A Comparative Study on Smart Mobility City Initiative in Thailand and Taiwan

Polwasit Lhakard

International Doctoral Program in Asia-Pacific Studies (IDAS), College of Social Science,
National Chengchi University, Taipei, Taiwan
E-mail: Polwasitlhakard@gmail.com

Abstract

According to the latest report *2019 Revision of World Urbanization Prospects* by the United Nations, by 2050, more than two-thirds of the world's population is expected to live in urban areas or about 6.3 billion people, with close to 90 percent of the increase concentrated in Asia and Africa. Therefore, it is necessary for Thailand to adjust itself wisely, planning and developing effective urban management to cope with such issues. Khon Kaen has been seen as the first smart city in Thailand, starting with the area of smart mobility. It is still being developed at the moment and needs to rely on the conceptual framework and knowledge of policy implementation on smart mobility that has already been developed and implemented in some foreign countries. Taiwan, especially in Taipei, is a showcase of this smart mobility model. The city has recognized expertise in its technological advancements and can efficiently and effectively apply this to urban planning development, particularly in the area of smart mobility. This study conducts documentary research on Smart cities development and collecting information from interviews and opinions of stakeholders that have been published in public media and information from meetings, seminars, and official documents. Thus, this article helps to answer the research question about knowing different ways of development and comparing between the two cities. The results give an insight into factors and components of smart mobility development that allow them to develop in different and same approaches through the Initiatives, Frameworks, Concept of Smart City creation, and Public participation. Also, this article can provide an important way to compare and understand the success of a successful city like Taipei and help cities that are developing smart mobility like Khon Kaen to set the framework for practice and policy.

Keywords: *Smart City, Comparison, Smart Mobility, Thailand, Taiwan*

1. Introduction

The concept of smart cities initially appeared in Thailand in 1997 under the definition of "Virtual Cities." The smart cities occurred because of the crisis in western countries, where economic growth has caused inequalities in urban areas and also inequalities in access to basic technological services such as telephone, computer, and telecommunication. Thus, the concept of virtual cities aimed to solve such inequalities through technological development at that time by using an internet connection. The local communication network initiative enabled the development of virtual cities (Anthopoulos, 2017). Many experts have given the definitions of the smart city in various dimensions, both in terms of academic and organizational context and in a wide and narrow range of meanings. For example, a smart city is a surveillance city and an integration of all of its critical infrastructure including roads, bridges, tunnels, railways, subways, airports, seaports, communications, water, power, and even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services for its citizens (Dameri, 2017). A city can be called smart when there are investments in human, social capital, infrastructures (information and communication technology), modern communication (transportation) to fuel sustainable economic growth and good quality of life, with smart management of natural resources through participatory governance (Dameri, 2017). In a smart city, all networks are connected and support each other. Therefore, technology and information should be first stably integrated. The collected data about a smart city should be analyzed and used for maximum efficiency and effectiveness to ensure competitiveness and sustainability. Secondly, the data and information of a city should be communicated and shared using mutual definitions and standards for ease of data and information usage. Lastly, several functions should be able to perform, so holistic solutions for a city should be prepared (Dameri, 2017). Hence, a smart city is a city whose infrastructures and rational social and technological solutions facilitate the city and its citizens, bringing about sustainable economic growth and improvement in the quality of urban life.

The United Nations (2015), as an international organization, has also realized how the importance of city development. Therefore, the United Nations Economic Commission for Europe (UNECE) had started the United Smart Cities Project in 2014 to promote sustainable development on a global scale, including transition support for developing countries to become smart sustainable cities (United Smart Cities, 2018). Furthermore, in the 18th United Nations Commission on Science and Technology for Development (CSTD) Conference in May 2015, a smart city and its basic infrastructures were one of the agendas for the conference between 2015 and 2016 (TECO, 2018). There was also another meeting of the CSTD 2018–2019 Inter-Sessional Panel on "Smart Cities and Infrastructure" in Vienna, Austria. The discussion and presentation of a smart city in different aspects were held at the conference. The following description was agreed during the meeting in Austria: "A smart sustainable city is an innovative city that uses information and communication technologies and other means to improve the quality of life, the efficiency of urban operations and services, and competitiveness while ensuring that it meets the needs of present and future generations with respect to economic, social, and environmental aspects" (TECO, 2018). With such different definitions, not only one definition can be defined for every country and every city, they are varied according to each country and each city depending on the development level of each country and city.

To get a smart city viewpoint of Rudolf et al (2017), the following table illustrates the characteristics and their assigned factors of a smart city (Kumar, & Dahiya, 2017).

Table 1 Characteristic of smart cities

Smart Type	Factor
Smart Economy (Competitiveness)	• Regional and global competitiveness • High productivity • High-speed internet access and ease of doing business • E-business e.g. e-banking, e-shopping • Driven by innovative spirit and entrepreneurship • Flexibility of labor market • International embeddedness • Ability to transform • Develop and promote economic image & trademarks at the national level
Smart Mobility (Transport and ICT)	• Efficient, smart, safe, and sustainable transport systems, i.e., fast mobility: subways, light rail transit, and monorail systems • Utilizing networks for efficient mobility in supporting the movement of vehicles, people, and goods as well as reducing congestion • Seamless Mobility • Mobility Sharing: New social attitudes, i.e., car sharing for people go along the same route, shared/rental public vehicle services (public transport and alternative travel modes) • Improve transport accessibility
Smart Environment (Natural resources)	• Pollution monitoring • Use of sustainable technology • Energy use through sustainable development initiatives, environmental protection and develop a low- carbon society • Reduce energy usage through innovations, while supporting energy conservation and reuse or recycle materials • Sustainable resource management • Efficient system of water resource management for water supply, wastewater, natural drainage and irrigation, floods, emphasizing on water conservation and reduction of unnecessary water consumption • Efficient (solid) waste management system

Smart Type	Factor
	• Efficient disaster management including disaster risk reduction, dealing with and rebuilding after a disaster
Smart Governance (Participation)	• Participation in decision-making • Transparent governance • Public and social services • Democratic process and social inclusion • Use of Big Data, a Spatial Decision Support System, and Geo-information technology to manage cities and regions • Efficiently improve the ability of public service delivery and access to community services
Smart People (Social and Human Capital)	• Smart People are international, open-minded/cosmopolitanism, possess a plurality of perspectives, maintain a healthy lifestyle, affinity to lifelong learning, and use e-learning models • High creativity and flexibility and well cope with changes • Participation in public life • High level of Human Development Index
Smart Living (Quality of life)	• Social dimensions of education facilities, health conditions, individual safety, and housing quality are at high levels • Accessibility of quality health services, including monitoring citizens' health remotely and electronic medical records • Home Automation system: Intelligent Buildings and Smart Homes • Touristic attractively • Accessibility to all types of social services • Cultural facilities

Therefore, the importance of this study is to help developers or policymakers to be able to apply the open data of each city in developing the city by creating new facilities and services to the local, making a smart city that responds to the development according to the national strategy. Bringing technology and digital innovation to help change the lives of people and reduce inequality as well as issuing a Smart City policy in Thailand is considered a national agenda, which the government hopes to be a mechanism that will help reduce the inequality and spread prosperity equally in all regions of the country.

2. Thailand and Smart City creation

In Thailand, the government has set up an action plan for smart city development in the 5-year National Digital Economic and Society Development Plan (2017-2021). To drive this strategic plan, the government then appointed Thailand Smart City Committee. The Committee's key role and responsibility are to propose a draft of both the Smart City Strategic Plan and Smart City Development Masterplan that are compatible with the National Development Plan according to Thailand 4.0 Driving Model and the 20-Year National Strategic Plan. The plan also includes an integrated system to follow up and evaluate the operation of the Smart City as well as recommending paths forward for effective Smart City development, coordinating with government agencies and the private sector both inside and outside Thailand, which will lead to flexibility and agility in the development of a smart city by reducing any limitations hindering the smart city development. In the meantime, the Digital Economy Promotion Agency under the Ministry of Development for Economy and Society mainly responsible for a smart city project has its main role in promoting and urging participatory development from the private sector. It has to believe that driving a smart city will result in sustainable development. The Khon Kaen Model sets an example of participatory development in which many private sectors take part in the process to establish Khon Kaen City Development Co., LTD or Khon

Kaen Think Tank (KKTT) to develop the city with private capital. There are still ten more cities gearing up for a smart city plan.

The public and private sectors and academics institutions/educational institutions have been working together to make those cities Smart Cities. The most important movement was the establishment of Thailand Smart City's Alliance, as a connecting point of collaboration, knowledge, and innovation for smart city development from all sectors. In Thailand, a smart city launched in the pilot areas is mostly taking transportation as a lead. Interestingly, it was found that the development of Khon Kaen's "Smart City" program has been mainly propelled and led by Khon Kaen private sectors, collaborating with civil society and local government agencies.

Khon Kaen is more distinctive than other cities in Thailand as the driving force of a smart city project is from different private sectors in the province that joined hands and established Khon Kaen City Development Co., LTD in 2013. The company as an initiative of the private sector aims to develop Khon Kaen to be in line with its rapid growth before the national action plan was established (Khon Kaen City Development, 2017). Khon Kaen has started the development with the ultimate goal of becoming a Smart Mobility City, therefore, the city focuses on its infrastructure development of public transport. The succeeded project that has already offered services to people is the Khon Kaen City Bus (TerraBKK, 2017), which is a mobile application that allows users to locate the bus's current position. Besides, several projects are now being developed such as Smart Parking as well as a big project like the light rail transit. The Digital Economy Promotion Agency has paved the next step regarding the Smart Living for Khon Kaen to be a Smart Health Care & Medical Hub, such as implementing wristbands that include internet and receivers to track patients' data. With the collaboration between the public and private sectors, the progress of project development is being seen.

3. Conceptual framework for the development of Khon Kaen Smart City

Khon Kaen Smart City was initiated by Khon Kaen City Municipality, private sectors, educational institutions, and different local associations/ groups in the province. The municipal government acts as a coordinator to encourage public participation from all sectors. There are groups of creative people working together, emphasizing public participation from municipalities, civil society, and the academic sector. With a partnership between Khon Kaen City Municipality, Faculty of Architecture, Khon Kaen University, and the advisory committee of Thai Urban Designers Association, Khon Kaen Think Tank (KKTT) was established. Due to the highly-centralized budget allocation, which is mainly in Bangkok, the chance for other provinces to get development funds from the central government for their province's development in terms of preventive development plan remains very low. While seeing the province's exponential growth, Khon Kaen did not want to leave the province's development to the fate determined by the central government's distribution of funds as this can hinder its sustainable growth. Thus, another source of capital was needed for the province's development, and this led to fundraising from Khon Kaen's citizens for the development of the city's infrastructure in the best interest of their province (Khon Kaen City Municipality, 2016).

Currently, Khon Kaen City Municipality is driving the city's development together with other sectors in the province. Khon Kaen City Development Co., Ltd. or Khon Kaen Think Tank (KKTT) acts as a coordinator between the public and private sectors, both from central and local areas, with particularly the government who partake in driving "Khon Kaen" to a smart city as planned. Khon Kaen has its notion, "How to live in our country with hope?" as the province still encounters the barriers such as government restrictions and plans. Importantly, though all the city's development companies have already established the development plans, obstacles still exist. As a result, Khon Kaen laid out mega planning that requires a variety of operations, namely, capital markets, government budgets, and the private sector's investment. Today, Khon Kaen is one of the 22 cities that is being accelerated to be a smart city. Many provinces follow Khon Kaen's model and adapt it to suit their province. There is also collaboration from different groups, for example, the Chamber of Commerce and Federation of Thai Industries in their province (Teekayupan, 2016).

Khon Kaen has now elevated its provincial strategic plan to accelerate its pilot project of the rail system to be a fundraising tool so that it is not going to be the country's burden, which will result in

strengthening locality and enhancing the efficiency of the bureaucratic system for a sustainable organization. Besides, the central government allows Khon Kaen to push forward its budget. In the end, the land has been obtained to be used for its project development through pooled funds for development with an investment plan of around 15 billion baht. If the funds were received according to planned and the company was listed in The Stock Exchange of Thailand, the financial aid received would be approximately 10 times the development of government infrastructure, or approximately 150 billion baht (Wongthanawasu, 2017). It is the budget of the municipality that will be used to develop the project, and a Joint Public and Private Sector Consultative Committee have been established to take control of the project development.

4. Khon Kaen Smart City; how smart it is?

KKTT has started the infrastructure planning of public transportation with LRT construction for a distance of 23 kilometers as the first area of being a Smart City. Even though LRT can support fewer passengers than any other type of electric trains, it is suitable for Khon Kaen due to the following reason; less investment spending than heavy rails, so faster reaching break-even (the breakeven point). It is hoped that more income can be generated from the commercial development of areas around rail stations such as the advertising area. There is also the possibility that Khon Kaen will be a center of manufacturing light rail trains, which will consistently generate employment and income distribution in the areas. As for TOD (Transit-Oriented Development), the areas covered by the entire 5 rail lines will be used in the best interest of creating activities in the city. These areas will be also zoned out according to their building use as a commercial area, housing on flatlands and highlands, government institutions, areas of transport interchange point, and recreational areas. These can be applied for business creation and varied area utilization. The development of the areas near the rail stations will entirely support CBD creation. When there is more traffic of businesses, the development of becoming a smart city will be achieved. Khon Kaen's Smart City Project utilizes TOD as installed technological points with an emphasis on Smart Mobility. There is a development masterplan of Smart City Operation Center, SCOPC, to create Khon Kaen's technological development center, continued from the infrastructure operations. The Internet of Things (IoT) and Cloud-Based will be used to maintain and analyze the city data after the layout plan of infrastructure is done. To develop these areas, it will start from Zone A: new city area and Zone B: downtown revitalization area (TerraBKK, 2017). Khon Kaen Think Tank – KKTT is a company founded by local groups in the province and pool capital for building up the city's infrastructure. The company will set up a Provincial Infrastructure Fund (PIF) via The Stock Exchange of Thailand to raise funds in the stock market without requesting a budget from the central government. The central government will be just a supporter. Such operation is in the provincial strategic plan which needs to get done. If so, it will overcome the country's pain point where there is not enough budget for the development that may lead to development inequality.

5. Khon Kaen Smart City's concept in terms of 'Smart Mobility'

Mobility Drives City is the first development project that Khon Kaen chose for Khon Kaen's Smart City. KKTT believes that to become a Smart City, it is not necessary to be smart in all areas as described in its definition. Smart Mobility has been selected by Khon Kaen as a starting point to change the city into a Smart City, beginning with the Light Rail Transit (LRT) project, which is being seen as a clear, fundamental change that affects a lot of people. There is also a development plan on the areas around rail stations or Transit-Oriented Development, TOD, as a physical development to stimulate the economy, create traffic, or generate human interaction in public spaces by maximizing space use at an international level.

The city planning of Khon Kaen has been designed as a central business district (CBD) with outer areas of the rural-urban fringe to be protected agricultural and conservative agricultural areas. This is similar to the urban planning called Garden City, where there is a green belt at the outskirts to prevent the directionless growth of the city that may eventually result in an invasion of the green belt. Such city planning tends to bring the development to be concentrated in the middle of the city. Its compact city design is easily developed and also needs no budget distribution of infrastructure development to the province.

Network allocation of each Travel Mode has been planned for Khon Kaen's public transportation network system. Each zone of mass transportation mode is divided by its role to create activities around the rail stations following the routes of LRT (Light Rail Transit), city bus, sidewalk, and bicycle parking. Each travel mode will have walking distance/spacing between stations in transit at 400 meters to get to the services. This is in line with the city concept of a well-accessible Neighborhood. Also, nodes around the center of the city can be distributed thoroughly and equally (Banchanont, 2017).

The achievement will be 'economic multiply,' which means value multiples in the economy. In this case, the light rail system will generate economic multiply 4 times as seen in Portland, USA, where the economic multiply is 42 times (Teekayupan, 2016). Besides, the rail system will solve the problem of traffic jams if there is a better public transportation system. Moreover, in terms of the city structure, it will be adjusted so that people will use fewer cars, and the number of people using public transportation will increase.

6. Taiwan and Smart City creation

Taiwan is one of the countries that continuously employ science and technology for city development under Smart Cities as appeared in different projects and cities, such as in Taipei, Chiayi, Taichung, Taoyuan, and many more. Taiwan is best known for its outstanding technological capabilities. The country focuses on technological innovation to manage the modern city. It has transformed agro-industries that are capable of producing world-class products. Taiwan is now becoming one of the leading destinations in the Asian region. It has an automatic toll collection system that needs neither lane dividing barriers nor toll-booths and also uses laser sensors that detect every vehicle passes with cashless or cradles payment. The economy of Taiwan has been growing rapidly and has made the Taiwanese per capita income level of the population in almost every area equal. Taiwan's underground power cable system is installed by almost 100%. Empty spaces are arranged to be parks and communal spaces. Green spaces by planting minimize air pollution. The country also supports the use of electric cars and motorcycles. All of these have made Taiwan one of the remarkable smart cities in the world. Taiwan's public and private sectors are in the same direction, supporting each other in terms of new technologies in the current digital world or cyber world. Taiwan with its technological expertise, the country applies the technologies in creating smart cities such as big data, robots, VR & AR (Virtual Reality and Augmented Reality), which was intangible in the past. However, Taiwan has created something called Cyber-Physical Connectivity, which comprises of knowledge sharing concept by creating smart cities innovation to meet its goals.

Taiwan's government established the Taipei Smart City Project Management Office (TPMO) in 2016 to manage Taipei's smart city development and operations. The platform for collecting data by the government and industrial sectors has been created and operated to be a smart city in 6 areas; (1) SMART Public Housing: Smart Grid, Smart Meter, and Smart Parking and Services, (2) SMART Transportation: signage and indoor navigation inside Taipei Main Station, (3) SMART Education: an option for students to choose to study remotely via digital channels called "Taipei City CooC-Cloud," (4) SMART Payment: payment via mobile phones, (5) SMART Healthcare: Smart hospital such as patient monitor and records and platform of city healthcare in a hospital or Taipei City, and (6) SMART Innovation: the government has used innovations and technology to apply in a Smart City project for data system and services. The government also gives the opportunity to people in different industries to propose innovative solutions to them. Taipei is one of the remarkable smart cities in Taiwan due to its readiness in all aspects, which enhances the quality of people's life. In academic matters and practice, Taipei is another interesting and useful case study for smart city research regarding its success according to the frameworks employed by the city.

7. Conceptual framework for the development of Taipei Smart City

Taipei promotes smart cities by emphasizing three concepts of management as follows.

1) Top-down approach: The Department of Information Technology (DOIT) and Taipei Smart City Project Management Office (TPMO) has worked together under the policies and orders of the Taipei government to support, facilitate, and drive the collaboration between the related public and industrial sectors

with their proposed solutions. Smart Taipei Main Station, 4U Green & Sharing Transportation, and Public Housing are all the projects that prove the successful collaboration between them.

2) Bottom-up approach: Taipei Smart City Industrial Field Pilot Program in Taipei opens up smart city application-related proof of concept (POC) to private companies' proposal to the city government or innovative solutions through a proof of concept (POC) model. This model is the integration between the government concept towards service users and from the service users to operators. The "Taipei City Hospital Smart Ward Pilot Program" is a successful example of this collaboration.

3) Citizen participation through public engagement activities: The PMO will create initiatives to engage citizens and understand their needs. Participatory budgeting, Taipei I-Voting System, workshops, and open data provide its citizen various channels of participation toward policy decision-making and suggestion channel.

8. Taipei Smart City: How smart is it?

Taiwan Smart City has been developed through database development. Apart from such a concept, as a technological expert, thus Taiwan uses a technology they have for smart city development. For example, the platform of citizen participation to gain access to the government's data has been created. This encourages any organization in charge of such operations to ensure that people gain access to the organization's data by developing good digital government services to satisfy citizens' needs, then establish a smart city implementation plan. The plan has been developed by Executive Yuan, and the NDC drew up the Smart Government Action Plan (approved by the Executive Yuan on June 6, 2019) to accelerate digital changes of the government along with its sub-offices. The purpose of this is to create "Full Issue of New eID" and "Establish a secure and trusted data exchange system (T-Road)" as a platform to apply for online government services from different offices (TECO, 2018).

To promote a policy of maximizing the Taiwan government's open data, the National Development Council (NDC) established the Government Open Data Platform (Open Data: NDC) in 2018. The NDC's Open Government Data Platform currently provides access to more than 40,000 data sets, of which 64% have been opened. In terms of data usage, up to the end of September 2019, the data had been downloaded 13.5 million times, with the most popular data in transportation, tourism and travel, and weather observation. The My Health Bank service has been promoted, allowing people to download their national health insurance medical information and keep abreast of their seeking of medical attention, medication use, and tests (examination). The Open Banking policy is also being promoted to give control over financial data back to consumers through a cross-industry combination of bank and Third-Party Service Providers (TSP). Consumers will be provided with more innovative financial services to satisfy their financial requirements. The government also encourages people to download personalized data to eliminate the need for paper documents or transcripts when applying for government services (TECO, 2018).

9. Taipei Smart City's concept in terms of 'Smart Mobility'

Taiwan's transportation system is efficient because its infrastructure and data systems have been developed. These are two major factors that form a link between data and public transportation system, which creates the convenience of traveling for people. Initially, the National Geographic Information System (NGIS) as a reference for decision making has been developed since 1980. Essential maps for national land planning, such as nationwide electronic maps, national numerical terrain models, and aerial imagery were set up. The database of the national land information system was established to be used as data operational standards regulation for national land and geography. Also, the Government Service Network (GSN) was built to connect all government agencies and to form Government Public Key Infrastructure (GPKI), which ensures network secure identity verification mechanism (TECO, 2018). Such services, namely the Electronic Toll Collection (ETC) used by vehicles on national freeways, have been used daily by Taiwanese. 6.5 billion of the universal electronic invoices are issued annually. The E-Gate automatic customs clearance inspection service or E-Gate completes exit inspection in 12 seconds and has handled more than 80 million people. The simplified administration and public convenience online tax return (e-Taxation) that takes only five minutes

was used by 96% of people to file a tax return in 2018. The Taiwan wireless network provides its citizens with free usage of wireless internet when handling business, on public transport, and at scenic spots (TECO, 2018).

Regarding the creation of Smart Mobility, Taipei has been developing the Intelligent Transportation System (ITS) for more than 27 years, starting from the first tier of Infrastructure Development (1990-), the second tier of Services Systematization (1999-), the third tier of Sharing ITS Services (2000-), the fourth tier of Inauguration of Smart City Program (2014-), and the fifth tier of Smart City Lifestyle (2017-). It is expected that the future of the city will be improved by ITS technology and management thinking, an inspection of people's needs, inter-regional cooperation, integration of transport facilities, and proper application of information technology. The city employs innovative technology and data to solve people's problems. Today, AI technology calculation and big data analysis to help solve traffic problems in Taipei with real-time data and travel suggestions have been used. Besides, the analysis of travel time in the city can help determine when we should travel. A carpool feature also helps solve the traffic problems in Taipei City. People can choose to be either a driver or a passenger who can share a ride with friends and get a reward in return to encourage people to have smart driver decisions, which are using a car smartly, mindful, and helping each other more and more. A redeem card is also rewarded to shops who follow this scheme.

Moreover, Taipei Smart City Lifestyle in Transportation provides services; bike, bus, and metro. There are 400 stations and 13,000 bikes for the bike-sharing systems (You bike), which people can find where to rent or park via an application. More than 500 km of bike lanes already exist in the Taipei area. There are also 3,313 buses and 286 routes in Taipei, making 97.5% of the land area covered by public transport, with only a 500-meter walk to reach a bus stop. Therefore, every day 1.3 million people take a bus to the destination. All buses are requested to install the GPS and use the GPS data to create a dynamic or real-time bus information system. Passengers can learn the bus's estimated arrival time at the bus stop via a digital board or mobile application based on the dynamic bus information system. The accuracy rate of the smart bus system is over 95%. As for heavy transportation, Taipei has also a reliable Smart MRT system. At present, the MRT system has 5 lines and 117 stations, with 2 million passengers a day. The MRT trains and stations also offer public WiFi services for passengers and on-time performance of 99.6% with its smart train control and management systems, Taipei MRT's reliability index (MKBF), which had been the best in the world for a consecutive five years (TECO, 2018). Furthermore, the potential areas neighboring the travel stations such as Taipei Main Station are developed. Taipei Main Station is the center of the city transportation, including the Taiwan Railways Administration (TRA), Mass Rapid Transit (MRT), and High-Speed Rail (HSR), with current 10 stories in height and more than 5 million passengers per day. Hence, to have smart public transportation, the government operates clear signage and internal navigation, tourist service area and smart parking, and smart traffic safety. Taiwan also promotes 4U Green Shared Transportation (DOIT, 2019), which includes (1) You Bike: a public bicycle sharing service (shared biking) offered by the Taipei City Government in a collaboration with local bicycle manufacturers and rental providers The service now operates more than 13,000 bicycles across 400 rental stations in Taipei. Secondly, (2) U-Motor: More than 1,000 scooters are currently available for rent across Taipei. Users can rent it via the application, and the service providers can check the number of the scooters and their battery status at all times. Thirdly, (3) U-EV: More than 200 EV Chargers stations are installed at 80 public parking lots, and lastly, (4) U-Parking Sharing Parking Space. Nevertheless, another thing that is still being developed and improved by Taipei is "Self-driving bus or driverless bus." Two years ago, the city government closed the two-way bus lane on Xinyi Road to test French company 7Star Lake's driverless shuttle EZ10. However, the bus failed to distinguish traffic lights and did not pass the review. Thus, today the driverless "WinBus" has been developed by Taipei with financial support from the government in collaboration with industry groups (Tzu-Ti, 2019).

10. A comparison between Smart City development concept in Taiwan and Thailand

Comparing the development concept employed by Taiwan and Thailand will help understand the reasons and differences in operations deployed by both countries. Since Thailand is now working on its smart city development, the country will then understand the reasons and key factors that make Taipei successful

in developing itself into a smart city. Therefore, Thailand can apply such a framework to its smart city operations in the future.

Table 2 Smart city comparison between Taipei and Khon Kaen

Comparison	Taipei	Khon Kaen
Initiatives	Follow the policy and order of the government: The Department of Information Technology (DOIT) was assigned to establish the Taipei Smart City Project Management Office (TPMO) to create a development platform	Initiated as a partnership between Khon Kaen City Municipality and private sectors which include educational institutions, associations, and other groups in the province, working together with the municipal government as a core
Frameworks	Three main concepts: Top-down integrated with Bottom-Up and citizen participation concepts through varied kinds of collaboration such as Public-Private Partnerships (PPP) and project selection for development	a coalition within Khon Kaen Province: There are groups of creative people working together, emphasizing on public participation from a municipality, civil society, and academic sector. They established Khon Kaen Think Tank – KKTT.
Concept of Smart City creation	Complete in all areas: Smart Mobility, using innovation to drive the economy (Smart Economy), the government's digital transformation (Smart Government), and Smart Healthcare; all are based on the development of infrastructure and technology to assist in the management	Only Smart Mobility: an operation continued and derived from LRT project which is a clear transformation of transport infrastructure that affects a lot of people and next step will be the development of database using information technology
Public participation	Civic participation in open government through a technological platform to understand citizens' need and feedback from the citizens	Mostly from the leading groups in Khon Kaen, not more open for the general public and most of the time the activities held are academic seminar and public forum for public opinions

According to the concept comparison of smart city development in both cities; as for Taipei, **initially** due to having a strong government and Public-Private Partnerships (PPP), there is great potential for the city to undertake successful smart city projects and eventually become a smart city. However, these arrangements can be hampered by excessive and strict regulations on interactions between the public and private sector. This is a reason why the Department of Information Technology (DOIT) established the Taipei Smart City Project Management Office (PMO) to address the issue. Together they created a platform and framework to facilitate partnerships between government offices and private companies. DOIT and PMO regularly do research to determine the needs of the Taipei government and its citizens. They use big data to match public and private entities that would produce products and services that would cater to these needs. On the other hand, as for Khon Kaen, the development initiatives started from the local governments and private sectors, educational institutions, associations, and other groups in the province itself. They did not receive any funds from the central government, so they aggregated the capital from individuals within the province to establish Khon Kaen Think Tank – KKTT. The company is in charge of pooled funds for building up the city's infrastructure to deliver developed Khon Kaen City to the next generations. They believe that development

projects in Thailand are mostly designed by the central government but local citizens are the people who truly know their problems. In developed countries, most developments of the local areas came from the locality. Therefore, they have the idea of encouraging local citizens to be able to stand on their own feet and reduce support and assistance from the central government.

As to the frameworks adopted by Taipei, the Top-down approach is integrated with the Bottom-Up approach and public participation. DOIT and PMO also carry out careful budgeting and procurement procedures. They also support their partners by carrying out field trials to attract even more private investment, government grants, or subsidies. PMO is fully funded by the government. The budget allocates 80% on human resources, 15% on hardware and software purchase and development, and 5% on miscellaneous expenditure (DOIT, 2019). Given that most projects developed under DOIT and PMO are quite innovative, their application may conflict with current regulations. In such cases, DOIT, PMO, and the partners involved are seeking assistance from the central government for conducive legal interpretation or revision of relevant regulations. Meanwhile, Khon Kaen is trying to find a way out of smart city development to be free from several government regulatory issues. Therefore, KKTT was founded to solve the pain point in terms of allocated budget (funds) from the central government and its bureaucracy. The funds from the individual investors were pooled together to build smart mobility by themselves, with no need to depend on the government budget allocation from the central government. The government only acts as a supporter or facilitator and is responsible for screening a "Project Plan," in collaboration with the Cabinet Department, Office of the Prime Minister, Ministry of Interior, Ministry of Agriculture and Cooperatives, and Ministry of Transport. This is considered as an inspection from a government regulator, so any operations according to the plan submitted will not have regulatory issues later. The collaboration among the government departments is divided into 3 main responsibilities as follows; 1) Ministry of Transport: studying the possibility of a project plan. Secondly, 2) Cabinet Department: putting Khon Kaen Smart City in the provincial strategic plan.

As to the concept of smart city creation, Taipei has developed both the city's infrastructure and database for building a smart city in all aspects: Smart Mobility, using innovation to drive the economy (Smart Economy), the government's digital transformation (Smart Government) and Smart Healthcare. To create smart spaces, Taipei has its infrastructure that supports being a smart city, together with technology usage through platforms co-developed with alliances. Taipei has developed a dataset and 66 smart city projects. Therefore, Taipei becomes a city that shares smart city's best practices and provides professional advice with Taipei City's government agencies domestically and internationally. Meanwhile, Khon Kaen chose to become a smart city in terms of Smart Mobility as a pilot development project. The city has started this development with light rail transit as a model project. In Thailand, there are no other cities that yet built an infrastructure to support a smart city. Khon Kaen foresees that this project can make changes in people's way of life. The public transportation system needs to be built to help make this happen. Afterward, the system of data management, together with the construction of public transport feeder, can be created. As for the implementation guideline, 5 municipalities in Khon Kaen were formed as a company under the municipal management. The Federation of Thai Industries and Khon Kaen University are responsible for technology, building a hub of LRT, and the Chamber of Commerce oversees any commerce or business-related. Lastly, 3) Office of the Prime Minister: The Special Committee on Driving the Provincial Development and Public-Private Partnership committee.

With respect to public participation, in Taipei, its citizens are allowed to participate in any projects operating through technology. Taipei Smart City website has been set up to showcase their projects. The website also allows citizens to make suggestions and submit project proposals. People can submit their needs or feedback to the government via platforms built by the government. As Taipei is an innovative city connected to a smart city in several aspects, DOIT has also developed an IoT Experimental Platform, which is an online portal that allows anyone to research and develop the technology. Taipei has developed a platform open for people to express their needs, which is a meaning of public participation, while in Khon Kaen's Model, there is no online platform for people to participate in a smart city project. Only a public forum, opinion exchange through the public forum for open discussion, and the academic forum are organized by the provincial government agencies and educational institutes. Therefore, people who participate in such

activities are only the ones interested in city development. This may lead to data or feedback of the project's undertaking being not recorded or not taken seriously. However, the framework of both cities is a collaboration from the major sectors, including government, business, and educational institutions. This is consistent with the Triple Helix model, which is an innovation development concept consisting of 3 divisions or institutions; the public sector, business sector, and the education sector, with each of them having different roles (Etzkowitz & Leydesdorff, 2000) as a model of innovation, meaning a collaborative service innovation. The Triple Helix concept focuses on interaction. It is a system of integration of innovation processes, in which each side, in addition to performing its duties. There is also support for the roles of other parties. To promote each other, such as in Khon Kaen, there is a local municipality that works together with the private sector in the province and Khon Kaen University, similarly to Taipei that has DOIT and PMO as a collaborator for the private sector and educational institutions such as National Taiwan University and National Chengchi University. The development of the Khon Kaen Model is a joint effort to create a mechanism that drives the Ecosystem to facilitate innovation development. It is called the "Triple Helix model" which reflects the shared vision and consensus of the Khon Kaen people and the central government. It is a mechanism for creating cooperation that makes all sectors see a picture of joint development, leading to Collaboration Planning in the Khon Kaen Model (Wongthanawasu et al., 2019) that does not rely on or add to the burden of fiscal to the central government but considered a model of urban development in Thailand.

By creating a forum for exchange and brainstorming to build cooperation in the development of the city, the actors from various sectors were discussed, building cooperation in urban development without waiting for the government for such participation. This is due to the positive motivations of the people in the area who use formal and informal dialogues in brainstorming to create a joint vision for the development of the Smart City, to make problem-solving options, and to make decisions together at all levels and working with government agencies at the Partnership level as well as various sectors. In this example, the city of Portland used a dialogue, engagement, and collaborative approach to operate together. This indicated that the level of public participation, starting from joint policy-making and working on joint projects to achieve the results of the objectives participation at the Partnership level, is defined as the participation in a collaboration or effective change level in all decision-making processes.

11. Lessons learn from creation smart mobility in both cities

By comparing the guidelines for creating smart cities through Initiatives, Frameworks, Concept of Smart City, and Public participation, it shows the trends and directions to develop and manage the city in the future through " socio- technological approach," to understand the dynamics of working of all sectors, government, private, civil society through public participation with technology- driven to improve the living and quality of life. The lessons of both cities that show the difference are as follows.

First lesson, the development depends on the social, cultural, and topographical conditions of each country. Both cities have different points and similarities. Firstly, Taipei is the capital city. It has a mountainous terrain with few plains, resulting in population density. Thus, it is necessary to build an efficient mass transportation system. Taipei has laid the foundation for smart mobility development for more than 27 years, making its people familiar and able to adapt easily to technology that helps in smart mobility in all areas. While Khon Kaen is a major city in the northeastern region with flat terrain, resulting in a fragmented habitat, mass transportation is not the priority for the public. Therefore, the development of the public transportation system is the main guideline for constructing infrastructure to being a smart city. Social innovation in Khon Kaen was invented and developed. In particular, the civil society has pioneered a concept that integrates working groups of educational institutes or Khon Kaen University, banking groups, and economic organizations in the Khon Kaen area to work in the economic development of tourism and problem-solving of different sides of the city. The working groups consist of 8 main organizations, namely, 1) Bank of Thailand Northeastern Region Office, 2) Khon Kaen Bank Club, 3) Federation of Industry, Khon Kaen Province, 4) Khon Kaen Tourism Business Association, 5) Khon Kaen Business School, Khon Kaen University, 6) MBA KKU Alumni Association, 7) Association for Entrepreneurship of small and medium

enterprises, Thai, Khon Kaen, and 8) Khon Kaen Chamber of Commerce. These organizations work together and when strengthened together, they have to continue to work with the government.

The second lesson, the development depends on the institution or organization on politics, bureaucracy, and law in each country, which makes Taipei and Khon Kaen have different development points. As Taipei can be developed before and beyond, it becomes an example of the world's leading smart cities. Taipei has an ongoing institute of development with inclusive features where benefits and opportunities are distributed to most people. There is also a reliable legal system that provides opportunities for all citizens by using the strengths of their technology to change the transportation behavior of people and working together in all sectors. For instance, creating legal institutions is the most important part of a development by developing laws between the public and private sectors to unlock regulations that hinder innovation development. Taipei also created the Taipei Smart City Living Lab after the Department of Information Technology (DOIT) established the Taipei Smart City Project Management Office (PMO) as a development institution. This development institution includes inclusive development to provide incentives for public participation by investing and innovating through the guarantee of personal property rights and enforcing contract laws. It encourages investment and growth through education and infrastructure and the promotion of public participation. While Khon Kaen can proceed following Taipei, Taipei can be an example of policy formulation and implementation. Khon Kaen is getting out of the trap from the extractive work of the bureaucratic system in Thailand. Establishing smart cities in Thailand is difficult and chaotic, which makes the city unable to have continuous development (Sustained Growth). Besides, the regulations that are unable to respond to development make it a national pain point, causing Khon Kaen to solve problems within the province by using participation from all sectors such as self-procurement budgeting and legislation that is conducive to removing regulations difficult for the development of public transportation. Therefore, to develop the Triple Helix approach, the locality must have a good understanding of the principles of decentralization, knowledge and understanding of the philosophy of "Local government," ability to create a shared vision, understanding of the principles of building an infrastructure potential, ability to create City Enterprise Architecture, and ability to coordinate and create ecosystems to develop innovation governance to help local communities achieve a sustainable development according to the framework of the model, as shown in Figure 1.

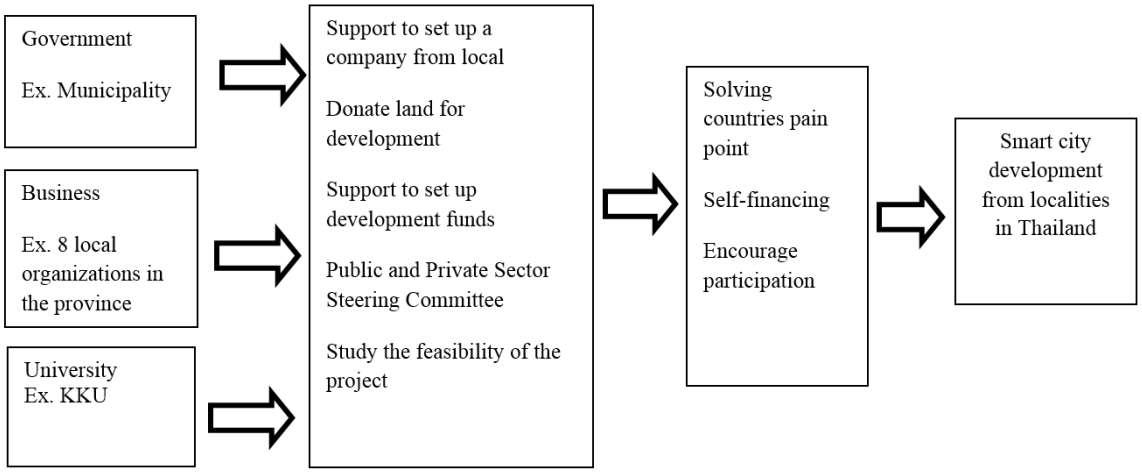

Figure 1 The Triple Helix Khon Kaen Concept was synthesized by the writer (2020)

12. Conclusion

A Smart City is a solution to deal with the growing urban population. Apart from the increasing population density, the wasteful use of natural resources is another problem of concern. Efficient management with the help of technological innovation as a tool should be implemented to support resource allocation for the best interest and sustainability. The development concept of a smart city in Thailand is still under the development stage that combined various concepts of cities and countries around the world. Smart Mobility is an interesting smart city development indicator that local authorities of Thailand can further develop in the future. However, Thailand still needs to adapt the concepts of smart cities from other countries and relies on those successful countries in developing its smart city. Taiwan is one of the successful countries, particularly in public transportation in terms of the development of information technology databases, development, and public transportation services. Even though Thailand might have different initiatives but the objective is the same, that is, to improve public transportation and people's quality of life. Thus, it is a good opportunity for Thailand to study the causes and factors of Taiwan Smart City development as a case study and benchmark for the development of Thailand Smart City in the future.

13. References

Anthopoulos, L. G. (2017). The rise of the smart city. In *Understanding smart cities: A tool for smart government or an industrial trick?* (pp. 5-45). New York, USA; Springer.

Banchanon, P. (2017). *Wi-khro Thailand 4.0: Wi-sai-that thi yang khat rai-la-iat [Review of Thailand 4.0: The National Vision with Sketchy Details]*. Retrieved on 27 May 2020 from https://www.bbc.com/thai/thailand-38527250 [in Thai]

Dameri, R. P. (2017). The conceptual idea of smart city: University, industry, and government vision. In *Smart City Implementation* (pp. 23-43). New York, USA; Springer.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations. *Research policy*, *29*(2), 109-123.

Khon Kaen City Municipality. (2016). *Khon Kaen Smart City project*. Retrieved May 5, 2020, from http://www.kkmuni.go.th/center-main.php

Kumar, T. V., & Dahiya, B. (2017). Smart economy in smart cities. In *Smart economy in smart cities* (pp. 3-76). Singapore: Springer.

Rudolf, G., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., & Meijers, E. (2007). *Smart cities-ranking of european medium-sized cities.* Retrieved May 2 2020, from http://www.smart-cities.eu/download/city_ranking_final.pdf

Taipei Economic & Cultural Office (TECO). (2018). *Smart Cities in Taiwan Introduction Booklet (pp. 2-15)*. Retrieved May 8, 2020, from https://www.roc-taiwan.org/uploads/sites/89/2019/11/Taiwan-Smart-Cities-Brochure-V-20191112.pdf

Teekayupan, W. (2016). *Discussion on "Smart city to drive the economy of Khon Kaen and the northeast region" Khon Kaen Mekong Connect invades the northeast, extending the development of Startup and Digital Economy nationwide to build a base for Thailand 4.0 that drives the economy with innovation*. Retrieved on May 5, 2020, from https://www.youtube.com/watch?v=t0altJBPrA [in Thai]

The Department of Information Technology (DOIT). (2019). *Smart Taipei*. Retrieved May 8, 2020, from https://smartcity.taipei/docs/en/Presentation.pdf

Tzu-Ti, H. (2019). *Taiwan unveils driverless WinBus*. Retrieved May 5, 2020, from https://www.taiwannews.com.tw/en/news/3768126

TerraBKK. (2017). *Khon Kaen Smart City*. Retrieved May 2, 2020, from http://www.smartgrowththailand.org/khonkaen-smart-city-lrt/

United Nations. (2015). *World Urbanization Prospects (2014 Revision)*. Retrieved May 5, 2020, from https://esa.un.org/unpd/wup/Publications/Files/WUP2014–Report.pdf

United Smart Cities. (2018). *Organization for International Economic Relations*. Retrieved May 6, 2020, from http://www.unitedsmartcities.org

Wongthanawasu, S. (2017). *Opening a new dimension to local, private joint venture organizations. Build a Smart City; Talk on the Addition, Development, Informational, Conflict Newsletter*. Retrieved May 20, 2020, from http://www.smartgrowththailand.org/local-administration-private-sector-joint-venture-smart-city/ [in Thai]

Wongthanawasu, S., et al. (2019). *Khon Kaen Model: Khon Kaen Model*. (pp. 16). 1st edition. Khon Kaen: klngaana vitthaya press.