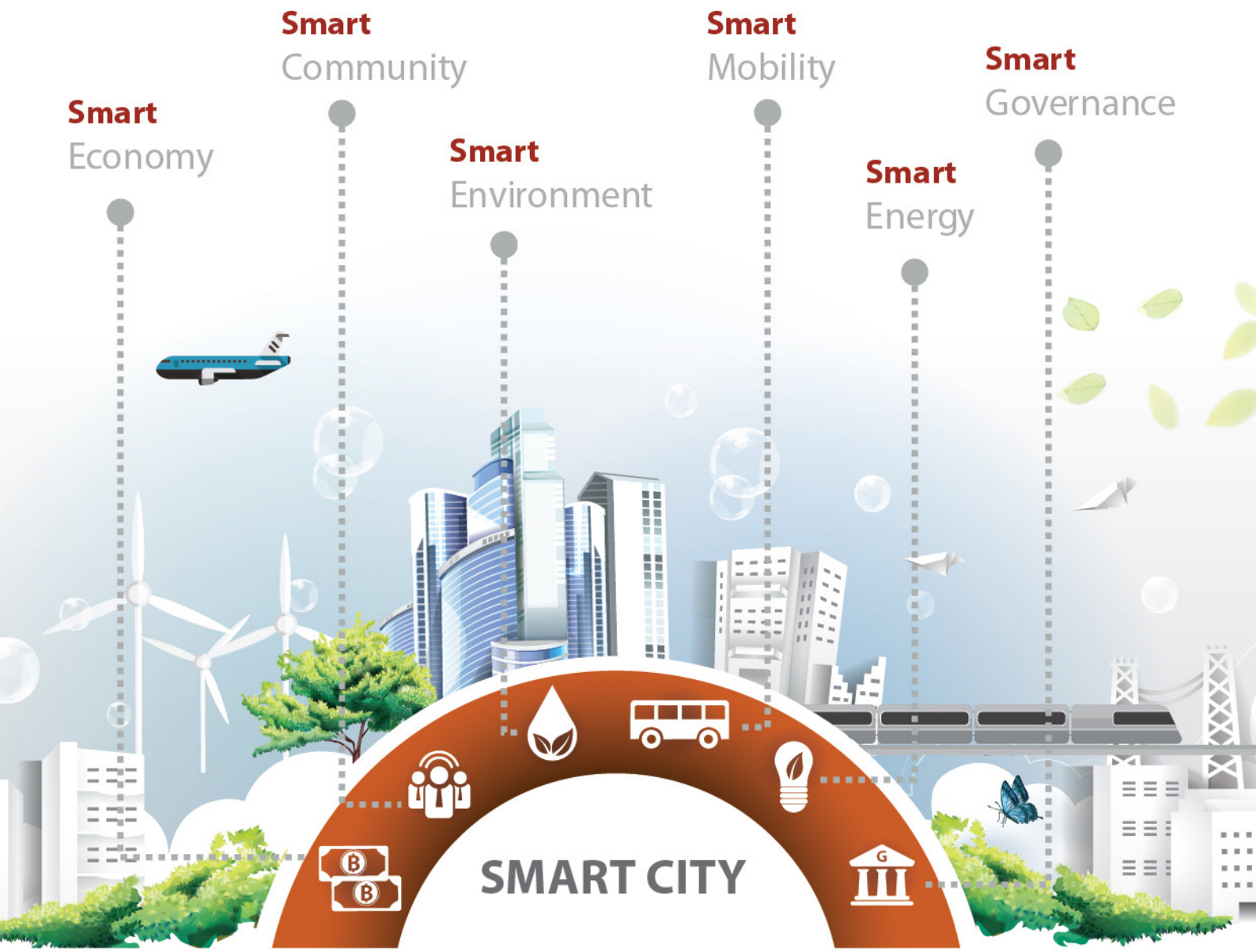
UNISEARCH JOURNAL

Volume 5 Number 1 January - April 2018



Smart City

Effect of Mobile Phone Use on Quality of Life and Sleep Quality among Elderly in Urban Area

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Urban Ecology: Landscape Element and Ecosystem Services

Smart Health as a Part of Smart City

Developing a Smart City by Developing Innovation District

ISSN 2465-3764

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Editor's Note

UNISEARCH JOURNAL

By 2050, the global urban population is expected to grow by 66 percent. As a result, urbanization and urban growth are accelerating, and many cities around the world are experiencing unprecedented environmental challenges, including resource usage, pollution, waste management, transportation and a steady erosion of quality of life for urban dwellers.

Many urban development concepts have been proposed and implemented around the world to realize the goal of sustainable cities, with a pleasant living environment with convenience, safety and visual amenity and higher quality of life. The Smart City is one such emerging concept which is gaining increasing attention at global level. Countries around the world including Thailand have initiated 'Smart City' urban development policies, integrating digital technologies, and data-driven information and communication technologies in city management plans and operations. The programmes aim to manage use of the city's resources to maximize benefits for its citizens, particularly in areas such as energy use, communications and transport systems, environmental management and security. However, building a functioning 'Smart City' needs cooperation among a wide range of actors in both public and private sectors, and including research and educational institutes.

The transformation towards 'smart cities' in Thailand requires the harnessing of a wide array of new technologies and information systems. However, often overlooked is the importance of a cultural transformation- smart cities require open collaboration – among and within agencies, and full civic participation. A truly 'smart city' must 'plan smart', by listening constantly to the views of its citizens, rather than simply impose technological solutions without consultation. The challenge for Thailand's urban dwellers well indeed be to create this sense of community and collaboration- to transform ourselves as 'Smart people', while conserving the uniqueness, charm and historical identity of our cities.

The Editorial Board

Vol. 5 No. 1 Jan. - Apr. 2018
Published by
Chula Unisearch, Chulalongkorn University

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Smart City

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Introduction

A national policy that prioritizes development of rail transportation including mass rapid transit systems, double-track railways and high-speed trains offers its citizens the prospect of more convenient, faster and safer ways to travel. It will also contribute to the effective use of energy and mitigate greenhouse gas emissions from transport sector. Moreover, such a policy will also catalyse the future development of areas surrounding stations (Transit Oriented Development: TOD), integrating rail transportation with other modes of transportation; by land, sea and air. Integration is important at the city level, but also among cities and regions, as well as to serve international linkages.

The development of TOD areas will contribute to economic development and changes in society based on access to reliable and fast transportation services. However, the increasing use of energy in transport and in commercial buildings will inevitably impact on natural resources and environment. Therefore, a feasibility study to develop a smart city in which digital technology and information and communication technologies (ICT) are integrated into city planning will increase our knowledge and understanding not only of the likely trajectory of the development itself, but also its implications for energy and resource use, and sustainable development.

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Smart City

A *"Smart City"* is defined as a city where digital technology and information and communication technologies (ICT) are deployed to enhance quality of life and optimise operations and services for its residents. This includes cost reduction, effective resources management, and connection with the citizens (Smart Cities Council, 2016). Using ICT allows cities to benefit from transportation systems and public utilities more efficiently, monitor the impact of development, and inclusively engage with citizens. Smart cities operate without discrimination, which contributes to social inclusivity and reduced inequality.

Smart City Domain

The development of a smart city aims towards creating a city that strikes a balance among the requirements for economic development, social equality and natural resource conservation. The idea was derived from the concept of sustainable development and by integrating different technologies including energy technology, environmental management technology, and ICT to optimize city development to serve diverse needs of its many stakeholders. However, each smart city around the globe requires unique solutions to address unique sets of urban development challenges. To develop a smart city in Thailand, a study is therefore required to identify these challenges and locally appropriate solutions, guidelines for implementation, as well as a monitoring and evaluation framework. The Smart City framework comprises six domains (see Figure 1 below):

1) Smart Economy enables economic development appropriates for the area and generates income to the citizens. This establishes an industrial and/or commercial and service hub that generates both short-term and long-term income to the community which contributes to the city's budget for further development.

2) Smart Community aims to provide quality education and health care, and creates a strong and safe community, contributing to quality of life.

3) Smart Environment is crucial for a smart city. The urban environment must be liveable, safe, and environmentally friendly, which contributes to the sustainable physical development of the city.

4) Smart Mobility aims to foster development of an effective transportation system both for people and goods. It also leads to a communication and data exchange system that is safe and affordable. Smart mobility helps to create new economic opportunities, promotes social equity and contributes to environmental conservation.

5) Smart Energy aims to shift key urban services away from dependence on fossil fuels to operating effectively on renewable energy such as solar or wind power, or waste-to-energy sources. Some cities might use a Smart Grid – an electricity supply network that uses digital technologies to optimize management of local energy supply and demand, as well as passive energy-efficient design for buildings and education for its citizens to use energy efficiently.

6) Smart Governance leads to effective, inclusive and transparent city management, budget stability and other community benefits. It also allows citizens to participate fully in co-developing urban development policies e.g. for provision of local services.

Conceptual development of the Smart City

There is a database with information on 402 Smart City projects from around the world (Figure 2).

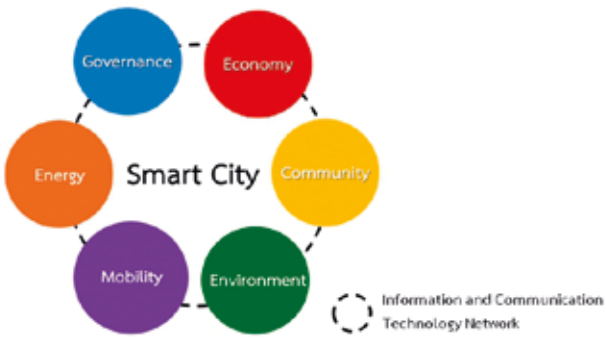

Figure 1 Domains of a Smart City
Source: Tapananont, designed in January 2016

Figure 2 Smart City Projects in Different Parts of the World
Source: Nikkei BP Clean Tech Institute (2013)

This database was created by the Nikkei BP Clean Tech Institute. The database includes 87 Smart City projects in North America, 4 in South America, 72 in Europe, 235 in Asia, and 4 in Africa.

1) New Urban Development

New urban development in areas traditionally used for agriculture (i.e., Green field) focuses on development of worksites, residences, and the related infrastructure for transportation, public utilities and facilities. This strategy is to accommodate the projected influx of the population into these areas, and to create the foundation for modern production and services to boost the economy.

Masdar City is an example of new urban development which is part of Abu Dhabi metropolis in the UAE, and is 17 kilometers from central Abu Dhabi (Figure 3). Masdar City is close to the international airport, and the goal is to develop urban commerce, services and research, and apply technology to create a friendly city through careful consideration of the environment as part of the design. Masdar City has an area of 6 sq.km. and is designed to accommodate a resident population of 45,000–50,000 persons, 1,500 companies and office buildings, with a labor force of 60,000. The city was designed by the British architectural firm of Foster and Partners City with support from the Massachusetts Institute of Technology. The project began in 2006 with a budget of US$ 1.8-2.2 billion. Phase 1 construction began in 2008 and was completed in 2010. However, due to slowed economic growth in the UAE, the budget ceiling was reduced to US$ 1.98 billion.

Masdar City was developed through the lens of a Middle East desert environment and culture. Thus, the city has innovative ways of reducing heat and conserving energy. Wind Towers were constructed to improve air circulation throughout the city, which is already at a higher elevation than other surrounding terrain. Buildings are located in clusters in order to provide shade for pedestrian paths. Roads were constructed to be more narrow than usual. Buildings at the end of roadways were designed to deflect hot air up and away from ground level to increase cooling of roads and walkways. The result is a consistently cool air temperature, ranging from 15-20 °C.

The city was designed to be pedestrian-friendly. Private vehicles are not allowed into the inner city and, thus, people are motivated to use mass transit. Transportation options include the people rapid transit, and the freight rapid transit, each with multiple links between systems, which also intersect with major roads, long-distance train stations, residential areas and worksites. Solar energy is used to power electricity plants which are outside the city limits. There is a sophisticated solid waste collection and recycling system.

2) Urban Redevelopment

Urban redevelopment refers to improvements and changes to land use and infrastructure to existing towns and cities which have degraded and/or inappropriate urban environment to accommodate future development. The redevelopment encompasses both inner city and suburbs which have capacity for improved development, and more efficient use of energy in residential and commercial areas. This includes better production and distribution of renewable energy and control systems for public utilities. Smart City projects are appropriate as a strategy for urban redevelopment, especially in cities which are dilapidated and not currently prepared to accommodate modern city living of the future. These cities need modern factories, ports, train stations, airports, and electricity generating plants.

Figure 3 A Smart City in the Middle East: Masdar City (UAE)
Source: Alvarez (2017)

Figure 4 Smart City in Hammarby Sjöstad, Stockholm (Sweden)
Source: Ericson (2011)

The Hammarby Sjöstad Smart City Project is also referred to as the Stockholm Symbio City concept, and aims to create a sustainable urban environment which is pollution-free (Figure 4). The project converts industrial factories which are no longer producing goods and covers an area of about 2 sq.km. into a residential area with 8,500 units to accommodate a population of 27,000. There is 150,000 sq.m. of commercial space which can accommodate a workforce of 10,000. The city is on the perimeter of Vartan Lake and about 4 km. from Stockholm. The project design included quality domiciles in an eco-friendly environment. The designers made sure to expand the amount of green area near public water resources. There is convenient and affordable mass transit, bike paths, and walkways covering all parts of the city. Carpooling is strongly encouraged and there are piers for water commutes to Stockholm to reduce use of personal cars. The construction of dwellings and office space are designed for transparency and full exposure to natural light. Raw materials are eco-friendly.

A key aim of Hammarby Sjöstad is to reduce use of fossil fuels to a level that is below the national average. Another aim is to reduce the volume of waste, and conversion of bio-waste and solid waste into energy. Renewable energy sources are a priority, as well as recycling. The goal of the project is to end use of fossil fuels by 2030.

3) Development of the Urban Management System

Development of the urban management system does not include interventions with the physical layout which would change the nature of the urban environment. Instead, this strategy focuses on developing the ICT system to improve public utilities, information sharing, and increasing participation and involvement of the local residents in management for increased efficiency. This strategy is more common in developed countries which seek increased efficiency of energy use and transit/transport, and increased access to information through mobile electronic devices. One goal is to increase flexibility for the working population to optimize their productivity and boost the economy.

The Boulder Smart Grid City project is an example of the development of the urban management system strategy (Figure 5). The project was launched in 2008 and is a collaboration between the Xcel Energy Company, the Boulder Municipality, Colorado University, the National Energy Research Institute, and other government agencies. The Smart Grid aims to control the distribution of electrical energy, increase the ability to assess efficiency of use, and control use of electricity. The project covers an area of 66 sq.km. with 16,000 households, and has a budget of about US$ 15 million.

The Boulder Smart Grid City also emphasizes the use of ICT to provide real-time measures of the quantity of electricity used, and promotes Internet-based communication between the energy control center and energy consumers in order to find ways to economize energy use. There are electricity meters located throughout the city to measure use and rapidly detect defects. *"Smart"* meters are installed

Figure 5 Smart City in the US: Boulder City, Colorado
Source: Trotter (2008)

in homes of residents of the Smart City to help them improve efficient of energy use. The goal is for all households to be self-sufficient for energy use.

The analysis of the 402 Smart City projects in the Nikkei BP Clean Tech Institute database shows that the cities are pursuing new urban development, urban redevelopment and development of the urban management system in similar proportions. In North America, the proportion of Smart City projects which use development of the urban management system comprise 86% of the total, whereas 71% of projects in Europe use urban

Table 1 Criteria and KPIs for a Smart City

1 SMART ECONOMY	Economic Growth			Economic Distribution		
	Gross Provincial Product (GPP) per capita > Gross Domestic Product (GDP) per capita			Rate of employment of people in the vicinity > Rate of employment of people in the country		
2 SMART COMMUNITY	Quality of Life			Social Diversity		
	Ratio of students to teachers: 20:1	Ratio of doctors to patients: 1:1,500	Number of police per 100,000 population	Proportion of the population with higher than average educational attainment for the local population	Coefficient of difference between population structure and stability equal to zero	Population who were born outside of Thailand as a proportion of the local resident population
3 SMART ENVIRONMENT	Green Area		Waste Management		Climate Change	
	Ratio of green area to the population: 10 sq.m./person	Ratio of eco-space to project space : Biotope Area Factor: 45%	Proportion of waste subject to the 3R system per volume of waste: 30%	Proportion reduction of waste water draining into natural water sources: 35%	Proportion of areas prone to disaster impact with disaster prevention plans: 50%	Proportionate reduction of greenhouse gas emissions: 20%
4 SMART MOBILITY	Transportation			Telecommunication		
	Proportion of Environmentally Sustainable Transport (EST): 60%	Proportion of transported goods using rail: 40%	Proportion of the population with broad band Internet access: 95%	Proportion of the area with 3G/4G: 100%	Land-line speed for Internet use and downloading: 100 mbps	Wireless speed for Internet use and downloading: 10 mbps
5 SMART ENERGY	Renewable Energy			Energy Efficiency		
	Proportion of all energy that is renewable: 20%			Proportion of efficient energy users: 20%		
6 SMART GOVERNANCE	Competency			Transparency		
	Average revenue from property and income tax	Ratio of staff of local government to the total population of the area		Proportion of eligible voters who voted	Proportion of the population with access to the database of the city or municipality: 50%	

Source: Tapananont, designed in January 2016

redevelopment. In Asia, two-thirds of the Smart City projects use a new urban development strategy.

Criteria and Indicators for being a Smart City

Criteria and KPIs used by smart cities in Europe and USA as well as standards set by international organisations have been used here to establish smart city criteria and KPIs for Thailand. These are listed in Table 1 below.

Selection of areas appropriate for Smart City development

Initial criteria for selection of an area for development as a Smart City must take into account policy-level criteria such as the Master Plan on ASEAN Connectivity, the National Economic and Social Development Plan, and the Special Economic Zones (SEZs). It must also consider physical capacity and constraints in terms of population, geographic location, national resources and environment, land use, transport and freight, public utilities and facilities, economic infrastructure and growth, employment, and social context of the city.

Moreover, the study also considered the linkages and level of integration between different modes of transportation of people and freight- land, water and air, at present in the city, and its potential to enhance its connections with other major cities, both domestic and international. The carrying capacity and vulnerability of local natural resources and the environment, the risk of man-made disasters including pollution and climate-change impacts such as floods and drought, were also taken into consideration in the analysis.

Conclusion

The prioritization of large-scale rail infrastructure projects including the mass rapid transit system in Bangkok and vicinity provinces, double-track railways and high-speed trains throughout the country will lead to significant economic development, especially for the areas surrounding stations. The study of the smart city concept revealed that using ICT and digital technologies offers major potential to benefit urban communities under the 'Smart City' concept, in particular, for those areas surrounding the stations where interchange between services occur. This approach offers significant potential to contribute to the country's sustainable development, including economic growth, social equity, and national resource and environmental conservation.

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Developing a Smart City by Developing Innovation District

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Introduction

Smart Cities are emerging as a subject of discussion within many government and private organizations, as a concept to apply digital technology and information technology to effectively administer a city to ensure good quality of life, safety, and an ever-developing learning society. However, there are many approaches to developing a smart city, each of which presents certain risks and uncertainties. Therefore, it is important that selected smart technologies need to be tested and adapted to the specific context of the city. That is to say, there needs to be a test launch in a pilot area so that the smart city meets or resolves the problems of the area in a concrete and sustainable way. In other words, the investment to develop a smart city does not require all the budgets to be used for smart technology or installation of detection systems and video surveillance cameras at every street corner. Instead, it might start from just a small area in the city as the initial phase.

The concept of developing an innovation district to develop a smart city

One way to turn a typical city into a smart one is to create an *"innovation district"*. The philosophy of this concept is to establish an area for developing innovation or use it at a concentrated level. In the innovation district, innovators will help create innovations that meet the demands of local residents, add value, allocate resources, and promote participation of local people in order to lead to change that benefits residents and the nation. An innovation district could be compared to a special economic zone located within an urban area. Its goal is to promote business, cluster groups and startups with potential in the area in order to develop an innovation ecosystem. To achieve this goal, three types of assets need to be developed, including physical, economic and networking assets (Katz and Wagner, 2014). The innovation district allows the city to test its smart technology in different ways in order to identify the one that suits the context of the city. And once the suitable smart technology is selected, it will be extended in number and area to cover a larger urban area. As of the end of 2016, more than 80 percent of cities worldwide have started developing their own innovation districts (Horn, 2017).

The city of Las Vegas in Nevada, USA, is a good example of a city that has developed an innovation district in order to create a smart city. Apart from its large population of over 600,000 people, Las Vegas attracts millions of tourists each year, creating a major burden in terms of traffic, waste and other forms of pollution. These problems affect quality of life of residents and reduce its attraction as a tourist destination. The city administration is well aware of smart technology as a tool to help identify and manage a range of urban problems, but has limited knowledge when and how to commence using the technology. Local government and the private sector therefore started an innovation district near Las Vegas Strip, a business district and tourism landmark of the city. A system was installed and tested that integrates detection tools. By testing the system and studying the context of the area, the needs and behaviour of business, tourists, and local people, the city administration can now identify the technology needed to make Las Vegas a smart city.

The city of Denver in Colorado, USA, is another example city that develop innovation district to develop a smart city (Figure 1). The local government and Panasonic turned a deserted area in a Denver suburb near Peña Station and Denver International Airport into the *"Next Innovation District"*. The area is considered as a *"living city lab"* to develop the technologies and innovations needed to address current and future problems. The innovation district comprises a network of solar energy, high Wi-Fi coverage, air quality monitoring system, and autonomous vehicles to transport people from the district to the railway station (Chuang, 2016).

Figure 1 The Peña Station Next innovation district in Denver, Colorado, USA
Source: Chuang (2016)

Figure 2 22@ Innovation District in Barcelona, Spain
Source: Eurecat (2006)

Both Las Vegas and Denver opted to develop an innovation district before allocating their full budget allocations to cover their whole city. There are three advantages for developing an innovation district as the initial phase of developing a smart city. First, it enables the administration to become fully familiar with the plan and prepare to take action. Second, the cost for proving the concept is low. Finally, the city grows, as do new ideas.

By testing the technology in an innovation district, the information and details of the technology can be gathered within a short time. For instance, Las Vegas tested its data on waste management in the innovation district to develop Las Vegas Strip. This enabled the city to install a trash monitoring system to ensure that trash boxes are not overloaded, resulting in a clean and attractive city for both locals and visitors. In the meantime, Las Vegas is also developing other systems to support the increasing number and coverage of smart technology into other areas in the city.

Since technologies piloted in the innovation district are real-world tests, it is important to control the quality of the test before introducing new technologies at scale. Successful system development requires that the technology is practical and its coverage sufficient for the target area. Therefore, testing the technology in a small innovation district simplifies quality control and serves to confirm that such technology works in the real world and delivers the expected results. It could be said that the innovation district gives the administration correct information in verifying the concept of developing a smart city, without spending too much. The findings also agree with the survey conducted by the Center for Digital Government that local governments in the United States spent over USD 50 billion in 2016 to develop information technology systems, and they are likely to spend even more in future (Center for Digital Government, 2016). As such, the development of an innovation district can help change this unnecessary expense.

In addition, an innovation district helps promote businesses and commerce. It makes the city grow and become better known. As a technology lab, an innovation district attracts more investors and innovators, and creates high-skill workers and employment for the locality. An example of remarkably successful innovation district is the 22@ in Barcelona, Spain (Figure 2). Within 10 years after establishing the 22@, the population in the innovation district has increased by 23 percent (Ajuntament de Barcelona, 2010).

Development of an innovation district in Thailand

The development of an innovation district in Thailand was initiated by the National Innovation Agency (Public Organization) in 2015. Yothi was the first district to be developed as an innovation district. Currently, NIA has expanded the concept to 10 other areas in Bangkok and surrounding regions. Higher education institutes are leading this development. The six innovation districts in Bangkok are 1) Yothi Innovation District, 2) Pathumwan Innovation District, 3) Khlong San Innovation District, 4) Rattanakosin Innovation District, 5) Kluai Nam Thai

Figure 3 Vision for developing Yothi Innovation District
Source: Chulalongkorn University (2018a)

Figure 4 Vision for developing Yothi Innovation District
Source: Chulalongkorn University (2018a)

Innovation District, and 6) Lat Krabang Innovation District, while four others have been established in the Eastern Region: 1) Bang Saen Innovation District, 2) Si Racha Innovation District, 3) Pattaya Innovation District, and 4) U Taphao – Ban Chang Innovation District. In addition, Punnawithi is an innovation district driven by private sectors as a pilot area for developing innovation districts. In the future, the One Bangkok project situated on Rama IV Road and Wireless Road will be a high-potential project that could also become designated an innovation district.

As for the development of Yothi Innovation District, the vision, concept, and goal for development that leads to the initial development are established (Figure 3 and Figure 4), including:

1) Development of pavement and sky-walk, improved access from Victory Monument BTS Station to Rachawithi Road toward Ramathibodi Hospital via sky-walk, a pavement on Yothi Road from Phayathai Road to Rama VI Road and connecting the traffic network to Ramathibodi Hospital. The development of sky-walk project is a joint project among the relevant agencies within the district, with Phramongkutklao Hospital as the project leader.

2) Development of public areas in government agencies, and medical and educational institutes, development of Yothi Road in front of the Ministry of Science and Technology as an empty space as an activity area for local people, and encouraging innovation knowledge sharing.

3) Development of parking spaces in Yothi Innovation District, common area management by developing a smart parking system with facilitating technology.

Apart from Yothi Innovation District, Pathumwan is another centre of business, transport, and education. Pathumwan Innovation District has the highest potential to develop innovation in Thailand. With high dynamism, the district has seen many changes, both socially and economically. Pathumwan started as a modern trade district in the first generation and became a center for commerce and culture for modern people in the second generation. The district has become a commercial and transportation landmark in the third generation. Pathumwan foresees unprecedented fast-paced change due to globalization and rapid technology advancement. Therefore, the idea to develop Pathumwan as *"Pathumwan Innovation District"* was planned to support potential changes in physical, economic, and social contexts in the future and become the centre that links other innovation districts in Bangkok.

Chulalongkorn University is one of the main organizations that have embraced the innovation district concept to develop a smart city by

developing Siam Innovation District. In this initiative, the university employs five innovation concepts, including 1) lifestyle, 2) sustainable development, 3) inclusive community and smart city, 4) digital economy and robotics, and 5) innovative education (Prachachat Business, 2018). Also, the development of CU Smart City is based on the idea to turn Sam Yan into a model smart city. With this vision to transform such area into an innovation district that creates value for the community and society and enhances quality of life and business, aiming to best benefit sustainable life (Chula Property, Chulalongkorn University, 2018).

Figure 5 Vision for Developing Pathumwan Innovation District
Source: Chulalongkorn University (2018b)

Conclusion

Development of a smart city may not be a mere fashion fad or theoretical discourse. It offers an important means to improve the quality of life for city people sustainably. As seen from cities in the world, including in Thailand, people are trying to collect and analyze data within the city in order to use it to improve the quality of life. Smart city is not too difficult to achieve. It could start from one district at a time.

Acknowledgement

This article is part of the research projects entitled ***"Yothi Innovation District Development"*** and ***"Pathumwan Innovation District Development"*** funded by National Innovation Agency (Public Organization)

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Article

Pathways to Level Up Net Zero Carbon Building towards Smart Cities

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Introduction

The increase in the impact of global climate change, both in terms of magnitude and frequency, has increased awareness to give importance on collaborative on solving these problems and finding solutions. It is well known that the main cause of climate change is caused by human activities that cause emissions to the atmosphere. Thailand's latest greenhouse gas data showing that in 2013, Thailand has emitted 318.66 million tons of carbon dioxide equivalent ($MtCO_2e$), and about three quarters of its emissions accounted for the energy sector (Office of Natural Resources and Environmental Policy and Planning (ONEP), 2017). Although nowadays alternatives energy and / or innovative technologies have been promoted to reduce the effect of climate change. However, such implementations have not yet reduce the amount of greenhouse gas emissions to meet the goal of the Kyoto Protocol.

Building is classified as one of the important sectors since it consumes up to 40 percent of global energy consumption (the United Nations Environment Program (UNEP), 2009). Energy and fuel used in buildings is a major source of the greenhouse gas emissions. According to 5th Climate Change Assessment announced by The Intergovernmental Panel on Climate Change (IPCC), building, which includes residential buildings, commercial buildings and government buildings, emits direct and indirect carbon dioxide equal to 8.8 gigatons of carbon dioxide ($GtCO_2$) and the tendency of building's energy demand will double, resulting in an increase in carbon dioxide emissions by 50-150 percent by the middle of this century (Intergovernmental Panel on Climate Change (IPCC), 2014). This enormous increase in energy demand is due to the rapid development of urban communities and changing lifestyles as well as increasing access to advanced energy services recently. As a result, the building has become a major contributor to greenhouse gases, or in other words, building is a potential sector for reducing greenhouse gases.

A key strategy for greenhouse gas reduction is the Net (nearly) Zero Carbon Building (nZCB) which is net energy consumption or net carbon emission is zero in each year. (Construction Industrial Council (CIC), 2016). This strategy has been implemented in many countries, such as the United Kingdom, have set the goal for all new buildings to be Net (nearly) Zero Carbon Building:

(nZCB) buildings by 2019 (UK-Green Building Council (UK-GBC), 2015), while the European Union and the United States set up all new buildings as Net Zero Energy Buildings (nZEB) by 2020 and 2030 respectively (EU Directive, 2010; Office of Energy Efficiency and Renewable Energy (EERE), 2009).

In Thailand, there are two different types of building development: 1) Green Building is a building that focuses on maximizing resource efficiency while minimizing the impact on health and environment throughout the building life, and 2) Low carbon buildings, is a building focused on reducing greenhouse gas emissions for energy use in building and activities from building users. Expectedly, the combination of the two building development concepts will help push Thailand to develop a net zero energy buildings (nZEB) or Net (nearly) Zero Carbon Building: (nZCB) in the future (Thai Green Building Institute (TGBI), 2017). However, most of the previous study of energy use in Thai buildings is using top-down approach for statistics data in each area. The objective of this study, therefore, is aimed to study greenhouse gas emission from various type of building using bottom-up approach for analyzing the emissions' source and the adaptation potential towards smart communities.

Concepts and principles for greenhouse gas emissions from buildings.

To study the emissions of greenhouse gases generated from various activities of different types of building in urban areas through a bottom-up approach, the methodologies are briefly summarized as follows.

1) According to the Announcement of the Ministerial regulation type or size of buildings and standards criteria and methods of designing energy conservation building B.E. 2552, the building case studies were classified into 3 groups following the working hour as illustrated in Figure 1.

2) Although the life cycle of various types of buildings are as follows: 1) pre-use phase 2) use phase

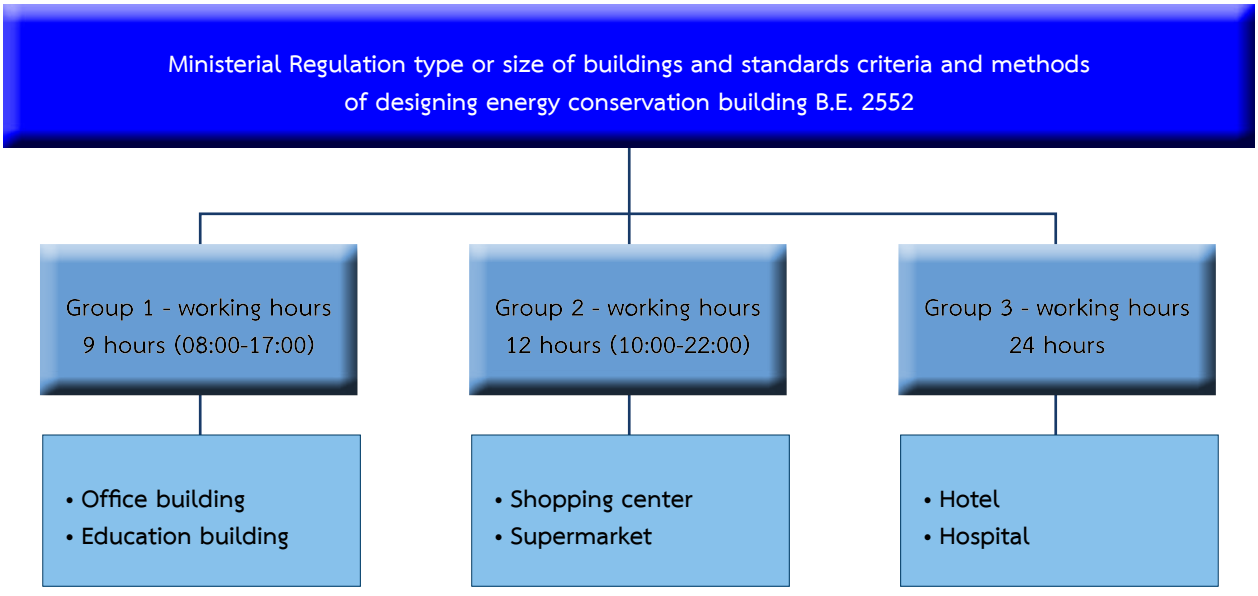


Figure 1 Classification of designated buildings
Source: Department of Alternative Energy Development and Efficiency (2009)

and 3) post-use phase, but more than 80 percent of greenhouse gas (GHG) emission was generated during the use phase (United Nations Environment Program (UNEP), 2009). Therefore, this study will only investigate activities related to GHG emissions during the use phase (Figure 2) through the collection of activity data for the past 12 months. Any other activities that are not directly related to GHG emissions from direct use of the facility, such as transportation, outdoor green space and parking space outside the building will be excluded from the scope of this study.

3) Assessment of the GHG emissions of various buildings and analysis of greenhouse gas reductions potential from current measures will be performed to find pathways for upgrading into Net (nearly) Zero Carbon Building: (nZCB) or Net Zero Energy Building: (nZEB) and improve to be smart communities in future

GHG emissions and various types of building activities

The analysis of GHG emissions from 20 buildings in the Bangkok metropolitan area revealed that the most important carbon source is electrical consumption. About 88-94 percent of total GHG emissions generated from electrical and fuel consumption for all cases, except for shopping centers and supermarkets which the proportion of GHG emissions from energy use is in the range of 67-73 percent followed by GHG emissions from waste management (22-31 percent). Even though the energy consumption in buildings is the most important source of GHG emissions. There are also other major GHG emissions, such as waste management and the use of fluorine gases in air conditioning and refrigerators. Therefore, the suitable pathways to reduce GHG emissions should be considered differently in each type of building.

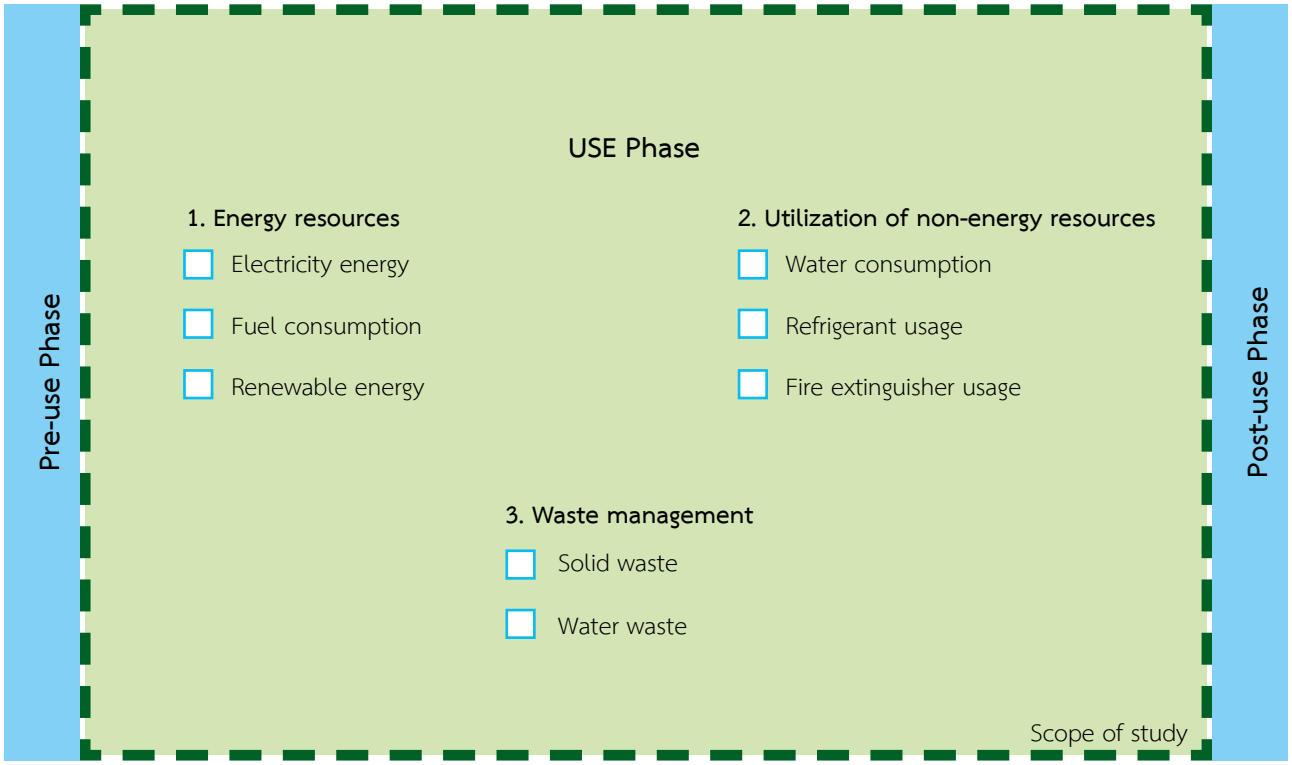
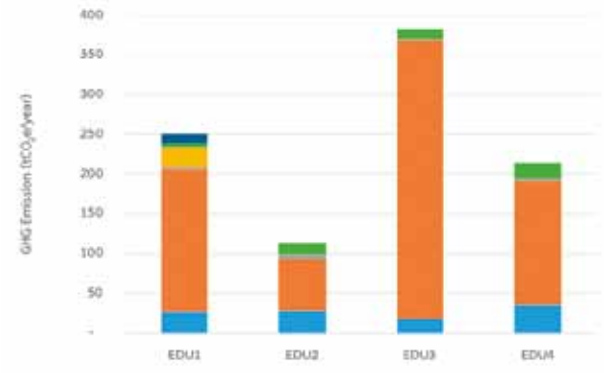


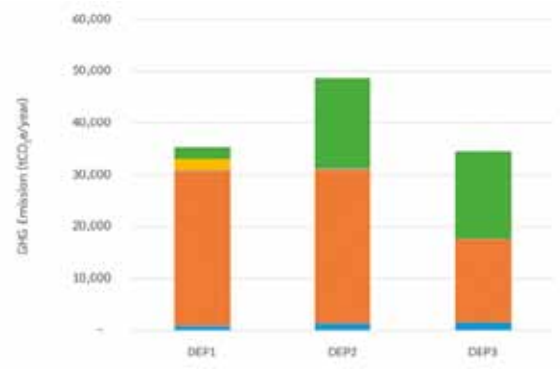
Figure 2 Scope of activities in each of the buildings.
Source: Atitinon Phuphatthong design on November 2017

Office Building

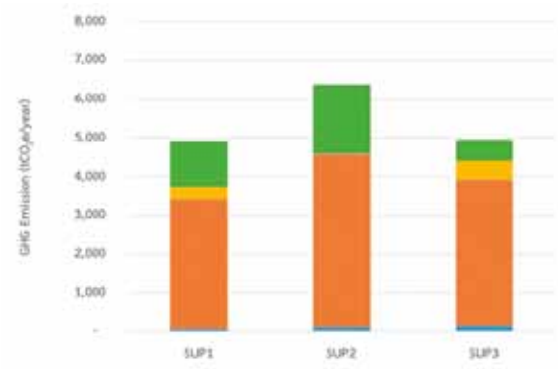


Education Building

(A) GHG emissions and building with working 9 hours per day

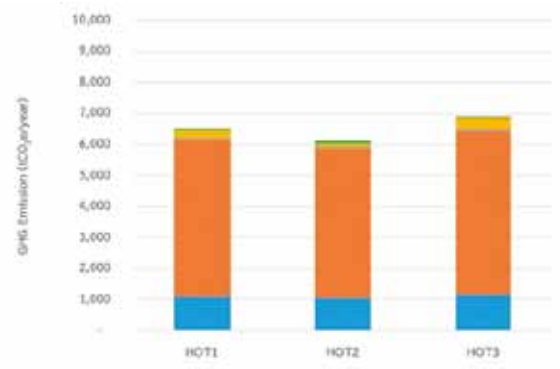


Shopping Center Building

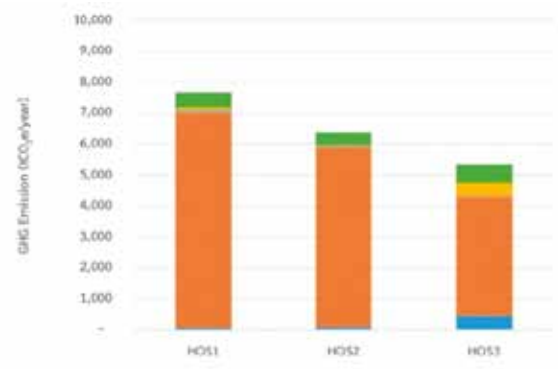


Supermarket

(B) GHG emissions and building with working 12 hours per day



Hotel



Hospital

(C) GHG emissions and building with working 24 hours per day

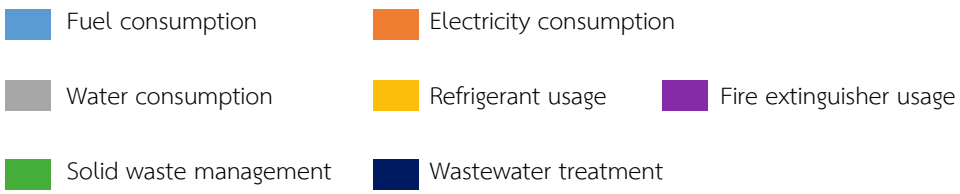


Figure 3 GHG emissions from various types of buildings.
Source: Atitinon Phuphatthong design on March 2018

Considering the amount of GHG emissions from various sources of buildings as demonstrated in Figure 3, the educational building had the lowest net annual GHG emissions with the carbon intensity of 26-64 kilogram carbon dioxide equivalent per square meter of building area ($kgCO_2e/m^2$). Whilst, the shopping center building had the highest net GHG emissions in the year, 112-457 $kgCO_2e/m^2$, followed by office building, supermarket, hotel and hospital have average carbon intensity of 85, 158, 90, 89 $kgCO_2e/m^2$, respectively,

GHG emissions Reduction Approach

Based on interviews with stakeholders of the building; building owner, building manager, building supervisor and the building users found that current practices in building management to increase the efficiency of building use and also contribute to the reduction of GHG emissions from building activities could be summarized as follows:

1) Energy Consumption Practices Energy is a major source of GHG emissions in the building sector. Most of them is the electricity consumption and more than half of the electricity used in all types of buildings is used in air conditioning systems. Except for shopping center and supermarket, the proportion of energy consumed in electrical appliances is higher than that of air-conditioning systems. The pathways to reduce GHG emissions approach can be classified as follows.

1.1) Air conditioning system. This is usually a water- cooled center with water cooling. Air-cooled or air-conditioned units. Effective use of equipment such as reduced working hours, adjust the temperature and maintenance of equipment regularly can reduce energy consumption by 5-10 percent. In addition, the installation of energy-saving equipment in air conditioning and ventilation, the use of automatic control system and building frame improvements can also reduce energy consumption by 15-30 percent of energy consumption in air conditioning systems.

1.2) Lighting system. Effective use of the lighting equipment can reduce energy use by 5-10 percent as well as air conditioning. While the improvement and installation of energy saving equipment will reduce energy consumption by up to 25-30 percent of the power consumption in the lighting system.

1.3) Other systems generally refer to office buildings, elevators and water pumps, etc. these systems account for about 10-15 percent of total energy consumption in buildings.

2) Guidelines for the use of non-energy resources. GHG emissions from the use of non-energy resources in all types of buildings account for less than 5 percent of total GHG emissions. In general, it can be ignored and not calculated. However, to make the net carbon buildings truly zero, all relevant factors should be considered together. Pathways for GHG emissions reductions from non-energy resource activities can be classified by resource types as follows:

2.1) Water usage. In general, each type of building has a water saving policy and the use of water saving equipment already. Reduce the use of tap water should be considered rainwater harvesting approach for implementation.

2.2) The use of refrigerants, fire extinguishers and chemicals. The selection of environmentally-friendly refrigerants, or the refrigerants with less potential for the Global Warming Potential (GWP) and Ozone Depleting Potential: ODP, as well as the choice of organic substitutes for chemicals, can help reduce a leakage of GHG emissions.

3) *Waste Management Practices*

3.1) Waste Management. Generally, the reduction of waste at the place of origin such as waste separation and recycling can be achieved. But some buildings such as educational building,

hotels and shopping center, where are the source of bio-waste such as food waste, used oil and leaves, etc., can increase GHG emissions reduction by producing bio-energy from waste.

3.2) Wastewater Management. Nowadays some buildings have recycled water. If the water used or grey water, such as water from the sink, water from the bath (not included black water from toilet and waste from kitchen) is used properly and properly disinfected, it can be re-used again for household purposes, such as watering the trees, washing the car or using toilet flush.

Conclusion and Suggestion for pathways to level up net (nearly) zero carbon building towards smart cities

Net (nearly) zero carbon building is the management approach aimed for the net zero energy or the net zero carbon in each base year. Every type of building requires the use of both energy and non-energy resources on different activities in a distinct way. Source of GHG emissions are varied depending on the type of building. These are all important factors for the development of a truly net zero carbon building. There should be a database on all types of resources related to the use of buildings, which is more than energy and water, such as refrigerants, fire extinguishers, in order to make the completed development of a net zero carbon building precisely in a smart way.

Strategies for reducing GHG emissions from different types of buildings in Thailand should consider the GHG emissions of each type of buildings as follows:

Office building and hospital. The main source of GHG emissions is the electrical energy used in air conditioning and electrical appliances. The development to be the net zero carbon building should be concentrated on the choice of high performance equipment, low energy consumption combined with the use of clean energy sources, such as solar energy instead of using import electricity source to make GHG emissions from energy change to be net zero energy.

Education building and hotel. There are major sources of GHG emissions from Fossil Fuel

Consumption in cooking and water heating system. Correction pathways for these types of building should consider using alternative energy sources that are environmentally friendly to replace consumable fuels, for instance; biogas selection, biodiesel, ethanol or gasohol replace the use of diesel or liquefied petroleum gas.

Shopping Center and Supermarket. In addition to energy consumption, there is another important source of GHG emissions for these buildings' type: waste management. The guidelines for the development of these type of buildings should follow the principle of 3Rs (Reduce, Reuse and Recycle) and applying sufficient consumption approach in conjunction with energy management by focusing on the most cost-effective use of resources to minimize waste, garbage separation and reuse / recycling for the most beneficial.

The use of resources in activities is inevitable, so the most important part of this change is how to maximize the effectiveness of every resources used with the least waste generated. Despite the efforts of various agencies to push the reliance on alternative energy sources, in fact, solar power has not been applied much as it should be. The campaign for solar energy installation persuasion is urgently needed. Moreover, carbon offset is one of activities that should be pushed aggressively in order to help compensate for the amount of GHG emissions by many activities in buildings.

Acknowledgments

This article is part of the research project entitled ***"Smart community preparation for climate change and disaster"*** funded by the Ratchadapiseksomphot Endowment Fund (2016), Chulalongkorn University (CU-59-002-IC).

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Urban Ecology:
Landscape Element and Ecosystem Services

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Introduction

Urban ecosystem has diverse landscape elements that have been formed by both nature and man. Land cover in city areas are like mosaics and are comprised of built-up, vegetations and water areas (Forman, 1986). Therefore, characterizing each type of land cover is essential for understanding the landscape elements, such as the relationships between the structure and pattern of landscape elements, landscape functions and ecosystem services. This knowledge could be used as preliminary information for planning and designing urban ecosystem pertaining to ecological processes, which would give a positive effects upon human life with a better quality of life for people in urban areas.

Landscape ecological perspective in the study

Landscapes are comprised of diverse ecological systems that differ in both their pattern and process. Landscape ecology is the study of natural occurrences within landscapes to find the interactions between the structure and pattern of landscapes and natural processes, such as energy exchange, nutrient cycling and species diversity, including the effects of the landscape structures on the landscape dynamics. Landscape ecology is an interdisciplinary field involving both natural science and social science and involves many topics that can help in understanding the landscape ecosystem. This knowledge can then be applied for planning, designing and managing natural resources and the environment on a landscape scale (Forman and Godron, 1986; Risser, Karr and Forman, 1983; Thaitakoo, 1998). Landscape ecology is used to understand the landscape through the study of the structure, function and dynamics of landscape (Pickett et al., 2013), which can be classified as follows:

1) Landscape structure: the physical arrangements of the landscape composition, including the size and pattern of the landscape, which can be used to explain the land covering differences and the land covering pattern (Pickett et al., 2013).

2) Landscape function: the ecological processes that occur in the landscape structure that affect human activities directly or indirectly. This is also called ecosystem services (Bolund and Hunhammar, 1999; Costanza et al., 1997)

3) Landscape dynamics and landscape change: the landscape is changing all the time due to natural processes, such as growth, and these changes in the landscape structure affect the landscape functions and lead to changes in the ecosystem services (Forman and Godron, 1986; Pickett et al., 2013).

The study of landscape structure, function and dynamics leads to an understanding of the landscape pattern and landscape process, since the landscape structure is related to the landscape function and dynamics (Forman, 1986). Thus, the diversity of landscape compostions, which are combined as mosaics, can be used to find the indices to analyse the effect of the landscape structure and pattern on the biodiversity, landscape abundance and dynamics (Forman, 1986).

From the landscape ecological theory, the landscape structure is the product of the landscape function on the other hand the landscape function is the product of landscape structure. Natural processes in the past have led to the present landscape structure, while the present landscape structure affects the natural processes and landscape functions and eventually the present natural processes will affect changes in the landscape structure in the future (Forman and Godron, 1986). The charactersitics of the landscape structure can be used as the landscape indices, where the size, shape, width, connectivities, narrowness, length and porosity of each mosaic in the landscape structure. These can be used to analyse and synthesize the landscape ecological data. Porosity is essential for urban ecology, especially in a deltaic landscape, such as Bangkok (Thaitakoo et al., 2013).

Porosity and deltaic landscape

Bangkok is located in the lower part of the Chaopraya River, which has the geomorphological characteristic of a deltaic landscape from the influences of tropical monsoons and the dynamics of coastal ecosystems. Nowadays, Bangkok is being a city that disregards relationship with water due to the lack of the understanding of natural hydrological processes and a lack of the local knowledge about living with water in the dry and monsoon seasons, which are important hydrological conditions for an urban landscape ecosystem. This declining relationship between humans and nature is responsible for the higher risk of flooding in Bangkok (Thaitakoo et al., 2013).

In the past, Bangkok's landscape structure was related to natural process, especially the hydrological system, as can be seen from the changing landscape along the Chaophraya River of canals and ditches which form a landscape infrastructure for agricultural water management. This system plays the role of catchment area, drainage and irrigation systems and flood prevention systems at the fundamental level based upon the conditions of the hydrological system and geographical features, combined with community level management. However, the current expansion of Bangkok is affecting the landscape structure by reducing high porosity areas, such as orchards and rice fields, and reducing the canal network (Figure 1

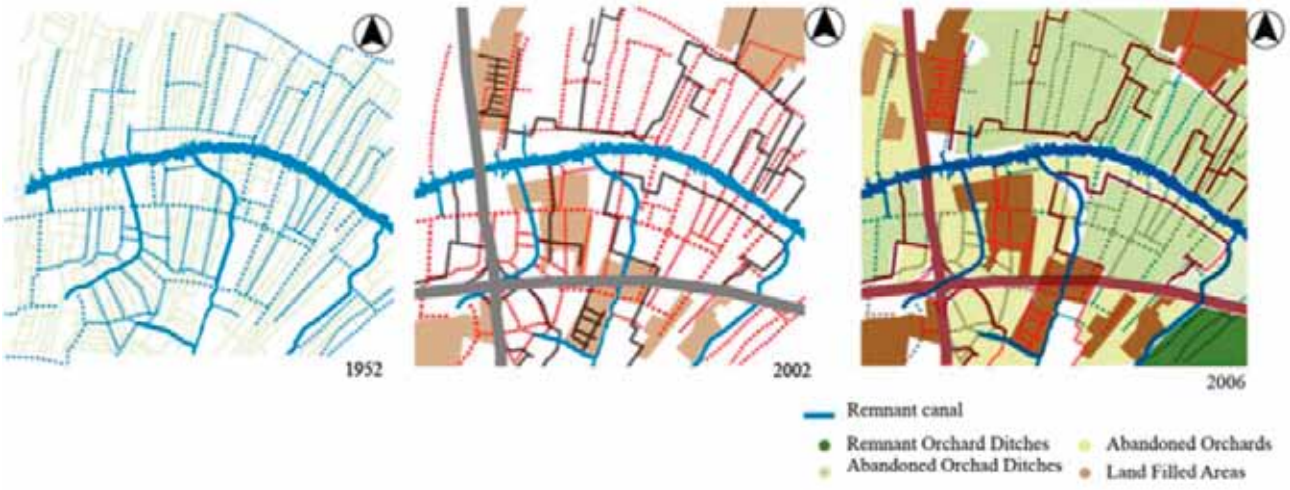


Figure 1 Comparison of the landscape structure of Khlong Om Non showing the changes in the orchard area and decreasing canal networks during 1952, 2002 and 2006
Source: Thaitakoo et al. (2013) modified from Palopakon (1999)

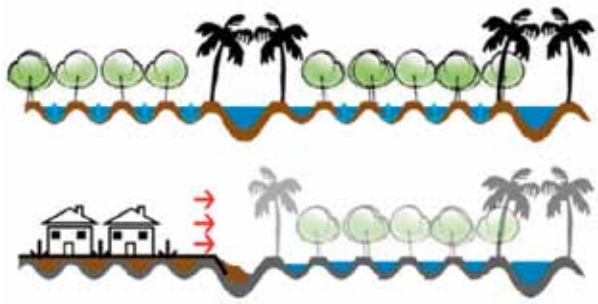


Figure 2 Changing landscape structures in an orchard area
Source: Thaitakoo et al. (2013) modified from Palopakon (1999)

and Figure 2). These will then greatly affect the ecological functions and services (Thaitakoo et al., 2013).

Areas with a high porosity landscape structure will have a high ability for retaining, detaining and permeating of water in the landscape. These hydrological processes in the landscape pertain to four main processes of atmospheric and surface water: interception, infiltration, surface storage and surface flow, as shown in Figure 3 (Marsh, 2005; Sakarthornsub, 2011). (i) The canopy interception is the ability of tree crowns to retain the rain, and is affected by many factors. The canopy interception can be calculated from the sum of the rainfall minus sum of rain combined with rain passing through the stems (Li et al., 2017). (ii) Infiltration occurs at the soil surface, a process that is also affected by many factors, such as the soil types, surface covering and humidity. Infiltration will increase the soil humidity and underground water level, which will then become surface water. (iii) Surface storage is stored water that will flow to the lowlands, and is one of the essential water resources for humans. (iv) Surface flow occurs when the left over water from canopy interception, infiltration and surface storage flows to the canals and lowlands. The rate of surface water flow depends on many factors (Dunne and Leopold, 1978; Marsh, 2005; Sakarthornsub, 2011).

A landscape with the ability to store and retain water is comprised of soil, water and vegetations (Herod, 2013; Marsh, 2005), whereas man-made landscape, such as built-up areas, do not have these abilities but rather allow immediate run off. Hence,

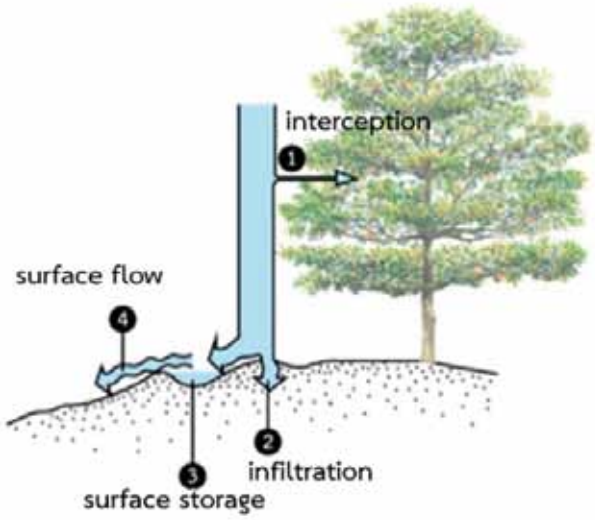


Figure 3 Hydrological processes in the landscape
Source: Sakarthornsub (2011) modified from Marsh (2005)

high porosity landscapes is a landscape of vegetations and water. Considering land use purpose, agricultural area such as orchards and rice fields are considered as areas that store and retain water. (Thaitakoo et al., 2013). However, classifying land usage does not show the relationship between the landscape structure and pattern and the landscape function and ecosystem services. Therefore, land cover classification is used instead to help understand the landscape structure and pattern, especially for landscape mosaics of vegetations and water, so as to gain a clearer picture of the landscape porosity.

Land cover classification can be performed by modification of the High Ecological Resolution Classification for Urban Landscapes and Environmental Systems (HERCULES) (Cadenasso, Pickett and Schwarz, 2007). This system can classify the land cover from both man-made and natural areas to landscape areas that are consistent with the objectives, and is able to find the relationship between the landscape structure and pattern and ecological function by classifying the land coverage into the three elements of (i) vegetations, which are divided into trees, shrubs and ground covering vegetations, (ii) built-up (including bare soil) and (iii) water, and then making a map of the land cover.

Results

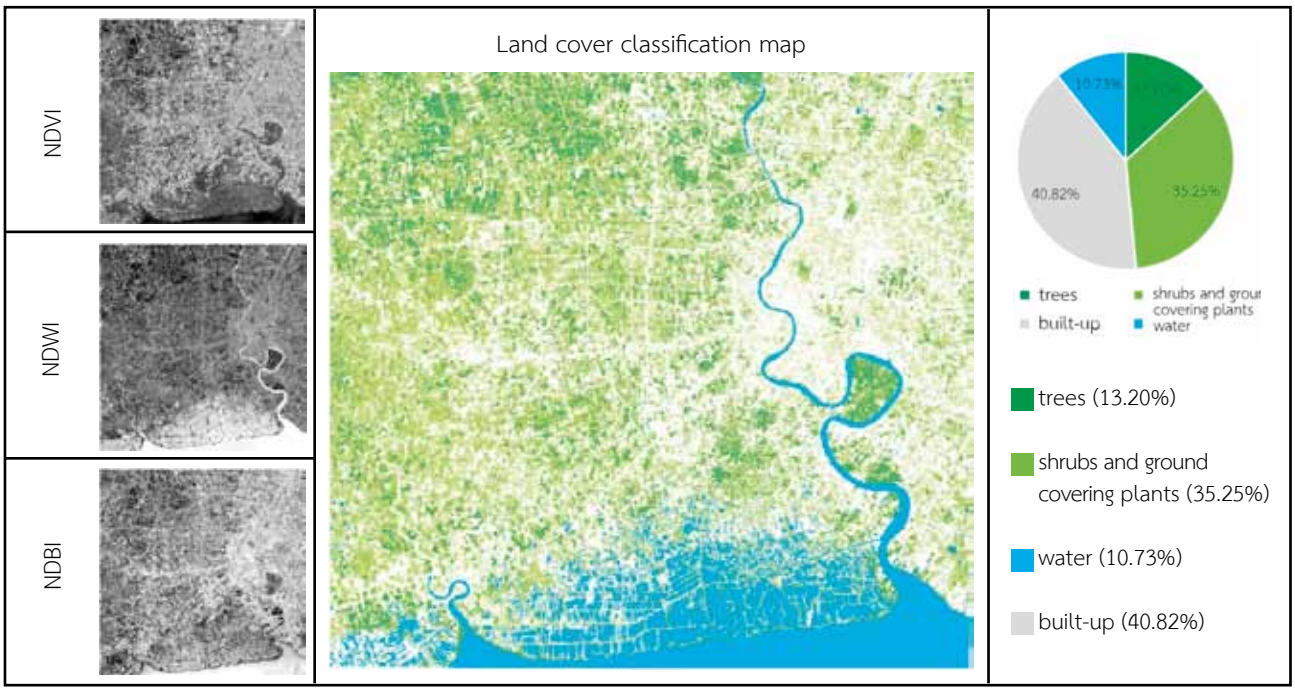
The land cover in Bangkok was classified according to the outlined objective by analysing satellite images, where the NDVI, NDBI and NDWI was calculated for the normalized difference of vegetation (Weier and Herring, 2000), built-up (Zha, Gao and Ni, 2003) and water (Gao, 1996), respectively. The resulting land cover in Bangkok is shown in Table 1 to display the landscape structure that demonstarte the porosity of the area.

From the land cover classification map of Bangkok (Table 1), the western side of the Chaopraya river had a landscape with more vegetations (trees, shrubs and ground covering plants) compared to the eastern side. Theoretically, landscapes with higher natural compositions, such as water and vegetations, would have a higher porosity compared to built-up landscapes. Therefore, these areas have better ecosystem services, which can be supported by the spatial structure and spatial pattern study using the surface temperature map to analyse the relationship of the landscape structure and pattern to the landscape functions and ecosystem services.

Further studies of the land cover classification map for Bangkok were performed by selecting areas of 3 x 3 km (9 km^2) in size that had a similar ratio of land cover to each other, but different land cover spatial patterns. As all three selected areas were located in the study area, the surface temperature and environmental variables can be controlled to be as similar as possible in each selected area. The study areas were divided into 2 areas (Bangkrajao, Klong Toei and Khlong Om Non), where each group had a similar land cover ratio but in a different spatial pattern (Nantavisai, 2016), and had four types of land cover, as detailed in Table 2.

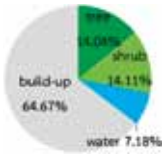
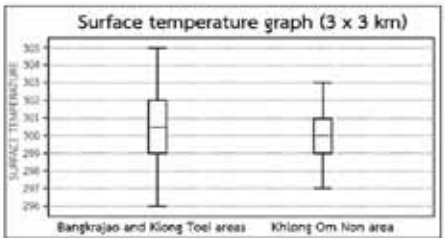
The land cover appeared to have a great impact on the surface temperature, especially for the vegetation patches (trees, shrubs and ground covering plants). Water landscapes had a lower surface temperature than built-up patches. Moreover, the spatial pattern of the landscape composition, both vegetations and water, affected the surface temperature (Figure 4). The Bangkrajao and Khlong Toei areas had both trees and large built-up patches, so the surface temperature was lower at the tree and water patches and the surrounding areas only. In contrast, the areas with a built-up patches and large area of bare soil had a higher surface temperature. In contrast, the spatial pattern of Khlong Om Non

Table 1 Classification of land cover in Bangkok



Source: Thaitakoo (2018)

Table 2 Ration of land cover, spatial pattern, and surface temperature

Map	Bangkrajao and Klong Toei areas	Khlong Om Non area
Map showing the **land cover** classification		
Ratio of **land cover**		
Spatial pattern		
Surface temperature graph		

Source: Nantavisai (2016)

was comprised of a small tree patches alternating with a built-up patches, and the lowest temperature was higher than at Bangkrajao and Khlong Toei, but the average and highest temperature was lower (Nantavisai, 2016).

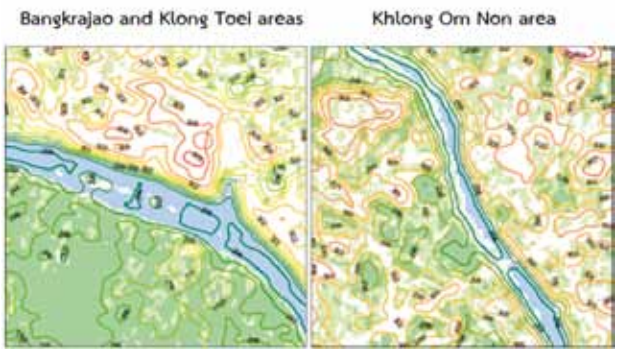


Figure 4 Comparison of the overlapping surface temperature and soil covering between Bangkrajao and Khlong Toei area and Khlong Om Non
Source: Nantavisai (2016)

Suggestion

From this study, the landscape structure and spatial pattern were found to be related to the function and ecosystem services, which lead to the land cover classification as landscape mosaics. These can all be used to analyse the ecological impact, and to develop process and applied knowledge on the urban and landscape ecologies that could be combined for designing and planning the city for sustainable development. The results of this study can be used as fundamental information for designing, site planning and strategic planing on urban ecology (Figure 5). This preliminary study shows the opportunities that can be used as the basis for further studies in many aspects and to develop and apply them in further more detailed studies in the future.

When designing urban ecosystem, the porosity index should be used in strategic planning, where

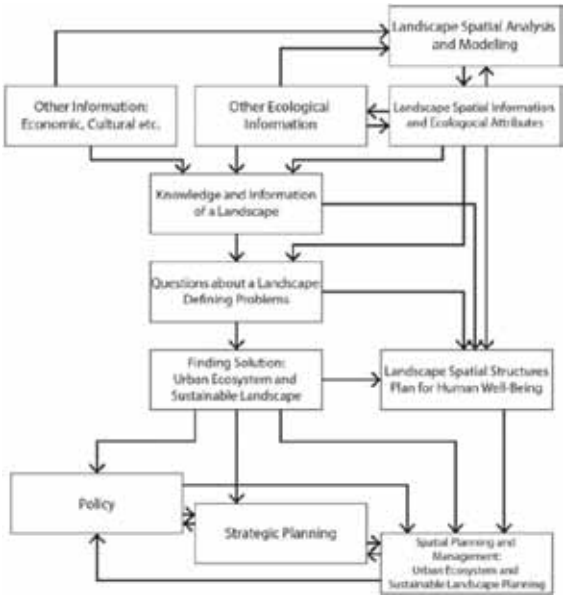


Figure 5 Flowchart of the steps and methods for the landscape spatial analyses and modelling of urban ecology
Source: Thaitakoo (2018) modified from Thaitakoo (1998)

natural elements, such as vegetations, water and bare soil, would have a positive effect on the urban ecosystem in terms of the hydrology and microclimate. In conclusion, the planning of urban landscape should consider planning for green infrastructure networks which would in turn increase landscape and environmental qualities and the human well-being in Bangkok.

Acknowledgements

This article is part of a research project entitled *"Analysis of urban vegetations using remote sensing and its application in strategic planning and designing of urban ecology, ecological functions and resilience of Bangkok"*, funded by the Ratchadaphiseksomphot Endowment Fund, fiscal year 2016, Chulalongkorn University.

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Smart Health as a Part of Smart City

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Introduction

Quality of life, especially the health of citizens, is a fundamental goal in the development of ***"smart cities"***. The transition from traditional agricultural societies to industrial, urban and then post-industrial societies have brought radical changes in lifestyles, diets and life expectancy. Urban citizens typically follow a diet high in calories, but lack physical exercise, increasing their vulnerability to non-communicable diseases (NCDs). Smart cities use social engineering to incentivize healthy eating and diets subconsciously through a clean and healthy urban environment.

This research project comprises 3 components: 1) Study on designing urban environments to enhance physical activity (Phase 2); 2) Development of an index of modern ecosystems for sustainability (Phase 2); and 3) Research and training on sustainable design (Phase 2). The scope of these components covers three main areas: designing the environment to incentivize physical exercise; designing the environment to reduce energy consumption and develop indices to assess the impact of interventions to promote sustainable urban ecosystems; and disseminating knowledge and lessons learned in order to establish better understanding and application.

Background and context of the project

The lifestyles of urban dwellers today leave them highly susceptible to non-communicable diseases (NCDs) resulting from sedentary lifestyles and dietary choices. NCDs have become one of the leading causes of death among Thai people. Lack of physical exercise, high levels of stress, high-calorie diets combine and desk jobs requiring little physical activity combine to reduce metabolic rates among city dwellers compared with only 20 years ago and are among the most important root causes of NCDs.

To improve the balance between calorie intake and metabolism requires higher levels of physical exercise. The most convenient way of exercise is walking because it uses the large muscles of the body. According to studies, walking for one kilometre burns 60 kilocalories for a 60-kg person. If one needs to increase the metabolism rate, it is possible to increase the gradient rate of walking. Although doing exercise at a gym is a good practical option, it is challenging to permanently instill into city people as part of their daily routine. This research aims to instill sustainable exercise behaviour into urban people. The most effective way to exercise is to include it in their daily lives without their knowledge, rather than to make people feel forced to allocate specific time.

This research also aims to identify environmental factors that motivate people to walk outdoors. By collecting data in the absence of rain or weather extremes (Figure 2), it was learned that the key factors that motivated people to go outdoors were a refreshing view (62 percent), followed by beautiful landscapes (26 percent), beautiful scent of flowers (8 percent) and the sounds of nature (3 percent), respectively. In addition, the top motivations for people to exercise outside were the shade afforded by large trees (56 percent), walking on curved and sloping roads (18 percent) and interesting roadside attractions (14 percent), respectively. Lastly, the factors that led to longer periods of exercise were the cool and refreshing breezes (56 percent), followed by shady trees (19 percent), and the beauty of nature (17 percent), respectively.

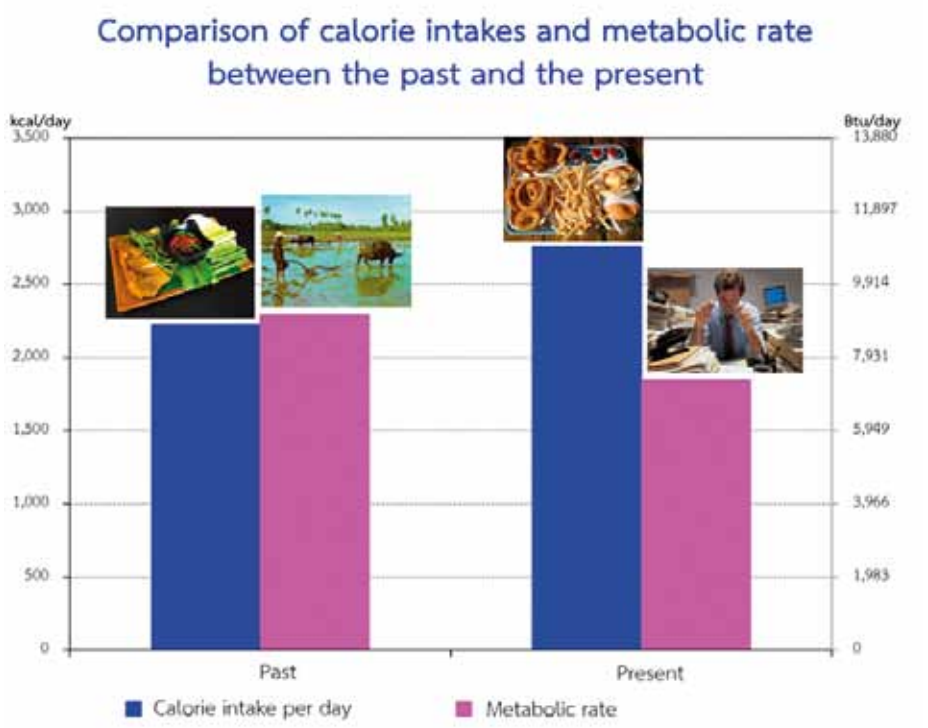

Figure 1 Comparison of calorie intake and metabolism between past and present
Source: Boonyatikarn et al. (2010a)

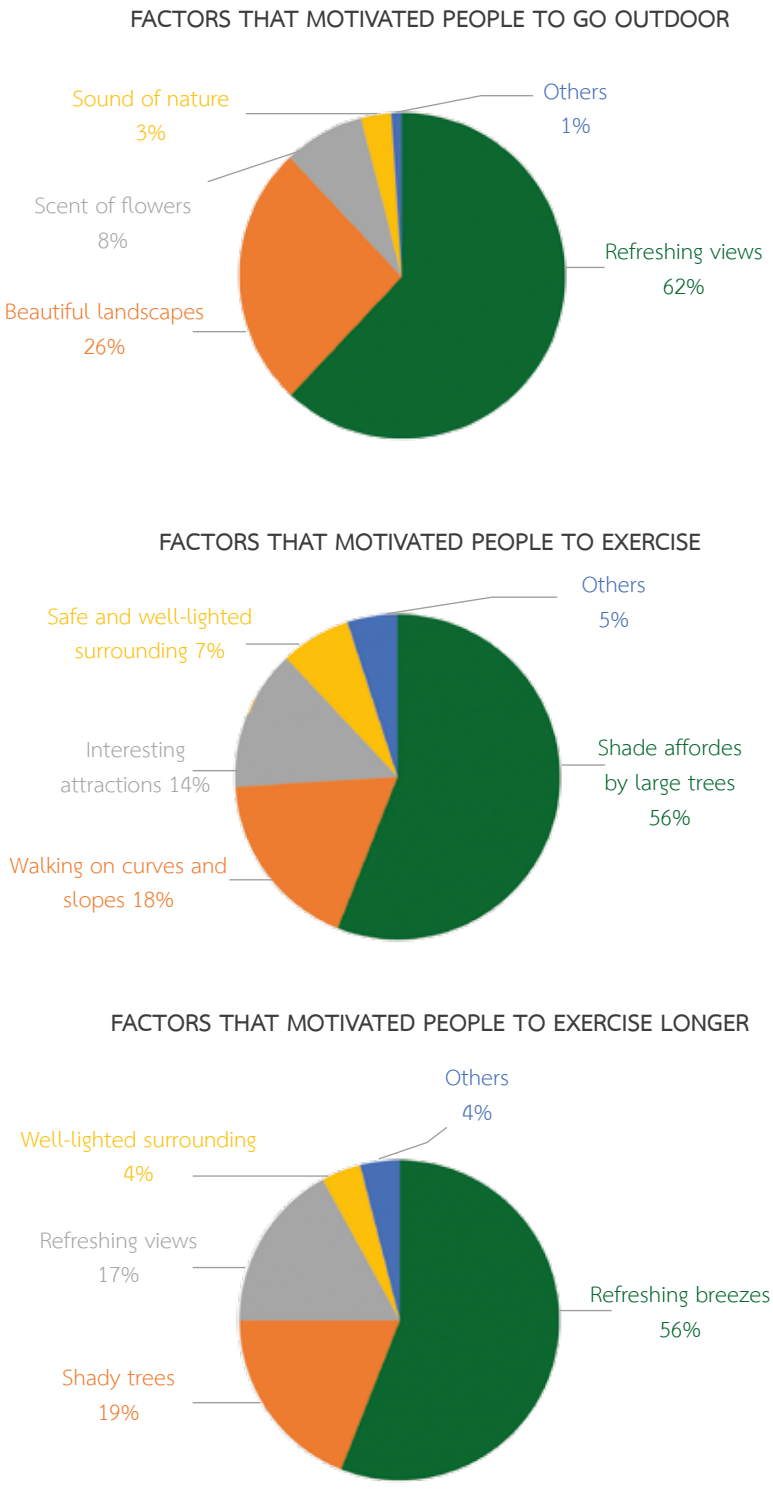

Figure 2 Factors encouraging exercise among urban dwellers
Source: Boonyatikarn et al. (2010a)

Innovation for smart health

All findings supported the conclusion that the strongest motivators for exercise were a shady, refreshing and cool atmosphere provided by large trees, because Thailand is a tropical country. The findings from this research may therefore be applicable to urban environments in other similar tropical countries. Based on this study, several key factors could be identified to design the urban environment as *"architectural therapy"*. The factors are as follows:

- A shady, refreshing, and cool atmosphere
- Beautiful view and natural scenery
- Curved and sloping roads with interesting attractions
- Fresh air and beautiful scent of nature
- Sounds of nature.

These factors were applied to real environments as showed in Figure 3. Three different levels of walkways were used for different functions, including walkways at ground level, on the second floor of the building, and a sky-level view.

The ground level walkway is designed to be of shady, cool, and pleasant atmosphere, with sloping pathways. It is ideal for walking at ground level where people can enjoy nature at close quarters (Figures 4).

The second level walkway is designed for walking during poor weather. These walkways are equipped with a roof and walls to protect walkers in all kinds of weather, but allowing a full view to nature through windows (Figures 5).

The sky view walkway is designed to showcase mountain views from the rooftop level. The walkway is around 200 meters long, ideal for morning or evening walks when it is not too hot (Figures 6). At night, it is a walkway to enjoy the moonlight and starlight, as well as the beauty of nature enhanced by the cool night air.

Observation of walkers using the walkways revealed that walkers in this enhancing natural environment exhibited increased levels of physical exercise compared with normal levels in an unenhanced environment. Furthermore, this increase was

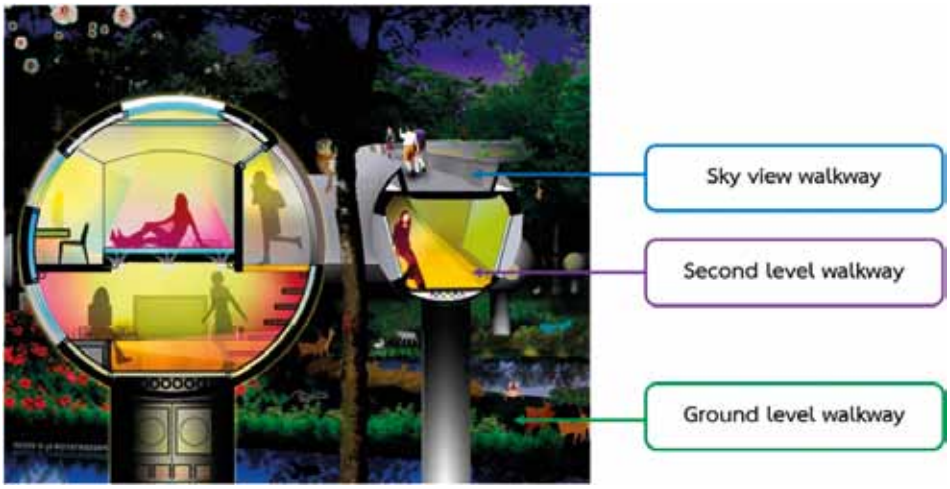

Figure 3 Three different walkways at DNA Resort, Khaoyai
Source: Boonyatikarn et al. (2010a)

Figure 4 The ground level walkway: a shady walkway at ground level with curves and slopes, offering an exotic touch of nature
Photographed by: Boonyatikarn, 2018

Figure 5 The second level indoor walkway: the curve that looks mysterious and the second level outdoor walkway with the leading line offering a touch of nature
Photographed by: Boonyatikarn, 2018

Figure 6 The sky view walkway with a leading line offering a natural experience, and a refreshing morning atmosphere among the mountains
Photographed by: Lohasuwan, 2018

subconscious and spontaneous, without any explicit messages to encourage exercise. This innovative environment design is therefore valuable; however, the greatest challenge in building a smart city is to create a ripple effect that triggers other elements of a smart city, including smart energy, smart mobility, and smart environment.

Additional elements to build a smart city

Smart energy. The important factor is the significant reduction of energy consumption in building. The study showed that reduction of energy consumption in building has highly correlation to conduction cooling load from building envelops. Which is simple to obtain in this case. The equation is used instead.

$$Q = U * A * \Delta T$$

Whereas Q = cooling load
U = heat transfer coefficient
A = surface area
ΔT = difference between indoor and outdoor temperature

The outside environment is cooled through the shade and moisture provided by tree cover, and can thus help reduce the average temperature gradient between external and internal building temperatures. The use of shade trees around public buildings can directly reduce energy consumption for air conditioning, as well as contributing to quality of urban life in many other ways.

Smart Mobility. A city endowed with pleasant, convenient pedestrian routes encourages people to walk and can reduce use of personal vehicles. With more people switching from driving to walking, energy consumption is reduced, hence lower carbon dioxide emission and improved health of city people. When more people opt to walk, the mission of smart mobility is achieved.

Smart Environment. In creating a cool and shady atmosphere and beautiful views in the urban environment, physical activity is subconsciously encouraged. The key factor is to plant sufficient numbers of large trees to absorb ground water and cool the air through evapotranspiration (Figure 7). Large trees also mitigate net emissions by directly absorbing carbon dioxide from the atmosphere.

Conclusion

Technological advancements and the convenience of urban life reduces levels of physical exercise among urban dwellers. Smart city design needs to motivate increased pedestrian activity in people's daily lives. The case study from this research indicted the possibility of improved urban quality of life

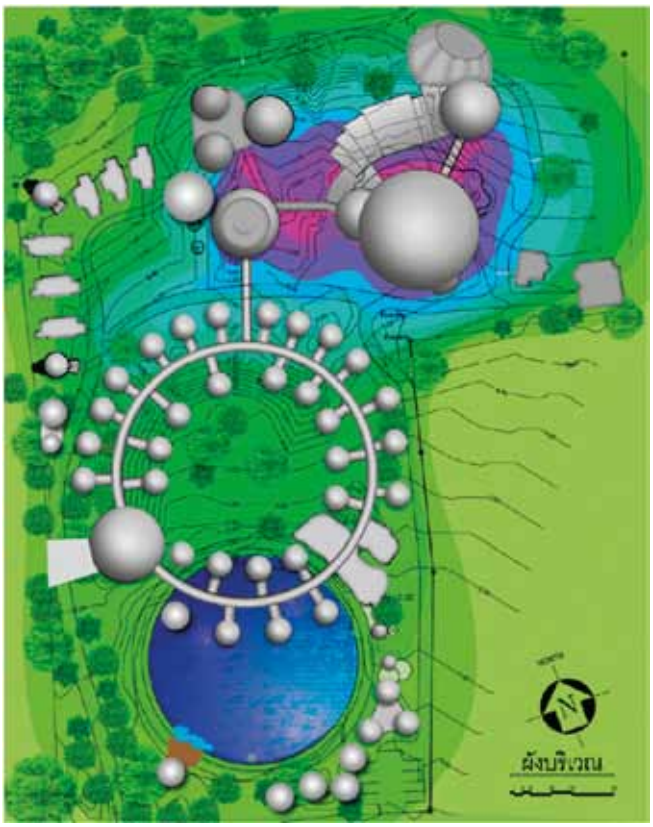

Figure 7 Plan of DNA Resort, Khaoyai
Illustrating cool air from the pond at the front and the mountain at the back to flow toward the project where the basin on the purple area collects cool air
Source: Boonyatikarn et al. (2010a)

simply by creating a pleasant, green urban environment that automatically encourages physical activity. Guests staying at the DNA Resort had approximately double their normal opportunity to exercise compared with elsewhere. This idea should be incorporated into smart city design to enhance quality of life in many dimensions. The improved environment also contributes to other elements of a smart city, including smart energy, smart mobility, smart health, and smart environment.

Acknowledgements

This article is part of the research projects entitled *"Designing and Creating the Index of Modern Ecosystem for Sustainability (Phase 2)"* and *"Designing and Creating the Index of Modern Ecosystem for Sustainability (Phase 3)"* funded by the National Research Council of Thailand under its 2010 budget. The researchers are also grateful to DNA Resort, Khaoyai, for allowing some parts of this research to be applied in real situations to improve the environment inside the resort and subconsciously encourage physical exercise for their guests.

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Effect of Mobile Phone Use on Quality of Life and Sleep Quality among Elderly in Urban Area

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Introduction

Smart City is today's development trend. It is the use of digital technology in improving the life and the fast access to the city's services, which ultimately results in the well-being of its citizens. In the age of wireless communication, mobile phone is an important part of the development of Smart Cities.

As a result of Thailand's decreasing birth rate, the country has entered its phase of aging society since 2005. Meanwhile, thanks to the globalization, the use of mobile phones has become popularized, especially among the senior citizens. According to Thailand's National Statistics Office's data on domestic use of information and communication technology in 2015, the use of mobile phones increased from 66.40 percent in 2011 to 79.30 in 2015, which equals to 3.23 percent growth per year. It is also found that 90.30 percent of mobile phone users are in Bangkok (National Statistics Office, 2015).

It is undeniable that mobile phone offers not only a convenient way to stay connected with our family and friends but also to live our daily life. It can, however, create various effects on our health, such as the quality of our sleep, the stages of depression, headache, and brain's function. According to a study of the effects of the use of mobile phones in senior citizens of Japan, it is found that the use of mobile phones results in a decrease of depression among male senior citizens and an increase of positivity in their female counterparts regards socialization (Minagawa and Saito, 2014).

Given the positive and negative effects of the use of mobile phones on both physical and mental health in senior citizens, this research aims to study the relationship between the use of mobile phones and the quality of life as well as sleep quality among the senior citizens of Bangkok, in hopes that it may contribute to the betterment of their health.

General information on senior citizens

This research is a cross-sectional study which consists of individual interview of 1,457 senior citizens aged between 50-70 years old who reside within Bangkok area. The interviews are performed in January-March of 2017, using a standard questionnaire format and a questionnaire developed by our team of researchers.

According to the analysis, the average age of the interviewees is 67.1 years old. 73.60 percent are female. 58.70 percent are married and 30.10 divorced/widowed. The highest educations obtained are 54.80 percent primary school and 14.50 percent high school. 62.40 percent of the interviewees live mainly in Bangkok. The average income of the interviewees is 9,013.13 baht per month. 91.70 percent of them live with their family, of which 47.20 percent consist of 3-4 members. 42.30 percent of the interviewees believe that they are in good health while 36.40 percent believe they have an average health.

Mobile use behavior

Outgoing and Incoming Calls

This study finds that, within the last 30 days before the interviews, 44.20 percent of the interviewees make two outgoing calls per day, 39.30 percent receive two incoming calls per day, while 20.00 percent make and receive one call per day. (Figure 1)

Mobile Use During Sleep

72.50 percent of the interviewees have never been interrupted by their mobile phone during their sleep. 26.40 have been interrupted sometimes and only 2.90 percent are interrupted every night. 29.50 percent leave their mobile phone outside of their bedroom, 26.20 percent leave it within their bedroom but away from their bed and 23.50 percent keep it on their bed. 64.30 percent of the

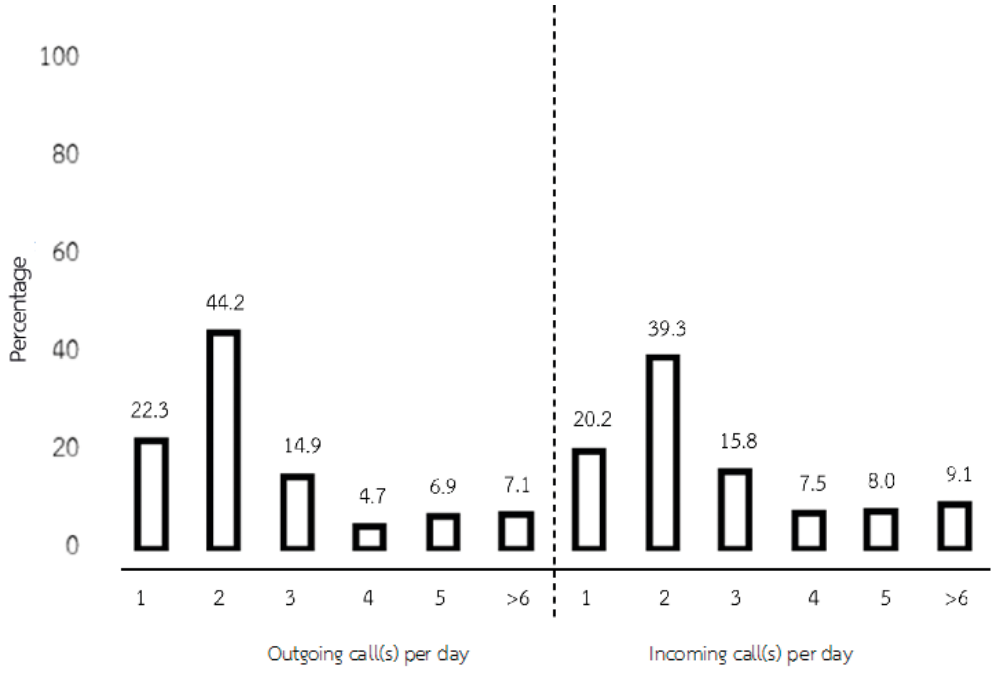

Figure 1 Percentage of the number of outgoing and incoming call(s) per day
Source: Taneepanichskul et al. (2016)

interviewees do not use with their mobile phone before going to sleep, while 18.40 do sometimes and 17.30 do every day. 57.60 percent of the interviewees keep their mobile phone on throughout the night, 27.20 percent turn their mobile phone off being going to sleep and 15.20 percent keep their mobile phone on during important events or 2-3 times per week.

Attitude Towards the Use of Mobile Phone

85.20 percent of the interviewees do not think that they use their mobile phone too much and 67.20 percent believe that people around them agree with them. 64.00 percent feel like the use of mobile phone has brought them closer to their loved ones. 79.20 percent do not think that the use of mobile phone has created distance between them and their loved ones. However, 78.60 percent of the interviewees still prefer face-to-face communication over communication through mobile phones.

Quality of life

In this study, the interviewees' quality of life is evaluated accordingly to the WHOQOL-BREF-THAI, which defines quality of life as an individual's attitude and habit which are closely related to their culture, society, and environment. An individual's quality of life can be grouped into four domains; 1) physical health or an individual's perception of their body which has an effect on their daily life 2) psychological health or an individual's understanding of their state of mind 3) social relationship or an individual's perception of the relationship they have with other people and the support they receive 4) environment or an individual's perception of how the environment affects their daily life. In this study, it is found that 59.80 percent of the interviewees have an average quality of life, 38.40 percent have a good quality of life, and only 1.90 percent have a bad quality of life. (Figure 2)

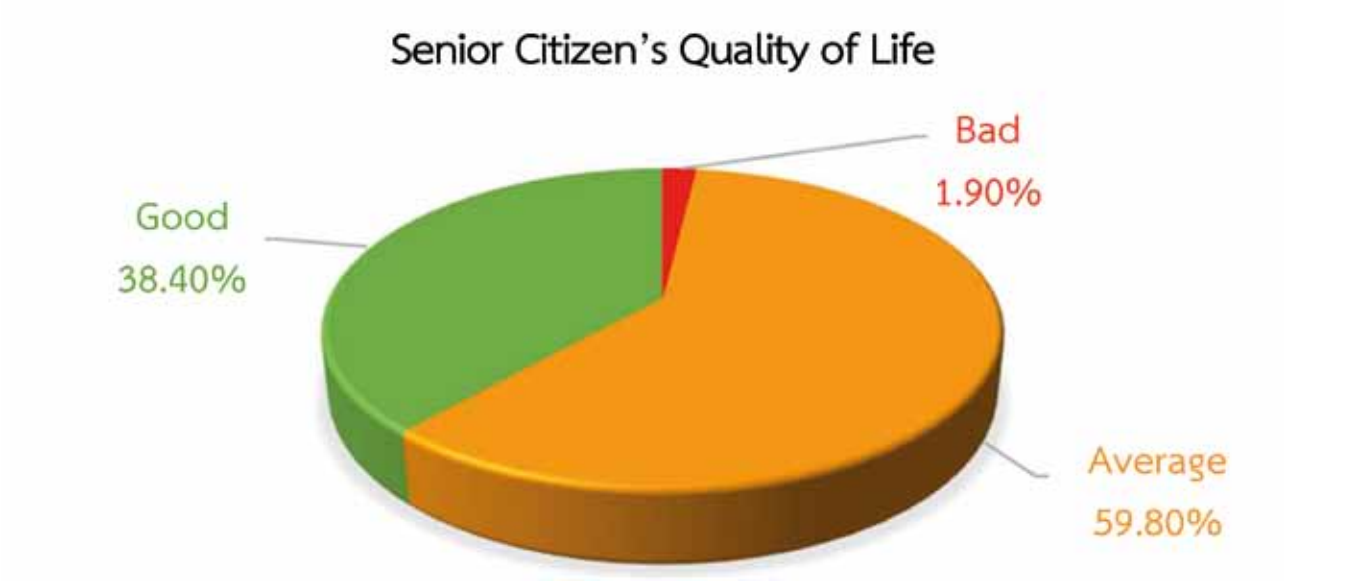

Figure 2 Interviewees' quality of life
Source: Taneepanichskul et al. (2016)

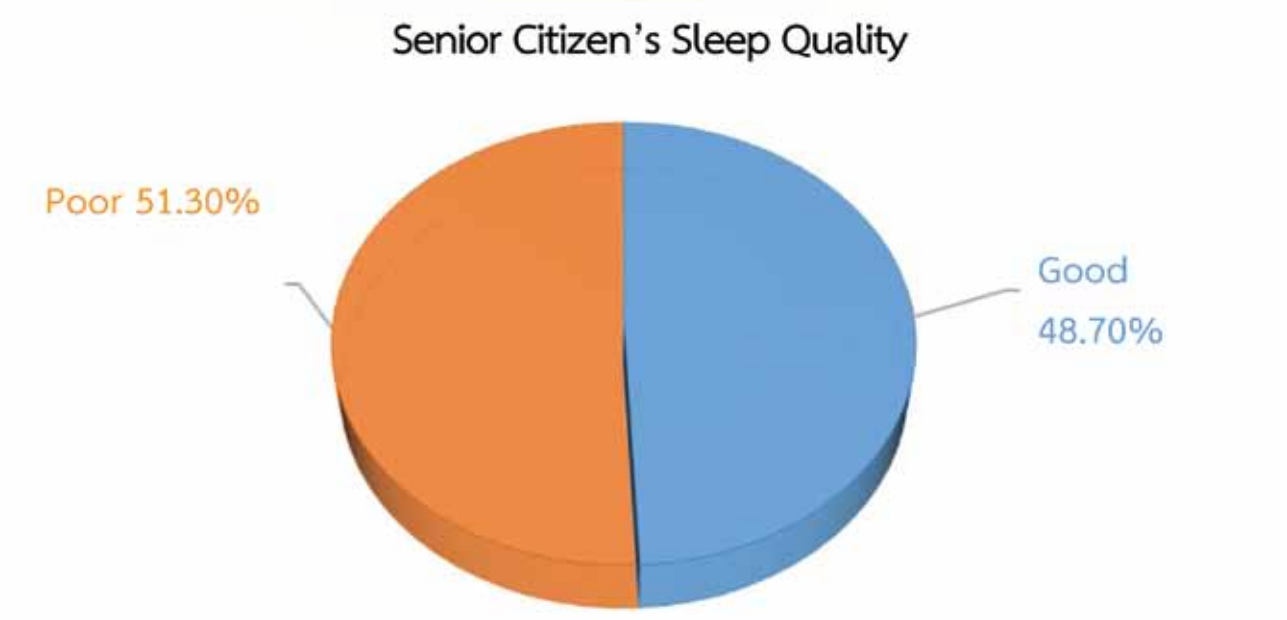

Figure 3 Interviewees' sleep quality
Source: Taneepanichskul et al. (2016)

Sleep quality

In this study, the interviewees' sleep quality is evaluated using to the Thai adaptation of The Pittsburgh Sleep Quality Index (PSQI) (Sitasuwan et al., 2014) which divides sleep quality into seven aspects; subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction. It is found that 48.70 percent of the interviewees have a good sleep quality while 51.30 percent have poor sleep quality. (Figure 3)

Effect of mobile phone use on quality of life

The analysis of statistical relationship between mobile phone use behavior and senior citizens' quality of life shows that the number of outgoing and incoming calls has a significantly positive effect on their quality of life ($p<0.05$), especially for those who believe that mobile phone use brings them closer to their family ($p<0.05$). The other factors of mobile phone use, however, have no effect on the quality of life of senior citizens. The findings of this study agree with another study conducted in New Zealand, which found that social media use improve the quality of life of senior citizens and their family members. Because mobile phone allows its user to communicate with other people without the limitation of space and time, the use of mobile phones, social media, and other applications, including communication techniques, makes the communication between senior citizens and their family easier and more frequent, resulting in a stronger familial bond (Siricharoen, 2015). This agree with the study of Thaweesit and Boonyamanon (2010), which found that mobile phone use for communication brings senior citizens closer to their family. It is, therefore, undeniable that mobile phone is not merely a mean of audio communications but also a device which offers fast and unlimited access to news and information, which improve the quality of life of senior citizens. Mobile phones also offers senior citizens a convenient way to stay connected with their family members, reducing the sense of loneliness, abandonment, and worthlessness, while improving their self-esteem and the relationship

they have with their family member. However, the overuse of mobile phone may lower the life quality of its user.

Effect of mobile phone use on sleep quality

The analysis of statistical relationship between mobile phone use behavior and senior citizens' sleep quality shows those who are interrupted by their mobile phones during their sleep have a lower sleep quality than those who are not ($p<0.05$). Those who use their mobile phone before going to sleep have a lower sleep quality than those who do not ($p<0.05$). This is due to the exposure to the blue light which emits from mobile phone's screen and reduces the production of melatonin, a hormone which is significant to sleep quality (Exelmans and Van den Bulck, 2016). However, it is not found whether senior citizens' quality of sleep is affected by whether the mobile phone is on or off and where it is kept during their sleep.

Conclusion

Mobile phone is a technology crucial to the development of Smart City. However, senior citizens should not use their mobile phone excessively. The use of mobile phone may promote their quality of life because it offers daily life convenience and easy communication with their family and friends, including an easy access to news and information. However, using mobile phone before going to sleep and interruptions caused by mobile phone results in a lower sleep quality.

Acknowledgement

This article is part of the research project entitled ***"The relationship between quality of life and smart phone communication in daily life of elderly people: a case study of elderly people in urban area in Thailand"*** funded by National Research Universities 2015, Aging Society Cluster, Office of the Higher Education Commission.

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Assoc. Prof. Weerasak Krueathep, Ph.D.

Thai Local Administration's Readiness for Smart City Initiatives

Assoc. Prof. Weerasak Krueathep, Ph.D., a specialist in local finance, public financial administration and public budgeting, shares his perspectives on the readiness of Thai local administration in transforming towards smart city.

Factors Influencing promotion and development of a Smart City

"...different interpretations of the legal framework impose critical barriers at local level, affecting decision-making of local authorities such as granting of building permits or installing local administration initiatives supporting smart city development..."

Experience from Thai local administration has taught us that the development of each city are for the most-part, highly location-specific and do not follow a common pattern. Each city's problems emerge from diverse combinations of many issues including law, human resources, policies, and budget. Local administrators need to adapt themselves in order to overcome the combined impact of these multiple challenges. Central government budget allocations are no longer a major obstacle to community promotion and development because city development initiatives nowadays rely increasingly on funding from local private sector – actors whose businesses stand to benefit from the development.

Also, local development projects are now being completed in a more cost-effective manner. At the same time, human resources and local management policies have no longer been issues in smart city development as there have been increasing developments in these areas in the past few years. At present, local communities in many areas are able to adapt to and initiate practical platforms that provide pathways to smart city moves.

Nevertheless, several laws and regulations impose important barriers to launching local administration initiatives. While there is ample resources regarding the promotion of smart city development, local administrators units are barely willing to take on the risk of initiating some projects where there is legal or regulatory ambiguity. They are also wary of the possibility of being charged on ultra vires by the Office of the Auditor General. Although it can be said that the major barrier is the lack of essential laws to promoting local government roles in smart city development, it is, in fact, the inconsistent interpretations of laws, regulations and mandates that lead to risk-averse behavior by local administrative authorities. If the local government laws are interpreted in accordance with their fundamental principles, local administration will be fully empowered to take several smart city development actions as long as they serve the purpose of *"people, quality of life, and long-term local development"*. However, the narrow and subjective interpretation of laws as inhibited by several central government agencies has restricted the authority and discretion of local administrators such that no bold action has been embarked in many local service areas.

Moreover, it is clear that every aspect of smart city development is about city planning. Now the problems stem from underlying flaws in city planning and management in the past, as well as legal issues that no single agency has the sole power to enforce the city planning laws and solve these difficulties. The problems are deep-rooted and intractable, often going beyond the ability of local administrators to address them successfully. A good city planning should not allow the concentration of urbanization and development in just few CBD areas, but should ensure an even spread of modernization across all major neighborhoods in a city. However, this problem is impossible to be fixed in a short to medium term. Giving all these circumstances, the concept and principles of smart city development must be adapted to the existing city plan in order to bring the best possible outcomes. In any case, smart city development in Thailand should be designed to allow growth in all business sectors, including modern trade and traditional business such as small grocery stores serving vital community roles.

Thai Local Administration's Readiness and its Roles in Driving Smart City Initiatives

"...During the past few years, local administration's efforts in adapting themselves to smart city development are beginning to bear fruit. It can be seen in city's safety development, facility management initiatives, and even the installation of technological advancement in city management..."

From a social science perspective, smart city development represents the ability of local authority in implementing technology in city management in order to create solid foundations that enable a city to solve its own problems in a smarter, less time-consuming and more cost-effective way. Efforts over the past few years by local governments in line with the smart city initiatives are now beginning to shine. One case study of a city's safety program can be seen in Rangsit Municipality, Pathum Thani Province, just north of Bangkok. Public surveillance systems have been installed throughout the city, especially in crime hot-spots and accident risk-prone areas. The security

cameras are monitored closely 24 hours and seven days a week. When an emergency is detected, a rapid deployment unit is sent out to the scene in order to help relieve the damages and losses. Another case is in Songkhla Provincial Administrative Organization (PAO), where not only CCTV and monitoring systems are installed, but the Songkhla PAO also utilizes Geographic Information System (GIS) to linking with the Public Health Department. When an emergency is calling off, the system will immediately locate the emergency and describe the traffic surrounding the area. Then, it analyzes real-time traffic conditions in order to identify the fastest route to the scene for an emergency medical service (EMS) team. This is a result of collaboration between doctors and professional nurses from Songkhla PAO, the police, and all locales within the province, with the aim of accessing communal incidents and assisting patients in time.

In the area of facility management, another case can be found in Khon Kaen metropolitan area where a new transportation plan called the *"Khon Kaen Model"* has been implemented. The purpose is to improve city accessibility through a light rail transit system. This model is a result of close collaborations among several local authorities and private sectors in the area, together with the support from academics and central government agencies. The transit system is expected to run through the city's CBD zone and vicinity areas. In the future, it is expected that the project will be able to link all kinds of transportation, including the light rail system, bus and mass transit system, both in the central city and suburb areas.

There are many more cities that combine advanced technology with local wisdom in order to manage their own problems. Tab-Nam Tambon Administrative Organization (TAO) in Ayutthaya is one such example, where an irrigation system for agriculture was installed, incorporating water demand and supply database in serving the local agricultural needs. Household surveys were conducted to establish the intensity of farming in the area, the number of agricultural land plots and crops grown. The data were calculated in order to estimate future water demand, and each village assessed separately to help develop an integrated water management plan that best satisfies its own needs. Irrigation control gates were constructed, incorporating CCTV and level gauges to monitor water levels in a real time manner. A dedicated mobile app was also developed to help monitor the gate via a local Wi-Fi connection, which allows remote operations of the sluice gate without the need for any personnel to actually be present at the site.

Lampang Municipality offers another case study in waste water management system. The project had initially failed to secure governmental funds. However, with local wisdom and contributions from city officials and local residents, the city was able to raise a small amount of funds to create an alternative, low-cost end-of-pipe waste water management system. The mechanism uses filter ponds containing filter sheets, shells, and coal. The number of ponds built in each area was determined by the level of contamination of the discharged water. This method requires only 20-30 square meters in the local area and a budget of less than one million Baht. Its success has been confirmed by the water quality analysis results from scientific laboratories, which reveal that the treated wastewater from this conventional waste water management system has a comparable quality to that of other higher-cost systems.

The Advantages of Local Administration in City Development

"...as local government is a small organization, working closely with the local community, it is much more responsive to local problems and community concerns than other central government agencies..."

One of the advantages of local administration is its ability to respond in a quick manner. As local authorities are typically small organizations working closely with the local community, they can work much more responsive to community concerns than any other central government agencies. However, in many cases, the power of local administration to act is often constrained by narrow interpretations of laws and their duties prescribed by the audit agency. This leads to circumvent local officials in initiating many tasks and long-term city development. However, local administration has another advantage which is about its working style that allows the organization to build extensive networks. With some knowledge transfers, especially best practice examples and resolutions about regulatory issues, there is a strong potential for major accomplishment in smart city development managed by local administrators.

Nowadays, the government assigns the Office of the Decentralization to the Local Government Organization Committee (ODLOC) to assist in solving regulatory issues for local authorities. In case that a project initiated by the local administration faces regulatory challenges, local authority can bring the case to the Committee for review and consideration. If the Committee approves or agrees with the project, a certificate from ODLOC will be issued in support of the proposed plan. The certificate is considered as a law for practitioners with the same legal status as a ministerial regulation, allowing local administration to proceed the project into action. This system paves the new and more hopeful way for smart city development using authoritative legal interpretation to facilitate local administrators in developing the city to its full capacity.

Guiding Solutions to the Promotion of Smart City Development

"...In the where local administration does not want to risk its operations regarding legal restrictions and the government cannot allocate any more budget to the local initiatives, the success of smart city development must rely on funding from local businesses in order to support the local administration in managing their confronting issues..."

The autonomy of a local government to introduce smart city measures is frequently constrained by central government rules that literally prevent it from adopting new experiments. At the same time, central government takes no serious action in handling local issues, leaving the problems unresolved. Garbage disposal is a case in point. In the past, central government attempted to solve the problem but failed. Then, the problem was passed on to the responsibility of local administration. However, when the local authority wanted to proceed in fixing the problem, it was obstructed by legal and regulatory hurdles and received no support from the central government. Eventually, local residents and communities suffer from overwhelmed, non-disposable

solid waste. In short, city development was put on hold, leaving fundamental problems remained unchanged.

Until recently, there was one success case in solid waste management which relied cooperation and funding from local businesses, together with the effort of local government in promoting and managing legal issues. They altogether advanced the electrical power plant from solid waste in Khon Kaen City through fund raising from public-private partnerships (PPP). By embracing this concept as a model of smart city development, the chances of success will be increased. Local business leaders are now driven by a desire to improve the quality of life for their community, leading to a shared vision to develop the city in a way that brings about most benefits to the area. This provides a great advantage to the city itself. The city government, using 100% private sector funding, successfully initiated a garbage management system through a local-based private investor. The idea has a high potential to replicate successfully in other cities around the country.

Roles of Higher Educations in Promoting and Developing a Smart City

"Universities should foster knowledge integration in all dimensions, including people, economy, quality of life, in support of local administration, and help design options for city development models to accelerate smart city initiations."

Promoting, developing, and supporting the local administration must take into account and the diverse functions of cities and the needs of communal residents. Chulalongkorn University, as an educational institution with extensive expertise in this domain, is well placed to promote and support local governments in smart city development, and should proactively expand her expertise to accelerate knowledge integration at the local level, rather than developing knowledge in disengaged academic disciplines. The university should provide support in designing diverse models for smart city development by incorporating diversities of cities-historical, modern, large and small, agricultural cities, livable cities, environmental cities, MICE cities and so on. Such diverse models can then be matched to appropriate provincial and city contexts. If government agencies or local authorities are interested in any city development option, Chulalongkorn University should form a task force team and offer its specialized expertise and support the public sectors in planning and developing a roadmap and detailed management system. Such collaboration will help accelerate city innovation and ultimately the transformation towards smart cities across the nation.

Assoc. Prof. Weerasak Krueathep, Ph.D.

Assoc. Prof. Weerasak Krueathep, Ph.D. is at Department of Public Administration, Faculty of Political Science, Chulalongkorn University and serves as a committee member of the National Decentralization Committee. He graduated with Bachelor's Degree in Political Science with 1st class honor, majoring in Public Financial Administration, Master's degree in Public Policy from National Graduate Institute for Policy Studies (GRIPS), Japan (Japanese Government Scholarship) and doctorate degree in Public Administration from Rutgers, The State University of New Jersey, USA (Thai government scholarship).

Bangkok - A Smart City?

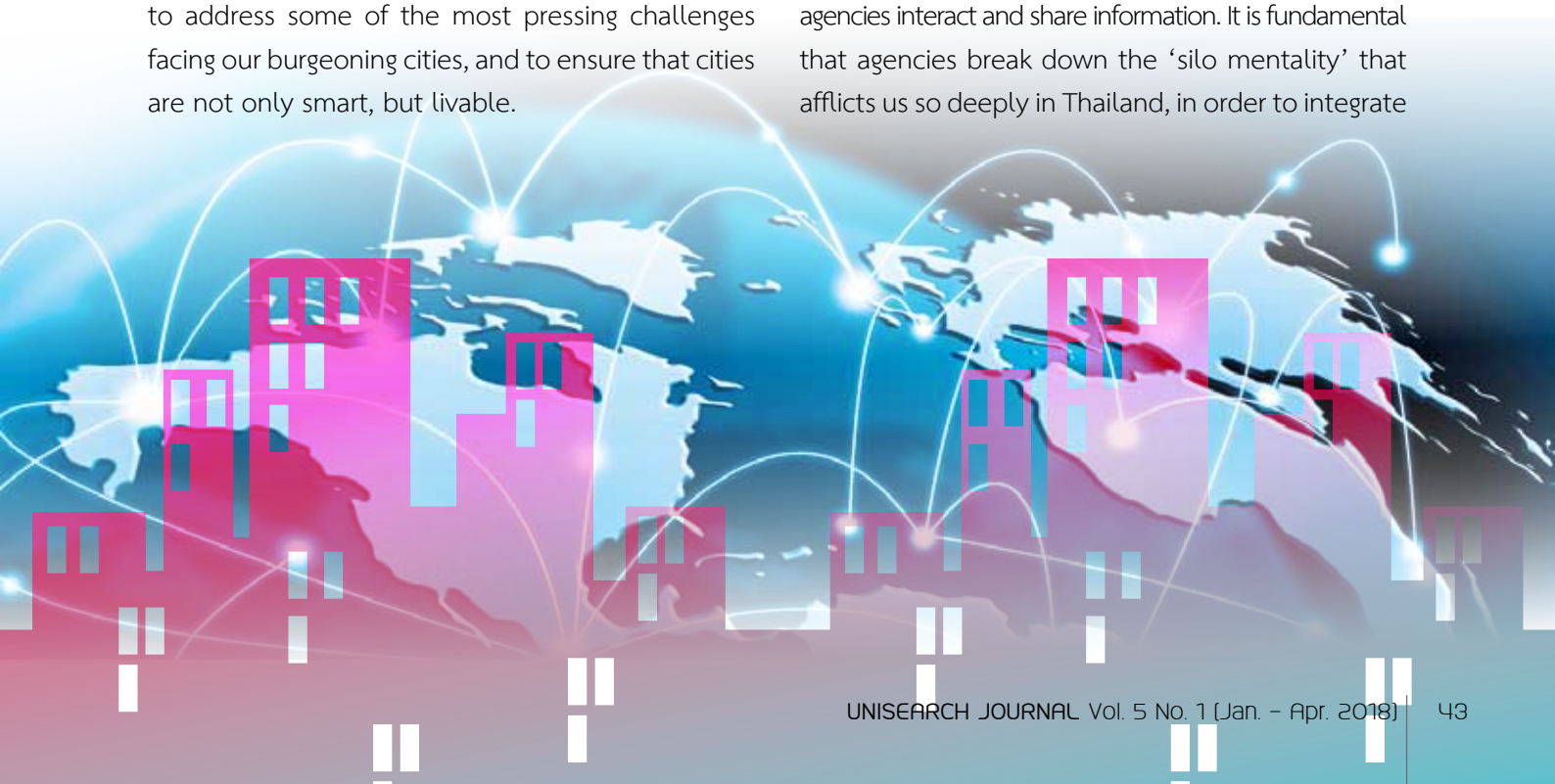
"Around us"

Assoc. Prof. Thavivongse Sriburi, Ph.D.

The term *"Smart City"* is increasingly frequently heard among academics and administrators, especially in reference to the government's drive towards a technologically advanced, innovation-led economy, or *"Thailand 4.0"*. However, though widely used, it is doubtful whether we all really understand what it means, beyond the obvious (e.g. cashless payment, smart cards, driverless cars, etc.). To understand more about the concept, we need to ask a few key questions. What actually is a Smart City? Why do cities have to be 'Smart'? What makes a city 'Smart'? How do people work together to create a Smart City? However, as even academics, planners and practitioners are not all agreed even on a definition for a Smart City, the task of planning the transformation towards a smart city is highly challenging, particularly as technological advance is so rapid and disruptive. Establishing the right conditions within the context of complex and fast-moving urban development requires a deeper understanding of the smart city concept among all related sectors. The concept is a new one for Thailand, but has enormous potential to address some of the most pressing challenges facing our burgeoning cities, and to ensure that cities are not only smart, but livable.

Many cities around the world have launched Smart City projects, harnessing technology convergence to address the everyday challenges of urban life. Each city is of course unique and will require unique solutions, depending on development objectives (e.g. tourism or industrial development). Nevertheless, they all face some common challenges, particularly in regard to transportation, energy, health, infrastructure and leisure. Smart cities aim to address these challenges in a way that is cost-effective, reducing pressure on finite resources such as water, energy and land, and improving the wellbeing and quality of life for urbanites.

Around the world, the concept is emerging as a mainstream strategy, harnessing digital technologies to create innovative solutions to urban development challenges and to give urban dwellers a more comfortable and livable city and way of life. In some cities, it is no longer an impossible dream, where citizens can quickly access a wide range of personalized public services using smartphone-linked apps, connected to cloud-based databases. Achieving this has required major changes in the ways organizations and public agencies interact and share information. It is fundamental that agencies break down the 'silo mentality' that afflicts us so deeply in Thailand, in order to integrate



digital technologies across a complex urban environment. Building trust and cooperation among local administration, business and society is essential to success. We see this reflected in countries such as Singapore, South Korea and Spain, where the transformation is initially driven by a master investment by joint ventures between public and private sector, in cooperation with some of the world's leading technology providers. Together, these consortia can deliver major synergies and scale in leveraging modern technologies to effectively manage the smooth functioning of cities and communities. These are the success stories and the models that Thailand needs to study.

Thailand has announced a policy drive towards a digital economy. Smart cities are an integral part of this initiative, which aims to create new opportunities to expand the economy and boost social development down to the local level. However, the technological vision, strategies and approaches to achieve smart and sustainable urban development are yet to be articulated, as has been done successfully in other model countries.

Although Thailand's *"Smart City"* drive has yet to make substantive progress, some important initiatives have been launched to model urban spaces in university areas in several provinces, following Smart City concepts as implemented in many cities around the world. In these prototype Smart Cities, residents enjoy a higher quality of life and a pleasant living environment. With these successes in mind, the Department of Energy, which carries responsibility for urban development, has defined the essential components of systems required for smart city development.

The Smart City concept can be described in terms of the following seven components:

1) Smart energy smart energy is generally characterized by the application of an energy consumption index, use of renewable energy, energy production at point of use, energy accumulation, centralized cooling and heating, smart energy management systems, reducing carbon emissions and promoting elevated rapid transit systems.

2) Smart mobility embraces integrated approaches to planning of power infrastructure, water distribution, transportation and mass transit systems, parking management, pedestrian- and bicycle-friendly cities, including mobility in relation to hospital and emergency services, security, schools, tourist attractions and waste management.

3) Smart community smart communities promote a higher quality of life in regard to safety, health and welfare, education, welfare, disaster prevention, and care for the elderly, disadvantaged and disabled.

4) Smart environment refers to integrated efforts to conserve and promote a green urban environment, including parks and green spaces and ecosystem biodiversity, urban agriculture, water management, air and water quality as well as broader efforts to mitigate urban heat island effects.

5) Smart economy smart cities need to foster innovation and entrepreneurship, e.g. through promotion and incubation of new business models, investment innovation benchmarks, business intelligence and competitiveness, participative approaches such as social entrepreneurship, revenue management and sustainable approaches to city management.

Having defined the core elements and objectives for a Smart City, planners need to set ambitious but realistic targets across a range of technological, economic, social and environmental criteria in order to achieve the ultimate goal of an enhanced quality of life for urban dwellers, while conserving the environment and ensuring sustainable use of resources.

6) Smart buildings perform a vital foundation for smart cities, in particular in maximizing energy efficiency and a conducive work environment as part of the assessment criteria for green buildings, as well as the promotion of Net Zero Energy Buildings systems and smart homes.

7) Smart governance underpins all of the above, with enlightened leadership, a connected organizational structure that fosters inter-agency collaboration, knowledge-sharing and problem-solving, supported by a coherent system to align human resources in the public sector, e.g. common key performance indicators (KPI).

Objectives of Smart City development

1) Foster research and development on platform technologies. It will be essential to foster research and development to build new systems to manage technologies to create connected cities, based upon concepts such as the Internet of Things (IoT) and the analytic potential of Big Data to manage the range of complex multi-dimensional challenges inherent in city management. This of course includes the monitoring of technological advances and- just as importantly- innovative social approaches at global and local levels.

2) Develop and position city infrastructure to optimize energy management and resource use. Effective urban planning and design can promote the use of renewable energy and its integrated management across key city functions and services, as well as improved use of scarce natural resources, including recycling and waste management systems.

3) Foster development and deployment of Information and Communication Technologies (ICT). Access to ICTs and a supporting high-speed ICT infrastructure is fundamental to smart city development, enabling integrated monitoring and control of complex and diverse city functions, to balance supply and demand and allow the city to meet the people's needs for basic services and boost quality of life.

4) Investment support to promote businesses and economic activity related to smart-city development.

Smart City development is grounded in the following four key principles:

1) Universal access to ICTs and public utilities: Broad coverage by efficient public utilities and infrastructure, accessible to all, whether free or at reasonable cost: access is needed by all citizens, regardless of ability, gender, age or status.

2) Flexibility of information and communication technologies (ICT): ICTs must be easy to learn, use and apply, and can be readily and quickly modified respond to changing urban needs.

3) Renewable energy: production, supply and the use of energy are managed to promote and incentivize the use of renewables among all sectors, including private homes.

4) Innovation-driven: To aspire as a high quality city, urban planners must foster technological and social innovation across all sectors, in order to enhance quality of life for urban residents and visitors, ensure safety and environmental conservation, increase efficiency of resource use, cultivate continuous 'smart' business development, and co-create a learning society.

Creating a Smart City requires long-term planning not only for design and construction, but also for continuing maintenance and development. This is not only to maintain existing services and systems, but also to accommodate a continuing dynamic evolution, including new ways of applying emerging technologies. Most importantly, smart cities also need to accommodate the changing needs of its communities. The success of Smart Cities will be measured in their future-proofing- their agility and capacity to adapt.

Cities in Thailand interested in embracing this development path face varying levels of interest and demand from government and the public. This depends in part on the scale of the challenges faced by each city and quality of life- whether from tourist pressure, congestion, pollution or waste management. The pressure on local infrastructure and especially on water and waste management services can be immense, and represent primary policy concerns at provincial level. For industrial cities, interest in a smart city will focus mainly on public transportation systems and facilities to house and transport personnel, and to accommodate the logistic needs of local industries, including the incorporation of environmental measures to minimize pollution and other environmental impacts.

It is crucial that Smart City design and development involves all sectors. A participatory approach is essential to ensure the final design is first and foremost people-centred, and addresses the needs of diverse urban constituencies, particularly the disempowered whose numbers are many, but whose voices are rarely heard or heeded. Only with this broad buy-in and support across all sectors in society can Smart Cities- and Thailand 4.0- succeed.

GoodWalk Project

Study of the potential for access to public amenities by promoting walkability and indicators of walkability potential

Assist. Prof. Niramon Kulsrisombat, Ph.D.
Pornsan Vichienpradit, Ph.D.
Adisak Guntamuanglee

Walking is an easy- and free- way to improve health as part of our daily lives, and needs to be promoted for its health benefits. In order to do this, it is therefore important to gain an understanding of pedestrian behaviour, in two key respects. Firstly, in regard to the objective and destination (generally divided into two categories: walking as part of urban life, such as walking to mass transit stations, school or workplace, as well as walking for health and recreation. The second aspect of pedestrian behavior relates to a pedestrian-friendly environment, for example the quality and continuity of pavements, lighting and shade, as well as social and economic activities along the route.

However, in the past, development of the Bangkok and its vicinity has given scant concern to creating a pedestrian-friendly urban environment. As a result, pedestrians face numerous hazards such as poorly maintained or no footpaths. Other factors such as the heat and heavy rains deter walking as a preferred means of getting around. In addition, it is clear that walking behaviour of Thai people tends to follow the theory of transport economics. Pedestrian behaviour is linked to economic activity- i.e. more shops encourage more walking.

Due to the importance of walking as a strategic component of the innovative *"Healthy City"* policy initiated by the Thai Health Promotion Foundation (ThaiHealth), ThaiHealth commissioned **Chula Unisearch** to conduct a research study of *"the potential for access to public amenities by promoting walkability and indicators of walkability potential – GoodWalk Project"* as a mechanism to link the *"Healthy City"* policy to spatial development plans and develop a strategy to encourage daily walking of Bangkok people. The study began by developing an empirical database to help identify challenges and potential strategies for improving wellness and stimulate healthy urban lifestyles. The project is divided into two components:

1) Study of accessibility potential to urban amenities, to realize accessibility potential of walking

destinations in order to encourage Bangkok people to walk in their daily lives. The study will focus on locations of walking attractive amenities such as transit points, parks, recreational spaces, etc. to provide an overview of urban development and its impact on pedestrian behaviour in public areas. The results are expected to provide important insights to inform urban policy reform and planning processes in the future.

2) Study of walkability potential, to identify environmental factors affecting people's desire and propensity to walk. The study will examine various types of urban areas, determine the 'walkability potential' for each type, and offer guidance on how to improve the environment to encourage walking. Such guidelines can be used as a template to develop other urban areas to encourage pedestrian activity.

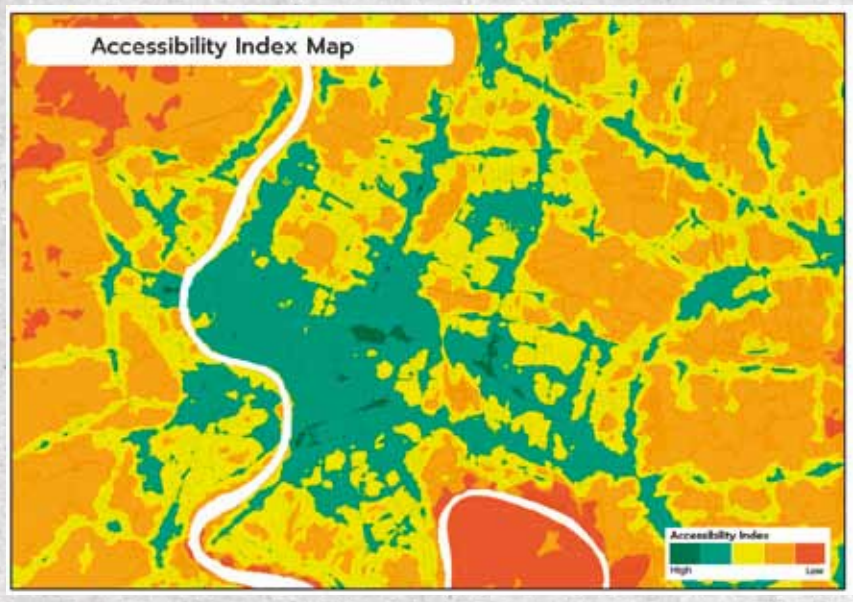
The project will be implemented in three phases as follows:

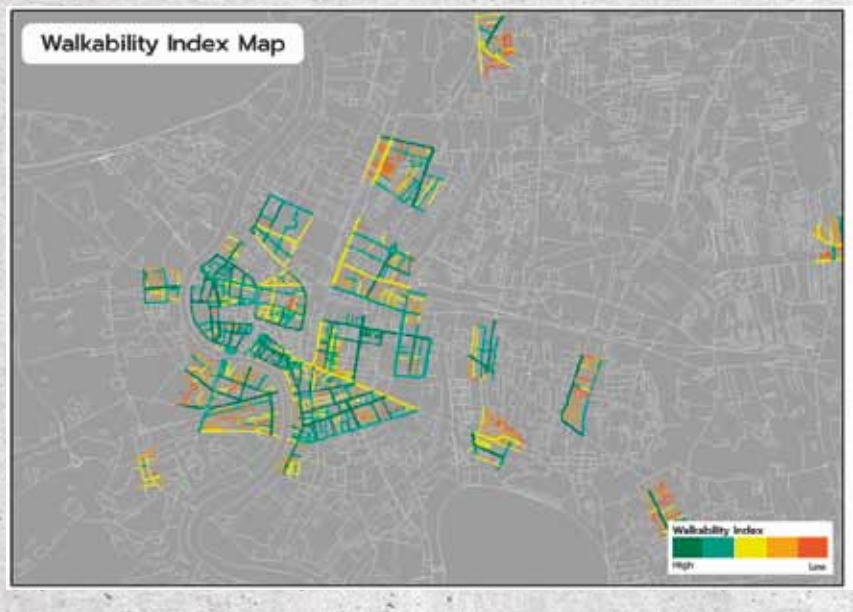
Phase 1 used spatial analysis to create an Accessibility Index map (A Score map) that calculated from agglomeration of amenities which possibly promotes pedestrian activity in Bangkok and its vicinity. The map graphically illustrates the potential of high-reach areas with cool colours. These represent areas recommended for improvement of the urban environment to promote pedestrian activity.

Phase 2 analysed survey data and developed a Walkability Index map (W Score map) to indicate *"pedestrian potential"* by identifying constraints and challenges to pedestrian activity, and establish a pedestrian-friendly urban design standard. From a study of the 34 pilot areas identified by their high scores in Phase 1, the resulting pedestrian potential map shows pedestrian-friendly routes in cool tones, with less conducive routes shown in warm tones.

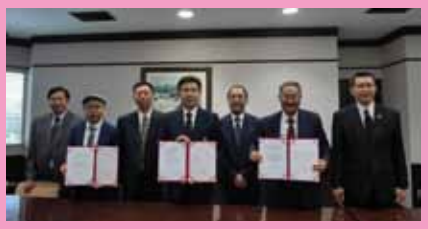
Phase 3 will finalize recommendations and guidelines for physical design to stimulate pedestrian activity. An in-depth study of the physical environment for pedestrians will examine social factors and needs of pedestrians in three pilot areas in the city: Aree – Pradiphat, Silom – Sathorn and Kadeejeen - Klongsan. The objective is to develop a prototype design for a pedestrian-friendly urban environment. This phase is now in progress.

All those interested can follow news and events relating to the project at http://www.goodwalk.org and FB Fanpage: GoodwalkThailand





Signing ceremony of MOU to build the international Geographic Information Systems (GIS) Laboratory



On Tuesday 1 August, 2017, Chulalongkorn University, represented by **Chula Unisearch**, signed a MOU to build the international Geographic Information Systems (GIS) Laboratory to continue to build up its R&D cooperation with industry, both within Thailand domestic and overseas. The MOU, for a period of 5 years, was signed under the title: *"Strategic Cooperation Framework Agreement on Building Sino-Thai Beidou and Geospatial United Laboratory"* with the Wuhan Optics Valley Bei Dou Holding Group Co., Ltd. and the Institute of Geodesy and Geophysics, Chinese Academy of Sciences (CAS) of the People's Republic of China (PRC). The MOU will facilitate cooperation in research covering data from Bei Dou satellite navigation such as GIS, satellite remote sensing, geophysics and geodetics, UAV remote sensing, basic surveying and mapping, photogrammetry and other fields, as well as management of the Global Navigation Satellite System (GNSS). In addition, the MOU will include the exchange of information, researchers and students among the three agencies. Under the agreement, **Chula Unisearch** will be responsible for implementation and coordination of collaborative R&D to carry out activities that bring benefits to society and the country.

Stage hearing of the criteria for sustainable nature attractions carrying capacity assessment (draft)

The Department of Tourism, Ministry of Tourism and Sports together with **Chula Unisearch** recently held a first meeting on the drafting of criteria for sustainable nature attractions carrrying capacity assessment at Chulalongkorn University Research Building. The meeting was held in order to listen to expert opinions and suggestions from specialists in a variety of disciplines related to tourism management, including tourism management, environmental management, area development and urban planning, marine and coastal management, and political science. The meeting was attended by officials from several key agencies at central, provincial, and local authority level, including the Department of National Parks, Wildlife and Plant Conservation, Royal Forest Department, Department of Social Development and Welfare, the Office of Tourism and Sports of Phetchabun, and Marine and Coastal Resources Administration Office 9 (Phuket). Other participants included tourism operators and other public sector representatives and stakeholders in the project areas. The meeting was an important contribution to preparation of criteria for carrying capacity assessment and guidance on management of sustainable nature attractions. Pilot locations for implementation will include Bang Rachan Islet, Phetchabun province and Racha Yai Island, Phuket province.

CU exhibitions, research and innovation showcased at the Thailand Innovation and Design Expo 2017 (T.I.D.E. 2017)

Chulalongkorn University, represented by **Chula Unisearch**, showcased the University's latest innovations and design research University at the Thailand Innovation and Design Expo 2017 (T.I.D.E. 2017), held from 14-17 September, 2017 at the Queen Sirikit National Convention Center. The event was organized by the Department of International Trade Promotion, Ministry of Commerce. CU innovations presented

included reflective sheet forming one piece for street lighting, robotic system schemes for rehabilitation of stroke patients with symptoms of paralysis, equipment to study human face recognition, ornamental geopolymer bricks from fly ash and concrete sludge, mask on salivary glands and teeth, kaolin and black seed oil sunscreen, e-waste collector ROBO, *"Piggy bank la monnaie"*, fabric pattern designs and a controlled temperature rice husk biochar retort for slow pyrolysis process. The event attracted large numbers of entrepreneurs, students and interested members of the public.

Executive JAIST Japan visit and study Chula Unisearch

On Thursday 28 September, 2017, Assoc. Prof. Thavivongse Sriburi, Ph.D., Managing Director of Chula Unisearch welcomed Minoru Terano, Ph.D., Vice President of the Japan Advanced Institute of Science and Technology (JAIST) on a visit to study implementation of facility management services and academic and research services of **Chula Unisearch** to be applied in the implementation of JAIST, as well as to discuss future cooperation between the two authorities.



Executive of Toyota Motor Thailand and Toyota Mobility Foundation discuss cooperation with Chula Unisearch

On Monday 9 October, 2017, executives of **Chula Unisearch** led by Assoc. Prof. Thavivongse Sriburi, Ph.D., Managing Director, Assist. Prof. Saowanee Wijitkosum, Ph.D., and Supichai Tangjaitrong, Ph.D., Deputy Managing Director, welcomed Mutsura Fukuda, Program Manager of the Toyota Mobility Foundation and Ninnart Chaithirapinyo, Chairman of the Board of Toyota Motor Thailand Co., Ltd., for discussions to establish cooperation in research to resolve traffic problems and the development of the Sustainable Mobility Institute (SMI).



Merit-making ceremony in tribute to His Majesty the late King Bhumibol Adulyadej

On Thursday 12 October, 2017, executives and staff of **Chula Unisearch** joined a merit-making ceremony as a tribute to the late King Bhumibol Adulyadej, held by Chulalongkorn University in front of Chulalongkorn University Auditorium

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