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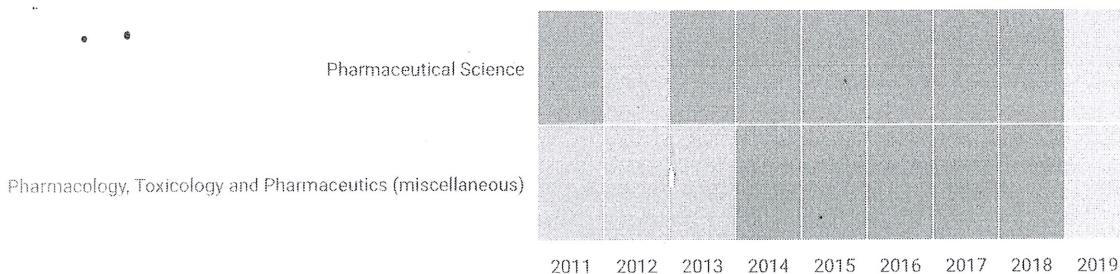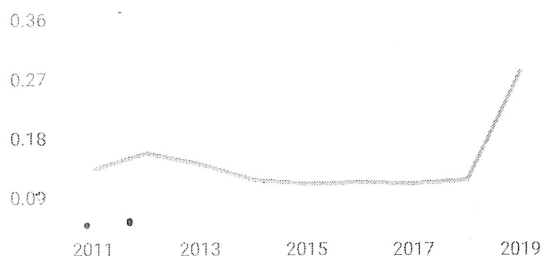|	
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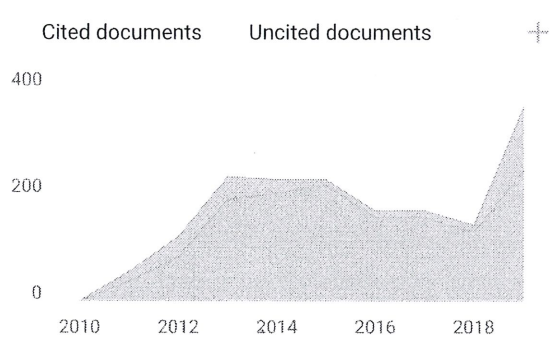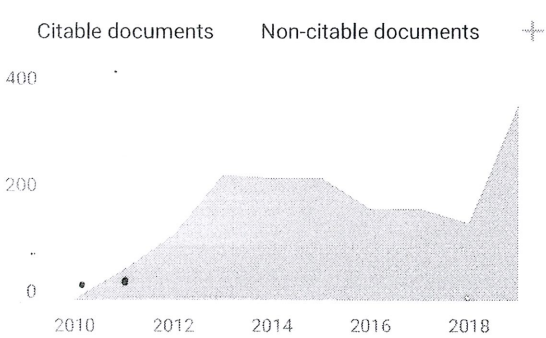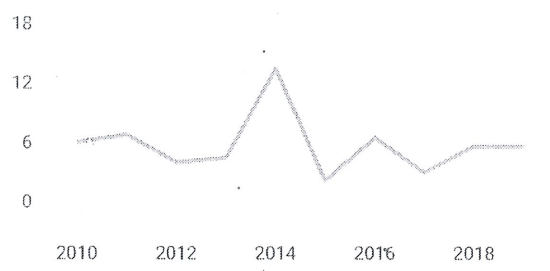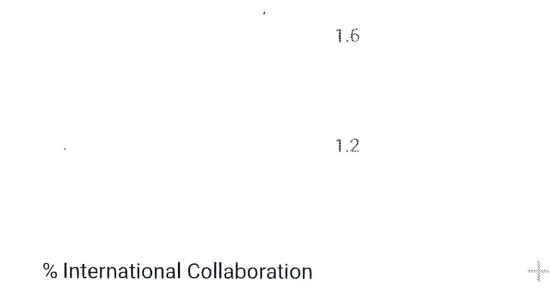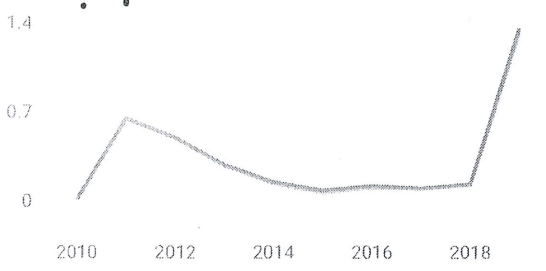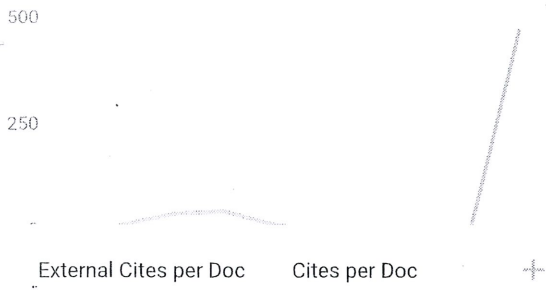
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Research Article

Factors Influencing Smart City Development in Khon Kaen, Thailand

AWUTH RUENPAKPOJ[1], SUKANYA AIM-IM-THAM[1], SUTTIPONG HOXSUWAN[2], NORRAPAT NOILUBLAO[3], PONGSATEAN LUENGALONGKOT[4], CHULA CHARERNVONG[5],DOMTHARADOL ANANTASAN[5], SUPHATTHANI KHOONSINGSAKUN[5], SUCHIN CHARNSUNGNERN[6],AKKAKORN CHAIYAPONG[7], KORAKOD TONGKACHOK[8],THONGPHON PROMSAKA NA SAKOLNAKORN[9*]

[1]Faculty of Humanities and Social Science, Khon Kaen University, Thailand
[2]Faculty of Education, Mahasarakham University, Thailand
[3]Faculty of Science and Technology, Rajabhat Maha Sarakham University, Thailand
[4]Faculty of Political Science and Law, Burapha University, Thailand
[5]Faculty of Humanities and Social Science, Phetchabun Rajabhat University, Thailand
[6]The Secondary Education Service Area office 40, Ministry of Education, Thailand
[7]Faculty of Law, Suratthani Rajabhat Yniversity, Thailand
[8]Faculty of Law, Thaksin University, Thailand
[9]Faculty of Management Science, Silpakorn University, Thailand
Corresponding author:
Email: thongphon.p@gmail.com

ABSTRACT

This study is aimed at examining the factors influencing the development of Khon Kaen's smart city. This study used a quantitative method by providing 400 questionnaires to members of the population, and the data were analyzed using factor analysis, which includes many related variables in one group or a single variable. The results indicate that because smart city development involves upgrading the city's quality to enhance people's quality of life and well-being, the city must be developed into a smart, healthy city with that addresses human health and the well-being of the physical environment. Therefore, the factors that influence Khon Kaen's smart city development include smart mobility, smart living, smart citizens, smart economy, smart environment, smart governance, and the smart healthy city concept.

Keywords: Smart city, Influential factors, Development

INTRODUCTION

The concept of smart city is an important concept in promoting sustainable development of cities around the world (Yigitcanlar & Kamruzzaman, 2018), by utilizing communication technology and infrastructure development to upgrade people's quality of life and for sustainability (Sumalee, 2015). Moreover, smart city is also a matter of using renewable energy and automatic traffic control (Molnar, 2020). In developing smart city the government has set up Thailand's National Smart City Committee to promote the development of smart city into reality, by opening opportunity to interested city to send smart city development proposal to the committee to receive various promotions from the government (Tortermvasana, 2020). Khon Kaen Smart City Project is set up according to the policy to move Thailand's economy (Thailand 4.0). The development of smart city is included in the National Agenda Action Plan to develop at least 10 smart city projects. Smart city according to universal standard consists of 6 sections: smart mobility, smart living, smart citizen, smart economy, smart environment and smart governance, in order to develop infrastructure and technology providing more convenience and people may have equal access.

Khon Kaen smart city concept originates from government's support and the prominent points of Khon Kaen are situating at the center of Isan region, having many universities, government agencies and government centers. Private sector organizations, civil society sector, chamber of commerce, council of industry, universities and local community sector had a meeting to consult and express opinions in creating the project to be continuously beneficial to the city. Thus Khon Kaen City Development (KKTT) Co., Ltd. was established by the combination of 20 companies of Khon Kaen businessmen, each contributing 10 million baht in registering the company. Its aim is

to mobilize ideas, to do research, and to search approaches to the projects to develop the city. The main concept of the company is the business operation which is not competing with the people of the city, but the business which is the infrastructure to support the growth of city, including mass transit system, convention centers, city-planning management, city area development planning, or even the environmental projects (Tortermvasana, 2020).

Khon Kaen City Development (KKTT) Co., Ltd. has the objective to develop Khon Kaen to grow with potentials, to move the development of light rail transit system (LRT). It received supporting fund in the study of suitable rail system from the Office of Transport and Traffic Policy and Planning (OTP) and developed into the Khon Kaen mass transit system master plan with 5 lines passing through 5 municipal districts. On June 10, 2015, the government had approved the Tha Phra-Samran line as the first line to be constructed. Later on March 2017 the Ministry of Interior had approved 5 municipalities in Khon Kaen to register to establish the Khon Kaen Transit System Co., Ltd. (KKTS), to manage and collect the revenue of the public mass transit system. Moreover on March 8, 2016, the prime minster had approved the Khon Kaen Smart City Project Plan in accordance with the policy to move the economy of the country (Thailand 4.0). Smart city development was included in the National Agenda Action Plan to develop the model of smart city development plan by developing smart city according to universal standard consisting of smart mobility, smart living, smart citizen, smart economy, smart environment and smart governance, to develop infrastructure and technology for more convenience and populace may have equal accessibility (Urban Studies Lab, 2020).

From the above description, the smart city project is one issue of city development based on using information technology for development, a knowledge-based society, and technology use as a mechanism to reduce social and economic equality. Thailand has a policy to promote smart city development and Thai government aims to build smart cities throughout the country. In addition, the government has seen the importance of smart city development in answering to the question of sustainable economic and social development, so it has promoted the smart city development. Khon Kaen city is on the way to develop the smart city according to the government policy. However, the smart city development of Khon Kaen has some issues to be studied for the approach to develop Khon Kaen city to be the most effective smart city. Hence, this study is aimed at examining the factors influencing the development of Khon Kaen's smart city.

Conceptual Framework

The smart city concept is an integrative approach that emerged from e-governance movements and collaborations between technology and companies and government (Coe, Paquet, & Roy, 2001). A smart city uses digital technology to connects the physical infrastructure, the information technology infrastructure, the social infrastructure and the business infrastructure to leverage the collective intelligence of the city (Hartley, 2005). Smart cities and communities focus on the intersection of energy, transportation, and information and communication technology (ICT) to develop environmentally friendly, livable cities that embrace the concepts of sustainability and quality of life for the people (Marsal-Llacuna et al., 2015). Such development efforts use technology and information (Batty, 2016), improve city infrastructure and technology to facilitate sustainable living (Marsal-Llacuna et al., 2015), use the Internet of Things (IoT) for city development by connecting all data, and analyze the city's design to improve its residents' quality of life (Williams, 2018).

Smart cities are supported by several types of technologies, including ICT, connected physical devices that use the IoT network, geographical information systems (GIS), and technology that should allow the city to become a more sustainable and efficient environment for its residents (CB Information Services, 2020). In addition, numerous studies have identified six dimensions of the smart city concept. These include smart mobility, smart people, smart economy, smart governance, smart living, and a smart environment (Ruenpakpoj et al., 2020). This conceptual framework is shown in Figure 1.
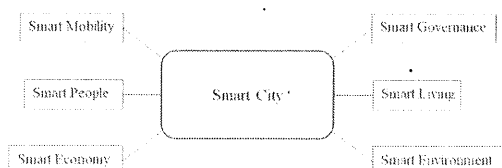

Fig1: Conceptual Framework

Source: Authors, 2020

METHODOLOGY

In this study, the area of study was located in Thailand's Khon Kaen province, and data were collected in six municipalities: Kho.n Kaen City, Sila Town Municipality, Ban Thum Town, Mueang Kao Sub-district, Tha Phra Sub-district and Ban Pet Sub-district. Khon Kaen City was the center of study area because it is an urban community; a center of business, trade and investment; and the location of provincial government agencies. Sila Town, Ban Thum Town, and Mueang Kao Sub-district are the surrounding areas of Khon Kaen City that must be developed along with Khon Kaen.

Population and sample

To employ a quantitative method, the data were collected using questionnaires with accidental sampling. A population of 269,179 people live and work in Khon Kaen City, Sila Town, Ban Thum Town, Mueang Kao Sub-district, Tha Phra Sub-district, and Ban Pet Sub-district. The sample of 400 people was acquired using Yamane's (1973) method.

Research instrument

The questionnaire used in this research was divided into three parts as follows: The first part collected general information, including sex, age, and income. The second part assessed the management of Khon Kaen's efforts to develop a smart healthy city through 27 questions on which respondents indicated their opinions using the following 5-level scale: strongly agree, agree, neutral, disagree, and strongly disagree. The third part, the open-ended questionnaire, collected other opinions. In addition, for reliability testing, the questionnaire was tested using 20 samples with similar qualifications of the population in Khon Kaen province. The reliability was analyzed using an alpha coefficient of 0.9140.

Data analysis

The data were analyzed using factor analysis, which includes many related variables in one group or a single variable.

RESULTS

From the review of documents, concepts and theories, and related researches, there are 6 influential factors for the management of Khon Kaen smart city for smart healthy city, consisting of (1) smart mobility, (2) smart citizen, (3) smart economy, (4) smart environment, (5) smart governance, and (6) smart living. The researcher had done factor analysis with the data obtained from questionnaires, by grouping many variables into a group or a single factor to have fewer factors: The new variables are able to explain easier the meaning of various variables in the factor. The factor analysis used the orthogonal rotation by varimax method, to confirm that all the six factors studied from the empirical data still relevant (confirmatory factor analysis). Variables affecting the management of Khon Kaen smart city for smart healthy city could be extracted into 6 factors and 27 variables. It is confirming the six influential factors as mentioned above, as follows: The first factor, smart mobility variable has Eigenvalues = 6.581 and % of variance = 16.873., the second factor, smart citizen variable has Eigenvalues = 3.220 and % of variance = 8.256., the third factor, smart economy variable has Eigenvalues = 2.059 and % of variance = 5.278., the fourth factor, smart environment variable has Eigenvalues = 1.855 and % of variance = 4.757, the fifth factor, smart governance variable has Eigenvalues = 1.606 and % of variance = 4.118, and the sixth factor, smart living variable has Eigenvalues = 1.538 and % of variance = 3.943.

The six extracted factors has the reliability of instrument by Cronbach's Apha = 0.949, and the suitability value of the sample data by Kaiser-Meyer-Olkin (KMO) = 0.909. For KMO, if the value of KMO is high (approaching 1), showing that the factor analysis technique is suitable for the data to be analyzed. The data using in this analysis has total variance explained value of 72.054%, showing that it is suitable for the factor analysis, because it is more than 60%. For the factor analysis, 27 variables could be extracted into 6 influential factors, by using factor loading to group the variables, with the relationship value that factor loading value of any variable related to which factor.

Table 1: Analysis of factors effecting to the management of Khon Kaen smart city		
Factor	Variable	Factor Loading
(X1) Smart Mobility	1. Linkage of public bus, airport, rail station, bus terminal and light electric rail with the coverage that facilitates mobility.	.678
	2. New smart traffic light control system which processing long-distant data from closed-circuit televisions and drones to enable better public transport.	.555

Table 1: Analysis of factors effecting to the management of Khon Kaen smart city		
Factor	Variable	Factor Loading
	3. The use of computer, internet, and smartphone application to enable easier data communication and transportation.	.777
	4. Revolving electric car and bike used to help easier move in transportation, reduce traffic congestion, environmental friendly and making people to have more physical exercise.	.598
(X2) Smart Citizen	1. Enhance strength and participation of people in the community available on the network of internet of thing (IoT).	.729
	2. Making the city as learning center, having learner-centered curriculum created by the cooperation of family and community.	.661
	3. Developing online learning system to provide classroom learning and live-long learning of the people.	.657
	4. Developing electronic library collecting academic knowledge, local wisdom, and as center for collecting and providing accurate and fast local information, accessible easily all the time.	.635
	5. Creating city-level creative space as the design and creative learning source for youth and creative economic entrepreneur, and making economic activities at neighborhood-level of the community.	.680
(X3) Smart Economy	1. Creating new business from innovation of educational institution's knowledge or city-level creative space.	.538
	2. Platform to support various start-ups, to initiate new business in Khon Kaen smart city.	.586
	3. Convention and exhibition center (MICE City) of the region with Isan identity, by utilizing the network of internet of thing (IoT).	.480
	4. Smart agricultural system using the network of the internet of thing; drone, blockchain, and electronic commerce.	.644
	5. Green smart industrial zone which is not toxic to environment, with industry that promotes business transaction connecting to Khon Kaen smart city, including quality labor force into the province.	.639
(X4) Smart Environment	1. Using smart growth criteria to develop city, such as, building garden in the city, public park, small park and green terrace, and green building standard or environmentally friendly building.	.684
	2. Utilizing the network of internet of thing (IoT) to manage environment and pollution, from household to city level to achieve the standard of smart environment city.	.627
	3. Promoting every household to sort garbage from the source by using the network of internet of thing (IoT), including sorting of wet or dry garbage in the household.	.681
	4. Applying of renewable energy from every source, especially solar energy of the household to control energy expenditure of every province at the stable level at least 25 year.	.666
(X5) Smart Governance	1. City management using technology connecting the communication and management both inside and outside the city to upgrade the people's quality of living.	.807
	2. Providing one-stop public service on the network of internet of thing, and application on smartphone to upgrade the quality of public service.	.832
	3. Open data system to collect various working data on the network of internet of thing (IoT) for data mining, to support the decision-making of the executives, the people, or stake-holder who is able to make use of it.	.818
	4. Khon Kaen City Development Co., Ltd., is the central organization in managing the smart city for the flexibility in operation.	.836
(X6) Smart Living	1. Medical application on smartphone connecting to the network of internet of thing (IoT) to reduce density of patient in hospital, and to	.599

Table 1: Analysis of factors effecting to the management of Khon Kaen smart city		
Factor	Variable	Factor Loading
	help the doctor's diagnosis to be more accurate, convenient, and faster.	
	2. City security system using close-circuit television ·and drone to observe, search, track, and giving instant help to the people, which working with application on smartphone through the network of internet of thing (IoT), ensuring the safety on life and property of the people.	.516
	3. Light controlling in the city by automatic light censor and other automatic public security system working with the network of internet of thing (IoT), ensuring the safety on life and property of the people.	.507
	4. Smart house which control the working of the system by the network of internet of thing (IoT), upgrading the safety in living, using renewable energy, and managing resource by information exchange in the community level.	.527
	5. Having connecting system of information technology and health system for the people to be aware of and able to access and look after their health with easy-accessible information technology.	.572

From the factor analysis as of table 1, smart city is the development and upgrading quality of the city to have environment and ecosystem that enable everyone to live happily, by focusing on human development and creating good community with infrastructure suitable for the people, every sex, every age, including the disables. Technology and innovation is used to support the smart city development, at the same time operating under the sustainable principles according to sustainable development goals, as follows:

1) Smart mobility is transportation and communication in every form, with the support of information technology and integration of communication system. The city must be convenient for traveling, with various transportation facilities in multi-format for the people to travel easily, such as, electric bicycle, hired electric bicycle or other vehicles, through electronic business transaction and mobile phone, including the designing of policy and infrastructure to support the convenience of vehicle accessibility. The study of Dowling and Albino, Berardi, and Dangelico (2015) discussed that the city must let the people to access variety of transportation, not limiting only on that provided by the state, such as, permitting people to use application to call taxi via service providers, such as, Uber. Moreover, Docherty et al., (2018) discussed that the city must have the transportation system which uses more alternative energy, for example, transport system which uses electricity more than petroleum, or allowing individual to bring vehicle into public service with control and using the information technology as the tool to communicate and in paying-receiving fare.

2) Smart citizen is the city development moving by information and communication technology (Batty, 2016; Mora & Bolici, 2017). The people must be active citizen with public minded in looking after each other, having the use of electronic system to develop various skills in working by using information technology in accessing to education and skill-building, in human resource management, and production force. There are creative adjustment and supporting in making innovation both inside and all of the society. From the study of Cardullo and Kitchin (2018), they gave an interesting idea that in developing smart city the key is that how to make people use information system of big data easier and usefully. The state provides platform for people to access the data easily. This is in line with Ranchordas (2020) who explained that smart city must have data base which is an open system, for the people to access and share data easily.

3) Smart economy is the development of smart city must also consider future economic development to be sustainable. So, there must be economic development from the grass root level to the business sector. Under what idea that the city will develop to have a sustainable economic system in both community economy and economy of the whole, including the making of environment and economic system that is supportive and suitable for creative economy. There is an interesting discussion of Söderström, Paasche, and Klauser (2014) that the development of smart city must have the development of infrastructure to support the economic expansion and growth, including high-speed internet system. This is the same as Sta (2017) who discussed that

high technology must be developed as the important part in upgrading the quality of the people's economic life. Moreover, Adapa (2018) discussed that it must be a city to support employment both skilled and unskilled labors.

4) Smart environment is the development of environment of the city with good management system, by using information technology without impact to environment. It is the development of city with consideration to the effect toward environment and the changing condition of the climate, by developing the cultivation of environmental consciousness, giving knowledge, and allowing the people to participate in environmental management, for example, being the city that chooses renewable energy, alternative energy, having garbage and wastewater management system that is friendly to the environment from the start. Moreover, Albino et al. (2015) explained that there must be a good system in monitoring environment. Including the study of Adapa (2018) who discussed that there is smart transportation and is friendly to the environment. In addition, Ahmed and Rani (2018) said that the city must have planning system in disaster management. Grossi and Pianezzi (2017) explained that the design of every activity in the city must protect the damage to environment.

5) Smart governance is the city management using technology connecting communication and city management both inside and outside the city to upgrade the people's quality of life. Having integration between public, private and civil sectors to the national-level organizations creates efficiency in working together, and a system with worthy effectiveness yielding highest benefit to the whole society. The important tool for having smart governance with information technology, from the study of Herdiyanti, Hapsari and Susanto (2019) they explained that the indicators of being a city with state administration for the people's convenience are readiness in designing city policy and strategy, readiness in implementation of the plan, good command and assignment for every agencies, sufficient budget in managing information technology, applications and computer system in management, using electronic management system in various works, for example, procurement, finance, document management, having an operation center, such as, website management, information and communication center.

6) Smart living is the creation of living environment for people's good quality of life. The city develops facilities by using friendly design for good health and quality of life, with safety and living happily. The city is developed for well-being of the people, with good physical health, good mental health, and being in social environment which supporting to each other. Information system is used in the way of life, daily living, and high-speed internet for the people to have access to various data easily and fast. The quality of life has completely the physical and mental happiness, safety and good society. Information technology is connected with health system for the people to have awareness, and be able to access and look after their health with easy-accessible information technology. It is ready to respond every need of the residence in every aspect, answer every question of caring, healing, reforming of health, and look after completely in every aspect. Moreover, Han and Zhang (2020) discussed that the city must be safe from crime, such as, having closed-circuit television technology and installed closed-circuit television covering every risky spot all over the city. In addition, Stieß, Umbach-Daniel and Fischer (2019) explained that the city has designed transport system that is convenient for living, such as, footpath, bicycle lane, and using renewable energy for convenience in living and environmental friendly.

CONCLUSION AND DISCUSSION

City management is the basic principle in administration for having sustainable development (Bibri & Krogstie, 2017). Smart city is the city that utilizes modern technology and innovation wisely to increase effectiveness in giving service and city management, by reducing expense and lessen the use of city resource for environmental friendly. The focus is on good design, and participation of business and civil sectors in city development, under the idea of the development of habitable city, modern city, for the people to have a good quality of life and be happy under the idea of sustainable development. For the development of smart city with the universal standard, it is consisting of 6 sections: smart mobility, smart living, smart citizen, smart economy, smart environment, and smart governance. However, the development of smart city must be developed to be smart healthy city with the aims covering both human health, well-being of physical environment, economic and social environment, and covering the city area that providing happiness, good health and well-being for the people in the city. This depends on community participation very much, such as, participation in decision-making of the people in the community especially in the issue of health and quality of life of the people in the community. Moreover, the state must cooperate with local hospital in providing public health service that is

able to service all over the community, especially the slum.

In developing to be smart healthy city, there must be the building of consciousness and motivation in keeping good health and connecting knowledge, reinforcing the understanding of being healthy, and more accessible health service for the poor in the community, for example, having activity in keeping cleanliness in living area, and making understanding on good health for the people. The study of Han and Zhang (2020) explained that smart healthy city must have environmentally friendly building designing, for example, energy conservation, using renewable energy, also using building materials with least health effecting, for example using eye-caring bulb, and making green area in the office building. Moreover, Bardley and Crum (2018) discussed that people in city area must consume safe food (nontoxic food), by producing safe food in agricultural area outside the city zone. Lastly, Angelidou (2014) discussed that smart city must have health application designing and supporting people to use various health applications to have basic health caring, and be able to protect oneself from basic health problems.

For the suggestions in developing Khon Kaen smart city are as follows: 1) Municipality and government agencies must support and build online market place to be goods and service exchanging space, and local agencies must be coordinators in building online market place. 2) The city central application should be set up to be public space for people to access city information. 3) Smart traffic and transport systems must be developed quickly in the city and nearby area for integrated development, by increasing efficiency and connectivity of diversified transport and traffic systems, increasing convenience and safety in travelling and transportation, including environmental friendly, for example, supporting the use of electric car. 4) Government should lower import tax for electric car or environmentally friendly vehicles to have low price so that general people could afford them. 5) Government agencies must increase the use of digital system or online system in issuing licenses or acquiring official documents. 6) Municipality must apply the clean and green city approach. 7) Municipality must apply the idea of circular economy. 8) Applications should be used more on health and promoting protective medicine by using more communication technology between doctor and patient.

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