Revolution of IoT Development in Smartest City: Review of Smart City Development in Singapore and Hong Kong

Kwok Tak Kit

Abstract—A smart city is an urban setting which effectively applies technology to enhance the benefits and provides solution to the shortcoming of urbanization for its citizens while the internet of things (loT) is to connect everything embedded with electronics, software, and sensors to the internet so as to enable them to collect and exchange data. Smart city development encompasses the development and application of IoT technology and prepares for the next generation of connectivity. The governments in the major developed cities and countries across the world already started the race to adopt the IoT technology to transform their cities into smart cities in coming few years. The development of smart city definitely can assist to tackle the problems which impede the quality of life of their citizens and the hindrance of the long-term challenges of sustainability and impacts from pollution. This paper is aims to outline the adoption of IoT in different key sectors in the Singapore and describe the revolution of IoT and its adoption in the smart city.

Keywords—Smart city, internet of things, sustainability, innovation.

I. INTRODUCTION

CITIES across the world are increasingly relying on IoT technology to transform into smart cities and help to address problems that continue to impede the quality of life of their citizens as well as address the long term challenges of sustainability and pollution. Smart cities, smart homes, smart pollution control, smart energy saving, smart transportation, and smart industries rely on the transformation and development of the IoT. There is great potential for further development and adoption of IoT technology in the coming future to facilitate the cities across the world to transform into a smart city. This paper helps to address the key factors for smart city transformation and provide more research area for further discussion and understanding of the applicability of IoT [1], [2].

II. SMART CITY AND IoT

Smart city development depends on IoT technology which embraces next generation connectivity. With the increase of population and the desire for a better living environment, the clever use of smart city widespread deployment of loT technology is crucial to meet the demands of the public for higher quality of life and lower the consumption of resources in an effective and efficient way.

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III. IoT FOR SMART CITIES

IoT is a new and emerging paradigm that changed the traditional way of living into a high tech lifestyle. The extensive use of loT, urban data platform, big data and artificial intelligence can transform the urban hub into a high level of smart and sustainable space in different areas: healthcare, manufacturing, transportation, education, etc. [11]

Relationship of IoT and Innovation Technology in AI, 5G and Big Data

The IoT system comprises a huge number of devices and sensors to collect, store, process and analyze the data. The development of the internet network and its transmission efficiency is crucial to the development of IoT. The advancement of artificial intelligence will play an important role for processing of the huge data in a streamline and accrual way. The huge big data storage and transmission in cloud or database also required a mature and more advanced development of 5G or higher network and improvement of cloud storage and database. To become a smart city, the internet access to household coverage and mobile phone penetration should be high enough to support the IoT technology application [6], [8].

TABLE I
ADOPTION OF IoT TECHNOLOGY IN SMART CITIES, IOT ANALYTICS AUGUST 2020 [5]

Rank	Use Case	Share	Category
1	Connected Public Transport	74%	Mobility & Transportation
2	Traffic Monitoring and Management	72%	Mobility & Transportation
3	Water Level and Flood Monitoring	72%	Environment
4	Video Surveillance & Analysis	72%	Public Safety
5	Connected Streetlights	68%	Energy & Utilities
6	Weather Monitoring	68%	Environment
7	Air Quality and Pollution Monitoring	68%	Environment
8	Smart Metering - Water	66%	Energy & Utilities
9	Fire and Smoke Detection	66%	Building & Infrastructure
10	Water Quality Monitoring	64%	Environment

Most Common Areas Adoption of IoT in Smart City

Cities across the world are increasingly relying on IoT technology to transform into smart city and help to address problems that continue to impede the quality of life of their citizens as well as address the long term challenges of sustainability and pollution. According to the survey from IOT

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Analytics August 2020, [5] the ranked #1 use case for adopting the IoT technology in smart cities is connected public transport (Table I).

Trend on IoT Application in Future

Smart city is one of the trendy application areas of IoT technology. In post COVID-19, the application of IoT in the medical sector like public and environmental hygiene can assist to combat the impact of COVID-19. With the global trend to tackle climate change under the Paris Agreement, the IoT technology will be more widely adopted in the sectors: energy management, waste management, transportation and building and infrastructure [9].
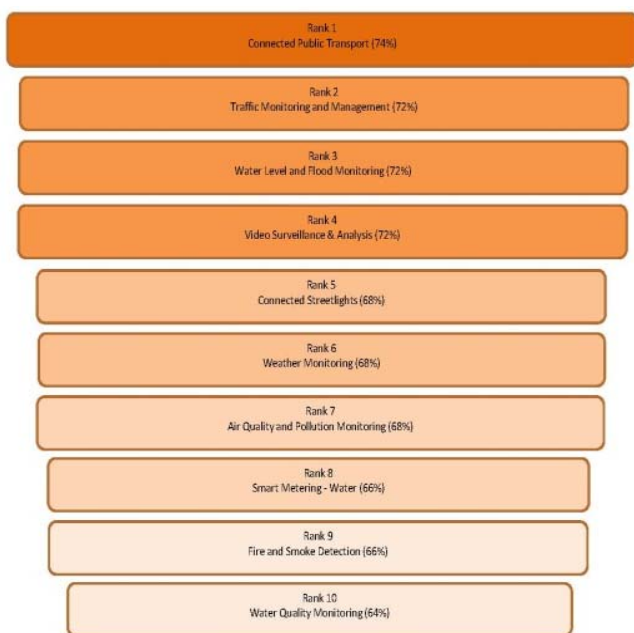

Fig. 1 Use case for adopting the IoT technology in smart cities, IOT Analytics August 2020 [5]

Four Key Areas of IoT Technology Development in Smart Cities in Asia Pacific Region

Adoption of IoT Technology development in different smart cities is varied based on regional, culture and economy model structure [7]. Based on literature review [13]-[16], four key areas of IoT technology projects in smart cities development in Asia Pacific are squared below:

1) Smart Traffic Management: is included in projects like automated parking system, traffic monitoring and control, electrical motor bike sharing and smart bus lanes
2) Connected Industry: covers a wide range of connected things included equipment monitoring in non-factory environment, monitoring and remote control of connected machinery.
3) Connected Transportation: increases of connected transportation on vehicle diagnostics and fleet management solutions. It includes real-time tracking, monitoring of senor reading and remote control of vehicles.
4) Connected Building: comprises a large number of IoT

projects which involve facility-automation to reduce costs, energy saving in HVAC/Heating/Cooling, waste management in domestic and C&D waste and advanced building technology like Building Information Modeling.
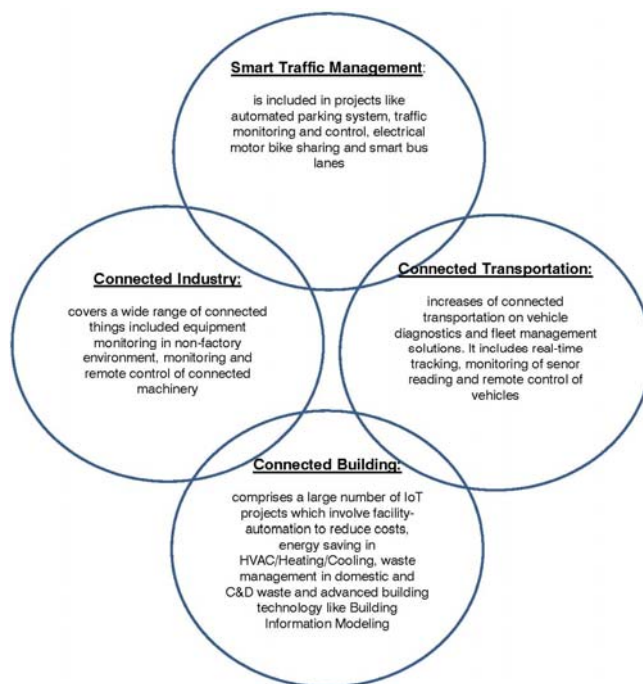

Fig. 2 Four key areas of IoT technology projects in smart cities development in Asia Pacific [13]-[16]
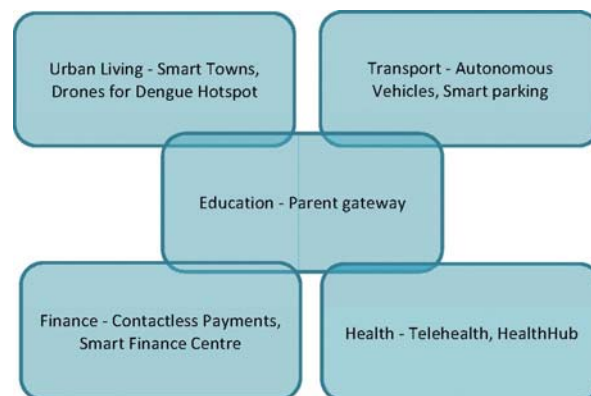

Fig. 3 Five domains for smart nation

TABLE II
SWISS BUSINESS SCHOOL IMD SMART CITY INDEX 2021 [12]

Rank	City
1	Singapore
2	Zurich, Switzerland
3	Oslo, Norway
4	Taipei, Taiwan
5	Lausanne, Switzerland
6	Helsinki, Denmark
7	Copenhagen, Denmark
8	Geneva, Switzerland
9	Auckland, New Zealand
10	Bilbao, Spain

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IV. SMARTEST CITY IN THE WORLD 2021: SINGAPORE

According to Swiss business school Institute of Management Development (IMD) Smart City Index, [4] Singapore is the smartest city in the world in 2021 for the third year running. The survey included five key areas: Health, and Safety, Mobility, Activities, Opportunities, and Governance. The ranking criteria have taken account of UN Development index like economic and social data and ranks countries on the elements of health, education and living standards [4]. The success of Singapore to be a smart nation is based on three key areas: Digital Economy, Digital Government and Digital Society. Further transformation to five domains was targeted at transport, urban living, finance, education and health.

1) Urban Living - Smart Towns, Drones for Dengue Hotspot
2) Transport - Autonomous Vehicles, Smart parking
3) Education - Parent gateway
4) Finance - Contactless Payments, Smart Finance Centre
5) Health - Telehealth, HealthHub

Fig. 4 Diagrammatic Smart City Index 2021 [12]

Success of Singapore to Smartest City in the World

Singapore is one of the most densely populated independent countries in the world. According to the data from The World Bank, the GDP of Singapore in 2020 is about 339.998 million (US$) which ranked #38 across the world. [12] To the success of the achievement of smart city, Singapore government is constantly reviewing and focusing on the development of livability, environmental sustainability, and economic competitiveness with other cities around the world with the aim to amid the increasing urban density with population growth. Singapore faced the problem of traffic congestion, difficulties in maintaining a livable environment with adequate greenery, transport and housing provision in view of the geology and population growth. The Singapore Government's Smart Nation vision was launched in response to growing challenges of aging population, urban density and energy sustainability. The government had the clear vision to achieve and transform it into a smart city in 1900s. The government has promoted and invited stakeholders such as technology builders and entrepreneurs around the world to use the nation as a 'living laboratory' to try out their new ideas and smart solutions with global potential. Most importantly, the Singapore government realized the critical role of ICT standards and aggressively involved the integration and interoperability of different ICT systems that are in place for Smart Nation initiatives and targeted to achieve and facilitate the optimal use of resources across different systems [10].

The Singapore government has the long sight and clear vision of being the world's first Smart Nation and launched the Smart Nation Program developed in 2014 to make use of ICT, networks and data in order to provide abs support better living environment and opportunities creation which eventually support stronger communities. The development of Intelligent Transport System (ITS) is implemented under Singapore strong e-governance foundation. The wide adoption of IoT technology and integration into the different public facilities, infrastructure and government administration is also one of the key factors to the success of the Singapore government to implement the policy for transformation into a smartest city in the past 10 years.

Singapore is also well planning the use of pilot projects in advance before implementing smart service nationwide which allows them to test factors and ensure the service provided is useful for citizens. The well implementation of the government pilot scheme also reduces the cost and risk of installing inappropriate smart systems in Singapore.

In this study, it is revealed that Singapore's future success as a Smart Nation depends on a number of factors as well as the government control over the Smart Nation Vision. The Singapore Government has fully funded the Smart Nation initiatives without adopting any external source from private firms. The other factor is regarding the manner of integration among implementing agencies. The Singapore Government realized the need to develop an integrated data sharing platform to facilitate all agencies to access commonly shared information collected from a shared smart sensor network. An interest in Integrated Operation and Command Centre (IOCC) is perceived to have higher risks due to variations in the sensitivity of data. The Singapore government also focused on the effective and proper utilization and management of data which is a key to the success of any smart city.

V. REVIEW OF PLANNING AND IMPLEMENTATION OF SMART CITY DESIGN IN HONG KONG

Hong Kong newly ranked #41 in IMD Smart City Index in 2021 from #32 in 2020. HKSAR first published the Smart City Blueprint in December 2017 and set out different initiatives to enhance and expand existing cites management measures and services. The aim is to bring benefits and convenience so the public can perceive the benefits from smart city and

innovation and technology in their daily lives. In the latest edition of Blueprint 2.0, there are 130 initiatives to combat the epidemic in 2020 "Use of I&T in Combating COVID-19" covering the measures to support home quarantine, exposure notification and development of health codes to facilitate cross-boundary travel [3]. There are six smart areas focused in the Blueprint 2.0 including:

1) Smart Mobility - ITS and Traffic Management
2) Smart Living - Wi-Fi Connected City, Digital Payment, eID/"iAM Smart" Applications, Support for Elderly and Persons with Disabilities, Support for Healthcare, Recreation, Sprot and Leisure, and Culture
3) Smart Environment - Climate Action Plan 2030+, Green and Intelligent Buildings, and Energy Efficiency, Waste Management, Pollution Monitoring, Environmental Hygiene,
4) Smart People - Nurturing Young Talent, Innovation and Entrepreneurial Culture,
5) Smart Government - Open Date, Smart City Infrastructure, Adoption of Technology
6) Smart Economy - Fintech, Smart Tourism, LawTech, Promote R&D and Re-industrialization, Development of Innovation and New Economy

VI. CONCLUSION

Research finding shows that the success of a smart city comprises the widespread use of IoT in different key major areas like economy, government and society. The model of transformation of smart city varied from cities to cities but the basic framework of IoT is almost the same which depends on the degree of application and government policy and vision. In the case study of Singapore, some insight in IoT technology adoption is critically reviewed and it is considered valuable and useful for other developing and developed countries to make reference for their future planning for transformation into a smart city.

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