A STUDY OF MALAYSIA'S SMART CITIES INITIATIVE PROGRESS IN COMPARISON OF NEIGHBOURING COUNTRIES (SINGAPORE & INDONESIA)

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Abstract
This research paper is aimed to discuss the Malaysia's Smart Cities. The paper will be started by an introduction that stated the problem statement. The aims for this paper is to study the Malaysia's Smart Cities initiative progress in comparison of neighbouring countries (Singapore & Indonesia) and compare adopted IoT-based Smart Cities applications in Malaysia with neighbouring countries. Interview and secondary research are chosen for the methodology conducting the data gathering due to the time and geographical constraints. The research take place in Malaysia and completed within 1 year. In terms of analysis, results gathered was discussed through a critical review that presents the current situation of Malaysia's Smart Cities and comparison of smart cities between Singapore, Indonesia and Malaysia. The data gathered shows that Malaysia has numerous smart cities that have their own goals and objectives. This has caused all the smart cities do not strive towards to national IoT goals and lead to duplication of development works. Malaysia is also the slowest progress in IoT smart cities development as compared to Indonesia and Singapore. The compared nations show that they have more solid foundation as they have defined the focus area and common goals while developing Smart Cities.

Keywords: IoT, Smart Cities, Smart Governance.

INTRODUCTION

Internet of Things (IoT) is a popular topic that is actively discussed among academicians and technology professionals [1], [2]. This popular buzzword is even being introduced to non-IT environments [3]–[6] such as sales and marketing [7]. Research journals often reference Kevin Ashton as the founder of the IoT, who believed IoT can change the world, as for how the internet has changed the world [2], [7], [8]. His vision for IoT was to connect the internet and the physical world through the usage of multiple sensors and a connected system, and this concept was often linked to the invention of RFID as the starting point. Gartner has defined "The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment." [9].

International Data Corporation (IDC) has then defined another set of definition which is "The Internet of Things (IoT) is a network of uniquely identifiable end points (or things) that communicate bi-directionally without human interaction using IP connectivity." [10]. Lastly, IERC-European Research Cluster on the Internet of Things stated that IoT is "A dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network."[11]. In a nutshell, IoT consists of "things" that are uniquely identified, that will interact and communicate with each other without human intervention, eventually, react to the external environment using intelligent systems. Gartner forecasts that there will be "20.4 billion" connected "things" that will be in use by the year 2020 and spending on IoT Services will reach almost "$2 trillion" in the year 2017 [12]. Other than that, IoT also impacts the enterprise by transforming traditional businesses into digital businesses to generate a new channel of revenue [13], [14]. In addition, IDC also has the same prediction that the market of IoT will continue to grow and the spending expected to near "$1.4 trillion" by the year 2021 [15]. From the analysis above that was conducted by various researchers and research bodies, it can be analysed that there are wide opportunities for IoT implementation and the market value is high.

IoT applications can be broken into 3 big domains and various types of application, namely Industrial domain, Smart City domain and Health-Wellbeing domain. "Smart" is often being tagged with IoT implementation such as Smart Home, Smart Country, where the "things" in the environment are able to send information over the internet for analysis purposes. There are various technologies or devices has enabled the invention of IoT such as "sensors, network computing devices, web storage, data processing and the applications for IoT". Sensors are the first enabler for IoT where it collects the data from the environment and send it connected data processing also known as actuators. Sensors have been continuously evolved as microprocessors and even a cell phone consists of 14 sensors such as camera, motion sensors, GPS and many more.

Other than that, the cost of sensors are not expensive, therefore it has become one of the enablers to IoT where IoT depend heavily on the large number of sensors. However, by relying solely on sensors does not help to promote IoT usability, therefore apart from sensors, networking and network computing devices that are able to read data generated by the sensors and transfer the data for processing are essential for IoT as well. There are few available networks for IoT which are Bluetooth, Lora, Wifi and Cellular.

These networking technologies are commonly embedded with mobile smartphones. These networks are selected mainly because they require low energy to operate and it is getting more affordable to be embedded into any devices including IoT devices. Other than that, there are already several IoT applications using Bluetooth and Wi-Fi, for example, Vacuum

robot by Xiaomi as part of the IoT home automation is using Wi-Fi connection to sense the environment and clean accordingly [16]. Wi-Fi and Bluetooth are also commonly embedded into Smart Lock system and this IoT lock will then use this network to communicate to the application developed in mobile devices [17]. LoRa and LTE-M module are also embedded in a smart home systems for the usage of IoT [18].

These applications show that low-cost and low energy networking system has helped to drive IoT development into next-level and the applications are becoming very common nowadays. Real-time data that is captured by the sensors and the actuators will be stored to a local or cloud storage using the network. Lastly, the data stored in the storage will be then analysed and push into better applications to day-to-day activities.

For example, the application of IoT based on data gathered can be used to control the timing of the traffic light in the city to avoid traffic congestions.[19]–[22]. Other than that, the applications can help to determine the environment such as the air quality so that the authority can react accordingly [23].

The aim of this paper is to study the Malaysia's Smart Cities initiative progress in comparison of neighbouring countries (Singapore & Indonesia). The rest of the paper is organized as follows. Section 2 provides an introduction of Smart Cities and how IoT enabled applications help in building a Smart Cities. The section will also be discussed how IoT is changing people life in various industries. In section 3, the methodologies to conduct the research are discussed. Furthermore, the author has provided the research results in section 4. In-depth discussion based on the results are discussed in section 5. Lastly, the concluding remarks are given in section 6.

SMART CITIES

Smart Cities defined as "Smart Cities put data and digital technology to work to make better decisions and improve the quality of life" [24]. Other than that, "Smart Cities are, by definition, focused on using emerging technologies and innovation to make cities more livable, and offer new services and economic opportunities" [25]. IoT technologies play an important role in overcoming common challenges that will be faced by Smart Cities [26]. IoT devices can be distributed into the Smart Cities at large scale, this will help to form Smart Cities. The implementation of IoT technologies can improvise the economy, healthcare and quality of life of the citizens in the cities [29], [30]. IoT aims to improve human's lifestyle by using information gathered from the IoT devices through sensors, then the data can be analysed and perform appropriate actions. By making full use of IoT, various process, services and industries can be improved and better outcome can be created, for example, a Smart home system will enable home automation and enhancing users experiences in the home [31]. In line with its benefits, various countries have adopted IoT into the implementation of Smart Cities, to introduce new services to their citizens [32].

South Korea has started its IoT Smart Cities Journey since the year 2003[32] [32] and Malaysia has also started the journey towards Smart Cities with the introduction of National Internet of Things (IoT) roadmap during the third quarter of the year 2015 through the collaboration with MIMOS [33].

IoT technological advancement has also affected the government applications by making them more efficient, this has also helped to increase the effectiveness of Smart Cities that has been done by several countries [5]. Industry players of IoT are already very active in implementing IoT solution in a large scale basis' for instance, through the Smart Cities concept, the city council can take advantage of the implementation for managing the cities in a more effective way [31]. With the distribution of IoT devices in

Smart Cities, the city council is able to collect large scale of data to these data can be used to generate useful information, and then give a "bird's eye" view of the city [28]. Through the help of IoT devices within Smart Cities, the city council can immediately understand the condition of transportation, security, waste management and other city-related condition [28]. Thus, the city council can have better control over the activities happened in the city through the data collected and analysed by the IoT technologies [27], [28]. IoT implementations can guarantee the road to "Smart Future" and improvise the quality of the citizen's life by using IoT technology to provide "Smart Services" [27], [20].

Most governments are focusing on transportation issues in the Smart Cities through the implementation of IoT technology. For example, the city councils are able to detect the congested areas of the Smart City by using IoT sensors that collect data and information. These data becomes very useful for the city council to plan the route details and need of public transport in order to solve the traffic issue in that particular area [28], [20].

Malaysia, Singapore and Indonesia are also aware of this issue, therefore each country has generated different ideas such as, smart traffic light, driverless car and integrating GPS sensor to the transportation [34]–[36]. Other than that, garbage services are also very important in the Smart Cities as it helps the city council to plan the garbage truck route by measuring the volume of each area in the Smart City [28]. This has been implemented by Singapore's smart waste bin and Indonesia dump truck tracker as both countries measure the volume of the waste and arrange the right amount of dump truck as needed, creating effective use of resources and reduce wastage of manpower [36]–[40].

METHODOLOGY

Judgement sampling will be adopted in data collection. The information and expertise in both IoT and Smart Cities are limited due to this area is relatively new in the industry. For example, companies that participate in Malaysia Smart Cities is very limited as the valid and accurate data can only be obtained from the appointed companies by the Malaysian government. Thus, judgement sampling is selected so that the researcher can target the right audiences and data sources for both primary and secondary research will be pre-determined by the researchers. In terms of interviewing technique, structured interview method will be selected for this research.

Structured interview promotes standardized questions and with this technique, the answers can also be standardized. This method also allows the researcher to replicate the data easier [41]. Replication of data is needed because the interview session will be done more than once, and standardized answers are needed because it can ensure all the predetermined questions can be covered during the interview sessions. This is needed especially interviewing an important person in the companies. The target audiences of the structured interview are MIMOS and Altize as both companies actively participate in the Malaysian IoT's Smart Cities implementation. Journal, article, internet, website article, newspaper, government reports, organisation reports and case studies will be the sources of secondary research. Using data collected by institution and government can improve the discussion process because it can help the researcher to avoid duplicate effort and process of data collection.

As the Smart Cities initiative is relatively new in Malaysia, most data are only available through internet articles and newspapers, the secondary data collection is highly required to obtain the latest information. Other than that, secondary data collection is

needed for collecting data for Singapore and Indonesia due to geographical constraints.

RESULTS

As a summary, Malaysia is developing 3 Smart Cities and Indonesia is developing 5 Smart Cities. Singapore is slightly different as the nation is developing the whole nation as Smart City. The numbers of Malaysia are generated from both primary sources and secondary sources, whereas Singapore and Indonesia is only based on secondary sources. Three of the nations started their Smart City initiative at the same time. Malaysia developed a proper roadmap by working together with MIMOS since the year 2014. However, the projects that have been implemented as part of the Smart Cities Initiative is still very limited as compared to Singapore and Indonesia.

According to Table 4.1, Malaysia did not cover many industries as compared to another countries because all three smart cities are having different focus areas than the MIMOS roadmap. For example, Smart Selangor is having 12 domains to focus on and MIMOS is having 4 areas to be covered. IoT ecosystem was established in Cyberview Smart City by a private company, Altize in the year 2017 despite the MIMOS roadmap has been planned and published in the year 2014. MIMOS roadmap is the Malaysian's National Roadmap in IoT implementation to Smart Cities, however, this is not followed through by other Smart Cities initiative and this lead to inconsistency in implementing their solutions. Based on the data collected of implemented IoT system in Smart Cities in Malaysia, it is found that each Smart City has its own vision and objectives. The focus areas or domains are not uniformed across all the Smart Cities and this will lead to duplicate works being done to individual Smart City. Norhizam Abdul Kadir, MDEC Infotech Division Vice President mentioned that all smart city projects in Malaysia are working independently, alliances are needed in order for Malaysia to move forward [42]. In 2018, Malaysian's government decided to collaborate with Alibaba to adopt its City Brain Smart City's ecosystems after LoRa Network Ecosystems has been implemented.

City Brain aims to implement traffic light control, traffic command and ambulance call. However, several of the applications are duplicated such as traffic command and traffic light control where Cyberview Smart City is having Smart Traffic Analytics and Recognition System for traffic control and monitoring, this system also controlling the traffic light of the city.

Thus, it shows that the aims and objectives are not properly communicated between the government and each of the Smart City and it has led to duplicate works being done. The Malaysian government also require proper planning and work distribution among all the Smart Cities so that each Smart City can learn from each other.

Based on the data gathered from the interview session with Gerard Lim and Boon Chong Foo, Malaysia has no technological advancement as compared to other nations. Both mentioned that there is no proprietary technology that can advance the development of IoT that Malaysia has it and overseas does not has it. Other than that, Boon Chong Foo also mentioned that Malaysia will need 2-5 years duration to have the technology that is ready to be deployed into Malaysia's Smart City. By comparing it to the data from secondary research, Malaysia requires more time and effort in advancing its technology to compete with overseas. Gerard Lim mentioned that it requires collaboration between private sector and government sector.

Singapore Government has started the Smart Nation Initiative in the year 2014 with three key plans, they are "Digital Economy Framework for Action, Digital Government Blueprint and Digital Readiness Blueprint" [43].

Singapore is more focused in Community and Transportation Sector as they are having most IoT systems to support the community as Smart Nation initiative, as summarized in Table 4.2. Most of the areas are having 2 or more IoT systems to support the implementation of Smart Nation Initiative. The implementation is consistent as the whole nation is working together to achieve one goal and does not separate by different areas or smart city like Malaysia.

Indonesia has started its Smart City initiative in the year 2014 where Jakarta has been selected as the first Smart City program [44]. The city has encouraged citizens to use applications for transportation and communication between the citizens and the government. The second city, Bandung in West Java, has also started its Smart City initiative and followed by Surabaya city, Makassar City and Medan City [44], and they are using modern technology such as IoT to achieve smart city initiative.

Singapore is performing better than Malaysia by looking at the numbers of implemented systems, which Singapore is having 17 implemented IoT Systems and 5 projects that are under development. By combining the information gathered from the interview, there are total of 7 implemented systems which is still less than half from what Singapore has achieved. This shows that Malaysian may still need more time to develop more IoT Applications and implement it into any of the Smart City.

Table 4.1: Smart Cities in Malaysia

Initiative	IoT projects	Implemented	In-progress
Cyberview Smart City	LoRa Network [45], [23], [46] Smart Traffic Analytics and Recognition System Air Quality Index Sensors [23] MasterCard Cashless Hub [47], [48] Wireless Energy Management [49] Hyperlocal advertising [50]	α α α	α α α
Iskandar Smart City	Command Centre for IoT Services [51], [52]	α	
Smart Selangor	Smart Transportation Information System [53]		α
Others (Gathered from interview)	Smart-Lokap Insurance Detarrification (AXA FlexiDrive) Real-Time Diagnostic for Car (MY VWDrive) International Schools Smart System Indoor Location sensors Asset Management	α α α	α α α

		α
Transportation Tracking		α
Car Plate Recognition		α
Community Surveillance		α
Greenhouse Farming		α
Highway traffic and accident monitoring		α
ECall Malaysia		α
Smart Parking		α
TNB Smart Meter		α

Table 4.2: Implementation of Smart Cities IoT applications in Singapore

IoT projects	Implemented	In-progress
MindSphere [54]	α	
StarHub and Nokia [55]	α	
Smart Living		
- Elderly Monitoring Systems [56]	α	
- Home Energy Management System [56]	α	
- Home Water Management Systems [42]	α	
Smart Neighbourhood		
- Smart Pneumatic Waste Conveyance System (Smart PWCS) [42]	α	
- Smart Electrical Sub-meters and Remote Water Meters [42]	α	
- Smart Solar Energy Monitoring System [42]	α	
MyTransport[57], [58]	α	
Electronic Road Pricing System (ERP) [59]	α	
Beeline SG [60]	α	
Parking.SG [61]	α	
Contactless Payment [62]	α	
Sensors to control the air conditioning temperature [63]	α	
myENV [64]	α	
Fusion AnalyticS for public Transport Emergency Response (FASTER) [59]	α	
Smart waste bins [37]		
Smart Walking Stick [65]	α	
Self-Driving Vehicles [66], [67]		α
RoboCoach [68]		α
Smart wheelchair [69]		α
Audio Sensing Camera [70]		α
		α

Table 4.3: Implementation of Smart Cities IoT applications in Indonesia

IoT projects	Implemented	In-progress
Local applications in Bandung [71]	α	
Qlue [72], [73]	α	
Jakarta Smart Ciy Lounge [73]	α	
E-Musrenbang [74]	α	
CCTV in Surabaya and Bandung [75]	α	
GPS for a construction vehicle [40]	α	
Waze License Plate GPS for public transport [36]	α	
JAKMikro [76]	α	
Automatic Weather Station [77]	α	
Smart CCTV [40], [71], [78]	α	
Banjir Online/Disaster Warning System/Automatic Water Level Recorder [79], [80]	α	
Smart Parking [81]		
Early Warning System GPS in fire truck and ambulance [79]	α	
Dump Truck Tracker [40]	α	
Project Loon [82]		α
Jakarta One Card [40]		α
Smart Street Light [83], [84]		α
		α

Indonesia is in the middle among three nations where Indonesia is having 13 implemented systems to their smart cities with 4 IoT systems under development. From the above, the number of implemented systems in Malaysia is lower than what Indonesia has achieved. Indonesia is able to have a high number of systems implemented due to most development are small and achievable, such as by just installing GPS to the

vehicle and keeping track of the location and route during transporting.

DISCUSSION

Comparison of Smart Cities progress

By comparing Malaysia to Singapore, it is found that Singapore is very consistent in implementing their solution after the announcement of Smart Nation initiative. For example, driverless car has been in testing since the year 2015, one year after the announcement and Smart Living where consists of 5 IoT systems has been launched by Singapore HDB department. This shows that Singapore government are in progress of building Smart Nation and following the milestone as planned. The Singapore government has also published their milestone on the website to inform their citizens of what they have done from the day they have started the initiative. Future milestones have also been published into the website to show that the government are committed to transforming the nation into Smart Nation. In addition, Singapore has streamlined its initiative to the only one objective which is the Smart Nation. This has ensured that the nation is moving forward to achieve the same goals and objectives. Thus, there are no duplicated systems being adopted or implemented. All of the systems have its clear vision such as transportation, most of the transportation systems being implemented is to promote the use of public transport in the nation. The ERP systems have also aimed to collect data on traffic condition and ease the operation of public transport such as a bus. This shows that the nation is very clear on what they need to achieve while implementing the Smart Nation. Thus, being consistent in aims and objective towards Smart Nation has become the key edge of succeeding in implementing the IoT-based Smart Nation. Singapore do not diverse themselves into different smart cities but as one Nation and this has been key factor that Malaysia does not have.

Indonesia is focusing on Transportation as they are having 5 different IoT Implementations towards this area. Indonesia is also having 5 different smart cities to focus on. Despite having different Smart Cities, they still have one common attribute where they will fully utilize the local expertise by developing application before implementing IoT technologies in the cities. The data showed that Indonesia is progressing better and ahead of Malaysia Smart Cities. Indonesia has their key edge in terms of implementing Smart Cities which is involving the citizens in the initiative. Indonesia is having more smart cities than Malaysia and they can continue implementing new systems in their Smart Cities especially Jakarta Smart City. They foster their local talent and giving them opportunities in participating in Smart Cities implementation. Jakarta alone is having 300 local applications to support the Smart City. Indonesia has a high level of engagement between the governments, this can help the city council to understand their problems. From the problem raised by the citizen, the city council can prioritize the implementation. For example, Jakarta is focusing on transportation issue because they are having serious traffic jams in the city. Indonesia also focuses a lot on the disaster prevention by looking at the number of implemented systems.

Compared to Indonesia, Malaysia lack of communication with citizens as it lack local applications that enhance the communication between the government and citizens. From the data collected, Malaysia is making bigger steps comparing to Indonesia as Malaysia implementation is larger and require more cost such as implementing Alibaba City Brain, Lora Network and Smart Lokap while Indonesia is making smaller steps such as installing GPS to transport and installing water level sensor to the river. However, making bigger steps does not mean that the initiative is progressing better. This is because it will be time-consuming for bigger steps and wrong decisions will lead to more time losses. For example, Gerard Lim from Altize has stated that LoRa network ecosystem is implemented and this is

sufficient to allow the startup to develop IoT applications. But in February 2018, the government decided to adopted Alibaba City Brain to create the new IoT ecosystem which is duplicate of LoRa network ecosystem. From the interview with MIMOS, they are looking at SigFox ecosystem which is duplicate to LoRa network that is readily available in Cyberjaya. This is duplicate efforts that will prolong the implementation of IoT in Smart City.

Despite having more smart cities initiative than Malaysia, the nation has the same goals in mind where they foster their talent in the country in developing Smart Cities. They do not collaborate much with foreign investors like Malaysia did, thus this will further enhance the speed of implementation because the time of negotiating contract can be reduced and development can be started immediately. By taking secondary research into account, Indonesia achieves more than what Malaysia and Singapore have achieved.

CONCLUSION

In conclusion, Malaysia has launched several Smart Cities initiative in Malaysia, it is still the slowest among the three countries which are Malaysia, Singapore and Indonesia in Smart Cities development given that three nations started the initiative at the same year (2014). It is very crucial to understand what have Malaysia achieve during the implementation and development, then locate the main issue or challenges faced by Malaysia.Other than that, Malaysia should analyse how other countries such as Singapore and Indonesia implement their solution and serve these cases as a reference. In this research, it is clear that both Singapore and Indonesia has a clear understanding on the basis of Smart Cities implementation and they have fully utilized it during Smart Cities implementation. Indonesia is using local talents and takes smaller steps by creating applications then later link them to IoT devices. In another way, Singapore has streamlined the whole nation to follow only one aim and objective so that the nation can move forward together in the same direction. This is very important for Singapore so that public and private sector understand their directions well. Thus, it is crucial for Malaysia to start to examine the fundamentals of Malaysia Smart Cities initiative and create a solid foundation so that all the Smart Cities in Malaysia can move forward in the right direction. There is no consistency in setting aims and objective of Smart Cities in Malaysia and it leads to duplicated implementations. Three smart city initiatives have been identified and their focus areas are different from each other. It is very important for the Malaysian government to understand that all Smart Cities initiative must share the same vision and objective, then collaborate together to increase the speed of the implementation together. With this approach, it can then avoid duplicate implementation because different smart cities can learn from each other and avoid the same effort or mistakes. The aim and objectives of this research have been achieved as the researcher has determined and discussed the outcome in the analysis, results and discussion section. Careful analysis has been derived from both primary and secondary sources. The result has been discussed critically and recommendation has been adviced in this section. Malaysia is still progressing into Smart Cities initiative, but adjustments are needed to be done to the plan in order to increase the efficiency and effectiveness of the implementation.

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