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A Study of Smart ICT model of Hat Yai Smart City, Thailand

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Abstract:

This study intends to develop Hat Yai's Smart ICT model. IoT, Big Data, Cloud, etc. This study will help Hat Yai's governor create a Smart City and Smart ICT solution. It helps discover the Smart City component that will benefit residents most while maintaining faithfully to the city's original development goal. This research will also help create Smart ICT solutions for Smart City development. A Smart Society, Smart Environment, and Smart Economy fit Hat Yai City's development strategy. The project aims to find a relationship between IoT, Big Data, Cyber-Physical systems, and Cloud Computing. The researcher surveyed 565 respondents in Hat Yai, Thailand, both those whose world is important to Smart ICT or the Internet of Things, Big Data, Cyber-Physical systems, and Cloud Computing and those who are not, and evaluated the data using Pearson Correlation. Internet of Things (IoT) technology is linked to a Smart Society, Smart Environment, and Smart Economy. Big Data helps build a Smart Society. Cyber-Physical System result demonstrates a relationship between a Smart Society and Smart Environment, and Cloud Computing shows a relationship.

Keywords : Smart Society, Smart Environment, Smart Economy, Internet of Thing, Big Data, Cyber Physical system and Cloud Computing

JEL Classification Code: E44, F31, F37, G15

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1. Introduction

Smart City is one of the most frequently used terms to describe the expanding efforts to develop a strategy for achieving "smart" urban growth through innovative and sustainable policies (Caragliu et al., 2011). The phrase "smart" has many distinct connotations, resulting in a multitude of alternative terms such as "intelligent city," "knowledge city," "ubiquitous city," and "sustainable city" (Cocchia, 2014). The lack of a single, commonly acknowledged definition of the term has rendered it "fuzzy" and unclear (Angelidou, 2014; Caragliu et al., 2011; Chourabi et al., 2012; Vanolo, 2014).

Smart City Development (SCD) was established to address urbanization issues such as overpopulation, mismanagement of resources, environmental problems, and economic and social issues (Jamous & Hart, 2019). Globally, municipal governments are investing heavily in technology-driven programs aimed at transforming cities into "smart cities" with the purpose of enhancing the lives of their citizens by streamlining service delivery (Girardi & Temporelli, 2017; Komninos & Mora, 2018). In contrast, a city is considered as an integrated system comprised of subsystems such as healthcare, transportation, education, energy, and housing, as well as a number of management authorities and organizations that govern these subsystems (Javidroozi et al., 2015; Pierce et al., 2017). The framework for smart city initiatives has expanded on the systems integration concept in SCD, envisioning a smart city as an integrative framework of components including management and organization, technology, governance, policy, people and communities, economy, built infrastructure, and the natural environment (Chourabi et al., 2012). Consequently, city systems integration is a requirement for SCD, resulting in the integration of people, institutions, and technology-mediated services, comparable to Enterprise Systems Integration (ESI) in the private sector, where Business Process Change (BPC) enables businesses to integrate disparate information systems and improve operational efficiency (Motwani et al., 2002; Nam & Pardo, 2011; Harmon, 2014). Meanwhile, the majority of contemporary cities attempt to link their numerous "smart" initiatives and new digital apps to a well-organized strategic strategy and road map with clearly defined goals, objectives, and roles, there are a few exceptions (Chourabi et al., 2012; Neirotti et al., 2014).

However, in order for this to occur, a well-defined implementation framework must be developed. According to the literature, an ideal city strategy comprises several interconnected activity spheres, including a variety of activities and processes. Consequently, there is no "right" or "one-size-fits-all" strategy. Each city has its own requirements and resources, necessitating a diversity of approaches. Therefore, a strategy that is tailored to the city's characteristics is required and advised (Albino et al., 2015; Quraishi & Siegert, 2011). The continuous growth of information and communication technology (ICT) has resulted in advances in the application of urban informatization, allowing information technology to become an effective means and instrument for urban government and giving rise to the idea of the smart city (Li et al., 2019).

As an alternative to the traditional city planning model, a common definition for a smart city is a new concept and mode that promotes the intellectualization of urban planning, management, and services through the use of ICT, such as the Internet of things (IoT), cloud computing, and geospatial information. The smart city is a system based on information communication and geographic information technologies, with a concentration on a core set of technologies and applications for urban informatization creation, operation, service, and management. Among the important technologies are big data, intelligent sensing, next-generation communication networks, cloud computing, virtual reality, artificial intelligence, and spatiotemporal information. Within the context of this study, the Smart ICT development model of Hat Yai City seeks to explore, evaluate, and map the current implementation of a SC-oriented strategy in Hat Yai City. A more in-depth analysis of their internal operations and potential concerns is conducted, taking into account the technical, financial, and social advancements of the previous years. As a result, the research explores the influence of technical and institutional factors on the current approaches.

During the last few years, the public and private sectors have widely endorsed and promoted the concept of a Smart City that will bring about convenience and sustainable growth for the citizen. There is a wide range of Smart ICT solutions that potentially enable the concept of a Smart city in each dimension: Smart Governance, Smart Living, Smart People, Smart Mobility, Smart Environment, and Smart Economy. However, to fully maximize the benefits of Smart ICT toward Hat Yai city, It is essential to incorporate various factors into the analysis. For example, the Hat Yai City development plan, Smart ICT model, etc.

Research objective - this study explores the Smart ICT development model of Hat Yai Smart City to develop Smart ICT deployment strategies accordingly.

Despite the tremendous effort, countless work hours, and business meetings, many initiated Smart City projects get stuck and cannot be implemented as planned. As a result, officers in both the public and private sectors who get involved in the Smart City project feel confused and lost on how to push the project forward. This research will help stakeholders to know the Smart ICT development model of Hat Yai Smart City. Furthermore, this research will help stakeholders to form better strategies when planning the Smart City project.

2. Literature Review

2.1. Smart City Planning

Smart towns are "instruments for enhancing community and quality of life by increasing competitiveness" (Batty et al., 2012). According to Anthopoulos (2017), a smart city has been integrated with intelligence acquired from available intelligent technology and services that either improve or automate city functions (such as transportation and waste management), create employment, and enhance citizen satisfaction. Consequently, terms such as "intellectual transportation system" are utilized (Khan et al., 2017), "smart infrastructure" (Kim et al., 2016; Shichiyakh et al., 2016), and "smart living" (Khan et al., 2017; Raspotnik et al., 2020) has been commonly used to describe Smart City Development (SCD). Despite a lack of agreement on the definition and conceptualization of smart cities (Letaifa, 2015; Thomas et al., 2016), the majority of experts agree that a smart city has six characteristics: smart mobility, smart administration, smart economy, smart people, smart living, and smart environment (Khan et al., 2017; Kim et al., 2016; Myeong et al., 2018; Raspotnik et al., 2020).

2.2. Smart ICT

In terms of data exploitation, numerous applications and services will integrate and utilize data from several domains. As a result, the project envisions a Smart ICT platform in the center of smart city player engagement. The Smart ICT platform (see Figure 1) is responsible for, among other things, facilitating interactions between data owners/publishers and applications/services. Through the ICT platform, data owners can make their data accessible either directly or through a data publisher.

Application and service developers can use the platform to access the stored data and build new apps, which can then be made available to end users as shown in Figure 1. The ICT platform supports access control, policy enforcement, billing, monitoring, and discovery, among other capabilities (Dhungana et al., 2015).

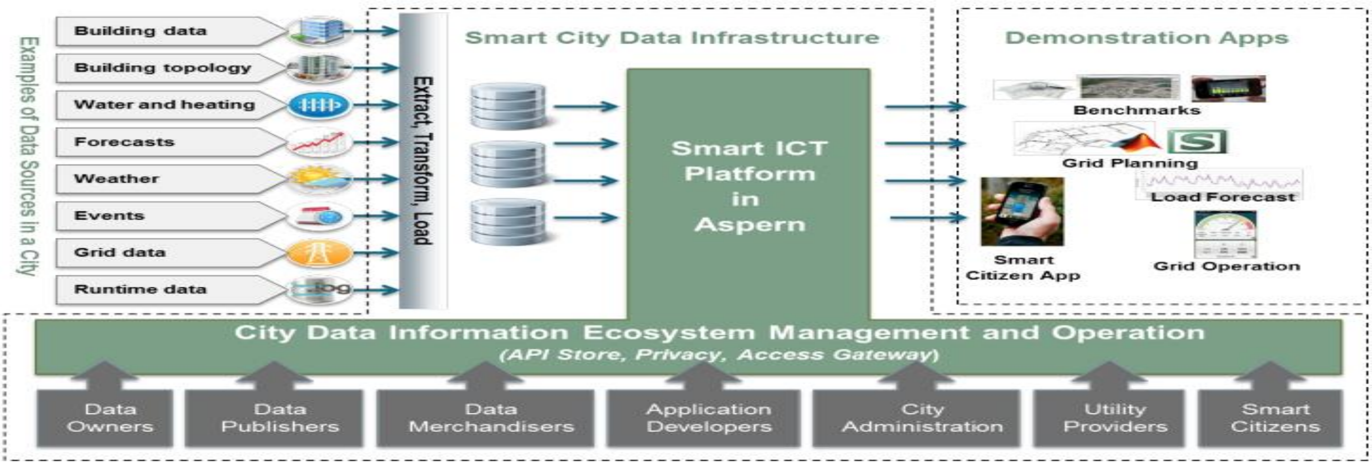

Figure 1. The Smart ICT Platform for Data Management

Source. Dhungana., D, Engelbrecht, G., Parreira, J., Schuster, A., Valerio, D. (2015)

Aside from funding considerations, government regulations, resource preparedness, and infrastructure as the primary buffers for effective smart city implementation, there is one more item to ensure successful technology adoption.

Any technology that can describe the function as a full system, namely input, process, and output, is meant. Components that can capture/collect, integrate/communicate, and analyze data/crunch communities to create information as needed are required components. Instrumentation and Control, Connectivity, Interoperability, Data Management and Analytics, and Security and Privacy are the components. Internet of Things (IoT), Big Data, Cyber-Physical Systems, and Cloud are the four technologies required to execute Smart City applications (Anindra et al., 2018).

2.3. Smart Economy

Its innovative spirit, entrepreneurship, trademarks, productivity, labor market flexibility, international embeddedness, and ability to transform (Giffinger & Gudrun, 2010) determine a city's competitiveness. The theme highlights efforts to bolster the municipality's economy by enhancing the business climate and increasing its appeal to investors and talent to build the economy innovatively using information and communication technology (ICT) (Beesmart, 2019). The smart economy, in general, is one in which current resources are used to develop and execute creative solutions (Zygiaris, 2013).

2.4. Smart People

The Smart people dimension refers to social and human capital measured by educational attainment, a proclivity for lifelong learning, social and ethnic diversity, adaptability, creativity, cosmopolitanism/open-mindedness, and civic engagement (Giffinger & Gudrun, 2010). Cabrilo et al. (2013) reported an empirical study on human capital across Serbian industries, identifying gaps in employee innovation performance that can be used to develop more successful innovation strategies and policies as presented in Figure 2. To make the most of human capital, the first step is identifying the relevant gaps between human capital value drivers and company innovation target scenarios. Participation in decision-making, the provision of public and social services, the creation of transparent governance, and political strategies and viewpoints are all examples of smart governance traits and factors (Giffinger & Gudrun, 2010). Smart governance refers to the use of new approaches (e.g., co-creation or crowdsourcing) or the implementation of innovations to increase the links between the government and its stakeholders (people, corporations, and other civil society organizations) (Beesmart, 2019). Romanian citizens responded that they perceive good governance through the quality of public services, national security, and the state's efficiency at the economic, political, and administrative levels in a Chirlesan (2015) survey.

Figure 2. The Smart City Enabling Technologies
Source. Anindra, F., Harco, Warnars, L.H.S, & MinStudied, D.M. (2018)

2.5. Smart Mobility

Smart mobility solutions (Giffinger & Gudrun, 2010) are intended to improve the efficiency of urban transportation and include local accessibility, (inter)national accessibility, the availability of ICT infrastructure, and sustainable, innovative, and safe transportation systems. New modes of transportation, such as electric automobiles, autonomous vehicles, e-scooters, and new mobile applications for car and bike sharing, are examples of smart mobility. Mobility as a theme drew moderate interest from researchers, with 15% of publications relating to various forms of mobility. However, the majority of them focused on public and freight transportation, as well as parking.

2.6. Smart Environment

A smart environment relates to a city's natural resources and waste management; water management, energy efficiency, monitoring, and pollution management are just a few of the smart environment themes where new technologies and techniques can be used to make changes (Giffinger & Gudrun, 2010). The most prevalent sub-theme is energy, which is the main keyword of the smart environment in the SEE, with 'energy' as a keyword combined with either efficiency, management, or renewable energy. Trombadore (2017) discussed the MEETHINK Energy research project, which will result in a platform focusing on three key areas (energy efficiency in buildings and districts, renewable energy sources, and distributed energy generation and energy in urban mobility). The project's goal will be accomplished by sharing activities via networking, learning, and best practices, as well as assessing the training needs of participating municipalities in energy-efficiency planning and a capacity-building strategy for public authorities at various levels of government.

2.7. Smart Living

Cripps et al. (2012) discuss electronic health (smart) cards in a case study in Slovenia, citing benefits such as faster tracking of prescriptions, insurance rebates, and similar items, as well as drawbacks such as low data quality and patient data security issues. Vucetic et al. (2011) discussed the design, architecture, and tactics for developing an e-health records-based health information system in Serbia. A performance review of the new information system was done to assess each attribute, such as system and information quality, user happiness, and personal and organizational impacts (ibid). The findings of this new strategy indicated an increase in performance compared to the results of the previous approach (ibid). IoT is explored in the smart governance dimension as a basis for decision-making processes, whereas IoT in the smart living dimension focuses on improving citizens' living situations. Vrabie (2018) provides a broad overview of how IoT networks and services might contribute to the growth and living in smart cities. Sofic et al. (2016) exposed that stress the importance of IoT in the communications sector and point out key issues to consider when designing communications infrastructure for new IoT solutions. The goal should be to deploy fast Internet technology to accomplish the digital market Internet's long-term economic and social benefits.

2.8. City development plan (Hat Yai City)

According to the regulations of the Ministry of Interior On the preparation of the development plans of local government organizations, BE 2548 has stipulated that every local government organization will prepare a development strategy plan, which is the economic and social development plan of the local governance to determine the direction of development of each locality in accordance with the problems, needs and potential of each locality, including to coordinate and support provincial development strategies and national development accordingly National Economic and Social Development Plan as well as government policies which must have a consistent relationship.

To align with the Ministry of Interior policy, Hat Yai municipality has developed the city development strategy as the following Hat Yai Municipality has set vision, mission, and development objectives to be main guidelines for conducting Work to achieve the desired goals in the development of Hat Yai City Municipality as follows:

Vision: "The City of Happiness" (CITY OF HAPPINESS)

Strategy:

Strategy 1: Social Development

1. Educational development

2. Development, promotion and support of sports

3. Preservation and maintenance of religion, art, culture, customs and customs and local wisdom

4. Public Health Development

5. Community Development and Public Welfare

Strategy 2: Natural Resources and Environment Management

1. Green City Development

2. Development of wastewater treatment

3. Cleanliness solid waste management

Strategy 3: Economic Promotion Strategy trade and tourism

1. Promote and support trade activities, tourism and services.

2. Develop according to the sufficiency economy.

3. Promote careers for people.

Strategy 4: Political and Management Development

1. Enhance personnel capacity Increase operational efficiency and public service.

2. Promote people's participation in good public affairs under the rule in a democracy.

3. Maintaining order Promote and support the protection and maintenance of Safety in life and property of the people.

Strategy 5: Infrastructure Development

1. Construction, improvement of public utilities, and urban planning

2. Develop and improve the lighting system

3. Develop and improve the transportation system and traffic engineering

4. Flood Prevention and Mitigation

2.9. Smart Society, Smart Environment, and Smart Economic

More than half of the world's population lives in cities, which will climb to 68% by 2050. Growing urbanization harms the environment, necessitating sustainable urban development. Smart has become a digital response for city development, enabling a more sustainable and livable future (Lee et al., 2020). Smart city development uses ICTs to improve public services. SCD implements smart solutions to improve public infrastructure and services, enhancing residents' lives and tackling social challenges (Andreani et al., 2019; Doran, 2019; Andreani et al., 2019; Daniel, 2014). Japan's Rural Living Support System provides real-time information to rural seniors. This smart service promises to improve the elderly's mobility, socializing, and health monitoring. SCD improves residents' lives by meeting their needs, addressing everyday problems, and offering improved services and real-time information (Albino et al., 2015; Doran & Daniel, 2014; Khan et al., 2017). McKinsey Global Institute (2018) says SCD and smart city applications may enhance QOL by 10–30%. Smart apps reduce commute times, living costs, greenhouse gas emissions, water use, and city operations efficiency. A smart city arises when more people move to cities (Przysucha, 2020). This smart service promises to improve the elderly's mobility and health monitoring. SCD improves residents' lives by meeting their needs, addressing everyday problems, and offering improved services and real-time information (Albino et al., 2015; Doran & Daniel, 2014; Khan et al., 2017). McKinsey Global Institute (2018) said SCD and smart city applications may enhance QOL by 10–30%. Smart apps reduce commute times, living costs, greenhouse gas emissions, water use, and city operations efficiency. Sector-specific changes will not make a city "smart." "Smart" cities horizontally accumulate smart governance, transportation, living, resource use, residents, and economics (Gori et al., 2015). Space limitations and population density make cities share economies, with consumption involving access to shared resources rather than asset ownership (Sundararajan, 2014). Smart cities share information to promote efficient economies and communities (Agyeman & McLaren, 2014).

The literature describes several fields of activity related to the term Smart City: industry, education, participation, technical infrastructure, and various "soft factors"; we can identify six characteristics (see Fig. 1) as a roof for the further development of smart cities, which should incorporate the findings but also allow for the inclusion of additional factors (Giffinger, 2007). Smart city (Smart health, smart government, smart education, smart energy, smart waste management, smart industry, smart mobility) efforts rely on ICT. ICT integration with development projects can change a city's urban landscape and bring up new opportunities and improve administration and operation (Salih, 2016).

Höjer and Wangel (2015) asserted that the emergence of the idea of "smart sustainable cities" has been propelled by five key themes in recent years: (1) the understanding that environmental challenges are universal and that sustainable development should be addressed at all scales (international and local); (2) the growth of the sustainable cities and urban development movements in an effort to take local action for sustainable development; (4) the technological advances in ICTs in recent years, which have had a significant impact on society, the economy, and the environment; (5) the trends in urbanization that place cities at the center of interest in the sustainability discussion; and (6) the rise of the sustainable cities and urban development movements in an effort to take.

The main premise is that internet resources and platforms are crucial to creating energy-efficient, ecologically friendly communities since they help reduce pollution and energy use (International Telecommunications Union, 2014). For instance, using online technologies can eliminate the need for workplaces and physical travel. Users' awareness of their own resource usage within the context of the general pattern of consumption is fostered by collective intelligence initiatives. By creating applications for resource sharing, a cleaner environment, trash management, and other topics, we can reduce external greenhouse gas emissions while also gaining health benefits. Furthermore, the happiness and financial security of residents are impacted by intelligent technologies (Ahvenniemi et al., 2017). This will eventually help cities to become more flexible, responsive, and resilient (Huston et al., 2015; Marsal-Llacuna et al., 2015).

The Global E-Sustainability Initiative (2012) identified four "change levers" for leveraging ICT enabled solutions to reduce emissions: digitalization and dematerialization; data collection and transmission; system integration; and process, activity, and functional optimization. In the following three paragraphs, we present three possible strategies for merging "smart" and "sustainable" city concepts. First, ICTs have the ability to influence the future of sustainable urban development, according to the review by Hilty et al. (2011). This is so that the effects of economic growth on the environment will be lessened because of a less material-intensive economy, which will enable increased resource decoupling. The majority of research on smart sustainable cities focuses on whether and how the platforms, tools, and technologies of smart cities contribute to long-term urban growth. It also looks into how well sustainable urban development frameworks can take advantage of the new opportunities presented by smart cities (Bibri & Krogstie, 2017). Smart is seen as an instrumental concept, but "sustainable" is seen as a normative one (Höjer & Wangel, 2015).

ICTs and sustainability are both considered as enabling forces of city smartness, smart city planning, and smart growth in Bifulco et al. (2016)'s proposed new approach to ICT, sustainability, and urban intelligence (instead of sustainability being an outcome of smart city practices). Sustainability in current policy-making is considerably correlated with smart city governance, economics, and people by Giffinger et al. (2007), and less strongly correlated with mobility, environment, and living. On the other hand, ICTs have a close relationship with a number of categories, including the environment. This could imply that sustainable development initiatives and policies in the environmental domain could be improved by employing ICT technologies available in the same region. As detailed above, this study has constructed the conceptual framework as shown in figure 3.

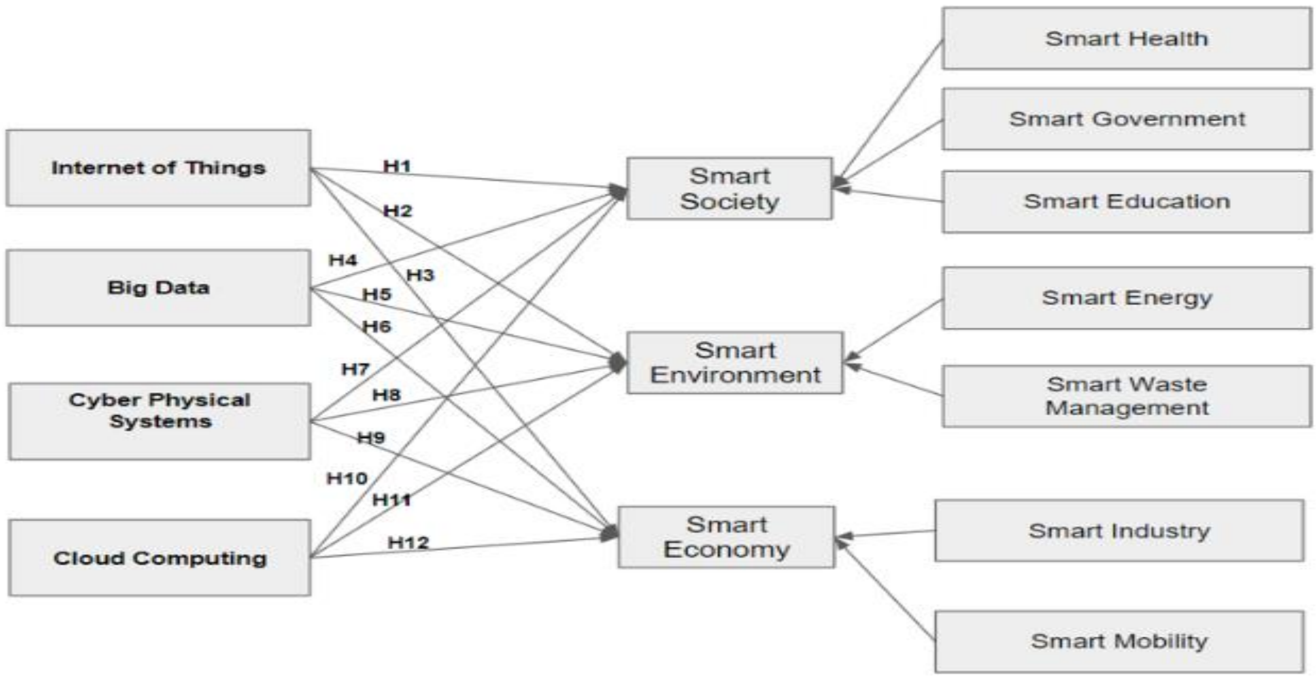

Figure 3. The Conceptual Framework
Source. Authors

A hypothesis is the researcher's presumption about the association between two or more variables. Twelve hypotheses are developed from the above conceptual framework, as follows:

H1o: Internet of Things (IoT) technology has no relationship with Smart Society.

H1a: Internet of Things (IoT) technology has a relationship with Smart Society development.

H2o: Internet of Things (IoT) technology has no relationship with Smart Environment.

H2a: Internet of Things (IoT) technology has a relationship with Smart Environment.

H3o: Internet of Things (IoT) technology has no relationship with Smart Economy.

H3a: Internet of Things (IoT) technology has a relationship with Smart Economy.

H4o: Big data technology has no relationship with Smart Society.

H4a: Big data technology has a relationship with Smart Society development.

H5o: Big data technology has no relationship with Smart Environment.

H5a: Big data technology has a relationship with Smart Environment.

H6o: Big data technology has no relationship with Smart Economy.

H6a: Big data technology has a relationship with Smart Economy.

H7o: Cyber-Physical System technology has no relationship with Smart Society.

H7a: Cyber-Physical System technology has a relationship with Smart Society development.

H8o: Cyber-Physical System technology has no relationship with Smart Environment.

H8a: Cyber-Physical System technology has a relationship with Smart Environment.

H9o: Cyber-Physical System technology has no relationship with Smart Economy.

H9a: Cyber-Physical System technology has a relationship with Smart Economy.

H10o: Cloud computing technology has no relationship with Smart Society.

H10a: Cloud computing technology has a relationship with Smart Society.

H11o: Cloud computing technology has no relationship with Smart Environment.

H11a: Cloud computing technology has a relationship with Smart Environment.

H12o: Cloud computing technology has no relationship with Smart Economy.

H12a: Cloud computing technology has a relationship with Smart Economy

3. Research Methods and Materials

Target Population - target respondents of this study are people living in Hat Yai city, around 374,891 people.

Sampling Size - to determine the appropriate sample size for the research study, Yamane's (1967) sampling formula is applied. A confidence level of 95% is obtained. The calculation was carried out based on Yamane's (1967) formula, and the sample size must include 400 respondents to meet the requirements of the research study (Yamane, 1967).

Sampling Procedures - the study of the Smart ICT model of Hat Yai Smart City, Thailand, was investigated using snowball sampling in this study. Snowball sampling is a type of convenience sampling. "Convenience sampling is the approach utilized by the investigator to collect information to reach those units or persons around him who are most helpful and accessible," Zikmund (2003) explains. Data may be gathered rapidly by polling 400 people who stayed in Hat Yai City, Thailand. Using Google Forms, a 5-point Likert Scale quiz was created. The questionnaire consisted of screening questions and was delivered online to target interviewees who had lived in Hat Yai city, Thailand. Due to time constraints, the study concentrates on data gathering and survey methodologies.

Research Instrument (Questionnaire) - for this quantitative research study, a questionnaire related to the Smart city dimension (Giffinger, 2007) and Smart ICT (Anindra et al., 2018) was designed with independent variables. The survey items were developed by the literature review conducted and were appropriately adapted to the target population and research objectives. The questionnaire is divided into four sections. The first section consists of screening questions to ensure that an appropriate result is obtained based on the target respondents. This section includes the respondent's residential location, whether they lived in Hat Yai city, and whether their work is relevant to ICT. Secondly, the respondents' demographic data is asked, including gender, age, and occupation. Finally, the variable measurements are studied.

Pretesting - pre-testing respondents' knowledge of the issue in the questionnaire is critical since it can aid researchers in identifying flaws and making changes. To collect data and uncover mistakes in the questionnaire, the researchers opted to generate predictions for 30 respondents. Cronbach Alpha was employed for internal consistency measurement, and the statistical program determined the alpha value of each scale according to Santos (1999). Ten factors were utilized to assess the questionnaire's dependability, including Smart Health, Smart Government (Public Service), Smart Education, Smart Energy, Smart Waste Management, Smart Industry, Smart Mobility, and Hat Yai Smart ICT.

According to Gliem (2003), the problem of all variables is assessing the internal consistency of project dependability using Cronbach's alpha coefficient, typically between 0 and 1. The closer the entry gets to 1, the more internal consistency it has. In addition, George and Mallery (2003) proposed a set of Cronbach's Alpha thumb rules as followed $\alpha \geq 0.9$ (Excellent), $0.9 > \alpha \geq 0.8$ (Good), $0.8 > \alpha \geq 0.7$ (Acceptable), $0.7 > \alpha \geq 0.6$ (Questionable), $0.6 > \alpha \geq 0.5$ (Poor), and $0.5 > \alpha$ (Unacceptable).

Given that the Cronbach Alpha for every variable in table 1 is higher than 0.64. Although all of the study's variables are related and significant, Cronbach's alpha ranges from 0.6 to 0.7, which immediately raises doubts about the reliability of the findings. However, it is determined that the questionnaires' content fits the validity criteria after comparing it to the theories from the prior study and after conferring with advisers and experts that the Cronbach alpha score may be approved and utilized for data collection for variables in this study. In reality, instrument dependability, as defined by Daud et al. (2018), is the stability and consistency of the constructed instrument (Creswell, 2010). An index with a Cronbach's alpha value greater than 0.6 is considered exceptional dependability (Nunnally & Bernstein, 1994; Pallant, 2001). It is considered low when the Alpha Cronbach's value is less than 0.6. Alpha Cronbach's coefficients are within the modest but respectable range of 0.60 to 0.80. Alpha

Cronbach's coefficients are rated as outstanding when they are between 0.8 and 1.00. The degree of instrument dependability is therefore evaluated in this article by measuring the Alpha Cronbach values on instruments built.

Table 1. Pre-testing results (N=30)

Variables	**Number of item**	**Cronbach's Alpha**	**Reliability**
Smart Health	3	0.649	Acceptable
Smart Government	3	0.644	Acceptable
Smart Education	3	0.653	Acceptable
Smart Energy	3	0.652	Acceptable
Smart Waste Management	3	0.656	Acceptable
Smart Industry	4	0.655	Acceptable
Smart Mobility	3	0.652	Acceptable
IoT Technology	7	0.653	Acceptable
Big Data	7	0.655	Acceptable
Cyber Physical System	7	0.657	Acceptable
Cloud Computing	7	0.651	Acceptable

4. Results and Discussion

4.1 Descriptive Data of Respondents

The researchers gathered information from 565 surveys and compiled a summary of all demographic characteristics, such as gender, age, and occupation. Two questions were used to screen it: They live in Hat Yai, Thailand, and have worked on projects including IoT, Big Data, Cyber Physical Systems, and Cloud Technology. For gender, out of 565 people, the majority of respondents were male (67.1%) and female (32.9%).

The majority over 435 respondents (77%) age between 31- 35. 89 respondents (15.8%) are age between 35-40. Only 24 respondents (4.2%) age between 26-30, 11 respondents (1.9%) age between 41-45, 4 respondents age between 46 - 50 and 2 respondents (0.4%) age between 56 - 60.

As for the occupation of respondents, over 536 respondents (94.9%) work with Private Company, 25 respondents (4.4%) are government employee and only 4 respondents (0.7%) work as freelancers.

4.2 Descriptive Mean and Standard Deviation

The means and standard deviations of the dependent and independent variables were calculated, and the mean range level was calculated. Mean range level interpretation by Shi (2020), 4.51 - 5.00 (very satisfied), 3.51 - 4.50 (Satisfied), 2.51 - 3.50 (Neutral), 1.51 - 2.50 (Dissatisfied), and 1.00 - 1.50 (Very dissatisfied).

From table 2 according to the survey the highest mean equal to 4.42 from “It will be great if I can register easily and quickly when going to hospital to receive medical service,” and the lowest mean is 4.33 from “I think the idea of being able to consult with doctors everywhere every time via online channel is necessary for me.” The highest standard deviation equal to 0.502 from “I would like to read information right away if there are some strange symptoms occur to me” and the lowest standard deviation equal to 0.474 from “I think the idea of being able to consult with doctor everywhere every time via online channel is necessary for me”

From table 2 according to the survey the highest mean is equal to 4.82 from “I want to know the latest update information about my local government announcement” and the lowest mean is 4.14 from “I will feel great if there is a one-stop-service for applying governmental related documents.” The highest standard deviation equal to 0.473 from “I will feel great if all my governmental related document application can be done online” and the lowest standard deviation equal to 0.385 from “I want to know the latest update information about my local government announcement”

From table 2 according to the survey the highest mean is equal to 4.8 from “I would like to be able to study the course I'm interested online anywhere anytime via online channel” and the lowest mean is 4.15 from “I want to participate in the community that enable me to learn new skills to improve my professional skill”. The highest standard deviation equal to 0.441 from “I want online education platform where I can track my online learning progress and achievement” and the lowest standard deviation equal to 0.398 from “I want to participate in the community that enable me to learn new skills to improve my professional skill.”

From table 2 according to the survey the highest mean is equal to 4.73 from “Renewable energy sources such as solar panel, Wind turbine, etc. are necessary for my community” and the lowest mean is 4.12 from “Pollution due to greenhouse gas is the serious issue in my community”. The highest standard deviation equal to 0.462 from “Renewable energy sources such as solar panel, Wind turbine, etc. are necessary for my community” and the lowest standard deviation equal to 0.439 from “I want to know real time information of how much electricity I utilized”

From table 2 according to the survey the highest mean is equal to 4.81 from “I think the filled waste bin present in my community is very unpleasant.” and the lowest mean is 2.24 from “I don't' want garbage pickup truck to visit if my garbage bin still not full”. The highest standard deviation equal to 0.936 from “I don't' want garbage pickup truck to visit if my garbage bin still not full” and the lowest standard deviation equal to 0.395 from “I think the filled waste bin present in my community is very unpleasant.”

From table 2 according to the survey the highest mean is equal to 4.77 from “In my opinion, robot and autonomous production system will be highly benefits to the business in my community,” and the lowest mean is 4.27 from “I feel great when I pay for product/services by using application without having to pay cash” and “ I like the idea of working remotely by utilizing internet as the tools to connect to my workplace.” The highest standard deviation equal to 0.527 from “I like the idea of launching business without having to pay big amount of money because government sector can initiate sharing economy business model for me,” and the lowest standard deviation equal to 0.432 from “In my opinion, robot and autonomous production system will be highly benefits to the business in my community.”

From table 2 according to the survey the highest mean is equal to 4.8 from “Public transportation is convenient without the need for personal vehicles,” and the lowest mean is 4.05 from “I think congested traffic is problematic in my community, I will be appreciated if there are less traffic jam in my community”. The highest standard deviation equal to 0.532 from “ I will be appreciate it if there are public personal vehicle that I can rent from time to time.” and the lowest standard deviation equal to 0.409 from “Public transportation is convenient without the need for personal vehicles.”

From table 2 according to the survey the highest mean is equal to 4.52 from “Smart education requires IoT Technology,” and the lowest mean is 4.21 from “Smart mobility requires IoT Technology.” The highest standard deviation equal to 0.539 from “Smart waste management requires IoT Technology,” and the lowest standard deviation equal to 0.471 from “Smart health (Public Service) requires IoT Technology,” and “Smart health solutions require IoT Technology.”

From table 2 according to the survey the highest mean is equal to 4.62 from “Smart health solutions require big data technology,” and the lowest mean is 4.21 from “Smart energy requires big data technology,” and “Smart mobility requires big data technology.” The highest standard deviation is 0.721 from “Smart energy requires big data technology,” and the lowest standard deviation equal to 0.509 from “Smart education requires big data technology.”

From table 2 according to the survey the highest mean is equal to 4.59 from “Smart health solutions require cyber physical system technology,” and the lowest mean is 4.15 from "Smart government (Public Service) requires cyber physical system technology." The highest standard deviation is 0.57 from "Smart education requires cyber physical system technology," and the lowest standard deviation equal to 0.417 from "Smart government (Public Service) requires cyber physical system technology."

From table 2 according to the survey the highest mean is equal to 4.52 from "Smart health solutions require cloud computing technology," and the lowest mean is 4.07 from "Smart mobility requires cloud computing technology." The highest standard deviation is 0.563 from "Smart energy requires cloud computing technology," and the lowest standard deviation equal to 0.443 from "Smart mobility requires cloud computing technology."

Table 2. The analysis by using mean and standard deviation

Item	Mean	Std. Deviation	Interpretation
Smart health (SH)			
SH1). It will be great if I can register easily and quickly when going to hospital to receive medical service.	4.35	0.485	Satisfied
SH2). I think the idea of being able to consult with doctor everywhere every time via online channel is necessary for me	4.32	0.47	Satisfied
SH3). I would like to read information right away if there are some strange symptoms occur to me	4.41	0.513	Satisfied
Smart Government (SG)			
SG1) I want to know the latest update information about my local government announcement	4.82	0.385	Satisfied
SG2) I will feel great if all my governmental related document application can be done online	4.32	0.473	Satisfied
SG3) I will feel great if there is a one-stop-service for applying governmental related documents.	4.14	0.397	Satisfied
Smart Education (SE)			
SE1) I would like to be able to study the course I'm interested online anywhere anytime via online channel	4.80	0.402	Satisfied
SE2) I want online education platform where I can track my online learning progress and achievement	4.22	0.441	Satisfied
SE3) I want to participate in the community that enable me to learn new skills to improve my professional skill	4.15	0.398	Satisfied
Smart Energy (SME)			
SME1) Renewable energy sources such as solar panel, Wind turbine, etc. are necessary for my community	4.73	0.462	Satisfied
SME2) I want to know real time information of how much electricity I utilized	4.24	0.439	Satisfied
SME3) Pollution due to greenhouse gas is the serious issue in my community	4.12	0.46	Satisfied
Smart waste management (SWM)			
SWM1) I think the filled waste bin present in my community is very unpleasant.	4.81	0.395	Satisfied
SWM2) I don't' want garbage pickup truck to visit if my garbage bin still not full	2.24	0.936	dissatisfied
SWM3) I am aware of recycling benefits and want the waste in my community to be recycled	4.27	0.587	Satisfied
Smart industry (SI)			
SI1) In my opinion, robot and autonomous production system will be highly benefits to the business in my community	4.77	0.432	Satisfied

SI2) I like the idea of working remotely by utilizing internet as the tools to connect to my workplace	4.27	0.456	Satisfied
SI3) I feel great when I pay for product/services by using application without having to pay cash	4.27	0.467	Satisfied
SI4) I like the idea of launching business without having to pay big amount of money because government sector can initiate sharing economy business model for me	4.34	0.527	Satisfied
Smart mobility (SM)			
SM1) Public transportation is convenient without the need for personal vehicles.	4.80	0.409	Satisfied
SM2) I will be appreciate it if there are public personal vehicle that I can rent from time to time.	4.20	0.532	Satisfied
SM3) I think congested traffic is problematic in my community, I will be appreciated if there are less traffic jam in my community	4.05	0.522	Satisfied
Internet of Things (IoT)			
IoT1) Smart health solutions require IoT Technology.	4.27	0.471	Satisfied
IoT2) Smart government (Public Service) requires IoT Technology.	4.33	0.471	Satisfied
IoT3) Smart education requires IoT Technology.	4.52	0.513	Satisfied
IoT4) Smart energy requires IoT Technology.	4.46	0.512	Satisfied
IoT5) Smart waste management requires IoT Technology.	4.36	0.539	Satisfied
IoT6) Smart industry requires IoT Technology.	4.28	0.499	Satisfied
IoT7) Smart mobility requires IoT Technology.	4.21	0.473	Satisfied
Big data (BD)			
BD1) Smart health solutions require big data technology.	4.62	0.499	Satisfied
BD2) Smart government (Public Service) requires big data technology.	4.22	0.442	Satisfied
BD3) Smart education requires big data technology.	4.30	0.509	Satisfied
BD4) Smart energy requires big data technology.	4.21	0.721	Satisfied
BD5) Smart waste management requires big data technology.	4.28	0.513	Satisfied
BD6) Smart industry requires big data technology.	4.28	0.524	Satisfied
BD7) Smart mobility requires big data technology.	4.21	0.543	Satisfied
Cyber Physical System (CP)			
CP1) Smart health solutions require cyber physical system technology.	4.59	0.516	Satisfied
CP2) Smart government (Public Service) requires cyber physical system technology.	4.15	0.417	Satisfied
CP3) Smart education requires cyber physical system technology.	4.29	0.57	Satisfied
CP4) Smart energy requires cyber physical system technology.	4.40	0.548	Satisfied
CP5) Smart waste management requires cyber physical system technology.	4.35	0.515	Satisfied
CP6) Smart industry requires cyber physical system technology.	4.27	0.552	Satisfied
CP7) Smart mobility requires cyber physical system technology.	4.18	0.47	Satisfied
Cloud computing (CC)			
CC1) Smart health solutions require cloud computing technology.	4.52	0.513	Satisfied
CC2) Smart government (Public Service) requires cloud computing technology.	4.26	0.478	Satisfied
CC3) Smart education requires cloud computing technology.	4.37	0.531	Satisfied
CC4) Smart energy requires cloud computing technology.	4.33	0.563	Satisfied
CC5) Smart waste management requires cloud computing technology.	4.36	0.507	Satisfied
CC6) Smart industry requires cloud computing technology.	4.23	0.475	Satisfied
CC7) Smart mobility requires cloud computing technology.	4.07	0.443	Satisfied

4.3. Hypothesis Testing Results

The Pearson correlation coefficient is a statistical test that is used to determine the link between two variables. If negative or equal to 0, values in the range +1 to -1 imply that there is no relationship between the two variables, while positive implies that there is. According to these values, variables are categorized into five grades (Ganti, 2019). The following table 3 was obtained:

Table 3. Pearson's correlation measures (Ganti, 2019)

Value	Strength of correlation
0.0 - 0.19	Very weak relationship
0.2 - 0.39	Weak relationship
0.4 - 0.59	Moderate
0.6 - 0.79	Strong
0.8 - 1.00	Very strong

Table 4. Correlation between Independent variables and Dependent variables

Dependent Variable	Correlation	Independent Variable		
		Smart Society	Smart Environment	Smart Economy
Internet of Things (IoT)	Pearson Correlation	.380**	.261**	.223**
	Significant Value at the 0.01 level (two-tailed)	.001*	.001*	.003**
Big Data	Pearson Correlation	.237**	.114**	.036**
	Significant Value at the 0.01 level (two-tailed)	.002**	.139	.641
Cyber Physical System	Pearson Correlation	.252**	.237**	.106**
	Significant Value at the 0.01 level (two-tailed)	.001*	.002**	.169
Cloud Computing	Pearson Correlation	.206**	.285**	.077**
	Significant Value at the 0.01 level (two-tailed)	.007*	.001*	.320

* P-value < 0.05; ** P-value < 0.01 (2-tailed).

According to Table 4, there are both significant and not significant correlation between dependent and independent variables. The researcher found that there are significant correlations between the Internet of Things (IoT) Technology, Smart Society, Smart environment and Smart Economy. For Big Data Technology there are significant correlation with Smart Society, however, the results show insignificant correlation with Smart Environment, Smart Economy, and the Cyber Physical System

The researchers utilized Pearson Correlation Analysis to evaluate hypotheses 1 through 12 in this section. To study the Smart ICT model of Hat Yai Smart City, Thailand, the researchers collected data from 566 respondents and evaluated the data using the Pearson Correlation approach. According to Table 5 Hypothesis H1o, H2o, H3o were rejected which suggest that Internet of Things (IoT) has a Positive weak relationship with Smart Society, Smart Environment and Smart Economy. Hypothesis H4o was rejected indicating that Big data technology has a positive weak relationship with Smart Society. However, H5o, H6o were accepted which suggested that there are insignificant relationship between Big Data technology, Smart Environment and Smart Economy.

For Cyber Physical system H7o, H8o were rejected implies that Cyber Physical system have positive weak relationship with Smart Society and Smart Environment, however, H9o was accepted that which means that there was insignificant relationship with Smart Economy. Lastly for Cloud Computing technology H10o, H11o were rejected which put forth that there were positive weak relationship between Cloud Computing technology, Smart Society and Smart Environment. However, H12o was accepted indicate that there was insignificant relationship between Cloud computing Technology and Smart Economy. From the results of Pearson's correlation analysis can be presented in Figure 4.

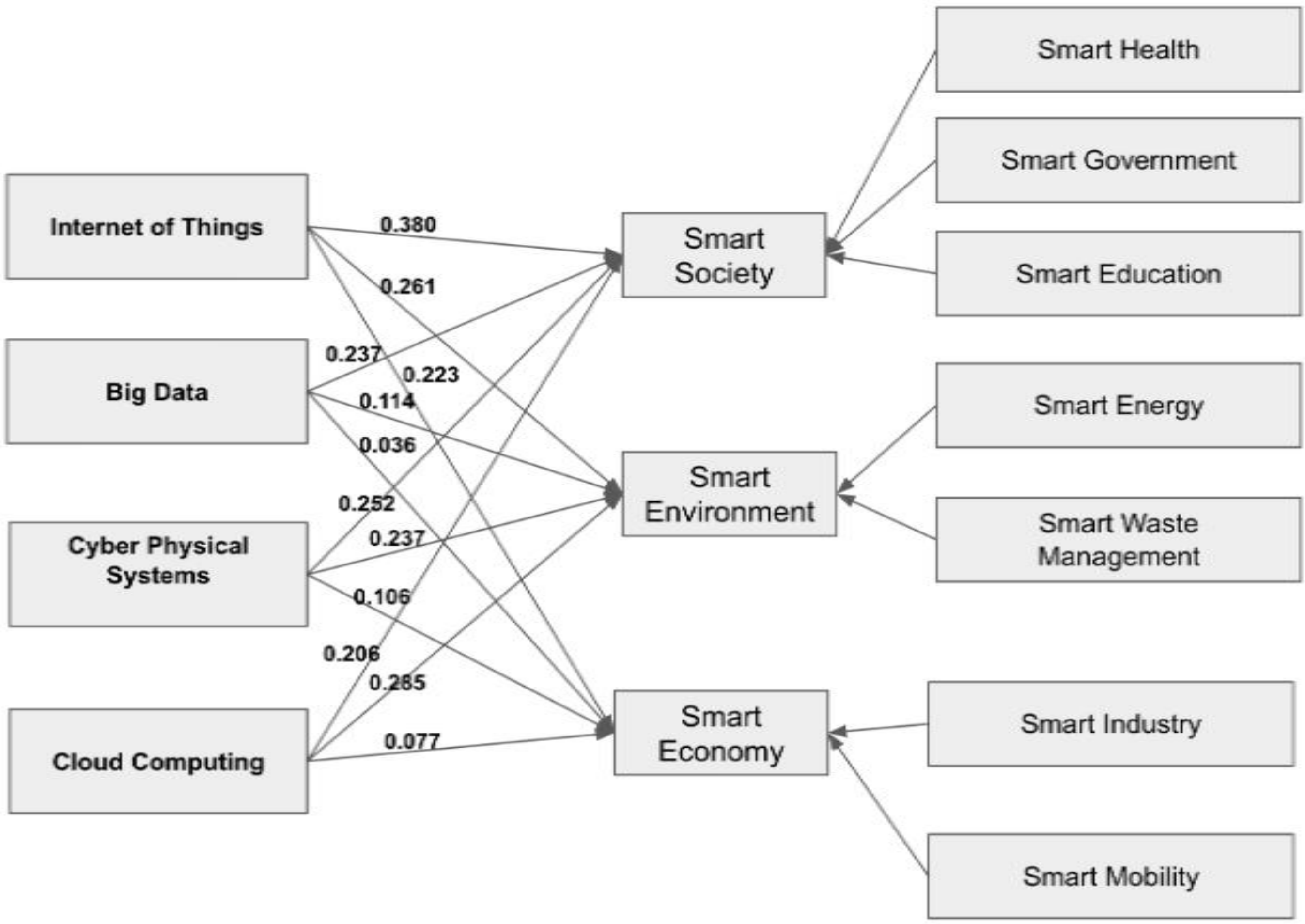

Figure 4. The Research Results Model
Source. Authors

Table 5. Pearson Correlation result interpretation result

Dependent variable	**Dependent variable**	**Hypothesis**	**Correlation Testing Result**	**Hypothesis Testing Result**
	Smart Society	H1o : Internet of Things (IoT) technology have no relationship with Smart Society	Positive Weak relationship	Rejected
Internet of Things (IoT)	Smart Environment	H2o : Internet of Things (IoT) technology have no relationship with Smart Environment	Positive Weak relationship	Rejected
	Smart Economy	H3o : Internet of Things (IoT) technology have no relationship with Smart Economy	Positive Weak relationship	Rejected
	Smart Society	H4o : Big data technology have no relationship with Smart Society	Positive Weak relationship	Rejected
Big data	Smart Environment	H5o : Big data technology have no relationship with Smart Environment	Positive Very weak relationship	Failed to reject
	Smart Economy	H6o :Big data technology have no relationship with Smart Economy		Failed to reject
	Smart Society	H7o : Cyber Physical System technology have no relationship with Smart Society	Positive Weak relationship	Rejected
Cyber Physical System	Smart Environment	H8o : Cyber Physical System technology have no relationship with Smart Environment	Positive Weak relationship	Rejected
	Smart Economy	H9o :Cyber Physical System technology have no relationship with Smart Economy	Very weak relationship	Failed to reject
	Smart Society	H10o : Cloud Computing technology have no relationship with Smart Society	Weak relationship	Rejected
Cloud Computing	Smart Environment	H11o : Cloud Computing technology have no relationship with Smart Environment	Weak relationship	Rejected
	Smart Economy	H12o : Cloud Computing technology have no relationship with Smart Economy	Very weak relationship	Failed to reject

5. Conclusions

5.1. Discussion and Implications

By using Pearson's correlation to test the hypothesis. The result found that Internet of Things (IoT) technology has a relationship with the development of Smart Society, Smart Environment and Smart Economy. As a large number of networked objects, generate a large volume of data. The IoT is built on three core functionalities of smart devices, according to Miorandi et al. (2012), traceability, communication, and interaction. As a result, IoT architecture should secure the entire system's security, stability, scalability, and interoperability.

Big Data technology has a relationship with the development with Smart Society but does not have relationship with the development of Smart Environment and Smart Economy. This can be referred to as mentioned by Baeza-Yates (2013). Being large is simply a matter of volume, yet there is no clear agreement on what size qualifies as large. It is true that utilizing a brute force strategy to acquire vast volumes of data is simple. So the true goal should not be huge data, but rather asking ourselves what is the correct data for a specific situation and how much of it is required.

For the Cyber Physical System, the result shows the relationship with the development of Smart Society and Smart Environment as a well-designed CPS will improve smart city comfort, rejuvenate urban production areas, and raise the prospects of entrepreneurial success. The advancement of CPS is critical for the deployment of technology for smart city applications (Jabbar et al., 2018).

Cloud Computing exhibits a relationship with the development of Smart Society and Smart Environment as Agarwal (2017) has put forth that the cloud service will aid in the dismantling of intergovernmental storage, in which separate agencies lack a clear path for communicating and understanding the data-driven priorities of other departments. Cloud-based solutions in infrastructure, platforms, and applications (IaaS, PaaS, SaaS), services using cloud platforms, impediments and enablers in employing cloud technologies, and modifications to applications and e-services can all benefit smart cities as they migrate to cloud settings.

5.2. Conclusion

The goal of this research is to study Hat Yai Smart City's Smart ICT concept. One of the most often used terms to characterize the growing attempts to design a strategy for achieving "smart" urban growth through innovative and sustainable policies is "smart city" (Caragliu et al., 2011). Smart City Development (SCD) was designed to solve urbanization issues such as overpopulation, resource mismanagement, environmental challenges, and economic and social issues. While most contemporary cities seek to link their numerous "smart" programs and new digital apps to a well-organized strategic strategy and roadmap with well-defined goals, objectives, and responsibilities, (Neirotti et al., 2014; Chourabi et al., 2012). However, this will need the creation of a well-defined framework for its execution. The progress of information and communication technology (ICT) has led to improvements in the application of urban informatization, allowing information technology to become an effective means and instrument for urban administration, giving rise to the notion of the smart city.

In order to formulate a Smart ICT model for Hat Yai Smart City, the researcher has first identified dimensions that contribute to the development of Hat Yai Smart City. Such a process has been done by matching Smart City dimension with Hat Yai City development strategy. The result shows that there are three main dimensions contributing to Hat Yai Smart City development, which are Smart Governance, Smart Environment and Smart Economy. As for the Smart ICT perspective, Anindra et al. (2018) suggested that there are four key technologies enabling Smart City development, being Internet of Things (IoT), Big Data, Cyber Physical system and Cloud Computing. Hence, the researcher conducts a survey by composing the questionnaire and distributing it to people who live in Hat Yai City.

There is one main objective and another sub objective of the study. The main objective is to formulate a Smart ICT model for Hat Yai Smart City and the sub objective is to verify whether Smart city dimensions (Smart Society, Smart Environment and Smart Economy) are perceived as valuable and desirable by Hat Yai City dwellers. The respondent that all three dimensions are seen as necessity for citizens validates the sub objective.

For the main objective, the researcher intends to find correlation between key technologies and each Smart City dimension. These questionnaires were distributed to Hat Yai citizens whose work is relevant to ICT or work with any task that is relevant to IoT, Big data, Cyber Physical system or Cloud Technology as these groups of respondents have strong knowledge in Smart ICT.

As the result, the survey feedback shows that Internet of Things (IoT) technology has a relationship with all dimensions. The results are intuitive since IoT serves as the core technology of monitoring and tracking sensors to transmit a wide range of information to the central platform. However, big data only shows a relationship with Smart Society as it comprises Smart Health, Smart Government, Smart Education and the use cases comprising these dimensions required big data to operate. Cyber Physical Systems show a positive relationship with Smart Society and Smart Environment while show no relationship with Smart Economy as most of the use cases are software applications which do not rely much on cyber physical systems. Similarly for Cloud computing which also show a relationship with Smart Society and Smart Environment but no relationship with Smart Economy.

5.3. Recommendation

The finding of this study will help Hat Yai City governor to effectively plan the development of Smart City and Smart ICT solution. It helps identify the Smart City dimension that will bring utmost benefits to their citizens, which align with the original city development plan. Furthermore, this research will help planning Smart ICT solutions that will serve as the digital infrastructure facilitating Smart City development.

According to the research findings, Hat Yai City governor should focus on developing the Smart Society (Smart Health, Smart Government, and Smart Education), Smart Environment (Smart Energy, Smart Waste Management) and Smart Economy (Smart Industry, Smart Mobility). Furthermore, it is crucial that the city governor deploy a Smart ICT solution (Internet of Thing, Big Data, Cyber Physical System, Cloud Computing) as a digital infrastructure to support the development of those Smart city dimensions.

5.4. Further Studies

This study identifies Hat Yai Smart City's Smart ICT concept. There are various factors of Smart City development that neither are not covered by this research such as legislation and legal environment, Social and political environment, resource constraint, economic and financial constraint, etc. This factor is considered to have a significant effect on different aspects of a city and especially on the transformation process from planning to implementation. The researcher highly recommends that these factors should be involved in further studies.

Additionally, the Smart ICT mentioned in this study is the overview of the key technologies that help enable Smart city development. However, there are a wide range of applications and services within these key technologies. The researchers also recommend that further study should dig deep into the detail of Smart ICT implementation.

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