *Marina Barrage*, Singapore: an example of a rooftop skygarden that serves as a public park

Architects such as Stephen Holl have explored the de-densification of urban centres by the incorporation of skycourts, skygardens and skybridges, and in doing so have created hybrid structures that balance solid and void.

The ability to explore vertical, diagonal and horizontal open space networks to reduce perceived densities substantially supports a mixed-use programme of activities that redefine the 24-hour city, and acts as a catalyst for spontaneity and interaction. Holl's *Linked Hybrid*, in Beijing, explores such a concept and acknowledges Beijing's change of urban morphology (Figure 31). What was historically a dense network of streets and courtyards was transformed post 1980s into a city of monotonous high-rise objects that expressed a greater verticality in the skyline (Per *et al.*, 2011). The Linked Hybrid conceptually seeks to reconcile the city of objects with a city of spaces by interlinking eight towers via a 20th-storey ring of skybridges that accommodate recreational and community-related facilities for both its occupants and visitors alike. The typically repetitive nature of the high-density residential development in the region is discarded in favour of a diversity of apartment configurations and sizes that are further spatially deconstructed by the presence of the skycourts that help reduce the perceived densities.

Figure 31 (top–bottom): *The Linked Hybrid*, Beijing: skycourts, skygardens and skybridges seek to reduce perceived densities



Diagrams 1, 1a, 1b, 1c, 1d, 1e, 1f
Skycourt and skygarden spatial morphology

2.3 The skycourt and skygarden as a social space

The philosopher Henri Lefebrve stated that society produces its own spatial code that isolates and separates fragments of everyday life through boundaries, producing spaces specific to itself. The academic Ulrich Struver's notion of *critical spatial identities*, however, acknowledges relationships between groups as opposed to boundaries (Best and Struver, 2002). Groups may have different spatial interpretations of a given space which sets up power struggles, requiring one power to be dominant (appropriating the space in such a way that would be perceived as conventional); the others subservient (often perceived as unconventional). For instance, what may be used as a transitional space between buildings (as governed by an institution and perceived as the conventional) may also be used as a skateboarding area appropriated by a subculture (as appropriated by society and perceived as the unconventional) (Figure 32). Such an interdependence of dominant and subservient powers creates a formative tension that can be used as an instrument of power; the enforcing of such, whether by a private corporate body, council, individual, group or association being the device to control, maintain or manage.

Figure 32: *The South Bank Arts Complex*, London: a public space being appropriated as a skateboarding environment

Skycourts and skygardens can act as social spaces in the sky that help replenish the loss of open space potentially surrendered through urban densification. Like the street and the square, they are spaces that provide a forum for social interaction and can facilitate chance or planned meetings with others as well as a means of recreation. Like its public space counterpart, these skyrise spaces can permit communal groups to form and disband, and in so doing potentially present the contestation of its space over its function amongst social groups that meet regularly. For instance, students may gather within such spaces outside of school hours to share notes before disbanding; office workers may meet with fellow workers from different departments for coffee or lunch breaks, before returning to their respective departments within a working day; residents may populate these spaces during the weekend and/or in evenings to meet with neighbours and friends before retiring to their home, and tourist groups may gather to observe a panoramic view but will similarly disband upon closing time (Figure 33). Its continual use by a dominant individual, group or association can imprint an element of informal territoriality on a place that may implicitly restrict the use of the space by others.

Figure 33: *Ssamziegil*, Seoul: the skygarden as an informal gathering place for friends and shoppers

Figure 34: *The Pinnacle*, Singapore: explicit rules of governance that negate particular freedoms of speech, motion and action

Unlike their open space counterparts on the ground, which tend to be governed by public interests and permit a spontaneity and freedom of movement, speech and action, skycourts and skygardens are often semi-public and are governed by private interests. This in turn imparts particular social restrictions that are more formal. Despite bearing public domain characteristics that allow the user a particular freedom of movement or the ability to appropriate the space as a place of recreation, amenity and social interaction, they are nevertheless managed spaces that are physically constrained by the very structure that retains them and are controlled by the institution, company, association or group that governs the tall building (Pomeroy, 2012a). This inevitably leads to limitations on the patterns of speech and action of the individual, group and association appropriating the space given the dominant (private) party's control of the space (Figure 34). The resultant social spaces are often highly classified environments that have explicit rules of exclusion that may be time-based (i.e the operating hours of the corporation or the levying of an entrance fee) or implicit rules of inclusion that are based on social activity (i.e. to be part of a studying community; an office community; a residential community or a tourist community).

The Pinnacle, in Singapore, demonstrates such an approach in its ability to use 12 skygardens to interconnect its seven, 50-storey high-density social housing blocks comprising of 1,848 family units (Figure 35). The skygardens reinterpret the ground-level void decks of the past social housing blocks as a series of elevated social spaces. The intermediary gardens at the 26th floor serve the residents only, whilst the 50th-floor rooftop garden is accessible to the public in addition to residents. The 26th-storey intermediary gardens have explicit rules of governance as to who can enter and who cannot – they are ultimately privatised spaces for the sole use of its residents and are thus encoded with explicit rules of exclusion, despite being deemed public by the state. Its 50th-storey skygarden, again deemed public, also has explicit rules of governance but is encoded with implicit rules of exclusion with the proposed levying of an entrance fee to gain access to it as an observation deck. Those who can afford to pay for a view will enjoy a panoramic skyline; those who will not or cannot will be excluded by their own choice or economic circumstance. Thus, in this case, it could be

argued that the freedom of passage and ability to appropriate the rooftop space as one feels free to socialise in the public domain of the street and square runs the risk of being nullified; not, as one would assume, by private interests anxious at the preservation of their asset, but paradoxically by state governance that would under normal circumstances promote greater levels of inclusivity in the use of open space by local and visitor, resident and non-resident (Pomeroy, 2011).

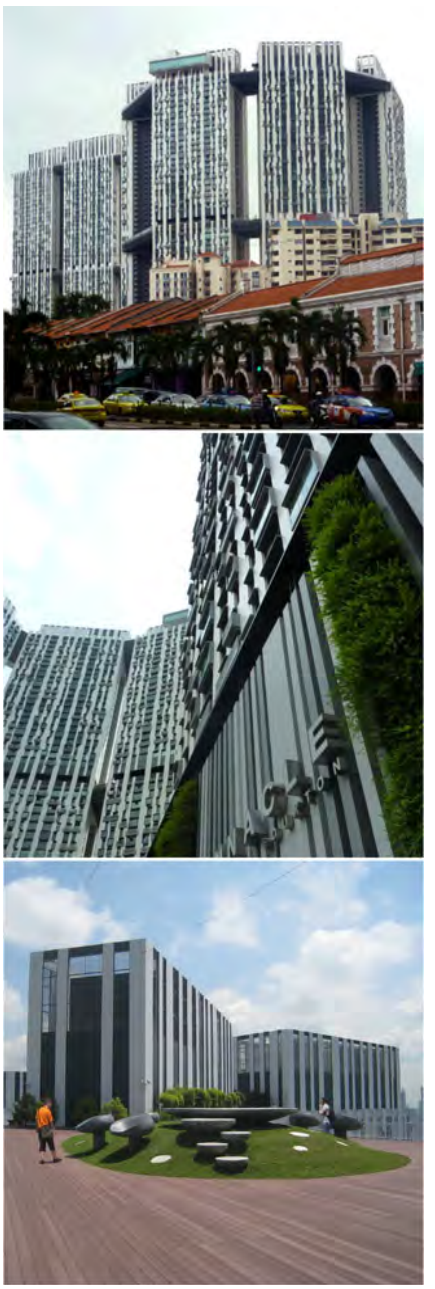
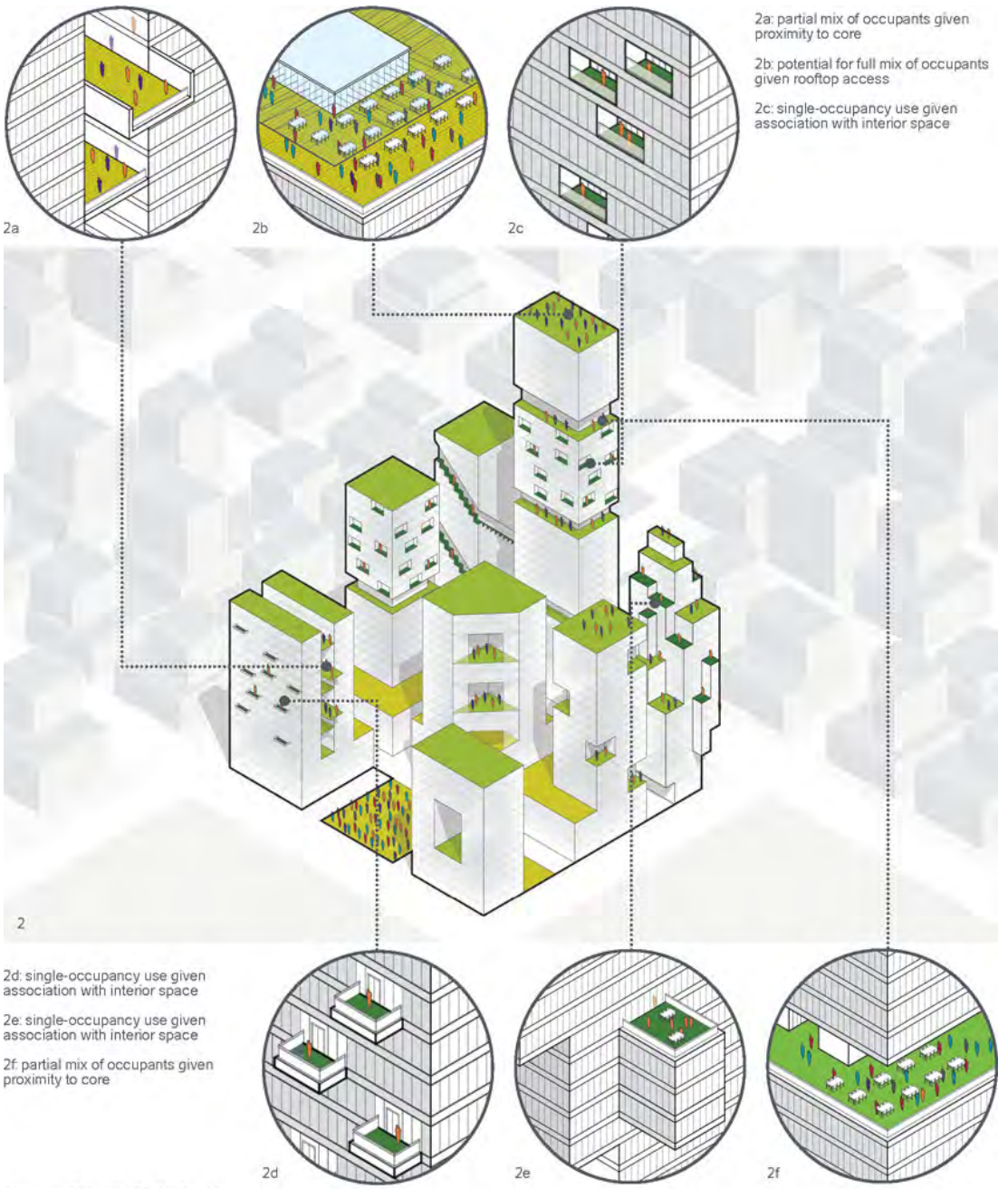


Figure 35 (top–bottom): *The Pinnacle*, Singapore: an example of how skycourts can act as the new social spaces for residents to enjoy



Diagrams 2, 2a, 2b, 2c, 2d, 2e, 2f
The skycourt and skygarden as a social space

2.4 The skycourt as a transitional space

According to the academic Arnis Siksna, when inner cities become denser and pedestrian movement increases, the two-dimensional plane of the city reaches its elastic limit. It forces the city to move to a second stage of development, whereby it can take no more growth without incorporating auxiliary systems and layers, such as transit, parking and subways, to facilitate choice and freedom of movement (Siksna, 1998). This inevitably thrusts itself into the third dimension in order to cater for increased density and movement. A city like Hong Kong, with its myriad of skyways, bridge links and multi-layered movement systems above and below ground, cannot reach such a threshold of movement needed to expand into the third dimension unless it has the pre-requisite urban density of its centre to sustain an increase in population (Figure 36). Without such infrastructure, the compact city would run the risk of accessibility suffocation due to its own success (Gabay and Aravot, 2003).

Figure 36: Central mid-level escalators, Hong Kong: a city that has embraced multi-level movement systems to address accessibility suffocation

Similarly, the tall building typology cannot reach the threshold needed to expand skywards into the third dimension unless it has the pre-requisite skycourts and auxiliary systems (i.e. the deployment of underground trains, parking structures, skybridges and other technical facilities) to sustain an increase in occupancy or pedestrian flow. Without such infrastructure, the compact city of objects would similarly run the risk of accessibility suffocation. The need for improved circulatory methods to facilitate an ease of pedestrian movement at height, is as pertinent in the tall building typology as it is to the urban environment at grade, and reinforces the importance of ensuring an equality of movement for civil society in the sky as well as on the ground.

The skycourt can act as a transitional space in its ability to be a circulatory interchange in super-tall buildings, whereby lift car capacities, waiting times and floor plate efficiencies necessitate the stacking of local lift cores to enhance the economic viability of the development. Just as civil society is provided with both choice of route and mode of transport on the ground (the ability to walk, cycle, drive, or take public transport through a variety of axes), the occupant or visitor is faced with a multiplicity of circulation routes and modes in the sky, making the skycourt not only a destination place of recreation and planned meeting, but also a transitional space of movement and chance meeting (Pomeroy, 2008)

Figure 37: *Taipei 101*, Taipei: transfer floors are expanded to be hubs of interaction between different functions

Figure 38: *Selfridges*, Birmingham: transitional spaces and bridge links that function as pseudo-vertical arcades

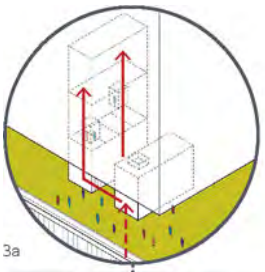
(Figure 37). Consequently, the incorporation of skycourts can facilitate the occupants' onward transition from one part of the tall building to another, by linking the disparate vertical circulation modes, and even to other buildings and their skycourts (Wood, 2003). The skycourt acts as a pseudo-vertical arcade by its ability to link primary, secondary and tertiary modes of vertical circulation.

The incorporation of retail compounds the analogy further – the skycourt being the (vertical) arcade; the lifts, escalators, staircases, ramps and other (vertical) circulation means being the hierarchical orders of boulevards, streets and passageways. It begins to ameliorate the risks of visual disconnection and separation from the activity of the street at ground level, as the horizontal and vertical means of circulation within a complex of tall buildings serves to create new eyes on the street in the sky, which can serve to aid security through the recognition of who is a stranger and who is not. It further harnesses the sense of community fostered through the movement of pedestrians, workers and residents from different parts of the tall building and beyond. Furthermore, it presents an opportunity to escape from one tall building into another via skybridge (Figure 38). Since the September 11 terrorist attacks, there has been a radical re-evaluation of mass evacuation procedures from tall buildings – thus ameliorating the need for phased evacuation which can compromise life safety and be economically unviable due to the increase in escape stairs required and therefore net-to-gross floor efficiencies (Wood, 2003).

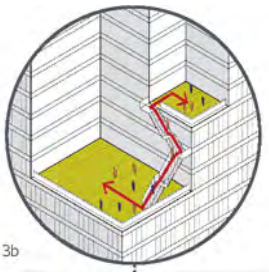
The Shard London Bridge demonstrates how skycourts can be incorporated at mid-level as a transitional space (Figure 39). The 72-storey tower is the tallest mixed-use structure in Europe and stands at over 310 metres tall. The first 26 floors above the public piazza houses 55,551 square metres of modern high-specification office space with winter gardens. A five-star hotel with 202 rooms from the 34th to the 52nd floors, and residential apartments from the 53rd to the 65th, complete the programme. Separating the working from the living spaces is a three-storey skycourt that acts not only as the community space that gels the disparate functions together, but also as a means of transition between them. It forms an effective interchange point amongst different social functions that starts to imprint a 24-hour city quality. Such a

space is designed to provide memorable views of London for its 800,000 visitors per year, and contains retail, bars, restaurants, leisure, performance and exhibition activities as well as social spaces for the tower's inhabitants and the broader community. It effectively becomes a new square in the sky – a place of orientation, chance or planned meeting and onward journey to one's destination via the multiple vertical transportation routes within the building's core.

Figure 39: (top–bottom) *The Shard*, London: its mid-level skycourt acts as a transitional space as well as a destination space



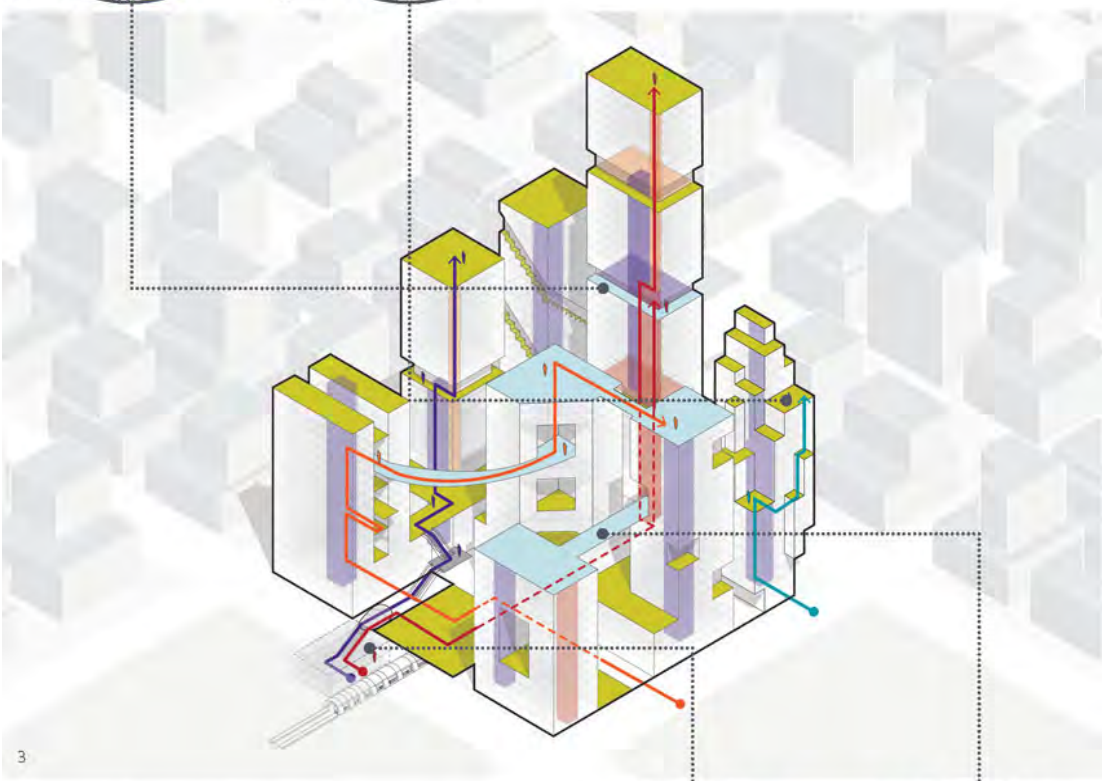
3a



3b

3a: the skycourt as a means of horizontally linking transitions in circulation

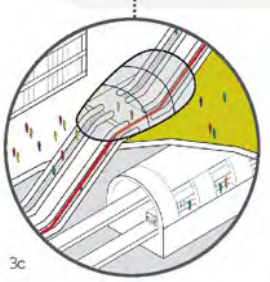
3b: the skycourt as a means of linking exterior circulation routes



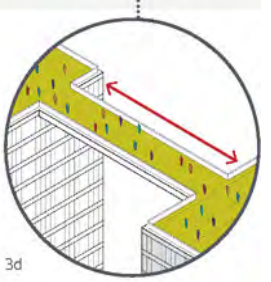
3

3c: the skycourt as a means of linking diagonal subterranean circulation routes

3d: the skybridge as a means of horizontally linking skycourts and their buildings



3c



3d

Diagrams 3, 3a, 3b, 3c, 3d
The skycourt as a transitional space

2.5 The skycourt and skygarden as an environmental filter

Natural light and ventilation are essential for the survival of living organisms. Builders of traditional buildings understood the importance of harvesting natural light and ventilation before Man's technological ingenuity led to inventions that removed the need to rely on a proximity to perimeter windows. As noted by the academic Rayner Banham in *The Architecture of the Well-Tempered Environment*, by the turn of the 19th century the architect had ceded such environmental considerations to the consulting engineer (Banham, 1984). Today, however, both academics and professionals alike have returned to the basics of passive design, in order to enhance internal comfort levels and reduce consumption in buildings. We see such considerations of filtering the benefits of natural light and ventilation through open spaces such as arcades and atria, though arguably this requires heightened glass performance and/or shading devices to counteract the potential heat gain through direct solar exposure (Figure 40).

Figure 40: *Allen Lambert Galleria*, Toronto: a structure that provides natural light but necessitates shading to counteract direct solar heat gain

Incorporating skycourts as interstitial openings at the perimeter of buildings provides an alternative aperture to atria that permits natural light and ventilation to penetrate deeper into the floor plate whilst avoiding overhead direct solar heat gain. Daylight design best practice guidelines suggest that natural light can penetrate a space from a single side by up to 2.5 times the floor-to-ceiling height (Baker and Steemers, 2000). Therefore, a skycourt with a floor-to-ceiling height of 6 metres should be able to permit up to 15 metres of daylight penetration, thus helping reduce the reliance on artificial lighting means. The appropriate orientation of skycourts is, however, required in order to provide an 'environmental filter' that can mitigate low-angle sun and the potential for noise and high-speed wind penetration. This is because the greater wall surface area exposed to climatic factors, as a result of incorporating skycourts, may also be to the detriment of a building's environmental performance (Puteri and Ip, 2006).

The incorporation of greenery to skycourts and skygardens can counteract such issues given the ability of plants to reduce external climatic factors. Greenery to the horizontal and vertical surfaces of skycourts and skygardens can help reduce urban heat island effect, the absorption of heat in the building fabric, and its subsequent re-radiation by harnessing the biological properties of plants – such as photosynthesis, respiration, transpiration and evaporation (Figure 41). Planted

Figure 41: *Acros Building*, Fukuoka: greening vertical and horizontal surfaces can help reduce ambient temperatures

surfaces can help cool the environment by 3.6–11.3 degrees centigrade, with wall surfaces being reduced by as much as 12 degrees centigrade (Alexandri and Jones, 2008; Wong *et al.*, 2009). When trees are positioned at the perimeter of skycourts, they can act as a shading device, with light tree canopies intercepting between 60% and 80% of sunlight and dense canopies intercepting as much as 98% (Johnston and Newton, 2004). They can also help act as a wind-break and thus reduce loading to structural frames. They also form an effective acoustic buffer to urban noise. Vertical planting, the trapped layer of air between the plants and the substrate can help absorb, reflect and deflect sound waves, and reduce low-frequency noise by as much as 9.9 dB (Wong *et al.*, 2010) (Figure 42).

Planted skycourts and skygardens can also improve air quality and help reduce respiratory illnesses by acting as a 'sponge' to noxious pollutants and carbon dioxide in the atmosphere, with climbing plants showing a particular susceptibility to absorbing and filtering dust particles. Urban settings with trees may reduce dust particles to 1,000–3,000 dust particles per litre, whilst an environment with no trees may contain 10,000–12,000 dust particles per litre (Johnston and Newton, 2004). They also have the added ecological benefit of retaining storm water, thus helping reduce run-off into drains and the occurrence of flash floods during extreme rain periods. Studies in Berlin showed that green roofs absorb 75% of precipitation that falls upon them, reducing immediate rainwater discharge by 25% of normal levels whilst helping remove impurities. The filtration properties of plants can remove over 95% of cadmium, copper and lead from rainwater and 16% of zinc, whilst nitrogen levels can also be reduced (Johnston and Newton, 2004).

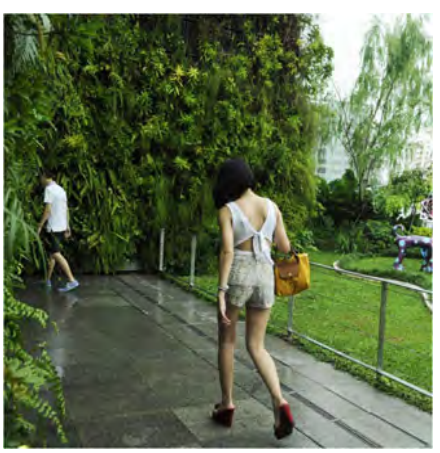


Figure 42: *Orchard Central*, Singapore: applying vertical greenery to reduce heat and noise generated by mechanical plant areas

Ken Yeang's *Singapore National Library* aptly demonstrates the incorporation of planted skycourts for such environmental benefits (Figure 43). The tall building consists of two blocks that are separated by a naturally lit internal street with connecting bridges, escalators and lifts to the upper levels. The library has over 6,300 square metres (or 11% of the total gross floor area) of designated green space that acts as an environmental filter to the low-angled east and west orientated sun. This helps reduce solar heat gain and provides an effective shading device. Of the 14 skycourts and

skygardens, there are two main areas situated on the fifth and tenth floors. These contain 12-metre-high trees that increase bio-diversity, help retain water on site and can also help regulate the ecosystem by acting as a respiratory system and filter of noxious pollutants. The provision of the skycourts, their greenery and the building's bio-climatic design considerations help enhance the indoor thermal performance and its energy efficiency. When compared with a typical Singaporean commercial building's energy consumption of 230 kWh/sqm/annum, the library has been able to reduce its consumption by 78 kWh/sqm/annum to give an energy consumption of 152 kWh/sqm/annum – making it one of the most energy-efficient buildings in Singapore (NLB, 2008).

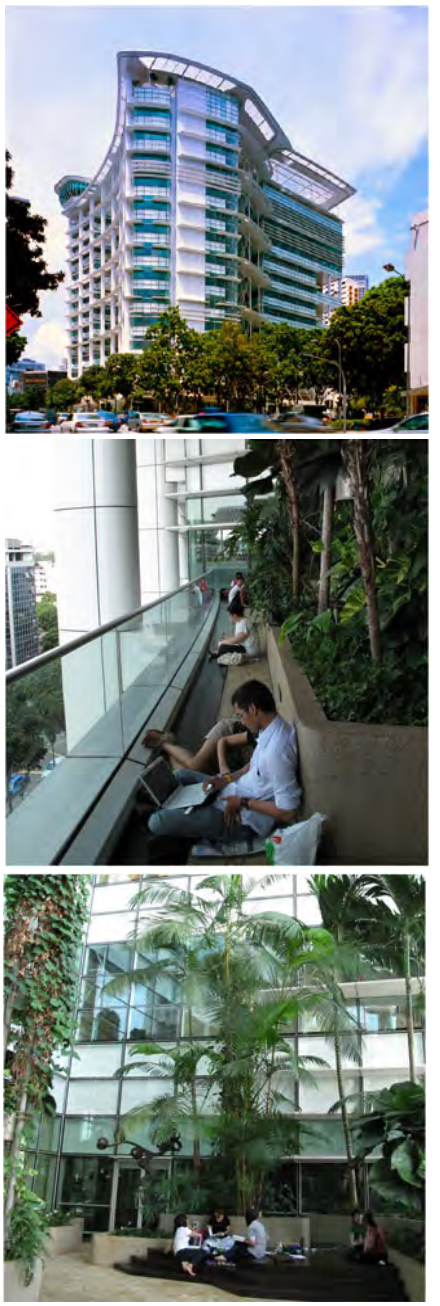
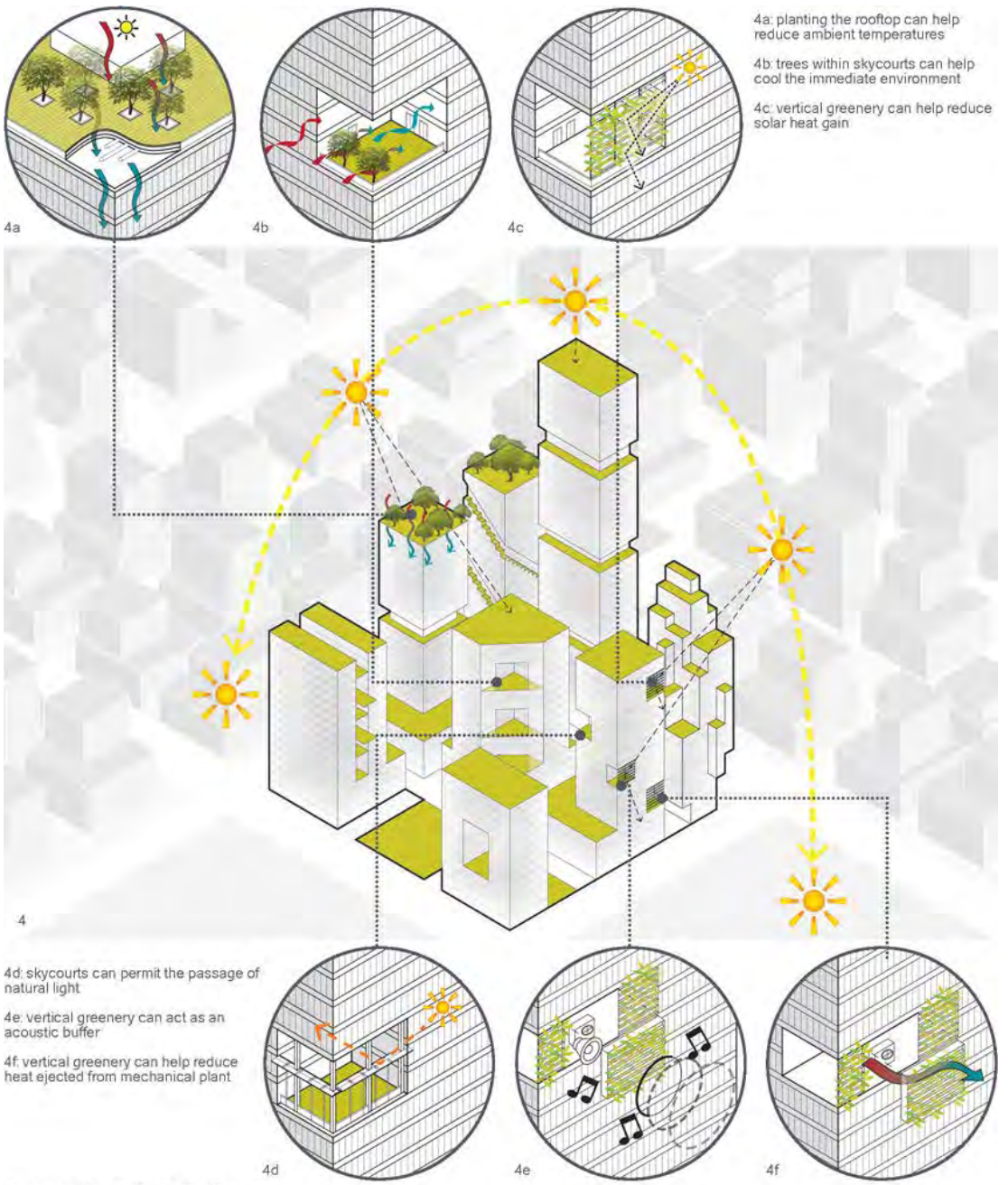


Figure 43 (top–bottom): *National Library*, Singapore: the skycourt as an exemplary environmental filter



Diagrams 4, 4a, 4b, 4c, 4d, 4e, 4f
The skycourt and skygarden as an environmental filter

2.6 The skycourt and skygarden: enhancing psycho-physiological well-being

An increased interest in the way that people process scenes formed the basis of a number of psychological studies held during the 1960s that considered what constituted beauty and what structural elements (for instance, boundary sharpness, complexity and light patterns) influenced people's perception of what is beautiful. Nature, or natural scenes, significantly influenced view preference scores, with people considering a scene as being natural 'if it contained predominantly vegetation and/or water, and if man-made features such as buildings or cars are absent or inconspicuous' (Ulrich, 1981, 1986). Such findings spurred further research into the psycho-physiological effects nature has on the individual, and considerations as to how it can help improve the mental state of health.

The academic Roger Ulrich's research further suggested that natural elements in the urban landscape counteracted physiological stress reactions through a stream of instantaneous affective (emotional) reactions (Ulrich, 1983). Studies of videotaped natural scenes were shown to speed physical and emotional recovery for traumatised people through nature's restorative power, by triggering quick, positive emotions to help reduce physiological stress. 'Findings were consistent with the predictions of the psycho-evolutionary theory that restorative influences of nature involve a shift towards a more positively-toned emotional state, positive changes in physiological activity levels, and that these changes are accompanied by sustained attention/ intake' (Ulrich *et al.*, 1990). Prisoners with windows facing surrounding hills were found to visit the infirmary with stress-related illnesses less frequently than those facing interior spaces, which further supports the hypotheses of the healing properties of nature (Moore, 1982).

The motivational qualities of viewing greenery have also been shown to positively affect task performance and mood (Shibata and Suzuki, 2002). Nature also has the ability to revive a person's concentration. Attention restoration theory suggests the mind's ability to avoid distraction can become exhausted with time. Direct attention, an inhibitory quality that can cause irritability, unwillingness to participate in group activity and inappropriate behaviour can be treated by focusing on natural environments that are rich in such qualities and can provide stimulation, but place no demands

Figure 44: *The Pinnacle@Duxton*, Singapore: an abundance of rooftop terraces provides inhabitants with social spaces in which to interact

on a person's ability to maintain concentration, in order to help ameliorate such reactions (Kaplan, 1995).

Landscaping has therefore been increasingly included in the design of skycourts and skygardens for not only their environmental benefits, but for their visual attributes that have been proven to enrich people's psycho-physiological well-being. Within a residential setting, landscaped skycourts and skygardens can encourage people to spend more time outdoors undertaking social and recreational activities, and thus heighten the likelihood of social interaction through chance meeting (Figure 44). This is particularly the case where trees have been found to act as a catalyst for congregation amongst a mix of ages and social groups, and can positively affect people's attitude to safety and adjustment in fostering a sense of community (Kuo *et al.*, 1998). This can result in heightened neighbourhood satisfaction and stronger social ties that can help protect the public welfare of the community. When incorporated into the workplace, skycourts and skygardens provide alternative informal working environments and places for meeting that can enhance productivity through the propagation of regular breaks outside of the formal office setting (Figure 45). They can also help foster inter-departmental social activity by acting as 'neutral' places to meet, that need not bear any particular departmental territoriality. In doing so, it can foster a greater sense of workplace community that can improve performance and productivity. The presence of greenery furthermore helps remove any noxious pollutants and heat released from computers, and offers visual relief from the workplace. In a healthcare setting, skycourts and skygardens similarly provide environments conducive to recuperation for the patient, but can also be places for healthcare staff to privately retreat, recuperate or socially interact in (Figure 46).

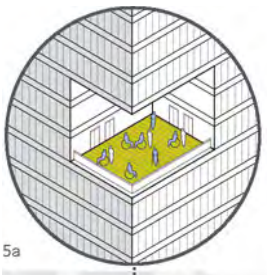
Figure 45: *Genzyme*, Boston: a research environment in which skycourts act as breakout social spaces

Figure 46: *Venice-Mestre Hospital*, Venice: a healthcare environment that uses greenery to improve psychological well-being of the individual

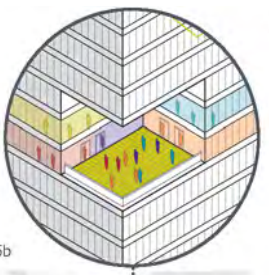
In the case of *Bedok Court*, a Singaporean residential development that dedicates 30–40% of its built-up area to skycourts, the academic Joo Hwa Bay found that 86% of the inhabitants used the skycourts for social purposes. A similarly high percentage found that they came into visual or physical contact with their neighbours through such spaces. The stepping of the skycourts also allowed 66% of the residents to interact with other neighbours on different levels.

This was attributed to the increased visual field through the staggered arrangement that allowed visual permeability (Figure 47). Bay's social survey was supplemented by a climatic survey, whereby residents' votes for thermal comfort were plotted against radiant temperature for morning, afternoon and evening. With the average radiant temperature of the skycourts being 28.5 degrees centigrade, a humidity level of 61% and a wind speed of 0.75 m/s, 70%–80% of the community felt slightly warm, comfortable or slightly cool for the three periods. The skycourt proved cooler than the external environment and only slightly warmer than the internal. Similar quantitative tests were undertaken for daylight factor and acoustics, which were then compared to the qualitative responses of residents. Bay asserted that the good thermal, acoustic and daylight properties of the skycourts created conducive environments for social interaction even during the hottest month (June) of the year. He concluded that such socio-climatic properties allowed the skycourts to promote community life as well as enhanced physiological well-being (Bay, 2004).

Figure 47 (top–bottom): *Bedok Court*, Singapore: generous skycourts allow homeowners to customise their space



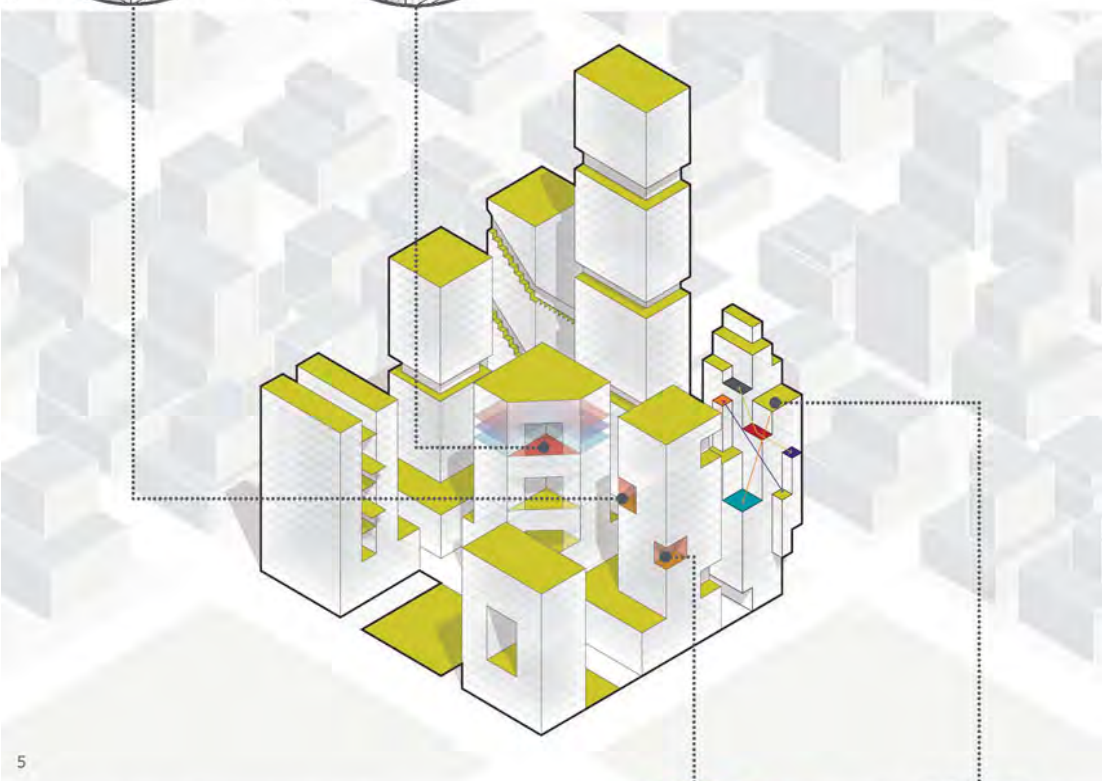
5a



5b

5a: skycourts and skygardens provide environments conducive to recuperation for the patient

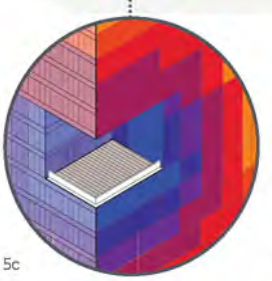
5b: skycourts and skygardens provide alternative informal working environments that can enhance productivity



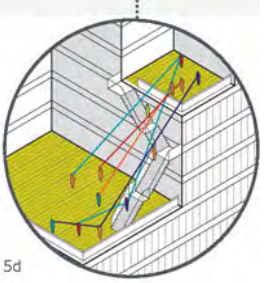
5

5c: when planted, skycourts provide thermally comfortable environments for their occupants

5d: the stepping of the skycourts allows interaction with neighbours on different levels, by increasing the visual field through a staggered arrangement



5c



5d

Diagrams 5, 5a, 5b, 5c, 5d
The skycourt and skygarden: enhancing psycho-physiological well-being

2.7 The skycourt and skygarden as a bio-diversity enhancer

The term 'bio-diversity' has a multitude of definitions relating to different scientific disciplines. Geneticists define it as the diversity of genes and organisms, whilst biologists define it as the accumulation of insects, fungi, plants, birds, animals and micro-organisms, their genetic and phenotypic variation and the manner in which they co-inhabit the Earth (Dirzo and Mendoza, 2008). In the urban habitat, bio-diversity refers to the quantification of habitable areas, and the diverse range of species and life forms that exist within (Currie and Bass, 2010). Such definitions demonstrate a commonality that bio-diversity is the degree of variation in life forms within a given ecosystem by which a measure of an ecosystem's health can be determined. The existence of such diverse life forms, each functioning and interconnecting with other organisms in life and death, creates a perpetual yet structured life-cycle that defines the level of bio-diversity within an ecosystem (Currie and Bass, 2010).

The consequent removal of greenery to make way for urban development has resulted in the reduction of bio-diversity to urban areas, and has necessitated the restoration, preservation and enhancement of bio-diversity to counteract the potential environmental ills caused by urban development. Bio-diversity within the urban habitat has often been manifested in the form of greenery through the planting of horizontal, diagonal and vertical surfaces. In doing so, the ability to increase a city's bio-diversity through the incorporation of skycourts and skygardens provides an opportunity to enhance the quality of life of urban dwellers as well as become an educational tool on urban sustainability-related issues (Hui and Chan, 2011).

One of the most common areas of exploitation is the rooftop – an environment often perceived as a non-accessible, undervalued part of the city. Green roofs, be they intensive (having depths of between 150 and 1,000 millimetres and a greater depth of growing medium to support a wider range of planting that includes shrubs and trees), extensive (having depths of between 50 to 150 millimetres and with low-growing plants, with no access other than for occasional maintenance) or brown (a non-seeded green roof system that undergoes natural colonisation with little human interaction, allowing local plant species to populate the roof over time) can help restore the imbalance of the

Figure 48: *PF-1 (Public Farm-1),* New York: provides an alternative food source and promotes social interaction through collaborative farming

Figure 49: *Solaris Research Centre*, Singapore: bio-diverse eco-corridors reach up into the sky

Figure 50: The *Highline*, Manhattan: reinstating urban greenery to enhance the bio-diversity of this former railway track

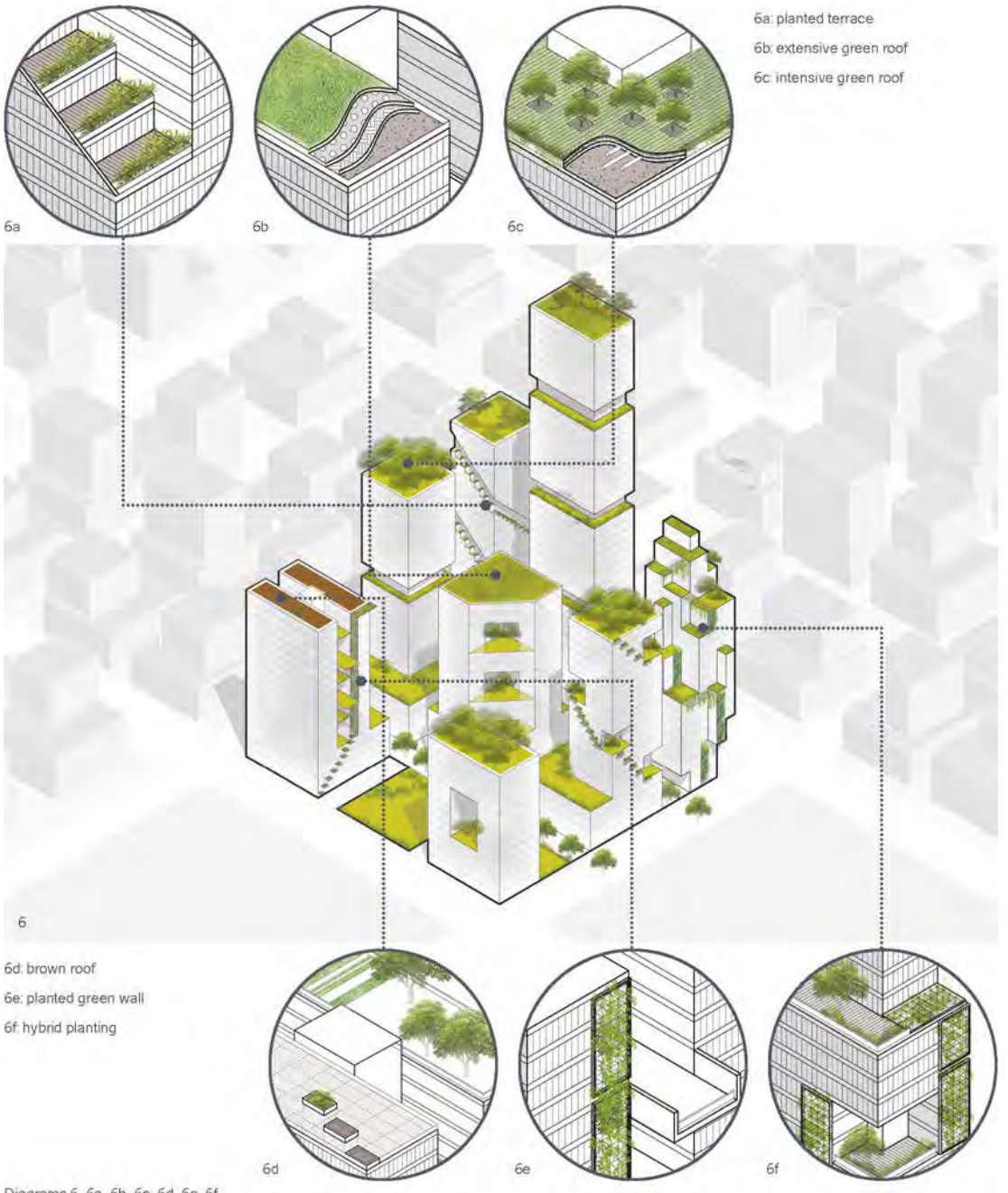
urban ecosystem by providing habitats for the coexistence of insects, birds, plants, vertebrates and invertebrate animal species within the urban environment. They can also be an important agricultural source. With the continued trend of migration to city centres and consequent spatial shortage, the conversion of existing rooftops to create urban agriculture has made them an important alternative food source that centralises food production in growing compact cities. Such an approach helps reduce the reliance on rural agricultural means, its energy consumption and waste in food transportation (Figure 48).

When considered holistically as part of an urban green programme, skycourts and skygardens provide pockets of urban greenery that can create islands of bio-diversity within the city and replace the natural habitats lost through development. They can enhance the bio-diversity in urban centres by helping replenish the loss of urban greenery and at the same time provide a home for a greater breadth of wildlife. Skycourts and skygardens can provide a nesting ground for small birds and can in turn attract butterflies and insects through the right selection of plants that are rich in fruit and flowers (Chiang and Tan, 2009). Their soil can provide a home for spiders, beetles and ants, whilst the presence of nectar can attract insects such as bees and butterflies to as high as 20 storeys (Johnston and Newton, 2004). Vertical and diagonal greenery within skycourts can also provide linkage between the horizontal planes, and therefore form a natural continuum of the natural environment and a transitional route for wildlife (Figure 49). In doing so, skycourts and skygardens facilitate an approach to urban greenery that can be conceived as a continuous green vein within the city, and with it the opportunity for bio-diverse eco-corridors that transcend the ground plane by reaching up into the sky. This can help establish a larger network of wildlife eco-corridors in urban and suburban areas that help stitch and integrate larger, bio-diverse places, such as parks and gardens (Figure 50).

The 'Supertrees' of the *Gardens by the Bay* development in Singapore start to consider the sense of vertical green continuity in order to enhance the bio-diversity in city centres (Figure 51). Whilst not necessarily tall buildings, their extruded forms are nevertheless deliberate attempts

to create green structures that would be in keeping with the scale, height and materiality of the surrounding tall building developments of the Marina Bay Financial District in Singapore. The public garden is punctuated by 18 of these man-made, tree-like structures of reinforced concrete, trunk, planting and canopy – 12 of which are contained in the Supertree grove, and a further six placed in clusters of three in the Golden and Silver Gardens. Ranging in heights of between 25 and 50 metres, they provide a home for an extensive array of localised species of wildlife, totalling over 162,900 plants and comprising 200 different species of bromeliads, orchids, ferns and tropical flowering climbers. Not only do the structures enhance the bio-diversity of the place, they also demonstrate an array of green technologies that seek to reduce waste, re-use water and recycle bio-matter for the preservation of other species inhabiting the structures as part of a broader eco-system life-cycle.

Figure 51 (top–bottom): Supertrees at *Gardens by the Bay*, Singapore: an urban opportunity to enhance bio-diversity



Diagrams 6, 6a, 6b, 6c, 6d, 6e, 6f
The skycourt and skygarden as a bio-diversity enhancer

2.8 The skycourt and skygarden: their economic benefits

In a time of increasing global environmental and social consciousness, the need to challenge the preconceived ideas of the 20th century tall building has led to a paradigm shift in tall building design that re-evaluates structure, envelope and the functional programme of uses. This has been in the interests of minimising consumption and preserving the natural and built environment for future generations. Such a shift has economic benefits. Skycourts and skygardens are increasingly important components within the architectural vocabulary of the sustainable tall building typology that can help reduce energy loads within buildings, whilst being an income-generating source that can attract people not normally associated with the development.

The environmental properties of greenery incorporated into skycourts and skygardens can reap benefits in terms of reduced energy consumption and therefore running costs. Rooftop gardens and their greenery have been shown to reduce ambient temperatures given plants' ability to absorb solar radiation (Figure 52). Studies have demonstrated that the exposed area of a black roof can reach 80 degrees centigrade, whilst an equivalent area beneath grass reaches only 27 degrees centigrade (Gotze, 1988; Kaiser, 1981). Gravel roofs have been shown to have temperatures of 30 degrees centigrade in comparison to 26 degrees centigrade for a green roof (Kaiser, 1981). The insulation properties of green roofs can reduce room temperatures beneath the structure by as much as 10%, thus helping to reduce artificial cooling and therefore running costs. When we also consider the shading properties of vertical planting within skycourts, Envelope Thermal Transfer Values (ETTV) can be reduced by 40% in comparison to a conventional building with no greenery (Chiang and Tan, 2009).

Yet skycourts and skygardens can also extend beyond their energy-reducing benefits to embrace direct income generation through their space provision. With continued urbanisation, the need to utilise available space becomes paramount. The ability to 'future-proof' developments by incorporating skycourts and skygardens provides opportunities to extend into the voids of skycourts, and into the airspace above skygardens in order to increase buildable area and therefore locally increase density (Figure 53). Such an approach optimises existing structures and can potentially

Figure 52: *Nanyang Technical University*, Singapore: the green roof as a means of reducing energy consumption

Figure 53: *Ontario College of Art and Design*, Toronto: exploiting the air rights above an existing building to increase density

Figure 54: *Red Sky*, Bangkok: A rooftop restaurant that manipulates views of the Bangkok skyline to be an income-generating destination

increase sellable and lettable areas of development whilst negating the need to demolish existing buildings and to rebuild – a process that can be potentially detrimental to the natural and built environment as well as to existing communities (Pomeroy, 2012b).

Their social function of providing a source of amenity can similarly offer economic benefits if incorporated midpoint within the building. They can be a useful source of convenience, recreation and amenity that can negate the need to travel groundwards for the grocery run, gymnasium visit or relaxation in open space. The critical mass of social and recreational activities, freed from the conventional setting of the ground plane, can enhance the footfall of the building's occupants at height, thus providing opportunities for passing trade and income generation (Pomeroy, 2012a). Just as research has shown how public space on the ground enhances property values, so too can skyrise social spaces command a premium.

Given rooftop skygardens' elevated position at the pinnacle of tall buildings, they can also function as observation decks, bars and restaurants that can be income-generating (Figure 54). The *Empire State Building* famously weathered the storm of financial crisis in the great depression through its 86th-floor observation deck that drew tourist receipts of $2 million in the first year of opening – as much money as was taken in rent that year (Tauranac, 1997). At the turn of the 21st century, there has been an unprecedented number of tall buildings of over 200 metres that have allowed Man to satiate his appetite for cityscape views in the form of observation decks. Rooftop skygardens therefore provide an opportunity to observe memorable skylines and panoramic views and the ability for people to pause and orientate themselves within both building and urban context. In doing so, they can potentially become a source of income by levying an entrance fee.

The *Marina Bay Sands*, Singapore, is a contemporary success story of the income-generating attributes of skycourts and skygardens (Figure 55). It is an integrated resort that accommodates up to 52,000 people. The three prominent hotel towers stand at 57 storeys and are crowned by a skypark, 191 metres above the ground. The 1.2 hectare

park is the world's largest public cantilever and hosts a variety of amenities, including the longest elevated swimming pool of 146 metres amongst a lush tropical landscape setting. The skygarden is open daily from 9:30am to 10pm and can cater for up to 3,900 people at any one time. It has become an income generator through the levying of an entrance fee of 10–20 SGD per person to gain panoramic views of Singapore's skyline from its observation deck, generating an income of 54,600–78,000 SGD per day(4). It also includes a number of rooftop bars, restaurants and shops that are positioned within the gardens. These have become a popular destination as it provides an alternative environment for locals and tourists alike to socially interact during the course of the day and through to the night, whilst its rooftop pool and performance areas provide further means of recreation and amenity for fee-paying guests.

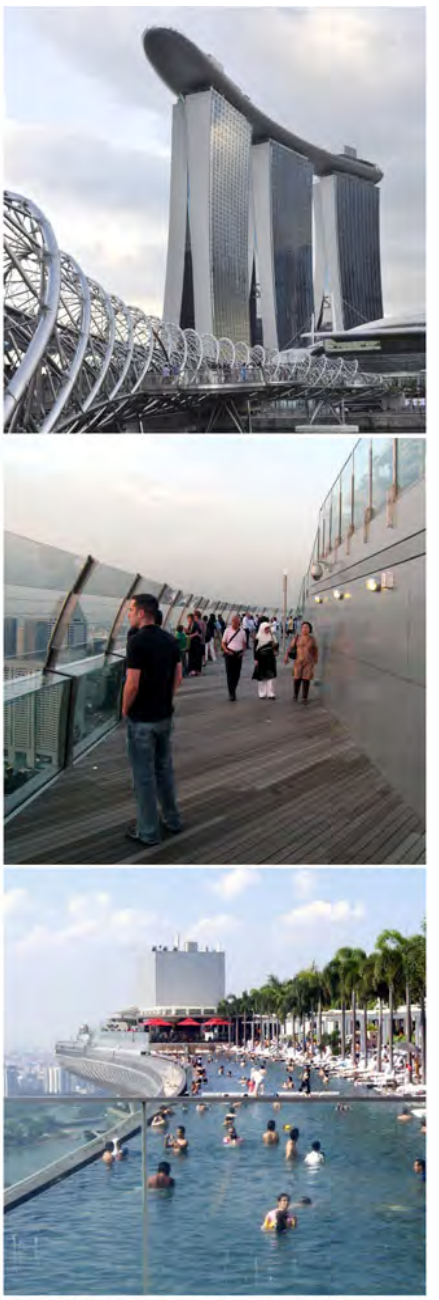
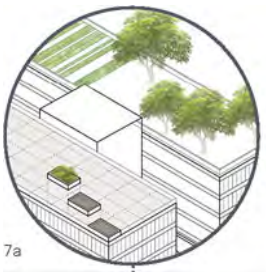
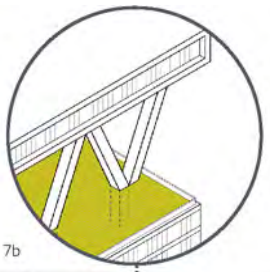


Figure 55: *Marina Bay Sands*, Singapore: the 1.2 ha skypark is the world's largest public cantilever

(4) MBS interview 2012



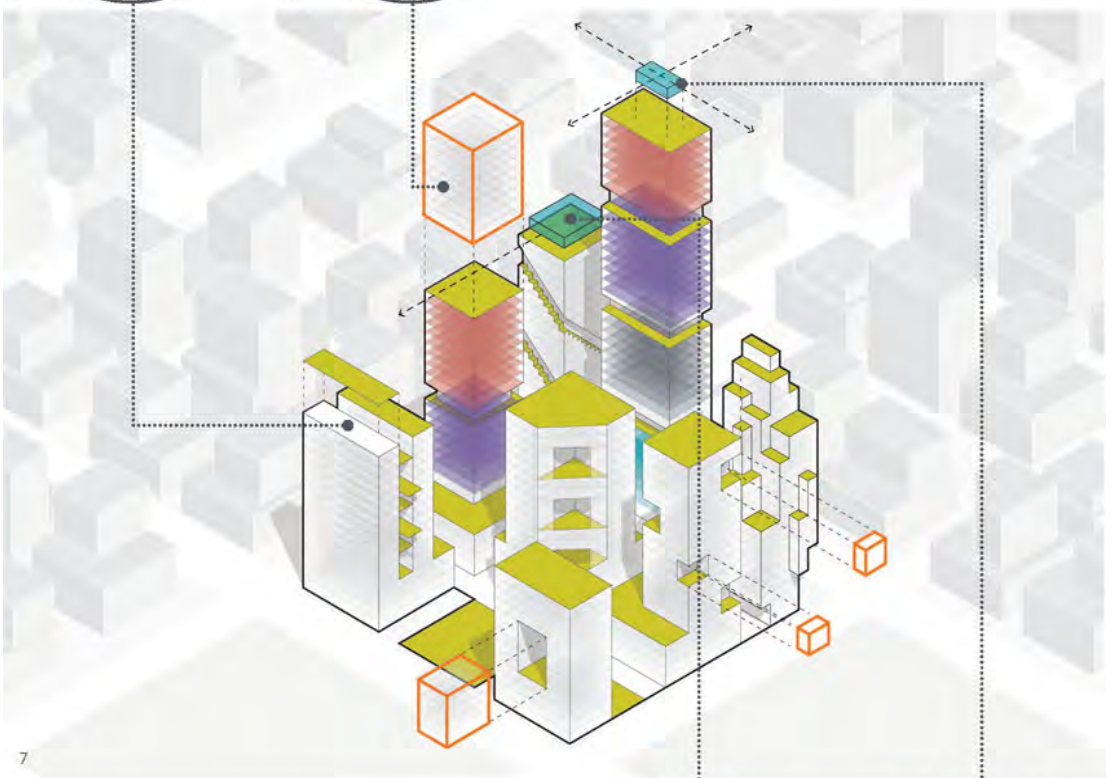
7a



7b

7a: greening the rooftop to reduce cooling load and therefore save on energy consumption

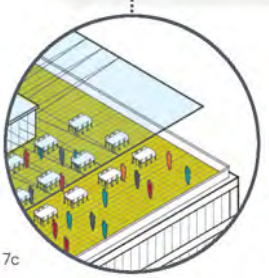
7b: extending upon the rooftop to increase sellable/lettable area



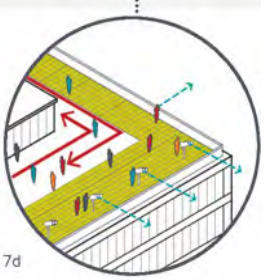
7

7c: the rooftop as an income-generating food and beverage destination

7d: the rooftop as an income-generating observation point



7c



7d

Diagrams 7, 7a, 7b, 7c, 7d
The skycourt and skygarden as an income generator

2.9 The skycourt and skygarden as part of a new legislated urban vocabulary

European and American planning policies that have encompassed urban renewal, construction, open space, nature conservation and drainage have all found relevance in shaping (almost literally) a greener urban habitat. We can see this in Germany, where legislated green roof construction, on all new-build development, has spawned an entire service industry. This has led to green-roof coverage increasing by approximately 13.5 million square metres per year (Haemmerle, 2002). In Chicago, and following the installation of its first rooftop garden on City Hall, more than 250 gardens and green roofs covering over 250,000 square metres have been constructed on schools, garages, museums and retail establishments (Daley and Johnson, 2008) (Figure 56). Despite the enviro-economic benefits that have seen green roofs celebrated, the ability to embrace the socio-economic agenda of creating alternative 'green' social spaces at height has been legislated significantly less, as can be seen in the scant guidance on the design and implementation of skycourts and skygardens.

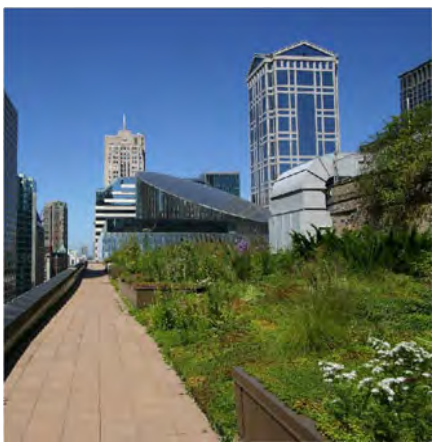


Figure 56: *City Hall*, Chicago: Mayor Daley's vision of greening the city started with his administrative building

The UK's plethora of reports published by the Commission for Architecture and the Built Environment (CABE), such as the *Better Public Spaces* manifesto, have all aimed to create a national consensus that good-quality civic spaces should be a political and financial priority. The manifesto further advocates the importance of creating public spaces in order to improve the quality of life. We similarly see this in CABE's *Guide for Tall Buildings*, and in particular its reference to the importance of including public space as an integral part of tall building developments (CABE, 2007). Yet it does not go further than offering 'best practice' recommendations when designing tall buildings or, more crucially at a time of increasing urban densification, offering better alternative sky-rise social spaces to support the public spaces on the ground, as a means of socio-spatial replenishment. It re-affirms the absence of legislation in Europe and America regarding the incorporation of skycourts and skygardens as part of a broader open space framework within the urban habitat, despite their important role. In the case of Europe, this is perhaps understandable given the preservation of historical buildings that, according to the architectural critic Aaron Betsky, has led to the generic European city becoming an 'urban museum', filled with built artefacts that cater for nostalgia tourism and its associated income generation (Betsky, 2005).

It perhaps comes as little surprise that the spatial, social and environmental properties of skycourts and skygardens have instead influenced the planning legislation of more high-density urban environments, such as Singapore. Historically, the Singapore government's development charges were based on overall development area, which is the summation of both habitable and common areas. Developers would therefore seek to minimise common areas and maximise the habitable (sellable) areas in the interests of improving economic returns on their investment. In the interests of reducing perceived densities, promoting social interaction and well-being for occupants, and offering greater environmental benefits to the built environment, the Urban Redevelopment Authority (the government agency responsible for the urban planning of Singapore) passed urban policy that promoted the incorporation of skycourts and skygardens as permissible common area that would be exempt from the overall development area calculation.

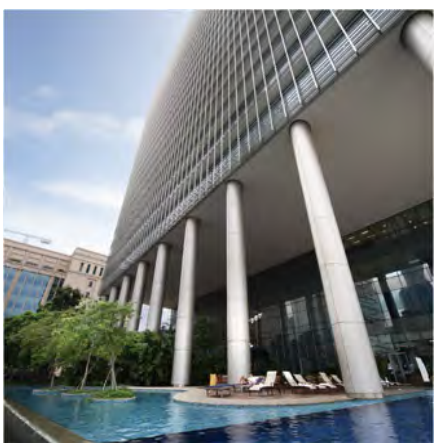


Figure 57: *One George Street*, Singapore: CapitaCommercial Trust's office tower, located in the central business district, demonstrates the 45-degree rule to create a skygarden

The policy effectively sees the concept of a 45-degree line taken from the underside of any permanent or opaque structure as the means of highlighting the area exempt from the area calculation, and therefore from the development charges. The 45-degree line permits the penetration of light and the greater floor-to-ceiling height of the aperture (i.e a taller skycourt), the greater the permissible area exempt from development charges (Figure 57). This benefits the developer by the reduction of development charges whilst benefiting users in the incorporation of well-lit, recreational open space.

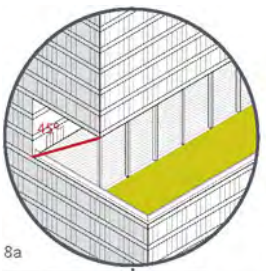
Figure 58: *Newton Suites*, Singapore: an example of skycourts acting as communal space that would be exempt from overall development area calculation

They are, however, subject to the following conditions: (1) the skycourt must be accessible to all occupants, (2) access to the skycourt must be from common areas only, (3) the skycourt is used for communal activities or for landscaping, (4) at least 40% of the perimeter wall of a skycourt must be open (Figure 58). Additional residual areas falling outside the 45-degree line can also be exempted, with a cap of 20% of the same floor plate, subject to the following criteria: (1) the areas within the 45-degree line must occupy at least 60% of the floor plate, and the remaining 40% (max) can be used for complementary uses, (2) the residual area must form an integral part of the skycourt remaining unenclosed, communal and non-commercial in nature, (3) at least 60%

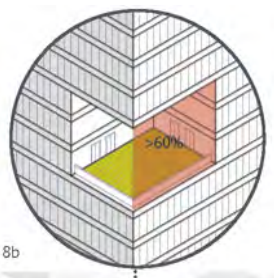
of the perimeter of the skycourt should be kept open with low walls (URA, 2008) (Figure 59). The government's introduction of *Landscaping for Urban Spaces and High Rises* (LUSH) further consolidates and synergises new and existing green initiatives, and sees the collaborative integration of urban and landscaping policies driven by the Urban Redevelopment Authority and the National Parks Board respectively.

Such policies balance the real estate economics of maximising sellable area for the benefit of the developer with the more civic imperative of creating places that can enhance the quality of life of the individual and society in general. It also ameliorates the risk of the former (private) interests outweighing the latter (public) interests – an issue that has historically seen the developer reduce recreational space to the detriment of the urban dweller and paradoxically to the long-term real estate value.

Figure 59 (top–bottom): *NTUC*, Singapore: an example of how at least 60% of the area of the skycourt should be kept open with low walls



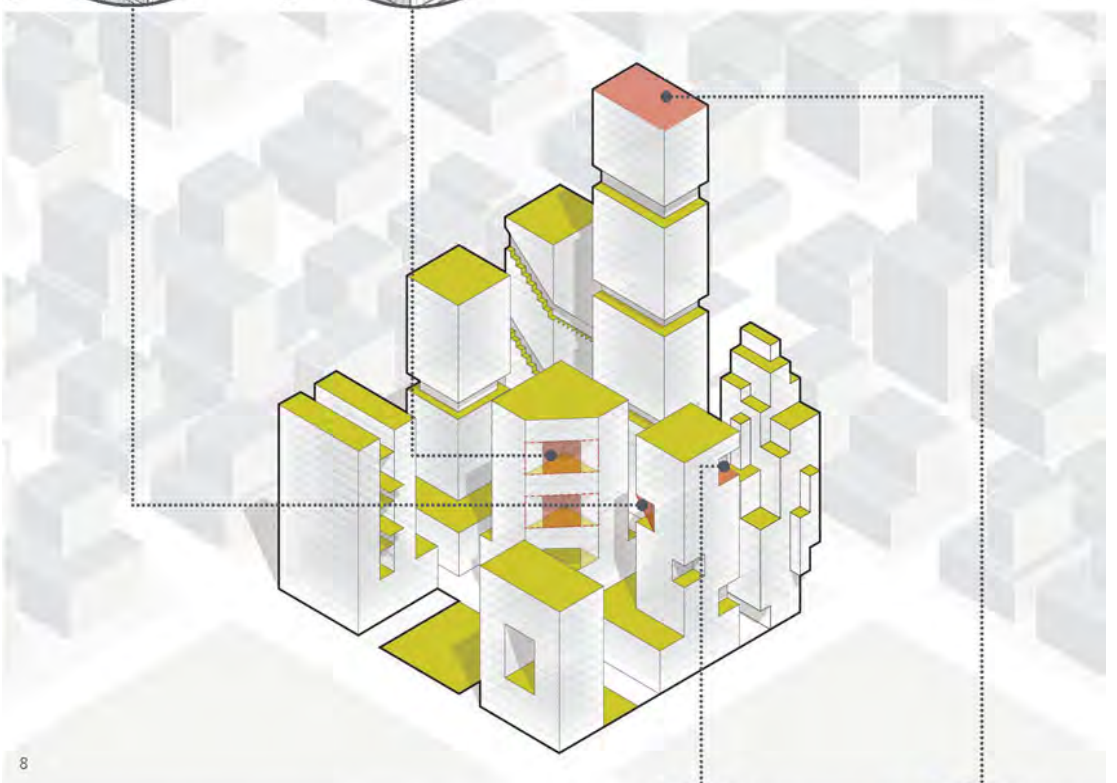
8a



8b

8a: the 45-degree line permits the penetration of light

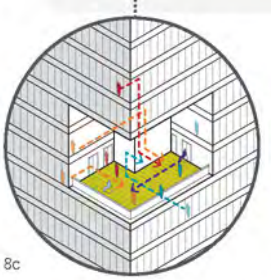
8b: at least 60% of the perimeter wall of a skycourt must be open with low walls



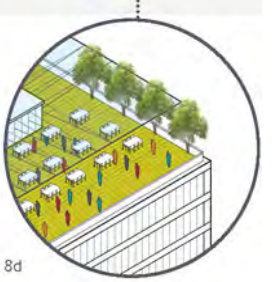
8

8c: the skycourts must be accessible to all occupants and access to the skycourts must be from common areas only

8d: the skycourts are used for communal activities or for landscaping



8c



8d

Diagrams 8, 8a, 8b, 8c, 8d
The skycourt and skygarden as part of a new legislated urban vocabulary

1 Towards radical inclusivity–community, Ummah and beyond

Introduction

As the subject of the book suggests the purpose of the analysis is to determine how different religious and ethnic communities utilise space/urban infrastructure in Kuala Lumpur (KL). This chapter introduces the idea of radical inclusivity as a significant effort to create a universal ontological framework that supersedes religious, national, economic or ethnic divisions. The aim is to test the hypothesis that the city produces non-consensual social structures—a kind of 'community of a higher order' which is not defined by a collective identity, but rather through co-dependence and co-living. The Malaysian conceptualisations of the notion of 'community', critically comparing its Western traditions, Anglo-Saxon colonial practices and legacy with the Islamic idea of the Ummah and Islamic approaches to non-Muslim communities are all analysed. This book focuses on the theory of an intellectual tool used to conduct research and guide the outcome of the empirical study. The purpose of this chapter is to define a theoretical context framing the investigation that follows.

The first part of the chapter explains in detail the notion of radical inclusivity and the Ummah as the Islamic notion of social unity.

Radical inclusivity

Radical inclusivity assumes an infinity of the universe; it assumes progress and constant change—also a change of hierarchies. There is a horizon of the whole, but there is no process of unification. In the urban scale, the city is the best environment to test the notion of radical inclusivity, since its space is 'naturally' used by a diverse range of people. Moreover, as a spatial entity, the city allows different (even contradictory) activities to happen at the same time. This section aims to explore the theoretical frameworks of the idea of 'Radical Inclusivity' to put the main argument in urban debates.

Radical or Absolute inclusivity has its roots in the Christian and Islamic Universalism (or in fact in any religion claiming the existence of Absolute); however, to have roots, it does not mean that radical inclusivity is exclusive to any religion. Focusing on the idea of 'inclusion', Carl Schmitt believes that "the specific political distinction to which political actions and motives can be reduced is that between friend and enemy". In this sense, the central argument of Schmitt's 'Concept of the Political' posits its juxtaposition in the dichotomy of friend versus enemy (Schmitt, 2007, p. 26). Jane Jacobs argues that definitions of 'self' and 'other' are building blocks for hierarchies of spatial power (Jacobs, 2002, p. 4). Focusing on the politics of identity enacted in urban space, Jacobs finds them as 'the struggles that produce promiscuous geographies of dwelling in place in which the categories of Self and Other, here and there, past and present, constantly solicit one another' (Jacobs, 2002, p. 5). The notion of inclusion can be rendered in Jacques Rancière's works as the inside-out dichotomy. He uses the concept of 'le partage du sensible' to describe the act of dividing between legitimate and illegitimate persons and forms of activity (Rancière, 2010, p. 60). In this definition, the sensible is precisely what can be thought, said, felt or perceived/the perceptible, the visible, etc. Rancière defines the urban space as a form of visibility that can serve as interruptions of the given partition of the sensible.

However, this dichotomy of friend and enemy is neither derived nor linked to another antithesis; instead, this binary grouping is independent and only corresponds to these other antitheses. As Torgovnick emphasised, we make sense of our world 'in the act of defining the other' (Torgovnick, 1999, p. 11). Similarly, Morton clarified that "western philosophy has traditionally defined 'the other'" as an object of consciousness for the western subject. This reductive definition has effectively destroyed the singular alterity of the other" (Morton, 2003, p. 37).' Focusing on Schmitt's concept of the political, Strauss argues that "the political – the grouping of humanity into friends and enemies – owes it legitimation to the seriousness of the question of what is right" (Strauss, 2007, p. 118).

On the other hand, Chinese philosopher Tingyang Zhao rejects Schmitt perspective on politics based on the distinction between a friend and a foe as a "…the typical wrong in western political consciousness, or subconsciousness, in which political impulse divides and breaks up the world" (Zhao, 2006, p. 34). Zhao believes that the Chinese system based on families differs fundamentally from the Western system based on individuals. Chinese political thinking is often criticised for its neglect of the individual as well as individual

rights, but this is a misunderstanding of the Chinese Philosophy and a poor understanding of political society (Zhao, 2006, p. 33). He questions the value of focusing on an individual while discussing politics:

> There is no Chinese denial of the value of the individual, but rather a denial of the individual to be a political foundation or starting point, because the political makes sense only when it deals with 'relations' rather than 'individuals', and the political is meant to speak for co-existence rather than a single existence.
>
> (Zhao, 2006, p. 33)

As Giddens clarified the modern western political theory is based on the system of nation/states (Giddens, 1985), while the Chinese most significant political unit is the framework of world/society. In the book by Krzysztof Nawratek titled *Total Urban Mobilisation* the author emphasised that Zhao's idea of All-under-Heaven as a political project allows us to see the cities (and also fragments of cities) as socio-spatial and temporal beings while reaching the ultimate horizon of the worldness (Nawratek, 2019, p. 88). Nawratek added, "the city exists because there is 'another dimension' (the commons, the public) putting private domains in a broader context and allowing them to interact" (Nawratek, 2019, p. 83).

Within the context of contemporary politics, there are different logics (or tendencies) to define radical inclusivity. Following Ernesto Laclau's definition, radical inclusion can be considered as the populist logic of inclusion that employs a liberal universalist conception of inclusivity in which "the 99 per cent" is a taken-for-granted category and understood to exist in itself (Laclau, 2005). Some other scholars believe that the radical politics of inclusion enacted through anti-oppressive practices in which ideals of inclusivity are understood as a process and a struggle. In the recent occupy movements, inclusivity is not just about the general participation in the movement, but also inherently tied to the procedures and practices through which decisions were made (Maharawal, 2013, p. 179). According to Gerald Raunig, radical inclusion means "to sustain and affirm the differences, and within them continue to differentiate, multiply, in a continuous expansion of multiplicity" (Raunig, 2014, p. 34). Moreover, radical inclusion involves the "reterritorialization of space and time", allowing for "a fundamentally inclusive territory without doors or thresholds, not surrounded or traversed from the outset by borders" (Raunig, 2014, p. 33). In this sense, radical inclusion recognises "a need for invention, innovation and multiplication of revolutionary practices and narratives" (Raunig, 2014, p. 34).

'Community' as a sociocultural paradigm

Robert Esposito, in his seminal book 'Communitas', defines a foundation of a community as an absence. He doesn't reject the communitarian understanding of its notion—as based on shared identity and values; but Esposito focuses his attention on a violent process of becoming a member of the community. The very act of birth violently puts a human being in specific social structures—family, nation, class. After that, every decision to join any community is grounded by a particular rite of passage—to become a part of a community one must change (or/and paid a specific price). Community imposes on us liabilities of obligations—even if belonging to the community is seen as a gift. Esposito writes about the 'gift' of Eucharist, through which Catholics become part of the church, defined as the mystical body of Christ—the same body that had been tortured and killed. What's more, this inclusion is something as alien as 'the body of God' tears us violently from our own individual identity. What Esposito ignores in his analysis is the fact that the Eucharist is a kind of mechanism/infrastructure that exists outside members of the community allowing them to 'plug in' to the Absolute (Esposito, 2010).

The Islamic sociopolitical Philosopher—Abu Nasr Farabi—envisioned an ideal or perfect city, under a philosopher–king for humankind to attain happiness through living in an entirely guided city. Besides, Farabi believes that humans cannot reach the perfection they are destined to outside the framework of political societies. According to Farabi, this political understanding of the concept of the city has always entangled into the theological concepts (Mehan, 2016, p. 311).

Agamben in his book 'The Coming Community' emphasised that the coming community finds its place in a profound present and within the potentiality of change and transformation to open up a reflection on the idea of 'radical change' (Agamben, 1993, p. 222). For Agamben, the advanced capitalism produces a high accumulation of 'dispositivi' extending its paranoid forms of control with mechanisms of inclusion/exclusion, while politics has disappeared, supporting the governmental machine (Agamben, 1998). In Agamben's definitions, the term 'dispositivi' suggests a reflection on the sovereignty of life and governmentality (Agamben, 2009). In this interpretation, Jean Luc Nancy defined the community through the political nature of its resistance against immanent power (Nancy, 1991).

Similarly, Krzysztof Nawratek, in his book 'City as a political idea' created a notion of a-androgyne, who can interact with the world/other people because of its incompleteness (Nawratek, 2011). The problem

with the community lies in its totality and unification—the community assumes a standard set of features that distinguish members of the community from those who are outside. But each of these features includes a (however small) mechanism of inclusion—this mechanism allows any community to expand, it also prevents the community against total unification. This 'inclusive remnants' (metaphorically could be defined as a 'free inclusive radicals') could be amplified to break through from the community itself and to become elements of 'inclusive infrastructure', not creating the community but building the commons. The infrastructure we can define as a semi-transcendent mechanism allowing diverse subjects to execute their agency.

Simone posits the concept of *People as infrastructure* as the residents' need to generate concrete acts and contexts of social collaboration inscribed with multiple identities rather than in overseeing and enforcing modulated transactions among discrete population groups (Simone, 2004, p. 419). Tingyang Zhao believes that the infrastructure connects subjects, allowing them to become 'political' by going beyond their individual existence; but infrastructure also allows subjects to redefine themselves, to strengthen its subjectivity. This dualistic way of operating of the infrastructure is possible only because the subject always exists and is defined in a context. It is always set in relation to other subjects. This relation is not necessarily equal or symmetrical, but nevertheless, it exists. The subject defines itself by an ability to look inside and to look outside. Therefore, the subject is a surface, it exists in-between (Zhao, 2006).

'Ummah': Islamic notion of social unity

Ummah (or Umma is an Arabic term literally means community or people) is often used in Quran, which had also shaped the historical consciousness of Muslims in early Islamic history, and it continues to affect the politics of Muslim states. Although the term Ummah is widely accepted by Muslims and Islamic scholars to refer to "community", "group" or "nation", it is used in 62 different forms in the Quran in relation to social, political and religious contexts (Denny, 1975, p. 43). Hasan argues that Ummah is constituted through a universal community, based on a shared faith, and the implementation of faith (Hasan, 2011, p. 145). In agreement, Bowen believes that Islamic culture promotes the sense of a worldwide community—Ummah—among ordinary Muslims (Bowen, 2006, p. 881).

As Abubakar pointed out, in the process of consolidation, the Muslim communities began to assume a distinct identity and to be

organised based on three meeting principles: religion (Islam), territory (Hula) and nation (Bangsa). As a result, a new consciousness emerged amongst the Muslims as a people belonging not only to a local entity, but also as a part of the expanding world of Islam (literally Dar al-Islam, which is an Islamic term for the Muslim regions of the world) in Southeast Asia (Abubakar, 2010, p. 134).

Danny shows (in the particular passages) that the term Ummah (refers exclusively to the Muslims) are found in the Medinan period, that is the time after the Prophet Muhammad had migrated to the city of Medina (Denny, 1975, p. 45). He added "the concept of Ummah itself develops from a general one, applying to non-Arab groups, too, toward a more exclusive one which is limited to the Muslim community" (Denny, 1975, p. 36). It is also during the Medinan period that the concept of an 'ummatanwasatan' (justly balanced community) came into effect at a time when the Muslim religious community reached its most developed stage (Denny, 1975, pp. 54–55). In terms of Quranic exegesis, conceptions of al-wasatiyyah (which is derived from an Arabic word "wasat" and means middle, moderate, fair, just and setting) are generally associated with the perspectives, beliefs and actions of the individual, as well as notions of a collective community (Ummah) (Davids, 2017, p. 310).

While the Constitution of Medina (and the related concept of dār al-Islām) seems to sanction diversity within the Islamic communities, the concept of the Ummah refers to an ideal state, which is a representative of original all-encompassing unity. According to Arkoun, the concept of an ummatanwasatan (a justly balanced community) contains a theological inclusion of all people (Arkoun, 1994, p. 53). However, under the pressure of European colonial encroachment on Muslim domains and challenging the sociopolitical identity of Muslims, the Islamic resistance movement defends the Ummah to confront European powers (Dallal et al., n.d).[1]

The western definition of the notion of Ummah within the context of political Islam may be termed by the French School of thought, which seemingly acknowledges the resilience of a transnational political Islam, while stressed the deterritorialization of political Islam within Western Europe (Kepel, 2004; Roy, 2004). By comparing the notion of Ummah vis-à-vis the Western nation-state definition, it can be concluded that Muslims have gradually realised that the nation-state system has become an impediment in accomplishing their way of life and in bringing about the kind of ummatic cooperation and security they seek (Akram, 2007, p. 381). In this regard, the concept of Ummah stands for a certain kind of transnational unity which aims to define a social and political unit.

Islam in Malaysia

KL did not evolve as an Islamic city but as a rough 'cowboy style' tin mining settlement full of gambling dens, bars and brothels. Sprouting from a tin mining settlement it was built mainly by Chinese and other Asian migrant workers. On the eve of independence, in the late 1950s, the city was still predominantly Chinese; however, since the 1960s, through Federal Government policies and interventions, this status drastically changed. Today, the demographics in KL indicate that Malay/Bumiputera constitute 45.9%, the Chinese 43.2%, Indians 10.3% and others 1.6%. The percentage of the Malay population in satellite cities of the Kuala Lumpur Metropolitan Region (KLMR) built after independence is considerably higher. For example, the Malay population of Shah Alam is 65%, and in the new administrative capital of Putrajaya, Malays constitute an overwhelming 97% of the total population (World Population Review, 2018).

Pre-Islamic society in Malaysia was either mostly Hindu (in Malaya, or West Malaysia) or animistic (in Sabah and Sarawak,[2] or East Malaysia); and the law was, in general, based on custom (*adat*) (Harding, 2012b, p. 358). Starting from the 13th to 15th century, it is more than 500 years that Islam has fully embedded in Malay Society.[3] The 'embeddedness' of Malaysian Islam had been integrated within the Dutch and British colonial systems as well as Indian, Chinese and European major civilisations (that existed before and after Islam came to the shores of the Malay world (Aziz and Shamsul, 2004, p. 341). It is important to note that some scholars pointed out that the term 'Malay' was employed more broadly by European observers after the 16th century, which reflects the way people identified themselves in those centuries (Reid, 2001; Sutherland, 2001).

As the result of the fusion of at least three significant civilisations and two colonial systems, Peletz (2002) emphasised the importance of understanding the depth and breadth of the 'embeddedness' of Malaysian Islam within the many civilisations and colonialisms that existed before and after Islam came to the shores of the Malay world (Peletz, 2002). In the Malay States, Islamic law seems to have played an essential role as the personal and religious law of Muslims (mainly family law, succession, the law relating to mosques, and religious observance) while Malay Adat (customary law) played an essential role in criminal law and property, but only marginally in family law (Harding, 2012, p. 359).[4]

In the whole of South East Asia, Muslims make up 40% of the region's total population. In order of distribution, Indonesia has the

largest Muslim majority of 88%, followed by Brunei with 67%, and Malaysia with 60% (Fealy and Hooker, 2006, p. 7; Saravanamuttu, 2010, p. 1). Utilising Islam as an ideological platform for nationalist movement is common throughout the Muslim world, including by Malay-Muslims in Malaysia (Milner, 1988). Anthony Burgess in his book Malay Trilogy written in the mid-1950s, just prior to Malaysia gaining its full independence, portrays Victor Crabbe, a British history teacher at an elite school for all the peninsula's ethnic groups—Malay, Chinese and Indian in a fictional town called Kuala Hantu (the school is modelled on the Malay College at Kuala Kangsar, Perak and Raffles Institution, Singapore). Burgess displays a society, where disregard of the ethnic group or religion, people socialise together even in clubs and bars. Such free social interaction would be a sporadic phenomenon in contemporary Malaysia where the ethnicity and religion have become a major determinant of one's social habits, social interaction and the way of life.

Reviewing the images of KL from the 1950s and 1960s, the perception is of a unified urban community disregard of race and religion. This is best manifested in the dressing styles applied by Chinese, Malay and Indian women who all followed the universal trends. Although the Malay ladies wore baju kurung and selendang, Indian ladies used sari during festivities and religious events[5] (Ahmad, 2017). A similar image of Malaysia was displayed after independence in the early 1960s in the movies directed by the most prominent icon of Malay entertainment P. Ramlee. In P. Ramlee movies, one could see Malays engaging in activities such as dancing or even alcohol drinking with a majority of women following western fashion trends. In contemporary Malaysian movies, the Malay community is shown in much different, non-western and traditional appearance.

In the 1970s, Malaysia experienced the unpredicted rise of a powerful and traditional Islamic movement that followed the implementation of programs designed to address 'Malay' economic disadvantage (Milner, 2008, p. 15). As a result of the Islamic revival movement that commenced in the late 1970s, this unified urban social environment gradually started to change. The conversion was evident in the dressing codes applied by Malay women who began to wear the head cover, commonly known as hijab. This was followed by the introduction of headscarves as part of a compulsory uniform for all Muslim school girls and the emergence of various hijab styles in magazines and the local mass media. Although wearing hijab is not mandatory, a majority of Malay women in Malaysia including the KLMR opt for using it on an everyday basis. The Islamic revival movement, which began in

the 1970s, has given the Malay population a new sense of pride and identity (Ahmad, 2017).

Indeed, there is a clear relationship between ethnicity and religion: indeed, the definition of 'Malay' in the Constitution includes being Muslim.[6] However, not all Muslims are Malay; they include Indian Muslims and Chinese, Indian and Sabah/Sarawak native converts (Harding, 2012, p. 356). In Malaysia, a 'Malay' is said to be someone who (in addition to fulfilling specific residential requirements) "professes the Muslim religion, habitually speaks the Malay language, (and) conforms to Malay custom (adat)" [7] (Siddique, 1981, p. 77). Milner believes that expressions such as 'Malay proper', 'authentic Malay culture', 'authentic Malays', 'ordinary Malays' and 'pure Malay' are also often used in the accounts of researchers in a way that can seem to allude to some core or typical 'Malay' community (Milner, 2008, p. 7). Milner added that specific forces operated to promote unity, especially when 'Malays' confront outsiders. He uses the example of the Malays' of Singapore in the immediate post World War II period, which was said to feel "considerable in-group solidarity" as one "discrete section" of the island's multi-ethnic assemblage (Djamour, 1959, p. 22; Milner, 2008, p. 8). However, in recent years, religion has, to some extent, replaced ethnicity in defining identity and interest in what has become a complex and contested polity (Harding, 2012; Nawratek and Mehan, 2018).

In the Malay world, the ulama (religious specialist), who were trained in traditional Islamic education, confronted and resisted the encroachment of western imperialism, articulated in the form of the anti-colonial movement (Aziz and Shamsul, 2004, p. 349).

The Malaysian Constitution became the single most important modern institutional tool that moulded and conditioned Malaysian Islam, thus defining its sociopolitical space in Malaysian government and politics (Aziz and Shamsul, 2004, p. 351). The Malaysian religion can be considered as a state matter that is under the supervision of the Federal Constitution. However, the Islamisation process in Malaysia with a large minority population (approximately 35%) of non-Muslims has moved faster over the last 40 years (Olivier, 2016, p. 267). The Islamic policies of successive administrations from that of Tunku Abdul Rahman (a Malaysian politician who became Malaya's first Prime Minister after independence in 1957) to Mahathir Bin Mohamad (the current prime minister of Malaysia for the second time) have helped to elevate Islam's public profile to new heights. Moreover, the modernisation that the British had left was later accelerated under the premiership of Dr Mahathir Mohamad, who introduced the principles of political Islam in Malaysian society (Liow, 2004, p. 200).

The Malaysian government aims to direct the kind of Islam that must evolve in a modernising society like Malaysia. Concerning the government's definition of Islamic values, the federal government continues its Islamisation efforts by initiating the setting up of Islamic institutions of various kinds (Shamsul, 1997). Islamic law is effective in its scope to family law, and Muslim religious offences; hence, the Syariah (the Malay spelling of Sharia) courts have particular jurisdiction (Peletz, 2002). It is also to be noted that various *negeri* legislations in Malaysia, deal with the administration of Muslim laws. Furthermore, because the administration of Islamic matters and Malay customs is not centralised at the Federal level but under the jurisdiction of each negeri (state) religious bureaucracy and its ruler, the interpretation of some parts of the Syariah laws differs from negeri to negeri (Ibrahim, 1978).[8]

For this purpose, there are the institutions of the Islamic "mufti" (an Islamic scholar who interprets the Islamic law), Sharia courts, as well as the Islamic Religious Council in each state.

> The Islamic Religious Council was established through the provision of the state constitution as the central authority of the state on Islamic affairs second only to the state's royal patron. As long as the actions of the said Council are not in conflict with the Constitution, the state shall recognise the Council as a strategic institution that enhances the acquisition of knowledge (fardukifayah) of the Muslim community which also functions as the crucial last bastion in the ensuring of the continuity and survival of Islam and the Islamic community and society notwithstanding the prevalent political scenario in the country.
>
> (Hamid et al., 2015)

Today's KL portrays an image of a urban community with two major components: the traditional Muslims mainly comprising Malays and the contemporary groups whose members follow the globalised fashions, trends and patterns. The latter comprises mostly Chinese Malaysians, Indian Malaysians of non-Muslim faith and foreign tourists and expats. The two components coexist peacefully with each other but do not constitute a fully integrated society. The two communities have different dressing codes and lifestyles, however, can be spotted next to each other in many parts of the city, including public spaces, shopping, business and entertainment centres. An image of unified KL in the 1960s and a contemporary urban community is shown in a collage of images in Figure 1.1a–c.

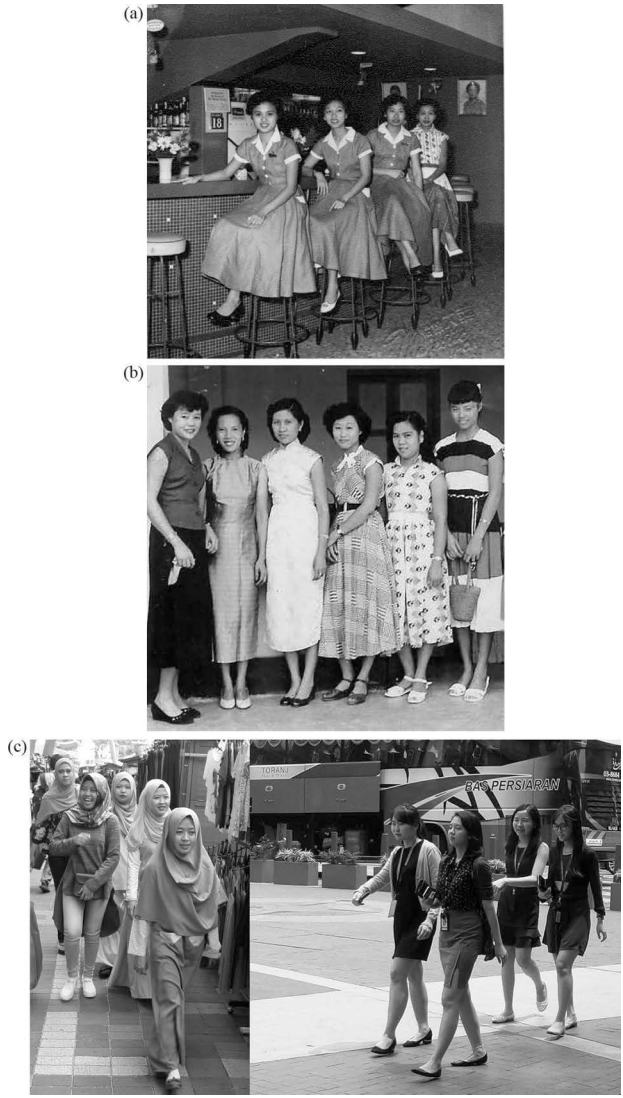


Figure 1.1 (a and b, upper and centre) Women of Kuala Lumpur in the 1960s representing a unified community disregard race and religion. (c, lower) The urban community of contemporary Kuala Lumpur (below).

Sources: www.pinterest.com/pin/515662226072837205/ and M. Kozlowski and S. Szewczykowski.

Note: Upper and centre image is over 50 years old; therefore, it constitutes public property.

For the last 10 years, the Federal Government has made several attempts to better integrate the Malaysian community. The former Prime Minister Datuk Seri NajibTun Abdul Razak launched the 1Malaysia concept as a platform to build upon the unique strength of the diversity of multiracial Malaysia (The Star Malaysia, 2010). The new Pakatan Harapan[9] government under Prime Minister Dr Tun Mahathir went one step forward and distributed several key ministries to Chinese Malaysian politician from the Chinese dominated DAP coalition party.[10] However, one of the pledges of the Pakatan Harapan when they were still in opposition was to ratify the International Convention on the Elimination of all Forms of Racism and Discrimination (ICERD) once elected. It should be noted that ICERD has been ratified by a majority of Muslim countries around the world. The attempt to confirm ICERD in 2018 resulted in massive demonstrations by the Malay population on the streets of KL and other major cities in Malaysia. The Malays were concerned that ICERD could end the privileges they enjoyed since the 1970s. As a result of community pressure, the government decided to withdraw from their election promise, and Malaysia still remains as one of the few countries in the world that have not ratified ICERD. The 'ICERD incident' implies that the differences along ethnic lines in contemporary KL and other major cities in Malaysia are likely to remain.

Major findings

KL, capital of Malaysia, is a city in which representatives of different religions and nationalities live together. The government is actively promoting national unity and cohesion through a program called '1Malaysia'. It is essential to investigate here how the ambition of this program— to unify Malaysian society—resonates in the daily spatial practices of the residents of KL. It is important to note that speaking at a press conference on 14th May of 2018, the current Prime Minister Dr Mahathir Mohamad, revealed that the 1Malaysia slogan and greeting will soon be a thing of the past. He added, "We may have to change to a different slogan, but we did not decide on a suitable slogan".

Although Malaysia is not labelled as a stronghold of religious extremism, the Malay community is very traditional, and a majority of them strictly follow the five pillars of Islam. According to the Pew Research Centre opinion poll survey published by the Los Angeles Times in 2016, around 52% of the population of Malaysia supports the introduction of strict Sharia law. This figure is significantly higher than in predominantly Muslim countries such as Indonesia and Turkey, where the

percentage of the population supporting Sharia is 22% and 13%, respectively. Considering that 64% of the population in Malaysia is Muslim, this opinion poll implies that a majority of the Muslim population in Malaysia support Sharia law (Simmons, 2016). However, this figure is based on a sample of 1000 face-to-face interviews; therefore, the margin of error is too high for the value to be fully reliable. Nevertheless, even with a high margin of error, one can assume that traditionalism and conservatism are well embedded within the Malay community.

Focusing on the idea of community from the Islamic tradition, the idea of 'Ummah' is often understood as the community/society followers of Allah. In the history of Islamic thought, meaning of Ummah sometimes goes beyond the religious boundaries, relating to people sharing the same territory (as residents—both Muslims and Jews—of Medina) or even refers to the humanity as a whole. On several occasions, the notion of Ummah is associated with specific duties and obligations, which makes it close to the community defined by Esposito. Because the meaning of Ummah stretched between universalist and sectarian condition, we should not try to pin down any specific definition, but rather focus on a critical power of its 'discursive displacement'.

By considering the city as the entity that produces non-consensual social structures—a kind of 'community of a higher order' which is not defined by a collective identity, but preferably through codependence and coliving, this part represented the notion of community as a sociocultural paradigm based on the Western philosophy. This chapter tries to produce a basis to compare the western traditions with the notion of Ummah and Islamic approaches to non-Muslim communities.

Notes

1 Malaya (former name of today's Malaysia) was never a real British colony. Each Malay state had a British resident, and the British had a profound influence on the economy and policies; however, the executive, legislative and judicial powers lay with the State Sultans and Malay Civil Institutions. The South Asian countries (India, Pakistan, Bangladesh, Bhutan, Sri Lanka, Sikkim and Nepal) had British rule much earlier than Malaysia.
2 Sabah and Sarawak were initially parts of the Brunei sultan-ate, which was also culturally related to the states of Malaya. Hence, Islam was invariably the State religion, and the ruler was also the Head of Islam. In Penang, Malacca, Sabah and Sarawak, however, Islam is not the state religion, and the *Yang di- Pertuan Agong* (King at the federal level) serves as the Head of Islam. See Andrew Harding, 2012. Constitutionalism, Islam and National Identity in Malaysia. In: R. Grote & T. Rode, eds. *Constitutionalism in Islamic Countries: Between Upheaval and Continuity.* Oxford: Oxford University Press.

3 Islam came to Malaysia in the 14th century through Arab merchants and Sufi missionaries. For reading the detailed history of 'Arrival of Islam in the Malay world', see: Azmi Aziz & A. B. Shamsul (2004) The religious, the plural, the secular and the modern: a brief critical survey on Islam in Malaysia, *Inter-Asia Cultural Studies*, 5:3, 341–35.
4 These laws are different from other parts of the Muslim world, especially the Middle East.
5 Selendang is a thin transparent rectangular shape wrapped around the head and worn by Malay women during special occasions (Ahmad 2017). Baju kurung is a regional cloth worn by Malay women. Baju is a kind of frock coat, whose sleeve length is to the wrist; kurung is a kind of skirt, which is of the ankle length (UK essays).
6 Constitution of Malaysia, art. 160, sec. 2.
7 Although the phrase 'Malay Custom (adat)' is often mentioned, even between villages located in one region, there are different customs.
8 At the negeri level, both pondok and madrasah began to lose their influence in many parts of the country, particularly in the Malay-Muslim dominated negeri of Kelantan, Terengganu, Kedah and Perlis, in the 1950s and 1960s.
9 Pakatan Harapan is a new coalition in Malaysia opposed to the former long-term ruling Barisan National (BN) coalition. It comprises the Democratic Action Party (DAP), People's Justice Party, National Trust Party and Malaysian United Indigenous Party (www.pakatanharapan.com.my).
10 DAP, The Democratic Action Party. One of the coalition partners of the Pakatan Harapan Government that took office in May 2018. It is a social democratic party established in 1966. Its members derive mainly from the Chinese Malaysian community. www.dapmalaysia.org.

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Chapter 6.2
THE RISE OF THE DIGITAL ECONOMY AND ITS IMPACT ON THE SMART CITY

6.2 THE RISE OF THE DIGITAL ECONOMY AND ITS IMPACT ON THE SMART CITY

By **PROF. JASON POMEROY**

SYNOPSIS

Oceans cover 71% of the earth's surface; deserts cover approximately 20% and cities only cover 3% of our planet (CIESIN, 2004). Yet since 2007, half of the world's population have been living in cities (UN, 2008). This number is set to increase to 70% by 2050, as people continue to migrate in belief of the social, economic and cultural prospects that cities seem to offer. The often-seen results of overcrowding, waste, energy and water consumption, pollution, traffic congestion and environmental degradation in cities do little to deter the migratory patterns of citizens seeking better lives. If we want to continue enjoying life in cities, then cities have to become more efficient, sustainable and embrace the benefits of what the digital revolution has to offer. Ultimately, cities have to be both smarter and greener if they are to be transformative of local and global economies. In Songdo, we see a city that seeks to embrace technology as a means of spurring North Asian economic growth. In Bandung, we see a city that taps into the creative consciousness of its citizens to enhance the quality and productivity of the city. In Amsterdam, we see a city that harnesses innovation and the circular economy to be self-sufficient and resilient. From these case studies, we can witness three generations of smart city evolution with unique insights into the inter-relationships between civil society, state, academia and private corporation.

Above image. The Smart City integrates digital technologies with traditional infrastructure © jamesteohart/Shutterstock

Opposite image. Incheon, Central Park in Songdo International Business District, South Korea © CJ Nattanai/Shutterstock

1. INTRODUCTION: THE DIGITAL REVOLUTION

The agricultural, industrial, technological and digital revolutions have each yielded fundamental disruptions in the way in which we live, work, play and learn in cities. Eighteenth-century labour-intensive farming processes and traditional hierarchical systems of landlords and tenant farmers were supplanted by 19th-century manufacturing processes in the hands of prominent industrialists by the time of the world's first industrial revolution. Central banks that recognised the economic upside of financially supporting the trade of mass-manufactured goods transformed the fabric of our living and working environments. Cities became places of production and industry, and people migrated from villages to metropolises to seek fame and fortune under the allure of a better way of life. Subsequent technological advances and a greater shared equity came to characterise a 20th-century technological revolution that further optimised product manufacture and business outputs through the mass production/adoption of computers in the workplace and the introduction of the World Wide Web. Time and space boundaries between the office and the home became increasingly blurred; and gaming and alternative recreational pastimes took on computerised and increasingly virtual definitions. The 21st century has built upon the third (Information Communications Technology) industrial revolution and arguably reached a zenith in the shift from 'the analogue' to 'the digital' fourth industrial revolution (Schwab, 2017).

Today, digital influence in everyday life can be seen in the phones we communicate with, the music we listen to, and the programmes that we watch. The terms 'digital' and 'smart' have become ubiquitous with many physical products that promise to enhance the quality of our lives. Unlike its forbears, the digital revolution has taken place in a shockingly shorter period of time. The last 20 years of the internet has seen the digital economy valued at more than US$3 trillion (Delices, 2010) and its appeal to the sharing culture of millennials and Generation Z has further borne influence on not just a global, digitally-connected audience, but has also impacted the way in which we conceive the city (*Image 1*).

Image 1. Laboratory scientist wearing virtual reality headset with interactive hologram display © Gorodenkoff/Shutterstock

2. FROM TRADITIONAL CITY TO SMART CITY

We have witnessed a fundamental shift from the city of spaces, as characterised by the traditional city of streets, boulevards and squares that take precedence over buildings; to the city of objects, as characterised by the modern city of towers that take precedence over space (Rowe and Koetter, 1978). In the traditional city, the open spaces of the street and the square provided the 'stage set' for society's performance — a place for political rally, religious sermon and trade and commerce. But the modern city of objects, adorned with skyscrapers as symbols of a city's economic prosperity (Sudjic, 2005), have reduced the street to vehicular thoroughfares that have compromised opportunities for social interaction and resulted in alternative social spaces for physical and virtual interaction (Dennis, 1986; Geist, 1983; Lozano, 1990; Pomeroy, 2014).

The 21st-century has yielded networks of cities that go beyond their spatial confines to embrace technological ingenuity, digital innovation and global initiatives as a means of spurring local and global economic growth whilst addressing the pressing challenges of climate change, transmigration, geo-political instability (Sassen, 2018). Technological and digital innovations have ameliorated the boundaries of time zone and geographic location, increased the speed in which people can connect and have offered unprecedented social and economic benefits to cities and its citizens (*Image 2*).

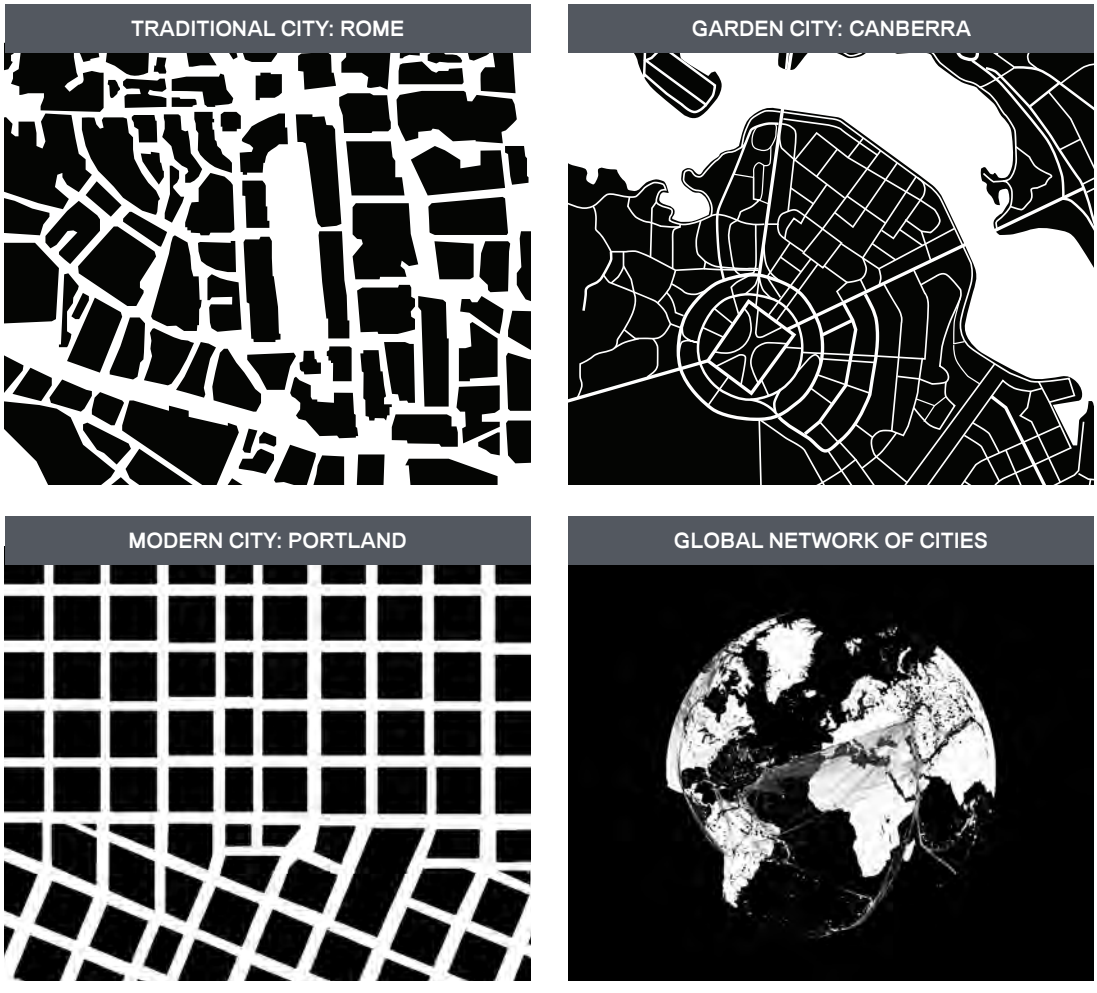

Image 2. The shift from traditional cities of physical spaces to networks of global cities with virtual spaces, 2016 © Pomeroy Studio

The term 'smart' has become an often-used appendage to 'city' that seeks to reflect the role Information Communication Technology (ICT) plays in delivering such benefits. It is unsurprising that the smart city is often portrayed in popular culture as a rich cornucopia of talking appliances, mobile applications, driverless cars, or the 'big brother' use of big data. Neither is it surprising that more academic definitions of a 'smart' city are as illusive as are the many descriptions of the smart metropolises that espouse technological innovations for the digital age. The academic Michael Batty, defines a smart city as a:

"city in which ICT is merged with traditional infrastructures, co-ordinated and integrated using new digital technologies".

- Batty et al. 2012

This may certainly be a favoured interpretation for many corporations, such as CISCO and IBM, whose business it has been to offer convenience, enhance productivity, and improve the lives of urbanites through the use of technology. In turn, this has attracted many mayors to adopt smart infrastructure to improve their city's urban wealth (Townsend, 2013), with smart city expenditure expected to reach US$100 billion in 2019[1] (IDC, 2019). Yet smart cities go beyond the physical and technological. As noted by Caragliu et al (2011):

"Urban performance ... depends not only on a city's endowment of hard infrastructure (physical capital), but also, and increasingly so, on the availability and quality of knowledge communication and social infrastructure (human and social capital)".

- Caragliu et al, 2011

The use of ICT for public administration, the level of education, an ease of movement through multi-modal accessibility and the presence of a creative class have all been positively correlated to a city's urban wealth (ibid). The notion of a creative class contributing to a city's urban wealth is considered further by academics Gert-Joost Peek and Kees Stam (2016) who, in their case study of the Rotterdam Innovation District, suggest that knowledge and innovation can act as an economic stimulus to the broader city

"in order to grow a new base of jobs, adjust to industrial change, or leverage technology to address sustainability, resilience, and social cohesion. In the current cycle, cities are focusing investment and promotion on new 'innovation districts' ... where the innovation economy may develop and expand".

- Peek and Stam, 2016

In this case, innovation is stimulated through the interactions between university, industry and government partners (ibid).

The many global smart city indices, such as the Smart City Index[2], the IESE Cities in Motion Index[3], ISO 37120 Sustainable Cities[4], ASEAN Smart Cities Framework[5], CITYKeys Indicators for Smart Cities[6] and the European Digital City Index[7] that act as frameworks for the assessment and development of smart cities similarly support the view of Information Communication Technology as an important component to the enhancement of a city's economy and its citizens' social mobility. But they also include a far broader and more nuanced understanding that alludes to more socio — cultural and socio — spatial parameters that have commonalities with the UN's sustainable development goals[8] and embraces issues relating to governance, the role of innovation, the creative culture of its citizens and the 'public good' of private corporation investment.

It is with the above in mind that we can now consider three smart city case studies in the form of Songdo, South Korea; Bandung, Indonesia; and Amsterdam, the Netherlands that each show, through a series of smart and sustainable initiatives, how technology, culture and innovation have improved local and national economic status of the respective cities.

3. SONGDO: ICT AS A STIMULUS TO NORTH ASIAN ECONOMIC GROWTH

Songdo city has been heralded as a 'first generation' smart city that is built on 600 hectares of reclaimed land and is located 12km from Incheon International Airport and 40km from Seoul. The International Business District (IBD) forms the core of Songdo city and,

Image 3. Aerial view of Songdo, South Korea © DreamArchitect/Shutterstock

together with the cities of Yeongjong and Cheongna, creates the Incheon Free Economic Zone — a South Korean initiative to transform Incheon into an economic hub for Northeast Asia (Shwaryi, 2013). Songdo IBD has ICT deeply engrained in its DNA and hosts a number of first-generation smart innovations that primarily focus on the private corporation-led use of big data and smart infrastructure in its quest to spur both the local city wealth and the nation's goal for low-carbon, knowledge-based economic growth (*Image 3*).

Use of Big Data: The use of Big Data provides Songdo's administrators with a more efficient means of managing operations within the city. Sensors placed throughout the city collect extremely large data sets of information (for instance a face, an action, an environmental condition and so on) that can be computationally analysed to reveal patterns, trends, and associations, especially relating to human behaviour and interactions. This has included the trialling of motion tracking, where vital information pertinent to missing persons is readily available for officials (Strickland, 2011).

Surveillance, and the Central operation centre: The Incheon U-City Integrated Operation and Control Centre (IOCC) collects big data from sensors in real time and is capable of identifying and managing incidents happening in the city, such as malfunctioning infrastructure, waste, electricity, water quality, traffic, crime or fire. In the event of an emergency, bystanders can serve as first responders and can report the incident details and location. Authorities are then able to respond quickly with an accurate plan of action to remedy the incident in an efficient and more economic manner (Lee et al, 2016) (*Image 4*).

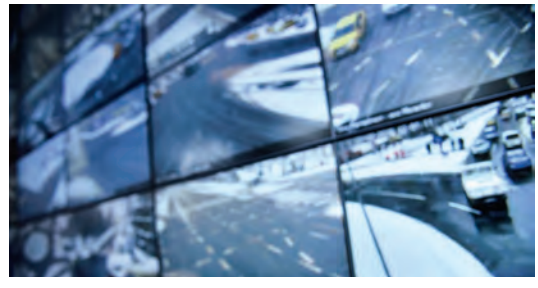

Image 4. Big data is supplied to a central operation centre to help manage and monitor operations © roibu/Shutterstock

Smart technologies: The notion of Songdo as a 'connected city' that uses Big Data has been championed by the US technology company, Cisco. The corporation invested US$47 million to use Songdo IBD as a living laboratory to smart technologies (Strickland, 2011). These range from intelligent parking solutions that allow one to identify parking spaces more easily, to health applications that share real-time medical data and real-time self diagnostics, to smart homes where energy, water consumption and waste can be monitored (Sellinger and Kim, 2015) (*Image 5*).

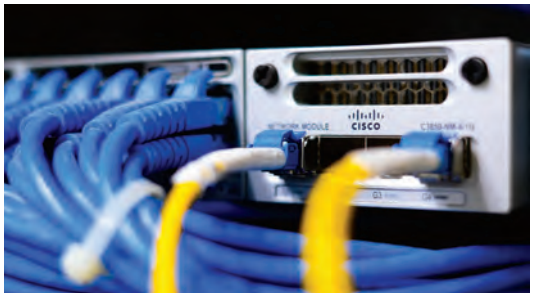

Image 5. Private technology corporations have contributed to the development of this smart city © Anucha Cheechang/Shutterstock

Waste management: By 2020, the city seeks to recycle 40% of its water and 76% of its waste. Its pneumatic trash system manages the city public bins, household and commercial refuse, efficiently separating dry waste from wet waste, as well as recyclables from non-recyclable waste. Seven collection points around the city receive the collected rubbish that is distributed via a 55km pipe network. The non-recycled waste is put into containers and compressed. The compressed waste is then sent to an incinerator where it is converted into energy, which in turn provides power back into the city (ibid).

Smart and remote learning: Songdo has become a knowledge hub through the establishment of secondary and tertiary education facilities. These include Chadwick International School, where coding and ICT feature heavily in the curriculum. Remote learning classes also provide a platform for citizens to study online and with real-time education via telepresence. There are 20 different remote learning classes that the people who live in Songdo can sign up for; from language classes, to Yoga, sewing courses and painting lessons, from the comfort of their home (ibid).

Observations: There have been many examples of cities in the latter part of the 20th century that have embraced a *tabula rasa* approach in order to be freed from spatial constraint and to incorporate new innovations and technologies. Such a phenomenon may be 'in part, due to a persistent belief by governments that newly constructed cities can set their nations on a fast path to the future' (Shawryi, 2013). Songdo can be seen as representative of this oeuvre. It has been heralded as a 'first generation' smart city, where the investment of private developer (Gale International) and technology corporation (Cisco); supported by a strong government mandate to transform its national economy from a manufacturing-based to a green and low-carbon-based economy has yielded a technology-focused smart city.

4. BANDUNG: CREATIVE CULTURE AND CITIZEN PARTICIPATION

Bandung, the capital of West Java in Indonesia, is a culturally rich city that used to be called the 'Paris of West Java'. The city was planned by Dutch colonists in the 18th century having been used as an entrepot by the Dutch East India Company (*Image 6*). Its cooler climate and river basin location made it an ideal place for tea plantations, trade and commerce and an idyllic retreat for approximately 100,000 Dutch colonials — much less than the 2.5-million people who reside there today (BCS, 2014). Like most cities facing rapid population increase and urbanisation, this city is having to address urban challenges such as crime, congestion, pollution and resource shortages. In contrast to Songdo, Bandung's economic and spatial condition did not allow for a financially intensive ICT solution nor a land-reclamation programme, and instead turned to empowering its citizens for creative urban solutions.

Fostering a creative culture of hackathons and start-up incubators: Indonesia is placed fourth in the world in terms of start-up growth and has been coined 'the Digital Energy of Asia'. The Indonesian government founded the National Movement for 1,000 Digital Startup (Kamil, 2017). The civic-driven movement hosts countless start-up initiatives, hackathons and incubators by technopreneurs, evangelists and volunteers aiming to create 1,000 start-ups in Bandung by the end of the year 2020 in order to improve the socio-economic and cultural prospects of its citizens (*Image 7*).

Image 6. The former Dutch colonial city is a beacon to start ups and young tech-entrepreneurs © Akhmad Dody Firmansyah/Shutterstock

Image 7. Gojek is a fine example of a tech start-up that is making a positive impact on people's movement through the city © findracadabra/Shutterstock

Big Data Management: The Bandung Command Centre is the City's digital monitoring facility that collects data in a variety of sectors in order to improve the city's operation and governance. Information is collected and relayed to the command centre through a series of CCTV cameras and GPS devices installed on public vehicles. In addition to street-level data, citizens social media posts are sifted via algorithms. To promote the decentralisation of smart city actions, smaller command centres have been set up in each district, which help in the implementation of services.

Social Service Smart Apps: 'Kiri' is a public transportation application which provides people with convenient travel options by means of public transport, therefore saving both money and the environment simultaneously. Angkot (a small bus) routes are fixed but there are no pre-determined pickup points and no pre-determined drop-off points. The Kiri app allows users to plot their journey, and based on their route, find the correct Angkots to use. The main reason why the app has about 15,000 to 20,000 active users every month is due to its open and free service (Nugroho and Natali, 2017) (*Image 8*).

Image 8. The plethora of social service apps, like Kiri, help people locate buses for an ease of movement © ardiwebs/Shutterstock

E-governance: E-governance permits the two-way communication between citizens and service providers with an emphasis on convenience, transparency and efficiency (Nugroho and Hikmat, 2017). The citizens' online aspiration and complaint service (LAPOR) is the first social-media-based complaint facility in Indonesia. The application helps citizens report public service grievances and is openly monitored by the Bandung government. Regardless of comment, compliment or complaint, the application encourages interaction between the government and community (ibid).

Community engagement: Ridwan Kamil, the former Mayor of Bandung, initiated the 'One Village One Architect' scheme, where every sub-district of approximately 20,000 people was assigned an architect who would assist local villages in micro-architecture projects. This equated to 151 architects in Bandung's 151 sub-districts, who were called in to help revitalise public spaces and improve infrastructure such as the building of libraries and community centres; and help in developing the cultural capital of Bandung through the collaboration between village heads, the community and local government (CLC, 2018) (*Image 9*).

Image 9. There are many community engagement projects and events that celebrate Bandung's traditional and Creative culture © ShidaPixeL/Shutterstock

Observations: While Bandung acknowledges the place of ICT in shaping the local economy, it eschews the conventional, government-driven approach of private corporation-backed technology companies in favour of using its citizens in a more community-driven engagement that seeks to employ the technology already in the hands of its people. Tapping into the zeitgeist of a young, tech-savvy and creative population, whose natural inclination to social media forms the basis from which big data can be sifted to address trending urban topics, has thus allowed the city to make informed decisions regarding the deployment of its resources economically and efficiently. A creative culture has further found voice through events and hackathons that have drawn the community closer to together to help influence city-wide decision-making.

Image 10. Amsterdam is a fine example of a pioneering smart city that pays particular consideration to resilience and the circular economy © photo.ua/Shutterstock

5. AMSTERDAM, THE NETHERLANDS

Amsterdam, the capital of the Netherlands, is home to 1.1-million people. The growth of the city began at the end of the 13th century when a dam was constructed on river Amstel, which led to the growth of the port of Amsterdam (*Image 10*). In the 19th century the city faced housing shortages due to an increase in the number of inhabitants. This was solved using the 'Plain Kaiff' method — a plan in which the buildings and the design of public space receive equal attention. Thus, over the years the city has been long known for its canals, cafes and bicycling culture; and in recent years, it has garnered a reputation as a pioneering smart city. In the face of climate change, Amsterdam is adapting itself as a smart city with a strong emphasis on resilience planning and the circular economy, as well an innovation programmes supported by civil society, state, academic and private corporation interests.

Circular economy: Amsterdam's embrace of the circular economy is evident at various scales. At the Amsterdam Arena, 148 used Nissan Leaf batteries, too degraded for automotive use but having plenty of capacity for energy storage, act as a stable power supply for the stadium. The 2.8MWh system has the capacity to store energy from the grid or the 4,200 solar panels on the arena's roof. The batteries can collect excess energy when the sun is shining and store it for use when the sun isn't. Energy storage also puts less strain on the grid by regulating peak energy demand that can occur during events (ENEL, 2018) (*Image 11*).

Image 11. Johan Cruyff Arena is one of the many circular economy projects in Amsterdam © taranchic/Shutterstock

Innovation labs: The Amsterdam Institute for Advanced Metropolitan Solutions[10] is a scientific institute located in Amsterdam. The institute contains an inter-sectoral exchange of ideas wherein science, education, government, business partners and societal organisations work in close collaboration to create solutions for the complex challenges faced by the metropolitan region of Amsterdam. The city and partners share urban data and Amsterdam allows the researchers to use their city as a living lab that involves many users or citizens to co-evaluate and co-create solutions.

Resilience planning: Amsterdam is constantly under flood risk, which has led its water company, Waternet, to rethink its municipal water systems to prevent a disaster. The technology-oriented water management agency maintains an online portal (My Waternet) where citizens can pay tap-water bills and keep informed of flood-protection initiatives such as Amsterdam Rainproof Programme — a scheme that uses 'Polderdak' roof gardens, which serve as an efficient space for water storage. After a rainfall event, the water flows slowly through the openings in the roof 'dykes', and flooding is greatly reduced (*Image 12*).

Mobility: 'Roboat'[11] is a joint five-year project, conducted by researchers from MIT Senseable City Lab, Delft University of Technology (TU Delft) and Wageningen University in collaboration with AMS. It is the world's first large-scale research on autonomous floating vessels in metropolitan areas. The autonomous boats are designed as a 3D-printed 4 x 2-metre rectangular fiberglass platform. Each boat is equipped with GPS, IMU sensor (for the boat's lattitude), an indoor ultrasound beacon for navigation and four thrusters on the boat's underside to allow precision in navigation.

Waterborne urbanism: 'Netherlands' actually means 'low countries', and lies two metres below sea level. With 50% of Amsterdam surface area being made up of water, Ijberg is a case study in waterborne urbanism. The development helped combat overcrowding in the city by regenerating an old dockyard with floating homes. The three-storey homes work on the Archimedes principle of water displacement given the two above water and a basement that is semi-submerged. Each household is supplied with basic services such as water, sewerage, electricity, natural gas, cable television and internet from the jetty (Pomeroy, 2016) (*Image 13*).

Image 12. Green roofs are being implemented to reduce flood risk as part of a broader water management strategy © S-F/Shutterstock

Image 13. Floating homes in Ijburg provide an alternative form of housing development in a city that is renown for water © Volker Rauch/Shutterstock

Observations: Like Songdo and Bandung, Amsterdam embraces ICT and big data but augments citizen participation with the inclusion of academia, private corporations and government in the fostering of city-specific innovations. Its ability to enable multiple stakeholders to use the city as a living laboratory has allowed a culture of innovation to flourish. Amsterdam's smart city initiative has created more than 80 pilot projects citywide that touch on many areas of urban life. While many major cities recognise the opportunity to improve urban life through data analytics, and information technologies to develop smarter services and a more sustainable footprint, Amsterdam, which has been working towards becoming a 'smart city' for almost seven years, offers insights into how urban complexities can be overcome by collaboration by a diverse groups of stakeholders.

CONCLUSION: FROM GEN 1.0 TO GEN 3.0

This essay has attempted to show how advancements in ICT have sought to improve the economies of three cities by enhancing operational efficiencies; providing its citizens with digital platforms that can positively impact their daily lives and fostering a culture of creativity and innovation that can increase social capital. Despite their common 'smart' monikers, each city demonstrated unique characteristics in how they connected ICT between people and place and have undergone an evolutionary process through the engagement of various stakeholders. It can be argued that we can witness three generations of smart city through these three case studies.

The bold vision of creating a technologically-advanced city from scratch as part of a Nation's grand economic plan has helped define Songdo — a metropolis supported by private-sector interests that has tried to establish itself as a replicable 'ubiquitous city'[9] for other Korean cities to emulate in the future. A 'top-down', government-mandated, economic vision that intends to transform itself from a manufacturing- to a knowledge-based economy, finds spatial and digital expression in Songdo through its built structures, smart infrastructure, green technologies and extensive use of ICT. While much has been covered in its technological advancements, it remains to be seen if the city will prove to be socially successful and whether enough has been done to actively engage its citizens.

Bandung, in stark spatial contrast, denotes a former Dutch colonial city with a strong Sundanese culture that did not have the opportunity for *Tabula Rasa*-style planning or land reclamation to quell its density issues; and perhaps neither would it have wished for such an approach, given its citizens' cultural appreciation of its city and landscape. Rather, Bandung's 'smartness' has been its ability to enable citizens to participate in city-wide decision-making through the use of social media; and for the collaboration between the public and private-sectors to forge a creative digital culture that has become a life-enhancing civic movement for its citizens. If Songdo is demonstrative of a first-generation smart city that employs technologies as a means of government and private-sector-led economic stimulus, Bandung is a second-generation smart city that mobilises its citizens through more citizen-oriented technologies that can help spur the local economy. Where the former could be regarded as a 'top-down' approach to smart city planning, the latter is 'bottom- up'.

Amsterdam acknowledges the importance of ICT, big data and the active participation of an empowered citizenry willing to create innovations for the public good of the city. But it goes further to consider the pressing challenges of our time: namely in its considerations of climate-change-related risks and spatial shortage through population increase and urbanisation. Its ability to create innovative solutions through quadripartite institutions has allowed it to turn one of the city's biggest threats — water — into an attribute. With two-thirds of the surface area of Earth being water, the smart city's innovations into floating and waterborne technologies may be timely and serves as a case study for other coastal smart cities in the future. Thus, its embrace of resilience planning and the circular economy, borne out of rigorous stakeholder engagements between not just civil society and government (i.e 'bottom-up' and 'top-down' influence) but also academia and private corporation, provide a further evolutionary step in this third-generation smart city.

Clearly, governance, regulation and mechanisms for inter-sectoral collaboration have much to contribute in shaping further smart and sustainable cities that can help enhance the digital economy in the future. As noted by Schwab:

"the current systems of public policy and decision-making evolved alongside the Second Industrial Revolution, when decision-makers had time to study a specific issue and develop the necessary response or appropriate regulatory framework. The whole process was designed to be linear and mechanistic, following a strict 'top-down' approach".

- Schwab, 2017

The same could arguably be true of the first generation of smart cities. But as we can see from the third generation, (as typified by Amsterdam), 'agile' governance and stakeholder engagement is a necessity if we are to keep pace with the speed of technological and digital advancement. This will require governments and regulatory forces to keep pace with the rate of innovation, often initiated by academics and spurred on by the private sector in response to the needs of civil society; and will undoubtedly require even closer collaboration in the future.

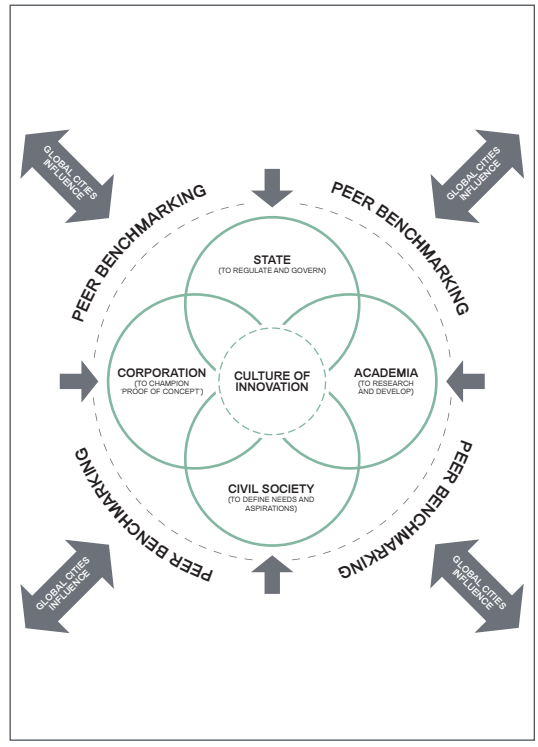

Figure 1. Quadripartite relationship between civil society, state, private corporation and academia to help shape smart and sustainable cities © Pomeroy Academy

Image 14. Panoramic aerial view of Amsterdam in a beautiful summer day, The Netherlands © S-F/Shutterstock

NOTES

[1] For more information on smart city expenditure, visit https://www.idc.com/getdoc.jsp?containerId=prUS44817419

[2] For more information on the IMD Smart City Index, visit https://www.imd.org/smart-city-observatory/smart-city-index/

[3] For more information on the IESE Cities in Motion Index, visit https://media.iese.edu/research/pdfs/ST-0471-E.pdf

[4] For more information on the ISO 37120 Sustainable Cities, visit https://www.iso.org/standard/68498.html

[5] For more information on the ASEAN Smart Cities Framework, visit https://asean.org/asean/asean-smart-cities-network/

[6] For more information on the CITYKeys Indicators for Smart Cities, visit http://www.citykeys-project.eu/citykeys/cities_and_regions/performance-measurement-framework

[7] For more information on the European Digital City Index, visit https://ec.europa.eu/digital-single-market/en/news/european-digital-city-index-2016-online

[8] For more information on the UN sustainable development goals, visit https://www.un.org/development/desa/disabilities/envision2030.html

[9] For more information on the concept of 'ubiquitous city', visit https://www.casaasia.eu/noticia/detalle/202459-ubiquitous-cities-in-asia-a-new-concept-of-urban-living

[10] For more information on Amsterdam Metropolitan Solutions, visit https://www.ams-institute.org/

[11] For more information on Roboat, visit http://roboat.org/

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