Lesson Learns of Success factors from 10 Smart Cities Development: Thailand Context

Pawinee Iamtrakul
Associate Professor, Director, Center for Excellence in Urban Mobility Research and Innovation
Faculty of Architecture and Planning, Thammasat University, Pathumthani, Thailand
Email: iamtrakul@gmail.com

Jirawan Klaylee
Research Assistants, Center for Excellence in Urban Mobility Research and Innovation
Faculty of Architecture and Planning, Thammasat University, Pathumthani, Thailand
Email: klaileejira@gmail.com

Office of the National Economic and Social Development Board (NESDB) has established a 20-year national strategic framework (2017 - 2036) which is the main plan to direct national development inconsistent with sustainable development goals (SDGs), including the restructuring to Thailand 4.0, as well as national reform issues. In addition, the importance of participation of all development parties can help for manage to utilize the knowledge of science, technology and innovation to implement on an area that responds to demonstrate the potential of technology and innovation with the efficiency of readiness, including personnel, area, organization, and various sectors in production and respond to smart city development. In order to direct the development with appropriate quality index in almost all important areas such as human quality, education and public health service as well as alleviating social inequality and preserving the quality of the environment to lead a city with a complete network of systems, case study from success stories must be reviewed. This study attempted to investigate lessons learns of successful factor from 10 foreign countries. It was found that there are 5 issues to be considered, including (1) government transparency, which builds confidence for people who can review the information that have been solved; (2) establishing a board to oversee the development of smart cities, which needs to be placed in the overall operating framework; (3) creating an environment that is conducive to further innovation by creating a space for testing equipment (test-bedding) ; (4) establish laws and regulation to protect rights and personal information (cyber security); and (5) local government needs to be the pioneer of smart city development and create an attraction for each sector to participate.

Keywords—Smart City, Quality of life, Urban Planning Integrated

I. INTRODUCTION

The urban growth and city population are growing in a fast pace causing different dynamic issues to the environment, economic and social sustainability of cities (Bibri and Krogstie, 2017; Neirotti et al., 2014). The traffic congestion, poor urban infrastructure, health issues, energy shortages, educational challenges, inadequate housing, increasing crime rates, higher unemployment, ageing infra-structure, power thefts, issues in supply connections, insufficient power generations capacity, high power loss in transmission, frequent power breakdowns and lack of real time data sharing are some of common concerns in existing cities mostly in developing countries like Thailand (Lee et al., 2013).

Resulting in efforts to solve problems of the city to reduce the effects that occur up until the year 1994, the concept of creating also known as smart city, which is derived from the obligation to bind each industrial country to reduce greenhouse gas emissions which have also known as Kyoto Protocol (Mattoni et al., 2015). As a result, each country has started to formulate a strategy that is aware of the environmental policy and become one of the main driving factors. The concept of Smart City has played a role as the choice of raising the quality of life of people and facilitate work of the government more transparent (Kramers et al., 2014).

Also, Thailand has initiated the Smart development with supportive from both public and private sectors. In 2016, the Smart City Thailand Association was established as a direct coordination center and to control guidelines development. From efforts to create a quality society of the future smart city, the Ministry of Digital Economy and Society (Depa) selected pilot cities such as Phuket, Chiang Mai and Khon Kaen which is currently in the process. In driving to become a smart city, it is important to make people truly enhance the quality of life and engaging the system. In addition, to lay the foundation for urban development by developing Smart City, it must create readiness for development that is built on existing policies. All operations, it is necessary to overcome the problems of the city that is currently facing urban development without the difficulties of existing regulations while beneath the challenges of elderly society, climate change, etc. Thus, the country must focus on an investment with the analysis of big data from the investment of the city's infrastructure with the installation of wireless internet for forecasting and planning and used trends analysis of changes in city directions and way of life of the people. Follow by establishing the infrastructure and public services by utilizing data from the analysis to find solutions of current problems by using intelligent technology to help by bringing the concept of smart city development integrated with Thailand Economy 4.0 and 10 target industry policies. Finally, it is a must to create cooperation between educational institutions and entrepreneurs including public and private agencies to contribute on technology development and linking data with the ICT based data and enable to exchange and connecting the city's systems with IoT. All process must create transparency for information sharing to lead for sustainable and smart city development.

II. LITERATURE REVIEW

A. Smart cities and infrastructure

There is no commonly standardized accepted definition or set of terminologies for a smart city. In 2014, an International Telecommunication Union report analyzed over 100 definitions related to smart cities, and the following definition was the outcome of this analysis: "A smart

sustainable city is an innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" (International Telecommunication Union, 2014). Several efforts are currently underway to develop comprehensive key performance indicators for smart cities (Carriero, 2015). A United Nations inter-agency group is developing a set of key performance indicators with the aim of turning them into a global smart sustainable city. Analyses of different definitions of the term smart city reveal that different definitions emphasize different aspects. Governments and stakeholders need to work together to develop a common understanding of what smart city means in their specific national and city-level contexts.

The smart city concept offers different opportunities for different countries. The immediate need for cities in developing countries is to provide adequate urban infrastructure to meet the increasing pace of urbanization. In the process of meeting infrastructure demands, smart infrastructure applications provide a way for such cities to achieve leapfrogging in technology (Belanche, D.,2016). In developed countries, the challenge is often to maintain legacy infrastructure systems, which cannot be abandoned due to cost, space and other considerations. In such countries, smart city applications may focus more on facilitating the optimal use of existing infrastructure resources and monitoring the operations of such legacy resources. However, in both developing and developed country contexts, the primary motive behind smart infrastructure applications should be responding to the sustainable development needs of society (Lee, J.H., 2013).

B. Smart digital layers

Smart digital infrastructure helps to increase understanding and the control of operations and optimize the use of limited resources in a city. One of the key value propositions of ICT in a smart city is the ability to capture and share information in a timely manner (Slater and Khandelwal, 2016). If the information is provided in real time and is accurate, cities can potentially take action before a problem begins to escalate. One way to consider digital infrastructure is in the form of different supporting digital layers which can be explained as follows:

(a) *Urban*: The layer where physical and digital infrastructures meet which include smart buildings, smart mobility, smart grids (for utilities such as water, electricity and gas) and smart waste management systems.

(b) *Sensor*: This layer includes smart devices that measure and monitor different parameters of the city and its environment.

(c) *Connectivity*: This layer involves the transport of data and information from the sensor level to storage and to data aggregators for further analysis.

(d) *Data analytics*: This layer involves the analysis of data collected by different smart infrastructure systems, to help predict some events (such as traffic congestion).

(e) *Automation*: The digital enabling interface layer that enables automation and scalability for a large number of devices across multiple domains and verticals.

Implementing smart city technologies often requires a robust, reliable and affordable broadband network, an efficient ecosystem for the Internet of Things and the capacity to make use of the big data generated (Al Nuaimi et al., 2015).

C. Implementing smart infrastructure: Some key challenges of science, technology and innovation-driven smart city development.

The implementation of smart infrastructure concepts, especially in developing countries faces numerous challenges. This section discusses some of these challenges and the role communities can play in overcoming them, including some policy instruments that could help to address each challenge (Belanche, 2016).

1) The need to localize smart infrastructure

A given smart city solution cannot simply be transplanted from one geographic region to another. Smart infrastructure concepts need to be made locally relevant and respond to local development needs. Context, culture and economics play a role in this process. Cities should consider urban problems in a holistic manner before selecting appropriate smart technology solutions. For example, the conventional intelligent transport systems approach, involving a huge network of sensors and the aggregation of data which may be too expensive and unsuitable for developing country needs (Belanche, 2016). A more localized and simpler version of intelligent transport systems may leverage more ubiquitous mobile telephone data, which may be more suited to developing country contexts. Local communities play a key role in addressing the challenge of localization.

2) Harness the local innovation system: An overarching solution.

Harnessing a local innovation system, which comprises inter alia entrepreneurs, local universities and research centers, is key to addressing the challenge of localization. For example, in South Africa, collaboration between a local university and city administration led to the design of smart shacks, which respond to urban housing needs in informal settlements (King, S., Cotterill, S., 2007). Governments can allocate research funds to smart city projects and provide incentives to make such projects a priority within their communities. Cities need to consider how best to use existing innovation infrastructure such as science parks, technology incubators and innovation hubs to develop new smart city ideas and adapt smart city concepts. For example, in Gothenburg, Sweden, collaboration between two science parks and several other stakeholders resulted in the first modern electric bus route. Most importantly, cities need to create policy environments where massive amounts of small-scale innovation related to smart cities can flourish (King and Cotterill, 2007).

3) Promote open data, open science models

Globally open data initiatives by Governments and the private sector have been a great impetus for smart city applications. For example, the open data platform in Singapore, promoted by the Government, successfully uses the potential of open data in promoting locally relevant smart city initiatives (DuPuis and Stahl, 2016). In order to make the

best use of open data initiatives, as well as promote further innovation, civic hacking events have been organized by various city governments and technology firms. Along similar lines, cities should encourage open science and innovation models that rely less on proprietary technology models. Such efforts can foster research collaborations and create opportunities for innovation (Manville et al., 2014).

4) Establish urban innovation units and living labs.

Smart city applications might benefit from new institutions such as urban innovation centers. Such innovation centers and labs may provide convenient platforms to demonstrate new ideas and concepts. Another pertinent institutional arrangement that promotes smart city innovations is that of living labs, which offer real-life test and experimentation environments in which users and producers may co-create innovations. Living labs methodologies have already been applied in developing countries, especially in Africa, promoted mainly through the Africa-European Union Strategic Partnership. Existing living labs networks may be used to test, incubate and promote smart city innovations (Kramers et al., 2014).

5) Exploit regional innovation networks and global collaborations.

When cities by themselves lack the capacity to conduct smart city-related research, make investments or create local adaptations, they can join with other cities confronting similar developmental challenges, as well as with technology partners, to conceptualize, finance, implement and exploit complementary competences and share lessons learned. A successful example in this regard is the European Innovation Partnership on Smart Cities and Communities that, by pooling resources, aims to co-fund demonstration projects, help coordinate existing city initiatives and projects and overcome bottlenecks to transition processes (Howe,2006). Similar collaborative initiatives, such as the International Summit for Smart Cities in North Africa (Howe,2006) and the Asia Africa Smart City Summit held in Bandung, Indonesia, and its declaration on smart cities, are nurturing partnerships across smart cites.

III. SMART CITY THAILAND CONTEXT

The government of Thailand has launched a national agenda to push the country to become a high-income nation. The initiative is often coined as the "Thailand 4.0" economic model and the four key objectives of Thailand 4.0 initiative include (Digital Economy Promotion Agency (depa), 2019):

1) *Economic prosperity*: To create a value-based economy driven by innovation, technology and creativity.
2) *Social well-being*: To create an inclusive society through the realization of the full potential of all members of the society.
3) *Raising human values*: To transform Thais into competent human beings in the 21st century and Thais 4.0 in the first world.
4) *Environmental protection*: To become a livable society that possesses an economic system capable of adjusting to climate change and low carbon society.

Fig. 1. Map of ASEAN Smart Cities Network and Pilot Cities
Source: Digital Economy Promotion Agency (depa), 2019

Important actions being implemented at the moment involve focusing on 10 high-value and high-tech industries, known as the S-curve industries (Digital Economy Promotion Agency (depa), 2019). The S-curve industries can be further segmented into 2 main types, the "S-curve" and the "new S-curve". S-curve includes traditional industries such as automotive, medical tourism, electronics, food technology and agriculture. These are industries which Thailand is particularly strong at, but technologies can be used to further boost their values. On the other hand, the new S-curve are industries which are somewhat technologically new to the country but, with the current ecosystem and environment, are seen to have high potential. This group of industries include robotics, biofuels, medical hubs, digital sector and aviation.

Currently, there are 7 cities (Phuket, Chiang Mai, Khon Kaen, Chonburi, Rayong, Chachoengsao, and Bangkok) that were selected for Smart City pilot cities. The development of pilot cities can be categorized into two waves. First wave consists of Phuket, Chiang Mai and Khon Kaen and the second wave consists of Chonburi, Rayong, Chachoengsao (EEC) and Bangkok as shown Figure 1.

IV. RSEARCH METHODOLOGY AND ANALYSIS

In this study, lessons learn of successful factor from 10 smart city development were taken: (1) Dublin, Republic of Ireland (2) Amsterdam. Netherlands (3) Dubai, United Arab Emirates (4) Copenhagen Denmark (5) Vienna, Austria (6) New York City, United States (7) Stockholm, Sweden (8) Tokyo, Japan (9) Republic of Singapore and (10) Seoul, South Korea. After that, it can be compared with the model of smart city development in Thailand context. To identify the gaps in development, it is useful to fill the development exactly which can be summarized for 5 developmental key points with details as follows:

A. Initiative and goal of smart city development

In Europe, most of the goals of smart city development require to reduce the amount of carbon dioxide emissions and to reduce climate change problems. The European Union (EU) is the main agency to support, motivate and provide an

international budget to invest in building a smart city. While in the Middle East countries, Dubai, United Arab Emirates and Singapore, which are the major economic centers in the world are rapidly growing and have limited development space. The government is a main agency that drives and supports enormous budgets for urban development. To build cities and integrate urban planning to accommodate the population and global change must be in the direction of achieving rapid success in smart city development. While Asian countries especially Japan, the goal is to create clean energy usage and reduce the cost of electricity generation. To create clean electricity production and reduce the impact to the people as much as possible must consistent with the basis of the community. The Republic of Korea, Modern city with modern technology, there is a problem with the city with a growing population as well. Therefore, changing the pattern of production and developing innovations to answer the industry as innovations that solve urban problems.

While Thailand is currently a country that still focuses on industrial development and industrial production base by reviewing the plan of smart city development. Therefore, it needs to solve problems in many areas with appropriate prioritization. Moreover, the goal of the amendment will help to see the process guidelines and results of joint development.

B. Government transparency

Each country has set the framework for the development of smart cities to create a common guideline. By developing from the context of the problems that each city faces. Most of the strategic plans of smart city development focus on creating the participation of each sector. By allowing communities and people to be the center of development. That is the way to creation of smart people by building confidence in the system and acceptance of the use of new technologies. The government must make an attempt to create more user-friendly applications and create transparency for the government for the people to trust and develop design a framework for the smart city development together. Information sharing and transparency in each country in the case study is equipped with a chaser to collect city-data by displaying the results on the online website that everyone can access and download to bring information to further develop and create new ideas in the future.

While, Thailand in the process of laying the foundation of development by considering the development period of each city at least 10-15 years, therefore achieving the same success as today. From the lessons learned of each country cities have to start planning for intelligent data collection and share information with each sector so that they can be further developed.

C. Establishing a board to oversee the development of smart cities

It is an important part of pushing the city to upgrade to a society with a quality of life under the mechanism of driving budgets, cooperation or marketing and investment incentives. Mostly, the main duty of the board will act as a project coordination center and operation plan manager. As well as develop strategies to manage plans to meet goals and check the progress of each project. Including developing strategies and implementing plans project management and coordinate and share information for each sector to achieve mutual access to common areas. Most of the Smart City Development Committee were established in the form by comprising of the government, private and educational sectors. In which the government will consider the overall picture of all operations, including the selection of research and innovation to develop urban areas in the real area. While Thailand has the same committee for smart city development which operates under the Office of the Digital Commission for National Economy and Society and all from government sectors. Therefore, this part of the operation still lack the participation of other sectors which may have different development perspectives and can be integrated to develop smart cities that elevate to develop in a context that can solve the city problem.

D. Creating a space for testing equipment (Test-Bedding)

Creating a partnership for each sector is very important, especially in the initial stages of development. In most cases, each country will have public-private partnerships that operate at an international level, such as IBM, Intel. By creating a test, experiment and work areas for all groups of people (Test-Bedding) is a space that everyone can use as a test area for innovation. It will be enabled to open for public awareness and jointly develop further work together to drive new creative ideas and solutions to problems that are appropriate for the context of each country and to stimulate behavior change. Therefore, using the theory of "Living Lab" as the principle of work could be used as a testing area for equipment in the real environment so that people in the city can easily join.

While Thailand, the area for innovation development is still a non-public area and is mainly developed by the private sector. From lesson learn, it is found that the education sector will participate in the development by having the space to test innovation which comes from the work of students or encourages the start-up to grow with education and research to support.

E. Establish laws to protect rights and personal information.

From lessons learn, the safety of data sharing and providing personal information to the government should cover process of data collection, analyze the trend results of daily life each country. It is therefore obliged to set regulations and laws to protect the rights and personal information of people in each country. In which the country of a clear legal definition and the most secure, the Republic of Singapore is number one in giving importance to cybersecurity. In data security with the protection of privacy in public information, it has been also focusing on the public health system, therefore, the Singapore Cybersecurity Strategy has been established to build system reliability for both the citizens and foreigners who would like to invest.

While Thailand, there are also laws and regulation that specify the security of data usage. However, with the system that was forced to fix the problem after it happened, therefore cannot create security for real usage. Including the fact that it is not yet possible to establish credibility in exchanging information.

F. Local government needs to be the pioneer of smart city development

To establish large-scale innovation development and create a network of innovation development, a small organization is an important unit to start as an area for innovation development. The important thing is to create a platform for testing, including data sharing areas for further innovation. That causes endless development and to solve the problems of cities that are always require more intelligent system. Also, building cooperation is not just at the level of administration only. At the level of operations, it is also an important part, especially the people who must be able to reflect the problem and showing solutions to common problems, to create common ground, balance point and equality of joint development. Incidentally, creating cooperation in Thailand began to use the principles of design thinking to help by obvious case studies, such as the Republic of Korea that applied this principle by taking about the 20-year development. It is obviously seen from the case of the Republic of Korea of the development plan or Japan by creating communities as the base for smart city development.

Therefore, making these countries successful is depend on cooperation from all parties, therefore, the integration of the participation among sectors can help understanding the problem and ready to solve the problem together. Thailand will be able to upgrade closer to the development of smart cities.

V. CONCLUSION

As discussed earlier, national and city governments have a variety of policy instruments to promote smart city projects including inter alia output-based contracting, public–private partnerships, procurement policies, long-term contracting and targeted research funds. In addition, Governments may play a variety of roles in promoting smart city concepts. For instance, in their roles as regulators, they need to review their regulatory frameworks to ensure that such frameworks are conducive to smart city innovations. In their roles as investors, they need to determine which skills development programmed or infrastructure component they should invest in to drive innovation. City governments can effectively play their roles as consumers to support small-scale smart city innovations by giving them preference and access to public procurement contracts. Governments need to actively make use of such policy instruments and engage in these diverse roles to create and shape well-functioning markets for smart infrastructure that responds to local sustainable urban development needs.

Table 1 Comparison of Smart City Development, Thailand Context.

Country	Initiative	Goal	Strategic Plan	Established a board	Local government needs to be the pioneer	Establish laws to protect rights	Test-Bedding (Living Labs)
	Smart City Development						
Dublin, Republic of Ireland	2011	Smart City Ecosystem	"Open, Engaged, Connected"	Chief Executive of the Four Dublin Local Authorities	√	√	√
Amsterdam. Netherlands	2007	New Amsterdam Climate Program	Amsterdam Smart City program	Amsterdam Innovation Motor (AIM)	-	√	√
Dubai, United Arab Emirates	2007	Technological Trust	To bring about happiness to all (Communication, Integration, Cooperation)	Smart Dubai Higher Committee	-	√	√
Copenhagen Denmark	2014	Quality of life and growth in a green city	Smart at Several Levels	Copenhagen Cleantech Cluster	√	√	√
Vienna, Austria	2011	low carbon economy	Smart City Wien Framework Strategy	the Austrian Climate and Energy Fund	√	√	√
New York City, United States	2007	the Plan for a Strong and Just City	#One NYC	-	-	√	√
Stockholm, Sweden	2007	Smart & Connected	Green-IT Strategy	KIsta	√	√	√
Tokyo, Japan	2010	Smart Energy Worldwide (JASE-W)	Smart Community	The Japan Smart Community Alliance (JSCA))	√	√	√
Republic of Singapore	2014	City in A Garden	Smart Nation	Urban Redevelopment Authority: URA	-	√	√
Seoul, South Korea	2014	Digital Social Innovation	Seoul Digital Plan 2020	Seoul Digital Foundation	-	√	√
Thailand	2017	Stability, Prosperity and Sustainability	Thailand 4.0	The Ministry of Digital Economy and Society	-	√	-

Note: √ = available, - not available

This is due to primary data analysis from the lessons learned can be considered that Thailand needs to integrate each part of operations effectively. Although, Thailand is currently defining the role of the Smart City Development Committee at the national level and provincial level, including establishing laws for determine the strategy of development as well as the guideline for smart city development, however with the development of each sector still unable to integrate and create cooperation acceptance of each party. The huge obstacle is that the government needs to break through the large wall and host the smart city development initiative and attract the private sector by invite the education sector to be developed together under research and development scheme. Finally, it will make the city upgrade to a truly smart city development as shown in Table 1.

REFERENCES

[1] Al Nuaimi, E., Al Neyadi, H., Mohamed, N., Al-Jaroodi, J., 2015. Applications of big data to smart cities. J. Internet Serv. Appl. 6 (1), 25.

[2] Belanche, D., Casaló, L.V., Orús, C., 2016. City attachment and use of urban services: benefits for smart cities. Cities 50, 75–81.

[3] Bibri, S.E., Krogstie, J., 2017. Smart sustainable cities of the future: An extensive interdisciplinary literature review. Sustain. Cities Soc. 31, 183–212.J. In press.

[4] CSTD intersessional panel; and B Jamoussi, 2015, Shaping tomorrow's smart sustainable cities today, presented at the CSTD intersessional panel.

[5] D Carriero, 2015, United smart cities: Towards smarter and more sustainable cities, presented at the at the CSTD intersessional panel.

[6] DuPuis, N., Stahl, E., 2016. Trends in smart city development-case studies and recommendations.In: National League Of Cities. Center For City Solutions And Applied Research.

[7] Howe, J., 2006. The rise of crowdsourcing. Wired Mag. 14 (6), 1–4.

[8] International Telecommunication Union, 2014, Smart sustainable cities: An analysis of definitions, Focus Group Technical Report, available at http://www.itu.int/en/ITUT/focusgroups/ssc/Pages/default.aspx

[9] King, S., Cotterill, S., 2007. Transformational government? The role of information technology in delivering citizen-centric local public services. Local Gov. Stud. 33 (3), 333–354.

[10] Kramers, A., Höjer, M., Lövehagen, N., Wangel, J., 2014. Smart sustainable cities–exploring ICT solutions for reduced energy use in cities. Environ. Model Softw. 56, 52–62.

[11] Lee, J.H., Phaal, R., Lee, S.H., 2013. An integrated service-device-technology roadmap for smart city development. Technol. Forecast. Soc. Chang. 80 (2), 286–306.

[12] Li, C.S., Darema, F., Chang, V., 2017. Distributed behavior model orchestration in cognitive internet of things solution. Enterp. Inf. Syst. 1–21.

[13] Catriona Manville et al., 2014. Mapping Smart Cities in the EU. Policy Department A: Economic and Scientific Policy, Jan. 2014), 200 p

[14] Mital, M., Chang, V., Choudhary, P., Papa, A., Pani, A.K., 2017. Adoption of Internet of things in India: a test of competing models using a structured equation modeling approach. Technol. Forecast. Soc. Chang. http://dx.doi.org/10.1016/j.techfore.2017. 03.001. (in press).

[15] Slater, R., Khandelwal, R., 2016. Report on Case Studies of Smart Cities International Benchmark, MPUIIP. ICF International.