Exploring the Potential of Smart City In Kota Bharu

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ABSTRACT

World has evolved to incorporate information and communication technologies (ICT) to enhance the quality of life. Internet of Things (IoT), Big Data, smart applications and industrial revolution 4.0 have emerged and become part of today's world. Smart city is part of the revolution makes use of the smart technologies to improve the quality of life and performance of urban services such as transportation, public infrastructure and utilities. Malaysia is also taking this advantage to strengthen the infrastructure and connectivity concentrating in green technology, innovation, industrial development and city info structure. Kelantan state government has taken several initiatives to support the smart city implementation in Kota Bharu. Unfortunately, the progress of the initiatives seems to be quite slow compared to other cities in Malaysia. This conceptual paper discusses smart city concept in Malaysia and other countries as well. Kelantan state government may refer to this paper to set up policies regarding the development of Kota Bharu smart city. Generic architecture will be explained thoroughly in this paper. This paper highlights several critical success factors (CSFs) that determine the successful implementation of smart city project. Several examples of smart city applications will also be described.

Keywords: *IoT, Smart city, Smart application, Quality of Life.*

I. INTRODUCTION

Over the years, the populations in cities around the world keep on increasing gradually. More and more people prefer to live in urban areas due to various opportunities offered. Life in cities becomes more congested in mostly all aspects. The consequences of this phenomenon have led to the occurrences of many difficulties in terms of traffic control and management, air, water and food management, settlement issues, waste-disposal management, poverty and many more. Cities are developing and changing continuously. Undoubtedly, municipal managers will be facing numerous challenges to build sustainable cities of tomorrow. Among the top issues faced by the municipal managers of Kota Bharu are traffic congestion and waste-disposal management.

Kota Bharu is the capital of Negeri Kelantan. It is the biggest city in Kelantan. Kota Bharu is situated in the north-eastern part of Peninsular Malaysia and lies near the mouth of the Kelantan River at 6°8'N 102°15'E. The north-eastern Malaysian city is close to the Thailand border. It is one of the most densely populated cities in the country. The total area is 115.64 km2 with population of 314,946. It has a diverse populace which is made up of Malays, Chinese, Indians, Siamese and some other minority ethnics. Internet access is readily available in Kota Bharu. Internet penetration in Kota Bharu is considered moderate at 51 per cent [21].

The objectives of this paper are:

1. To suggest smart city architecture for Kota Bharu
2. To identify critical success factors of Kota Bharu smart city
3. To recommend suitable smart applications that can be implemented in Kota Bharu smart city

This conceptual paper will critically discuss the theoretical backgrounds and the practices of smart cities and examine the ways and possibilities of implementing this concept in Kota Bharu. This paper is based on a thorough study of literature and examination of several implementations of smart cities in other parts of the world. It is important to understand what smart city is. Next section will discuss in detail the smart city concept and definitions.

II. SMART CITY CONCEPT AND DEFINITIONS

The smart city concept is an integration of Information and communication technologies (ICT), Internet of Things (IoT) and other smart applications. ICT is the backbone or core component in the development of a smart city project. In recent years, smart city has become the focus of stakeholders around the world as the result of the evolution of ICT and digital technology. The potential of these technologies has been adapted to improve economic competitiveness, sustainability, social and capital attractiveness [6].

A smart city is a city that is a well-planned city which adapts digital technology in every aspect and process. Smart city provides cost-efficient services, environmental efficiency initiatives and improve the quality of life of the citizens. There are many concepts and definitions of smart city given by scholars, yet there is no single accepted definition exist for "smart city". A smart city idea initially was introduced to the government by city developers to meet the demand of modern technology, effective interactions, efficient transportation and diversity of public infrastructure which are the basic necessities demanded by the urban population in a city [10]. According to Pinank and Himanshu [13] smart city is a city that takes advantage of information and communications technology (ICT) to increase efficiencies, reduce costs and enhance the quality of life. Although the formal definition of smart city is not yet widely adopted, according to Andrea et al [4], the final aim of smart city is to make better use of public resources, by increasing the quality of services offered to citizens, and at the same time reducing operational costs of the public administration.

In Malaysia, smart city initiatives are outlined in the Strategic Thrusts of the 11th Malaysia Plan (or RMK11) 2016 – 2020. It is stated in Chapter 7, under strategy C4 which is to strengthen infrastructure for smart cities through better connectivity and seamless integration of urban services [20]. Amongst the areas being addressed are green growth, innovation and industrial development in green technology, as well as city info structure. It is highlighted in the RMK11 that smart city is the next generation approach or future city approach to urban management with solutions that address these issues and improve the quality of life of urban dwellers.

According to Federal Town And Country Planning Department, smart cities initiatives are also part of the so called actions of National Physical Plan 3 (NNP3) which has recommended 1) to expand and enhance digital infrastructure 2) to strengthen and expand broadband coverage and 3) to strengthen the provision of infrastructure facilities and services for smart cities initiatives.

Malaysia adapts smart city framework as propound by Giffinger [13]. According to the framework, there are six smart city dimensions which comprises of smart economy, smart people, smart governance, smart mobility, smart environment and smart living as illustrated in Figure 1. These dimensions are used as indicators for city smartness, to indicate the extent to which a city is smart.

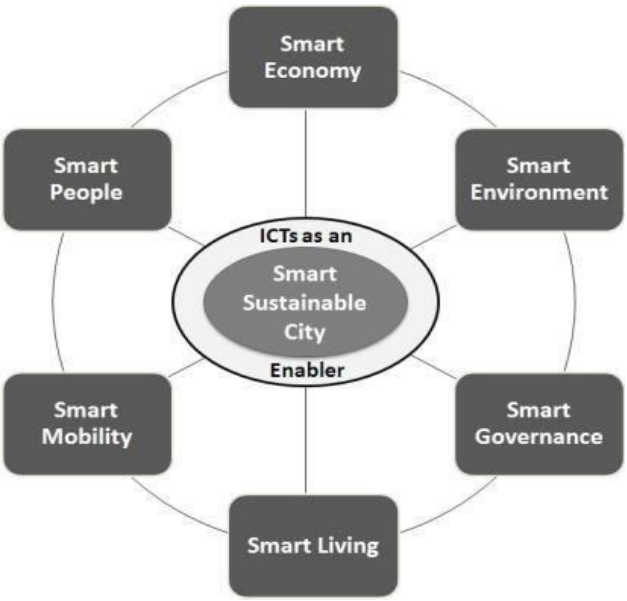

Figure 1: Six dimensions of smart city

Iskandar Malaysia in Johor is one of the pioneers in smart city project across the country. The characteristics for each dimension are detailed out in Figure 2. The six dimensions with 28 characteristics serve to guide Iskandar Malaysia on its journey towards becoming a smart city. The ongoing Smart City Iskandar Malaysia project acts as an enabler and a catalyst for the growth of Iskandar Malaysia in order to improve quality of living and expand the business opportunity in that region [19].

Figure 2: Six dimensions of Iskandar Malaysia's smart city

The deployment of a smart city involves the integration of systems, technology and infrastructure. Based on thorough analysis of recent works, next section of this paper elaborates a generic smart city architecture.

III. SMART CITY ARCHITECTURE

The development of a smart city involves the integration and application of digital systems and

Internet of Things (IoT) and communication technology. IoT provides essential components for smart cities such as data generation, data management and application handling. There are several smart city architectures proposed by researchers. Most of the architecture is similar with one another. Jose Antonio Rodriguez proposed two types of architectures, the one that monitors the exteriors of the city such as its streets and avenues, parks and leisure areas [6]. The second architecture is one that monitors the interior of buildings, the flow of people and goods, air conditioning and water. The architecture deployed in a city for external monitoring is based on long-range communication protocols, so that the entire city can be covered with few devices. These communication protocols cannot penetrate buildings due to interference with walls and electrical or piping installations. The architecture deployed internally in buildings usually takes advantage of the telecommunications infrastructure and the wired electrical network. It is easier and cheaper to rely on these facilities. In areas of difficult access or without wired installations, wireless protocols such as Wi-Fi, Bluetooth or RFID are used. These protocols are short-range and have coverage from 0.5 m to 10/15 m. It is important to use the correct architecture. A correct selection of external and internal architectures adapted to the geometries and distances to be covered will allow a correct communication with all the sensors and equipment of the city without errors or latencies of the necessary data for the analysis and optimization of resources [8].

Another architecture is proposed by Bhagya et al [5] as depicted in Figure 3. This architecture comprises of four layers including sensing layer, transmission layer, data management layer, and application layer. Data collection from physical devices is the main responsibility of sensing layer, which resides at the bottom of the architecture. This layer enables the capture and integration of real-world live data through the use of sensors. Example of activities at this level are sensors that measure water quality, collect electrical meter readings for a grid, or provide measurements to determine the energy usage. Most of the sensors are commonly placed on public light. Some of the system require sensors to be placed in other elements such as garbage containers, litter bins, bus shelters and even in certain strategic locations. Via various communication technologies, transmission layer carries data to the upper layers. The transmission layer acts as the backbone of any smart city architecture. This layer is a convergence of various communication networks. It consists of various types of wired, wireless, and satellite technologies.

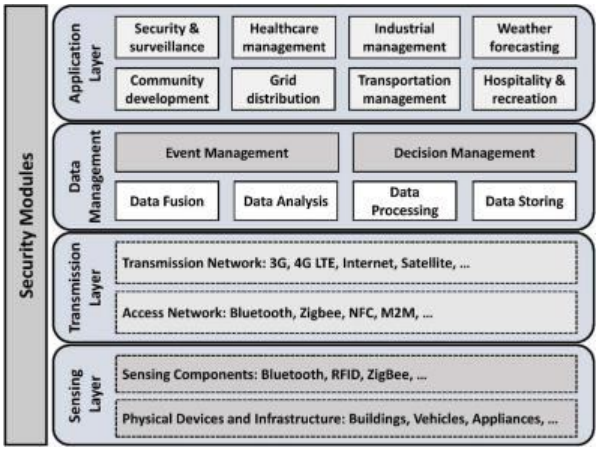

Figure 3: Layered architecture of a generic smart city

Data management layer processes and stores valuable information that are useful for service provision offered by various applications at the top layer. This layer incorporates the data into an enterprise computing platform and the communication of such information among the various city services. This layer performs a diversity of data manipulating, organizing, analysing, storing, and decision-making tasks [5]. The application layer is the top layer of smart city architecture that mediates between urban citizens and data management layer. This layer is responsible for delivering application specific services to the user. It defines various applications in which the Internet of Things can be deployed, for example, smart homes, smart cities, and smart health [13].

Based on the literature analysis, this architecture is considered as generic smart city architecture. Therefore, it is significant to propose this architecture to the authorities of Kota Bharu for them to consider in their smart city policy and plan and their future initiatives.

There are many factors that contribute to the successful deployment of a smart city. Next section will discourse several determinants of a smart city.

IV. CRITICAL SUCCESS FACTORS OF A SMART CITY

Critical success factors (CSFs) are those variables or circumstances necessary to enable a positive outcome for a program or strategy. Many researches have been carried out to examine the CSFs of a smart city. Seunghwan et al [17] suggested that there are internal and external factors that determine the successful deployment of a smart city. Citizen participation, leadership and infrastructure are the internal factors meanwhile fourth industrial revolution, political will and stakeholders are the external factors. This finding is in line with the idea highlighted by Aidan et al. [2] which states that active community involvement is

essential in ensuring the successful implementation of smart city project and towards achieving the mission of smart city. Leadership of government has a great influence on the success or failure of any smart city projects. Government has a key role in smart city initiatives by bringing resources and stakeholders together [9]. Smart cities should include government-led initiatives in collaboration with the private sector. Smart partnership between government and private sector may contribute to the successful smart city project implementation. Government role in terms of formal leadership is another critical factor to make smart city mission be realistic. The last point of internal factor is infrastructure. Infrastructure includes ICT technology devices and other physical infrastructure such as arrangement of commercial building, education institution, hospitals, roads and highway, pedestrian and recreation area. Proper management of infrastructure is one of the factors that ensure the success of smart city development [16].

Making a smart city requires a lot of government agility and political will to change and adapt [5]. The government plays an important role in the adoption of smart city technology by helping cities with the appropriate funding, regulations and standards as well as encouraging regional and nationwide smart city initiatives.

State government of Kelantan has underlined several initiatives in promoting smart city. However, there are still a long way to go for Kota Bharu to achieve a smart city title. But it is never late to start off. Next section will discuss several smart city applications that can be implemented.

V. EXAMPLES OF SMART CITY APPLICATIONS

Smart Cities are future urban combinations, where a multitude of heterogeneous systems and IoT devices interact to provide a safer, more efficient, and greener environment. There are several smart city applications that can be used by Kota Bharu municipal authority as pilot smart city project

A. Smart Street Light System

Street lights are basically used for the safety on roads. They provide the vehicles with light during the night-time on roads. A smart vehicle detection-based street light system shall be implemented in the smart city to help in reducing the cost and saves a lot of electricity for the betterment of the society. The basic idea of this concept emerged from the fact that roads at night are not being used much. Even if the roads are being used, there will be time when there is no vehicle, or no one is on the road. In this case if the street lights remain on, this might result in a complete waste of electricity. Electricity can be saved by turning the street lights off when there are no vehicles on the roads or when there is no one on the roads. This is basically the smart vehicle detection-based street light system.

In this smart application, IR sensors might be placed at some distance from one another and having a bunch of street lights in between. When a vehicle is detected by a sensor, then a bunch of street lights will be turned on and remains on until the vehicle is detected by the next sensor and when it is detected by the next sensor, the next bunch of street lights is turned on and so on. The main advantage of this vehicle detection-based street light system is that electricity is greatly saved.

B. Alert System

This system consists of a motion sensor or PIR (Passive Infrared) sensor which detects the movement of humans or living beings based on their body temperature. PIR sensor is basically divided into two parts, which works simultaneously by sending and receiving the infrared rays continuously altogether. In case of stable objects, both sides of the sensor will detect together and have high pulses which implies that the object is stable i.e. stationary. In case of when someone is moving, one part of the sensor receives a high pulse and the other part receives low pulse and just on the next instant when object has moved, the other part receives high pulse while first part receives low pulse thus this show a movement in the body. When such a movement is encountered at night when the banks or shops are closed then an alarm shall be turned on to indicate the presence of potential threat.

C. Car Parking System

This system is to notify whether the car parking area is full or not and to let the drivers know how many slots in the car parking area are vacant i.e. empty. Through this smart car parking system, drivers can have the knowledge of the availability of the parking slots prior to entering the car parking area. There will be *n* number of IR (Infra-Red) sensors implemented across each parking slot. At a particular slot, if the car is parked, then the sensor will detect the car and hence the output from that sensor can be taken as high or occupied, and if the slot is empty that is no car is parked in that slot, then the output is low. If all sensors show high, then the parking-is-full notification can be displayed and broadcasted to the drivers. Two more sensors might be connected at the input and output gates, so that whenever a car is sensed by the sensor at the input gate, then the details about the parking area can be displayed to the driver.

VI. DISCUSSIONS

Smart city implementation in Kota Bharu may face its own challenges. Figure 4 summarizes possible challenges related to Kota Bharu smart city planning. Firstly, smart city Kota Bharu task force needs to carry out preliminary investigation in the government level [1]. This will help them to produce smart city best practices in the future. Implementation cost is the second challenge for the city since the implementation requires smart city architecture to be in place to enable the execution of the initiatives. The third challenge is related to health and wellness [3] since undoubtedly this is also an important component to increase quality of life for the community. The policy makers need to conduct thorough investigation to ensure the introduction of smart cities can contribute to the quality of life. The policy makers should also highlight and provide appropriate platform for the elderly and disabled people in the smart city.

Next challenge is the people and environmental factors. The change and increase of infrastructure in the city will promote innovation in lifestyle among all the citizens. The government needs to foresee possible change management after smart city infrastructure is provided and implemented. Environmental factors such as climate change, demographic location, and geographical factor also need to be addressed continuously and properly by the government.

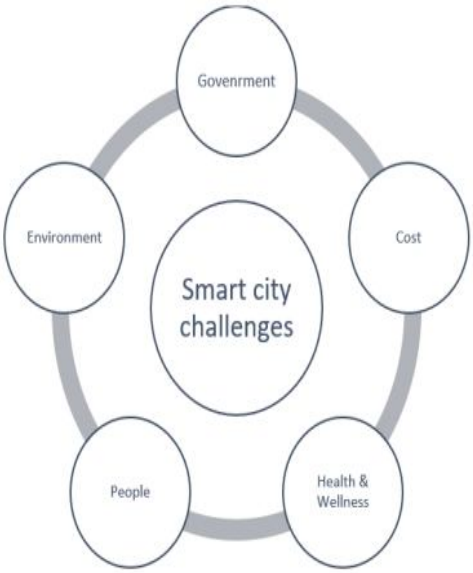

Figure 4: Smart city possible challenges in Kota Bharu

VII. CONCLUSION

Smart city initiatives involve many entities namely government and policy makers of Kota Bharu, citizens of Kota Bharu, operation and maintenance cost, businesses, infrastructure, technology architecture and smart applications. Collaboration and smooth integration of those entities are no doubt very crucial. Further assessment on smart city implementation in Kota Bharu needs to be conducted in order to address issues and challenges and to identify practical solutions to ensure the success of smart city implementation in Kota Bharu as well as to give comfort and enhanced facilities to the people.

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