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Building a smart nation: Singapore's digital journey

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1. Introduction

The journey towards smart city status is a strong global trend as governments around the world strive to harness technology to improve the quality of life for their citizens (United Nations, 2016). The widespread phenomenon of becoming "smart" is a key topic of discussion and research that continues to change as new digital technologies develop (Ishkineeva et al., 2015). The smart cities theme is important because it explores how governments, as providers of public goods, harness digital technologies to improve the lives of citizens around the world in the present and the future.

Singapore's smart nation journey began when the drive was officially announced by the country's Prime Minister Lee Hsien Loong in November 2014 (Lee, 2014). The vision is to improve people's lives and create more opportunities through information and communications technology (ICT). The smart nation drive is an effort by the government to co-create innovative, people-centric solutions with citizens and businesses. The three priority areas, underpinned by cyber security, are elderly, transportation and data. Since then, various digital strategies and policies have been further articulated, and digital programmes and projects implemented in the country.

2. Smart Nation Drive

The drive towards a smart nation is multi-faceted in nature and encompasses a multi-pronged approach to address issues involving a diverse group of stakeholders. Thus, it is natural that there would be overlaps when it comes to the analysis of smart nation trends and factors. To facilitate a better understanding of the key areas affecting smart nation, the section is organised under the various sub-topics: digital infrastructure, mobile apps, transportation, health, cashless economy, data, cyber security, technology start-ups, research and development (R&D), manpower development, administrative capacity, and regional network and global collaboration.

2.1. Digital Infrastructure

At the foundational level, a smart nation enables citizens to use ICT for stress-free and seamless transactions on a daily basis. Therefore, having a robust

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underlying digital infrastructure is key to the proper functioning of public and private services. In 2017, the key milestones for five strategic national projects were announced (Smart Nation and Digital Government Office, 2017). These projects include areas such as national digital identity, e-payments, sensor platform, smart transportation and moments of life. Please refer to Figure 1–Strategic National Projects from 2017 to 2020.

Briefly, the National Digital Identity (NDI) framework allows convenient and secure digital transactions between citizens and businesses with an online identity; E-Payments facilitate a simple, swift, seamless and safe way of payments for citizens; the Smart Nation Sensor Platform (SNSP) enables the pervasive connectivity of a network of physical devices; Smart Urban Mobility enhances public transport commute through data analytics, artificial intelligence and autonomous vehicles; and finally, Moments of Life (MOL) integrates services and information across multiple government agencies for citizens through a single platform.

To further streamline transactions for citizens with businesses, the Singapore government designed the Myinfo portal. MyInfo is a service for SingPass, Singapore's online access account management platform for e-services, which enables users to avoid having to repeatedly fill in personal data for every digital transaction. The service is linked to both government agencies and commercial entities.

In order to manage the technical aspects of such a diverse system of interrelated computing devices, the Minister for Foreign Affairs and Minister-in-Charge of Smart Nation has outlined Singapore's approach to Internet of Things (IoT) development. The approach includes avoiding vendor lock-in, defining open standards, using modular platforms, providing plug-and-play architecture and security by design (Lung, 2018).

Figure 1. Strategic National Projects from 2017 to 2020

Source: Smart Nation and Digital Government Office. (2017, August 20). Strategic national projects to build a smart nation [Press Release].

2.2. Mobile Apps

The population, nowadays, is always on the move and highly connected through mobile devices such as smart phones and tablets. Consequently, mobile apps feature prominently in many of the Singapore government's service delivery projects. Traditionally, apps were designed around the services provided rather than user experience. This approach is giving way to a more human-centred design method in which the solutions developed start with citizens' needs and end with the resolution of these needs.

There are many examples of mobile apps that have been developed with the active engagement of the citizens in mind. For instance, the Municipal Services Office (MSO) deployed the OneService app to give residents a convenient one-stop platform to alert government agencies and town councils about problems faced in their neighbourhoods, without having to know which department is in charge of the issue. Another recently launched app is the parking.sg app which allows motorist to pay for parking digitally instead of using coupons. The motorist simply selects the carpark, keys in the vehicle number and chooses the parking duration. The app would automatically compute the rates and payment could be paid through credit cards.

In many cases, it is very important to involve the citizens so as to achieve socially desired outcomes. Besides designing solutions around citizen needs and perspectives, there is an increase in the use of crowdsourcing for citizen inputs to improve impact. The myRepsonder and SGSecure are apps that demonstrate this principle. In order to quickly attend to emergency cases such as out-of-hospital cardiac arrest and minor fires, the Singapore Civil Defence Force (SCDF) rolled-out the myResponder app. The mobile app functions by notifying members of the public of cardiac arrest and fire cases within 400 metres of their location. The public could then choose to proceed to the location to render assistance, thereby, providing the quick turnaround time that is necessary for heart resuscitation and extinguishment of small fires. Similarly, the SGSecure app allows citizens to receive alerts, report suspicious activities through messages, photos and videos, and seek assistance from the police during major emergencies.

2.3. Transportation

Many major cities face urban traffic management challenges which cause congestion and road traffic accidents. Singapore has embarked on various mobility programmes to tackle these problems on the land scarce island. These projects include the extensive trialing of self-driving vehicles (SDV), researching of standards required prior to the deployment of SDVs on public roads, and exploring mobility-on-demand approaches for real-time booking of taxis and suggestions for best routes to destinations (Smart Nation and Digital Government Office, 2018a). The Land Transport Authority (LTA) has also published and made available the estimated arrival times of buses to help ease waiting time (Chng, 2016). The authority is further tapping on near field communication-enabled mobile devices for contactless payments on the mass rapid transit and public buses.

2.4. Health

With an aging population, the number of elderly persons is projected to rise rapidly in the coming years. The Singapore government has initiated a series of digital programmes and projects that are targeted to help this segment of the population. Some of the examples include HealthHub, a one-stop online health services portal and mobile app. Through this service, citizens are able to access health records and medical appointments, and locate health facilities island-wide (Smart Nation and Digital Government

Office, 2018b). There are also on-going telehealth projects such as elderly monitoring systems for families with elderly persons while they are away from home, and smart health video consultation which offers follow-up services beyond hospitals to the community.

The healthcare sector implemented a National Electronic Health Record (NEHR) system and is currently extending its coverage. The secure system collects patients' health records across different healthcare providers which enables authorised personnel to view a holistic picture of one's healthcare history even if that patient is new to a hospital or clinic. This platform would provide immense opportunities to grow data analytics capabilities for public health management (Bhandari, 2017).

2.5. Cashless Economy

At the 2017 National Day Rally, it was revealed that six in 10 transactions in Singapore are still made in cash or by cheques (Lee, 2017). Also, there are too many different, disparate payment schemes and systems that are not interfaced with one another. In order to speed-up the goal of a cashless economy, a number of initiatives have been launched by the public service and industry. For example, the establishment of a payments council comprising 20 leaders from banks, payment service providers, businesses and trade associations to promote interoperability among e-payments solutions and develop strategies to drive the wide-spread adoption of e-payments (Bhunia, 2017).

Other related initiatives include the launch of a new peer-to-peer funds transfer service called PayNow, development of an Unified Point-of-Sale (UPOS) terminal for merchants and a fully cashless public transport system by 2020.

2.6. Data

A significant part of Singapore's digitalisation journey is related to the use and application of data to solve problems. The Singapore government recognises that data is most valuable when different datasets are connected to form conclusions. It has taken the first step towards data transparency through the online database, data.gov.sg, which is free for public access. The Government Technology Agency (GovTech) is also building an API Exchange (APEX) to facilitate data sharing (Puthucheary, 2017). Other government-related sites such as LTA DataMall, SingStat and OneMap, also offer a variety of datasets and application programming interfaces (APIs) to the public.

In order to increase the efficiency in the delivery of public services, the Ministry of Health (MOH) and Central Provident Fund (CPF) Board collaborated on a consent-based data sharing initiative to extend healthcare financing schemes to Singaporeans based on their Medisave balances, MediShield coverage and subsidy levels. Medisave is a national savings scheme to help citizens set aside part of their income to meet medical needs. MediShield is a low-cost basic medical insurance scheme for hospitalisation bills. The initiative helps to ease administrative work and covers more recipients since their needs are automatically assessed by the system (Ong-Webb & Ang, 2017). The sharing of the Ministry of Social and Family Development's (MSF) data with social service offices, family service centres, divorce support specialist agencies and the Early Childhood Development Agency (EDCA) generated better estimates and informed assessments for government assistance to individuals and families.

On the city and urban management front, smart tools and data analytics to analyse wind flow and solar exposure are used for Punggol town planning (Smart Nation and Digital Government Office,

2018c). New flats are then designed and sited to provide better surroundings and living environment.

2.7. Cyber Security

Cyber security forms the bedrock of the entire technology infrastructure and data architecture in a smart city. In Singapore, a strong cyber security network is a key priority in the smart nation drive and is critical to digital advancement (Ministry of Communications and Information, 2017). Any form of cyber-attacks would have deep economic and societal ramifications (Chik, 2017; Cyber Security Agency of Singapore, 2016).

The country's parliament passed a cyber security bill in early 2018. The legislation covered key areas such as the establishment of a cyber security commissioner, setting out procedures to punish owners of critical information infrastructures, and licensing requirements for companies or individuals providing cyber security services. It includes 11 critical sectors ranging from banking and healthcare, to transport and energy. The comprehensive bill is an enhanced version of bills overseas and addresses many existing gaps in the digital ecosystem (Goh, 2017). Earlier, Singapore topped the global cyber security index 2017 (International Telecommunication Union, 2017).

To better manage cyber threats, the Ministry of Defence (Mindef) has set up a new Defence Cyber Organisation to lead and coordinate cyber-security efforts across the defence cluster, including the Defence Science and Technology Agency (DSTA) and DSO National Laboratories (Cheng, 2017). In line with recent cyber security measures, government computers have been delinked from the internet to prevent work email and document leaks. With the internet separation, public servants would be using Workplace to connect with one another (Tham, 2016). Workplace is a collaboration tool that is specifically designed by Facebook with tight cyber security measures to protect sensitive data.

2.8. Technology Start-ups

Singapore's economic success is in part due to the entrepreneurial culture and the support for small and medium-sized enterprises (SMEs) (Ministry of Communications and Information, 2017). Government-funded centres that offer expert advice, product testing hubs and generous grants play a vital role in this aspect. For example, SGInnovate is a private organisation, wholly owned by the Singapore government, which helps aspiring entrepreneurs to commercialise and scale innovations for the world (SGInnovate, 2018). It focuses on deep technologies such as artificial intelligence, blockchain and robotics that have horizontal applications across industries.

As a result of the government's efforts, the number of start-ups has increased significantly which, in turn, attracted much international attention from businesses looking to expand to Asian nations. Singapore is now considered to be the best Asian location for start-ups (McCauley, 2017). Start-up accelerators such as Jurong Town Corporation (JTC) Launchpad provides support to the ecosystem by connecting technopreneurs with the industry. Block71 houses the largest tech start-up community in Southeast Asia.

In order to maintain Singapore's status as a regional financial hub, there have been various efforts to advance financial technology or "fintech". Facilities such as the FinTech Innovation Lab by Monetary Authority of Singapore (MAS) and FinTech Innovation Village by Lattice80 offer the platforms and communities for experimentation and commercialisation of new products and services.

2.9. R&D

There has been an increase in government funding

for R&D programmes to drive greater adoption of digital technologies, automation and robotics (Ministry of Finance, 2018). The National Research Foundation (NRF) is investing S$19 billion for the Research, Innovation and Enterprise 2020 Plan over 2016 to 2020. The institutes of higher learning have also initiated many programmes and projects to contribute to the smart nation drive. For example, the National University of Singapore (NUS) established a Smart Nation Research Cluster to further develop strategic capabilities in data science and cyber security. The Nanyang Technological University (NTU) opened an autonomous vehicle test centre jointly with LTA and JTC (Land Transport Authority, 2017).

2.10. Manpower Development

Beyond the deployment of ICT, the smart nation drive also serves the objectives of improving the quality of life of citizens and enhancing jobs prospects (Balakrishnan, 2018). Government-funded initiatives such as the national SkillsFuture movement are crucial in helping citizens adapt to digital disruptions across industries and sectors. SkillsFuture is an adult education programme that provides an avenue for citizens to update their skillsets through training grants and help them find employment. Under the movement, a Skills Framework for Infocomm Technology was jointly developed by SkillsFuture Singapore (SSG), Workforce Singapore (WSG), and the Info-communications Media Development Authority (IMDA), together with industry associations, training providers and unions. It provides useful information such as career pathways, emerging skills and training programmes.

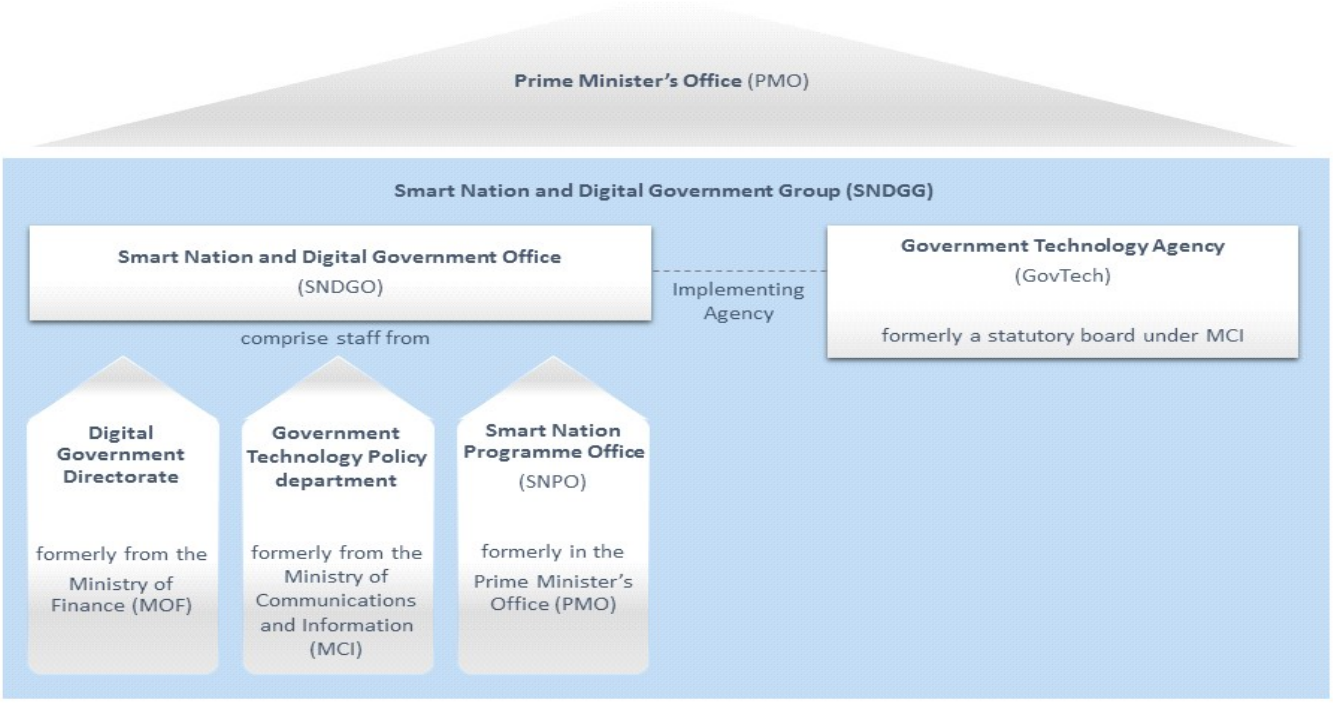
Beginning from the second half of 2018, Mindef would be training 50 to 70 selected full-time national servicemen (NSFs) in a pilot cyber-specialist scheme (Lim, 2018). The personnel would be attending classes at the Singapore Institute of Technology (SIT) once a week and also be deployed in roles such as penetration testing, cyber forensics and malware analysis. They would serve a total of three or four years in uniform, earning regular service pay after first completing a minimum period as NSFs.

The Singapore government has already committed significant resources to grow homegrown ICT talents and broaden the talent pool by attracting professionals from the science, technology, engineering and mathematics (STEM) disciplines (Ministry of Communications and Information, 2016). Furthermore, basic digital skills training would be introduced to the rest of the citizens. Some private and grassroots organisations have already begun to rollout classes on social media and mobile banking for seniors (Aw, 2018).

2.11. Administrative Capacity

The public administration plays a critical role in enabling the implementation of key strategic choices of the government. In order to ensure a more integrated and responsive way to implement the digital programmes, the Singapore government formed the Smart Nation and Digital Government Office (SNDGO) and GovTech, which both made-up the Smart Nation and Digital Government Group (SNDGG) in May 2017 (Prime Minister's Office Singapore, 2017). Please refer to Figure 2– Organisational chart for SNDGG in the Prime Minister's Office. The SNDGG, chaired by the Deputy Prime Minster, collaborates with other government ministries as well as businesses and citizens to develop smart solutions that would improve public service delivery and the quality of life of citizens, and grow economic value. It is hoped that by adopting a whole-of-government approach, in which ministries and statutory boards work jointly across functional boundaries, complex issues could be more readily resolved to hasten the implementation of digital programmes and projects.

Figure 2. Organisational Chart for SNDGG in the Prime Minister's Office



Source: Prime Minister's Office Singapore. (2017, March 20). Formation of the smart nation and digital government group in the prime minister's office [Press Release].

2.12. Regional Network and Global Collaboration

The Singapore government has stressed the importance of connecting with the world, especially in the digital age (Lee, 2017). Therefore, when Singapore took over the chairmanship of the Association of Southeast Asian Nations (ASEAN) in 2018, it proposed a smart cities network to better connect digital infrastructures and services such as e-payments across the region (Baker 2017; Yong, 2018). As many as 26 cities have been put forth by the 10 member countries as part of the ASEAN Smart Cities Network. The cities would be developing specific action plans which may include digital solutions to solve urban issues such as city congestion and air quality (Chia, 2018).

Angelidou (2017) suggested that global collaboration is a necessary component of smart cities because it fosters new and innovative solutions. Singapore is part of the Financial Services Information Sharing and Analysis Centre (FS-IASC), a grouping of nine nations in the Asia-Pacific region that provides security resources, supports cyber security initiatives and warns other countries about imminent threats (Tanoto, 2017). This global collaboration is very timely as nations face increasingly complex and sophisticated cyber-attacks.

3. Moving Forward

With one of the fastest internet speeds and over 100 per cent mobile phone penetration, Singapore is already one of the most digitally connected nations in the world (Bhandari, 2017). The smart nation drive further offers an excellent opportunity to re-look, re-think and re-design how public services could be best provided to the citizens. It is another great

chance to promote public service innovation and active citizen collaboration (Ong, 2017; Pereira et al., 2017). Although collaboration efforts are often very time-consuming and "messy," they help to generate buy-in, and create commitment and trust which are essential conditions for real and lasting social change.

The traditional e-government approach emphasises a supply-based service delivery model using web-based applications. The digital government approach, however, suggests a demand-based citizen-centric model using data and digital technologies such as mobile apps. Nonetheless, it is not just about digital technologies per se but their applications to solve citizen's problems (Chew, 2017). The programmes and projects introduced must solve every day challenges of the citizens (Poon, 2017). Furthermore, there is a need to go beyond efficiency and economic measures that are related to livelihood to innovative and effectiveness outcomes that promote livability or quality of life.

In the digital age, there are no standard frameworks or methodologies to follow, only some simple guidelines for problem solving and innovation. These guidelines include understanding the real problem or "pain point" from a customer's perspective, designing services around outcomes, building an ecosystem to "join the dots" and harnessing digital technology as part of the solution. By applying human-centred research to uncover the real needs of the citizens, there are immense opportunities to create meaningful user experience and systems to bring communities together through digital technologies. All the services provided should be based an end-to-end user-centric approach (Puthucheary, 2018).

4. Conclusion

Singapore has made significant progress in the last few years since the smart nation drive was announced in 2014. Through proactive policymaking and by taking on a whole-of-government approach, Singapore would be increasing the pace for digitalisation in the coming years. A fundamental shift of focus from efficiency and economics to innovation and quality is necessary. There is a need to develop proactive digital strategies and policies that promote public service innovation and active citizen collaboration. With the right approach to change, Singapore could become a more advanced city than what was ever thought to be possible.

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