

Innovative Perspectives on Public Administration in the Digital Age

Aroon P. Manoharan
University of Massachusetts – Boston, USA

James McQuiston
Kent State University, USA

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Zaigham Mahmood

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MISSION

The successful use of digital technologies (including social media and mobile technologies) to provide public services and foster economic development has become an objective for governments around the world. The development towards electronic government (or e-government) not only affects the efficiency and effectiveness of public services, but also has the potential to transform the nature of government interactions with its citizens. Current research and practice on the adoption of electronic/digital government and the implementation in organizations around the world aims to emphasize the extensiveness of this growing field.

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Chapter 1

A Semantic Approach to Evaluate Web Content of Government Websites 1

Manoj A. Thomas, Virginia Commonwealth University, USA
Samaa Elnagar, Virginia Commonwealth University, USA

Government agencies rely on websites to disseminate large volumes of information to the citizens. As public information changes over time due to changes in laws and regulations, maintaining currency and consistency of the web content becomes acutely important. Government agencies have to regularly evaluate the web content (WC) to ensure high quality of information available to the citizens, businesses, and public administrators. Currently there exists no standardized approach for monitoring and maintaining WC. In this chapter, the authors propose a WC ontology for the systematic and formal representation of the concepts and functions associated with the evaluation of web content on government websites. An ontology-based evaluation tool is proposed that can be used to improve the quality of web content and efficiency of the evaluation process. The ontological approach holds promising features and benefits including information sharing, reducing time and paperwork during evaluation, assuring more accurate results, and communicating evaluation results to knowledge engineers, public administrators, evaluators, and decision makers engaged in e-government initiatives.

Chapter 2

Foundations’ Civic Engagement With Stakeholders: Leveraging Social Media Strategies 25

Sarah Maxwell, University of Texas at Dallas, USA
Julia Carboni, Syracuse University, USA

Nonprofit organizations often adopt social media such as Facebook to encourage stakeholders to engage in the organizational mission. Calls to action via social media tend to reach subscribers who “like” or follow the organization via one-way communication. Researching effective approaches to dialogic communication, which asks followers to engage rather than observe, the authors focus on relationship management theory (RMT). RMT stresses organizational-stakeholder dynamic interactions. Using a quantitative modeling approach, the authors examine Facebook posts made by three different types of foundations (community, corporate, and independent) to determine how foundations call for stakeholder engagement. To date, few studies focus directly on types of posts and the response, or lack of response, to organizational messages via social media. Civic engagement requires action on the part of the stakeholder to address social problems. Defining participation and engagement varies by field and types of interaction. This research contributes to literature examining the “digital citizen.”

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In Prosperity Prepare for Adversity: Use of Social Media for Nonprofit Fundraising in Times of Disaster 42

Aya Okada, Kanazawa University, Japan
Yu Ishida, Miyagi University, Japan
Naoto Yamauchi, Osaka University, Japan

When a disaster strikes, nonprofit organizations face the need to mobilize resources as quickly as possible in a limited time frame. Given its characteristics to instantly spread information to masses of people, social media is considered one of the most effective ways for nonprofits to publicize opportunities to take voluntary actions. Despite the envisioned use, little has been examined about the effectiveness of social media in encouraging people to give. This chapter takes the case of earthquake, tsunami, and nuclear threat that struck Japan in 2011 to examine whether the use of social media was effective in nonprofit fundraising. Analyzing data collected in an original online survey, the authors find that the use of social media both before and after the disaster has a positive impact on the amount of donations that nonprofits raise. Use of social media during non-disaster times is the key for successful fundraising in times of disaster.

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E-Government of Occupational Safety and Health: Improvement Prospects for a Developing Nation65

Marcia Nathai-Balkissoon, The University of the West Indies — St. Augustine, Trinidad and Tobago
K. F. Pun, The University of the West Indies — St. Augustine, Trinidad and Tobago

Electronic government (e-gov) has not been implemented as extensively in many developing countries as in developed countries, especially in certain fields, such as occupational safety and health (OSH). This chapter considers e-gov that is effected through the websites of leading OSH bodies in a developing country, Trinidad and Tobago, and two developed nations, the USA and UK. Using a content analysis and comparison exercise, OSH e-gov shortcomings and opportunities in T&T are noted. Improvement recommendations include development of a strategy and strategy execution plan to boost stakeholder recognition of the value of the OSH agency and OSH e-gov in T&T; partnership-building to make resources available for OSH e-gov enhancement; enhanced accessibility and utility via a wider range of media formats to users; better stakeholder responsiveness via engagement with social media and better online support; and increased data collection and analysis in order to drive continual improvement.

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Deborah Mohammed-Spigner, Rutgers University, USA
Brian E. Porter, Montclair State University, USA
Lois W. Warner, Rutgers University, USA

Investments in criminal justice have been expanding over the decades especially as specific outcomes have been sought to address the issues surrounding crime and public safety. Reducing crime and the rate of imprisonment can both significantly impact public safety and cost savings, as well as address outcomes for the justice-involved population in reducing the rate of return to imprisonment, or recidivism. Lessening sentences for non-violent crimes and expanding drug courts as an alternative to incarceration,

along with other major criminal justice reform, have led some states to experience a reduction in crime and prison population. New Jersey, Hawaii, and California have made significant strides to reduce its crime and prison populations and are leaders in achieving major criminal justice reform. This chapter seeks to examine corrections spending for these three leading states that have implemented evidence-based policies and adapted information technology to improve criminal justice outcomes. It will also outline states spending on corrections over the past five years.

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Andrea Fradeani, University of Macerata, Italy

This chapter offers a theoretical analysis related to the eXtensible business reporting language (XBRL), a freely available computer language that has become the de facto standard for digital financial reporting. The aim is to deepen the role that XBRL could play within the public sector, which is partially different from its role in corporate reporting. Literature about that topic is lacking, and this research topic seems to be particularly relevant: considering the strong need for information transparency in government, strengthened by the financial crisis, XBRL could be a useful digital tool to push and improve governments’ accountability and transparency. Finally, the authors briefly present the Italian case: after the experimental period conducted by the Court of Auditors from 2013 to 2015, and since the end of 2016, XBRL has been the mandatory format for submitting the financial statements of all public entities to the Italian Ministry of Economy and Finance.

Chapter 7

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Christian Østergaard Madsen, ITU, Denmark
Pernille Kræmmergaard, Digitaliseringsinstituttet, Denmark

E-government channels are a key to achieving economic savings from public digitization. Citizens tend to use multiple channels in a service encounter and often use e-government channels as a supplement instead of replacing traditional channels. There is a lack of knowledge regarding how government organizations apply findings from user studies to migrate citizens online while reducing traffic through traditional channels. The authors present a case study on how public authorities collaborate to create a multichannel strategy for an online application for single parents. After the multichannel strategy was implemented, there was an increase in the use of the application and a reduction in telephone calls. The authors wrote this chapter to contribute to channel choice and multichannel management literature.

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<i>Ching Yuen Luk, Nanyang Technological University, Singapore</i>	

This chapter uses a historical perspective to examine the development trajectory of digital health in Singapore since 1980 and the impact of digital health on the current health care system and doctor-patient relationship. It shows that digital health is able to transform a fragmented and provider-centric health care system into a more integrated and patient-centric health care system. Besides, it improves the operational efficiency of health care providers, reduces administrative costs and turnaround time, and empowers patients to contribute in treatment decisions. It shows that the development of digital health requires the government to have strong political will and long-term commitment to support and promote the use of digital health to its full potential and engage stakeholders in the policy making process so that such policy can suit the special needs of stakeholders.

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<i>Dimitris Gouscos, National and Kapodistrian University of Athens, Greece</i>	

Since the beginning of the economic crisis in Greece, the first impacts were felt on standards of everyday living. Citizens felt the urge to self-organize and take action based on their own strengths as the only practical solution to fill in the gaps left by the state's absence of intervention. Rooted in the country's economic crisis, Greek citizens' self-organized social solidarity (SoSS) initiatives have been focused on acting and innovating rather than protesting. Examples of such initiatives are social grocery stores, alternative currencies, time banks, neighborhood groups for sanitation and general caretaking, assistance to students in primary/secondary education to name a few. The main objective of this chapter is to show the evolution of SoSS initiatives through a longitudinal research for the period 2014-2016. A second objective is to present the relationship between these initiatives and the online media: How did they use the internet and the social media for their communication for the same period of time? Finally, the authors will attempt an assessment of their operation so far, with data obtained from updating the platform Organosi 2.0, in the summer of 2017.

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<i>Ankit Dhamija, Amity University Gurgaon, India</i>	
<i>Deepika Dhamija, Amity University Gurgaon, India</i>	

The world today is witnessing unprecedented changes in every walk of life. Most of these changes can be attributed to advancements in information and communication technologies (ICT). It is because of ICT only, the trade between various economies, the education, physical movement, and everything else that can be thought of, takes place. Governments of today have realized that in this digital era, traditional methods of remaining connected with its citizens are not going to be sufficient. Therefore, they must come up with innovative measures to find out ways of providing government services to citizens through digital means. When governments adopt ICT to achieve this, it is called e-governance. This chapter will touch upon what e-governance is all about, the state of e-governance, the successful e-governance implementations, and the barriers and constraints that prevent the adoption of an e-governance platform.

The chapter has an Indian context due to the unprecedented change in India's economy and e-governance implementation.

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Results of survey from a snowball convenient sample of Kyrgyz respondents (N = 216) showed that employees of private sector are more likely to use government websites than those of government employees themselves and level of knowledge about security issues directly related to intention to use of Kyrgyz government websites. Specifically, higher level of knowledge about security issues leads less likely to use government websites. Factors such as ease of use and usefulness, relative advantage of using web sites, and compatibility with respondents' lifestyle have also great impact on intention to use government web sites. Image, given by using internet technologies to communicate with government also has a direct relation on people's intention. The findings also suggest about the gender role in if and under circumstances men and women tend to use government websites. The findings are explained via the investigation of diffusion of innovation model and technology acceptance model in relation to use of government websites in the context of Kyrgyz Republic.

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<i>Vinay Sharma, Indian Institute of Technology Roorkee, India</i>	
<i>Anita Sengar, University of Petroleum and Energy Studies, India</i>	

The chapter expresses the extent of the application of "e" and mobile mode for governance along with the extent to which, this application can be uplifted through building up the case around the healthcare system and changing market scenario in rural areas because of the researches which the authors/proponents of this chapter have been conducting. The premise that emerges in the chapter has evolved through the primary interaction with the concerned population. The findings suggest that the rural people of India opine and desire for better healthcare services and market scenario through alternative means, they are willing to pay for the services, they have opined positively and they wish to be involved in the market development scenario wherein E-governance and m-governance has emerged to be an important mode.

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<i>Karin Hansson, Stockholm University, Sweden</i>	
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Distributed decision making with several stakeholders has various facets. On one hand, it enables significant opportunities for fast and efficient information provision, in particular when various structuring frameworks are provided. On the other hand, there are several problems regarding the reliability and consistency of the data produced in social media contexts as well as with the frameworks themselves. Online collaborative data production systems where crowd feedbacks are aggregated and mediated

are easily affected by group biases. There are also several credibility and verification issues as the representativeness of the participants normally is difficult or impossible to determine. This chapter discusses the handling of user data in tools for crowd sourced data production and suggests a framework for describing the socio-technical setting for the production of data, and thereby the detectability of bias patterns in collaborative information production.

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Debika Sihi, Southwestern University, USA

Social media may be leveraged as a cost-effective way for nonprofit organizations (1) to share information and (2) as a platform for fundraising. This is especially true for regional nonprofit organizations which may have less dedicated resources for marketing and fundraising. This chapter has two main objectives. First, the impacts of regional nonprofit organizations’ leadership and strategic emphasis on the use of social media for information transmission is examined. Insights are gained from leadership at 121 nonprofits and through analysis of 377 days of Facebook data for seven nonprofit organizations. The second objective of this work is to examine regional nonprofit organizations’ use of social media for crowdfunding or raising donations through a network of social media followers. The Facebook pages of 647 regional nonprofits are examined, and insights are gained from key staff members at 10 organizations.

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Public administration has evolved and adapted to the changing technological environment and a tech-savvy citizenry. The collection of chapter in *Innovative Perspectives on Public Administration in the Digital Age* discusses a wide array of innovative approaches that are being utilized in the provision of e-government services to their citizens. As the general public increasingly finds itself online, stakeholders, businesses, and citizens expect more from their governments. Accordingly, this volume examines and discusses how public institutions can be more responsive, efficient, and transparent through e-government technologies.

In Chapter 1, “Designing a Semantic Tool to Evaluate Web Content of Government Websites,” Manoj Thomas and Samaa Elnagar propose a method for stakeholders, government officials, and researchers to ontologically evaluate the content of government websites. By standardizing the metric by which this content is evaluated, connections to other domains including records management and human resources training can be made. Making use of an ontology-based approach to web content ensures that the quality of material presented on these sites as well as the happiness level of citizens is high. The authors strongly recommend that a data-gathering process precede any attempt to establish programs, as locating best cases will increase the potential success rates of new programs. The system proposed in the chapter will increase the automation of online content and analysis of larger data.

In Chapter 2, “Foundations’ Civic Engagement With Stakeholders: Leveraging Social Media Strategies,” Sarah Maxwell and Julia Carboni explore the relationships that independent, corporate, and community groups have with their stakeholders utilizing Relationship Management Theory. The authors identify that community groups are using social media services like Facebook significantly more often in their calls to action to members. Where there has also been considerable usage of social media by public organizations, there has not been a monitoring of the analytics that are available from these services. The authors establish a tripartite typology that make it easier for managers of each group to review the communication strategies that they currently utilize and leverage social media activity for their greatest benefit.

In Chapter 3, “In Prosperity Prepare for Adversity: Use of Social Media for Nonprofit Fundraising in Times of Disaster,” Aya Okada, Yu Ishida and Naoto Yamauchi find evidence that social media users are more supportive of organizations during periods of extreme duress, such as during natural disasters or public health concerns. By analyzing the tsunami, earthquake, and nuclear accident that occurred in Japan in 2011, the authors find evidence that donations made to nonprofits increased significantly in the period after the event; however, there will be a non-zero effect on donations in the long-term. The authors propose that nonprofit organizations benefit from the interactive nature of social media websites to establish dialogue and increase the overall quality of service provision to those impacted by natural disasters.

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In Chapter 4, “E-Government of Occupational Safety and Health: Improvement Prospects for a Developing Nation,” Marcia Nathai-Balkissoon and KF Pun delve into the occupational safety and health situation with a qualitative case analysis of Trinidad and Tobago’s TTOSHA bureaucracy. The e-government services of Trinidad and Tobago’s occupational safety concerns are compared to institutions in other small island developing states as well as similar bureaucracies in the United States and the United Kingdom. The authors specifically compare the level of accessibility and support information, the provision of technical information, and the breadth of electronic media resources that the organization offers. The chapter describes a set of best practices from developed nation-states that can be adopted for developing countries wishing to establish e-government services. The study concludes with a set of policy prescriptions that the TTOSHA should adopt to decrease response times, increase transparency, and bolster citizen satisfaction with the organization.

In Chapter 5, “States’ Budget Investments in Technology and Improving Criminal Justice Outcomes,” Deborah Spigner and Lois Warner focus on the actions taken by California, Hawaii, and New Jersey to decrease incarceration rates, as well as state investments in criminal justice technologies. The authors discuss the programs available from the Office of Justice Programs to facilitate the adoption of new technologies by states and territories. They also examine the usage of evidence-based policymaking as a contributing factor to reduce the proportion of citizens incarcerated; strategic planning by cities, states, and the national government have led to considerable investments in new technology. Discussing the specific actions in each case study, the authors provide best practices for those administrators that aim to decrease the amount of resources utilized in the incarceration of citizens.

In Chapter 6, “The eXtensible Business Reporting Language: A Digital Tool to Enhance Public Sector Accountability,” Andrea Fradeani and Michela Soverchia provide readers with a detailed analysis about the eXtensible Business Reporting Language, and how the freeware tool can be utilized to increase government responsiveness, accountability, and transparency. A number of countries have voluntarily taken up the standard but this chapter represents the first substantive analysis of the tool in public administration literature. The authors discuss the experience of the Italian Court of Auditors, who used XBRL during a three-year trial period before adopting it for all financial statements made by public organizations in 2016. The benefits of utilizing the framework are numerous for public organizations as costs will be decreased, and other organizations can easily make sense of the data, including the private sector.

In Chapter 7, “How to Migrate Citizens Online and Reduce Traffic on Traditional Channels Through Multichannel Management: A Case Study of Cross-Organizational Collaboration Surrounding a Mandatory Self-Service Application,” Christian Østergaard Madsen and Pernille Kræmmegaard conduct a case study about Payments Denmark (Udbetaling Denmark) with an eye toward how the organization provided services with much smaller expenditures than the prior program of municipalities providing public benefits. The authors propose that organizations can move away from traditional avenues of service and move towards e-government modes of service provision. The authors identify that all stakeholders in public and private organizations should agree to share costs and revenue at a point before multichannel collaboration is started. Results indicate that there is a rebound effect observed; traditional modes of content (including phone calls) are utilized when users are unclear about how to navigate and make usage of e-government services. Although e-government services can be deemed mandatory for users, organizations must maintain some traditional channels for those citizens that require face-to-face interactions.

In Chapter 8, “The Impact of Digital Health on Traditional Healthcare Systems and Doctor-Patient Relationships: The Case Study of Singapore,” Ching Yuen Luk, present the development trajectory of digital health in Singapore since 1980 through a historical perspective and secondary data collected from

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government documents, literature, newspaper clips and survey reports. Singapore has over 30 years of experience in developing digital health, and has initiated several initiatives to improve productivity in health care and enhance the patient experience. These include MediNet, the Electronic Medical Record (EMR) System, the National Electronic Health Record (NEHR) System and related online health portals. The chapter studies the benefits brought by different digital health programmes, the views of doctors and citizens on digital health and the impact of digital health on the current health care system and doctor-patient relationship. It also examines the implications of digital health in Singapore for other countries.

In Chapter 9, “The Evolution of Self-Organized Social Solidarity (SoSS) Initiatives in Greece and Their Relationship to Online Media: A Longitudinal Research,” Dimitris Gouscos and Eleni-Revekka Staiou show the evolution of SoSS initiatives through a longitudinal research for the period 2014-2016, and provide an understanding of the relationship between these initiatives and the online media. Citizens felt the urge to self-organize and take action based on their own strengths as the only practical solution to fill in the gaps left by the state’s absence of intervention. Rooted in the country’s economic crisis, Greek citizens’ self-organized social solidarity (SoSS) initiatives have been focused on acting and innovating rather than protesting. Specifically, the chapter examines how the citizens utilized the internet and the social media for their communication during the same period of time, using data obtained from updating the platform Organosi 2.0, in the summer of 2017.

In Chapter 10, “Motivational Factors and Barriers for Technology-Driven Governance: An Indian Perspective,” Ankit and Deepika Dhamija make the case that the substantive technology barriers that exist in the developing world, which are numerous, are definitely surmountable. The chapter examines the barriers and constraints that are faced by developing nations globally, and addresses the specific context surrounding the implementation of e-governance in India. The chapters also present some of the successful e-governance initiatives in India, as well as the motivational factors for their implementation. The authors finally suggest a holistic approach to study and incorporate the needs of the stakeholders, understand the capacities of government organizations, and their processes and structures.

In Chapter 11, “A Central Asian View of E-Government Services Adoption: Citizens’ Trust and Intention to Use E-Services,” Rita Ismailova, Gulshat Muhametjanova, and Bahtiyar Kurambayev examine the development of e-government services in the context of Central Asian Kyrgyz Republic. The growing internet penetration in developing countries has led to the increasing focus on e-government services and its potential for efficiency in the public sector. Recent studies have also shown rapid adoption of new technologies in various parts of Asia and South America. However, Kyrgyzstan and other countries in Central Asian region still remain largely understudied as the internet technologies are still in their nascent stages in the region. Accordingly, this chapter examines seven research questions related to e-government services in Kyrgyz Republic, along with examining citizens’ intention to use government websites based on their perceived usefulness.

In Chapter 12, “Mobile Governance for Affordability and Profitability/Feasibility,” Vinay Sharma and Anita Sengar examine the application of ‘E’ and Mobile mode for governance, and more specifically among the ‘Health Care’ system and ‘Changing Market Scenario’ in rural areas. The chapter indicates that the rural people of India desire for better ‘Health Care’ services and ‘market scenario’ through alternative means, and are also willing to pay for such enhanced level of services. Thus E-Governance and M-Governance platforms have emerged as important mediums for governments to provide such improved services, as well as build citizen trust and bridge the digital divide.

In Chapter 13, “Embodiment and Gameplay: Situating the User in Crowdsourced Information Production,” Karin Hansson and Love Ekenberg discuss the handling of user data in tools for crowd sourced data

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production and suggest a framework for describing the socio-technical setting for the production of data, and thereby the detectability of bias patterns in collaborative information production. This framework combines the concept embodiment, to describe the situated perspective of the user belonging to a certain material reality, with the concept gameplay, describing the data gathered on user activity on the platform.

In Chapter 14, “Friending and Funding Through Facebook: Social Media Use of Regional Nonprofit Organizations,” Debika Sihi addresses the networking aspect of social networking services among nonprofit organizations. The use of social media by nonprofits provide a cost-effective means to share information among stakeholders and help in fundraising activities, which are very particularly essential for regional organizations. The chapter specifically addresses two important objectives with regard to nonprofits: 1) assess the impact of leadership and strategic emphasis on the use of social media for information transmission, and 2) study the utilization of social media tools for crowdfunding by nonprofits.

Chapter 8

The Impact of Digital Health on Traditional Healthcare Systems and Doctor–Patient Relationships: The Case Study of Singapore

Ching Yuen Luk

Nanyang Technological University, Singapore

ABSTRACT

This chapter uses a historical perspective to examine the development trajectory of digital health in Singapore since 1980 and the impact of digital health on the current health care system and doctor–patient relationship. It shows that digital health is able to transform a fragmented and provider-centric health care system into a more integrated and patient-centric health care system. Besides, it improves the operational efficiency of health care providers, reduces administrative costs and turnaround time, and empowers patients to contribute in treatment decisions. It shows that the development of digital health requires the government to have strong political will and long-term commitment to support and promote the use of digital health to its full potential and engage stakeholders in the policy making process so that such policy can suit the special needs of stakeholders.

BACKGROUND

Health and ICTs are closely linked (World Health Organization, 2005a, p.2). Health is increasingly seen as both a driver for and beneficiary of ICT development (World Health Organization, 2005a, p.2). Health care providers' heightened interest in enhancing the patient experience while facing a shortage of trained health personnel and patients' heightened expectation of high quality of medical care are two key factors that drive the adoption and innovation of ICT in health care. Meanwhile, advances in ICT over the past few decades have brought lots of benefits to patients and health care providers, including

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patients' improved access to medical care, better quality of care, increased productivity in health care delivery systems, and economy and efficiency of care (Dzenowagis, 2009, p.14). With the emergence of the Internet and web-based technologies, the health care sector is further revolutionised that there are faster and more efficient ways to disseminate health-related information, diagnose, treat and prevent diseases and perform physical exams and surgeries. It is undeniable that ICTs have played an important role in modernizing and reforming health care systems.

Digital health, in the broadest sense, refers to the use of information and communication technologies (ICTs), such as computers, the Internet, multimedia, and mobile phones, to provide four key functions in a timely manner: (1) collect, process, analyse, store, retrieve, share, exchange and manage clinical information and data; (2) provide patients with consultation, prescription, rehabilitation, booking and managing medical appointment or referral services; (3) make health-related information and resources more accessible to patients and the general public; and (4) provide non-clinical services such as medical education, clinical research, provider training and administrative meetings. E-health encompasses a wide range of systems or services, including e-health portals, electronic health records (EHRs), telehealth, robotics and mobile health (m-health). E-health is believed to bring lots of benefits to different types of stakeholders. For health care providers and health care professionals, e-health can enhance operational efficiency, facilitate exchange of clinical information, data and knowledge, facilitate better and more effective communications, enable more evidence-based decision making, improve diagnostic accuracy and safety, service delivery and productivity in health care, and strengthen coordination and collaboration among hospitals and health care professionals. For patients, e-health can increase their engagement and empowerment, reduce waiting and travel time, and receive more personalized medical care. Specifically, elderly patients, patients with physical disabilities and those who live in remote areas can benefit from e-health (World Health Organization, 2004, p.2) because they can have real-time communication and interaction with medical professionals. For the general public, e-health can improve health literacy and health outcomes at both an individual and a societal level, increase their awareness of disease outbreaks and emergencies (Wilson & Brownstein, 2009, p.829), and help them make better decisions about their health and that of family members. Different types of stakeholders hold similar thoughts that e-health plays a promising role in improving the quality of health care.

Since the early 2000s, e-health has attracted considerable international attention. In December 2003, the topic of e-health was discussed at First Phase of the World Summit on the Information Society (WSIS) (World Summit on the Information Society, 2003, p.8). The Geneva Plan of Action, which was agreed at the 2003 WSIS, identified e-health as one of the important areas of activity that required collaborative efforts of health professionals, governments, other agencies and international organizations to promote knowledge building and deployment in medicine and public health, facilitate access to local and international health-related information, extend the reach of medical care and medical assistance to vulnerable populations and those who lived in remote and undeserved areas through the use of ICTs (World Summit on the Information Society, 2003, p.8). Recognizing the potential impacts of ICTs on health care, the Fifty-eighth World Health Assembly in May 2005 adopted a resolution establishing an E-Health Strategy for World Health Organization (WHO) (World Health Organization, 2017) while at the same time calling upon Member States to draw up "a long-term strategic plan for developing and implementing eHealth services in the various areas of the health sector" (World Health Organization, 2005b, p.121) and "endeavour to reach communities, including vulnerable groups, with eHealth services appropriate to their needs" (World Health Organization, 2005b, p.121). The WHO believed that "[t]he strengthening of health systems through eHealth reinforces fundamental human rights by improving equity,

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solidarity, quality of life and quality of care” (World Health Organization, 2004, p.1). In the same year, the WHO established a facility called Global Observatory for eHealth (GOe), which was responsible for examining e-health capacity in Member States (World Health Organization, 2006, p.4) and “providing Member States with strategic information and guidance on effective practices, policies and standards in eHealth” (World Health Organization, 2006, p.5). Since then, e-health initiatives have been “pursued in various ways and to various degrees across countries and continents” (Gurak and Hudson, 2006, p.30).

THE DEVELOPMENT TRAJECTORY OF DIGITAL HEALTH IN SINGAPORE

Being Member State of the WHO, Singapore is one of the world’s most connected countries with an advanced information and communication infrastructure. This is attributed to the determined and unremitting efforts of the Singaporean government to excel and innovate in e-government initiatives in order to modernize public administration, provide more customer-oriented services, and accelerate economic and social development. Singapore’s e-government has gone through different stages of development over time. It has evolved in tandem with each national Infocomm Plan (Ministry of Finance and Infocomm Development Authority of Singapore, 2006, p.12). While e-government Master Plans were launched to set strategies for transforming the government sector, the national Infocomm Plans were launched to set strategies for transforming the business sector and society (Ministry of Finance and Infocomm Development Authority of Singapore, 2006, p.12). Since 1980, the government has launched five e-government Master Plans (GovTech, 2016), which are supported by six national Infocomm Plans (Chua, 2012, p.44; Tan et al., 2013, p.2). These national Infocomm Plans were: The National Computerization Plan (1980-1985), The National IT Plan (1986-1991), and A Vision of an Intelligent Island: The IT2000 Report (1992-1999), Infocomm 21 (2000-2003), Connected Singapore (2003-2006), and Intelligent Nation 2015 (iN2015) (Ministry of Finance and Infocomm Development Authority of Singapore, 2006). Over time, the government has been able to utilize ICT to establish an integrated network that links the entire civil service and helps government ministries establish relationship with the business sector and the general public. The nation has also become more connected when Singapore ONE (a.k.a. One Network for Everyone) was launched in July 1997 to deliver a variety of interactive, multimedia applications and services directly to workplace, school or home through a nation-wide high speed, high capacity broadband network (Ministry of Finance and Infocomm Development Authority of Singapore, 2003; Infocomm Media Development Authority, 2016a; Tan, 2002, p.661). The establishment of a technological infrastructure backbone facilitates the development and use of digital health in Singapore.

The Development of MediNet

Digital health in Singapore has evolved over time and its development trajectory follows the direction laid down in some e-government Master Plans and national Infocomm Plans. Being the first e-government Master Plan, the Civil Service Computerisation Programme (CSCP) from 1980 to 1985 focused on transforming the civil service from a labour intensive, paper-based work environment into a capital-intensive, computerized and automated work environment by using computing tools (Tan et al., 2013, pp.2-3). In 1984, computerization was introduced in the Ministry of Health (MOH) to improve operations of the hospitals and clinics (Ministry of Communications & Information, 1990a, p.2). From 1986 to 1991, the focus of the CSCP was on establishing data hubs to facilitate information sharing across public agencies

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(Ng, 2011, p.115; Tan et al., 2013, p.7) and making public sector information accessible and one-stop services available to the outside world by merging computers and communication technologies (Tan et al., 2013, p.5). This led to the development of a national medical network in the nation. In February 1989, the MOH and the National Computer Board (NCB), which was “a statutory board under the Ministry of Finance” (Michaelis, 1996, p.91), “jointly organised a feasibility and requirements study of a national medical network for Singapore, called MediNet” (Ministry of Communications & Information, 1989, p.2). More than 50 leaders and professionals from both the public and private health care sectors contributed to this feasibility study (Ministry of Communications & Information, 1989, p.2). After the study was completed in October 1989, the MOH decided to form partnership with the Singapore Network Services Pte Ltd (SNS) to jointly develop and operate MediNet (Ministry of Communications & Information, 1989, pp.2-3) and develop plans for the phased implementation of MediNet (Ministry of Communications & Information, 1990a, pp.2-3). The advantage of forming partnership with SNS was that the time and cost taken to develop and operate MediNet could be minimized by capitalising on the existing network infrastructure of SNS (Ministry of Communications & Information, 1989, p.3). It was because SNS since 1989 had already operated Singapore’s TradeNet, which was an electronic data interchange system that linked the trading community with all relevant government agencies (National Library Board of Singapore, 1989). It was believed that MediNet could bring lots of benefits to the health care community. Firstly, MediNet could increase connectivity among the health care community because this integrated computer network linked hospitals, clinics, medical practitioners, drug suppliers, and researchers with the MOH and other relevant government agencies (Ministry of Communications & Information, 1989, p.3). Secondly, it could “improve health surveillance” (Ministry of Communications & Information, 1990a, p.2) and facilitate “the planning, control, financing and delivery of health care services” (Ministry of Communications & Information, 1990a, p.1) because health data could be collected quickly and more efficiently via MediNet (Ministry of Communications & Information, 1990a, p.2). Thirdly, it could improve the efficiency of information management because the cost and turnaround time for preparing, transmitting and processing health information would decrease (Ministry of Communications & Information, 1989, pp.1-2). Fourthly, it could provide a better service for health care recipients because health information could be accessed in an accurate and timely manner and at a faster pace (Ministry of Communications & Information, 1989, pp.1-2). Fifthly, it could increase the productivity of doctors because the amount of paperwork would decrease (Ministry of Communications & Information, 1989, p.1) and doctors could spend more time on patient care and medical research (Ministry of Communications & Information, 1990a, p.2).

In 1990, the Central Claims Processing System (CCPS) became the first application of MediNet (Michaelis, 1996, p.90; Ministry of Communications & Information, 1990a, p.3). The CCPS was an automated system that processed Medisave and Catastrophic Illness Insurance claims (Ministry of Communications & Information, 1989, p.2). It could “receive electronic claim forms from the computers of hospitals and other health care providers, pre-process the forms and transmit them to the [Central Provident Fund] CPF Board” (Ministry of Communications & Information, 1989, p.2). The CPF Board could also use the CCPS to transmit all returns and payment advice to the senders of claim forms (Ministry of Communications & Information, 1989, p.2). The CCPS brought some benefits to the health care community. For hospitals and other health care providers, the use of the CCPS helped them save time and money because the turnaround time for the claims approval decreased from one week to hours and their administrative cost of processing claim forms decreased (Ministry of Communications & Information, 1989, pp.2-3). For the MOH and the CPF Board, the CCPS helped “provide comprehensive

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data for effective monitoring of national health care expenditure and long term planning” (Ministry of Communications & Information, 1989, p.3). For patients, the use of the CCPS brought convenience and efficiency to them because of “shorter waiting time and less form filling” (Ministry of Communications & Information, 1989, p.3). Another function of the CCPS was the provision of an abstract on every inpatient and surgery case, with information on the utilization of health care services, diseases and conditions treated, and procedures and interventions carried out (Emmanuel, 1998, p.13). This could facilitate the analysis on intervention and management outcomes for medical practitioners and implement remedial measures if necessary (Emmanuel, 1998, p.13). The CCPS also collected financial data on hospitals and medical bills that were obtained from day surgery patients and inpatients (Emmanuel, 1998, p.13). This could facilitate the conduct of clinical audit (Emmanuel, 1998, p.13) and planning, monitoring and control of costs.

Being the second application of MediNet, the Physician Data Query (PDQ) System for Cancer was officially launched on September 29, 1990 (Ministry of Communications & Information, 1990b, p.4). The PDQ System provided cancer specialists with an easy access to “a database on the latest state-of-the-art information on the treatment, early detection and diagnosis of each and every cancer” (Ministry of Communications & Information, 1990b, p.4). Such information which was updated monthly enabled cancer specialists to offer the best available cure to their patients (Ministry of Communications & Information, 1990b, p.4). In 1994, another application of MediNet called the National Patient Master Index (NPMI) system was launched (Tan, 1995, p.89). The NPMI system was a first national clinical database that contained three main categories of data, namely patient’s biographic, drug allergy and medical alert data (Low and Tan, 2016, p.345). “[I]n the original specifications there were plans to also store discharge summaries, though this was never implemented” (Low and Tan, 2016, p.345). The NPMI system “cater[ed] for the citizens, permanent residents and foreigners who stay[ed] more than 3 months in Singapore” (Tan, 1995, p.89). Regular and updated biographic data was provided by People Data Hub (Tan, 1995, p.90) while a patient’s drug allergy and medical alert data was reported or updated by Medical Records Officers based on Hospital Inpatient Discharge Summary Forms prepared by the attending doctors (Tan, 1995, p.90). Both the drug allergy and medical alert modules were available in two versions, namely the ‘Standalone’ version and ‘Integrated’ versions (Tan, 1995, p.90). The ‘Standalone’ version catered for hospitals without an internal drug allergy and medical alert database to enter related data into the NPMI system directly (Tan, 1995, p.90). Meanwhile, the ‘Integrated’ version catered for hospitals which linked up their internal drug allergy and medical alert database with the NPMI system and hence, data could be automatically transferred from the internal system to the NPMI system (Tan, 1995, p.90). Since medical data were sensitive and highly confidential in nature, all public and private hospitals were allowed to access the NPMI system only after they had signed a Memorandum of Understanding (MOU) with the MOH (Tan, 1995, p.93). Besides, any hospital staff who applied for access to the NPMI system must sign a security declaration to undertake safeguarding of NPMI data (Tan, 1995, p.93). Also, a certifying officer must be appointed by the hospital to approve and manage all NPMI user identification numbers within the hospital (Tan, 1995, p.93). Security measures including patient’s signed consent and the National Registration Identification Card (NRIC) were in place to safeguard the NPMI data retrieved (Tan, 1995, pp.92-3). Patient management was facilitated by the launch of the NPMI system because the NPMI system allowed “authorized users faster access to a patient’s essential medical data” (Tan, 1995, p.89) and “benefit[ed] the patient for a shorter registration time” (Tan, 1995, p.93). The NPMI system could be considered as the first ancestor of the National Electronic Health Record (NEHR) (Low and Tan, 2016, p.345). In 2006, the NPMI system was migrated to the Critical

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Medical Information Store (CMIS) (Low and Tan, 2016, p.345), which was launched in October 2005 to allow bidirectional sharing of drug allergies and medical alert data into Electronic Medical Records (EMRs) (Low and Li, 2015, p.6).

The Development of the Electronic Medical Record (EMR) System

In 1996, the EMR System was established within local health care institutions to allow doctors to retrieve patient's medical information concurrently and share such information across different departments easily (Infocomm Media Development Authority, 2016b). The EMR initiative was regarded by the NCB as a first step to realize a life-long medical record system for Singapore (Infocomm Media Development Authority, 2016b). The NCB thought that there was an increasing need to aggregate a patient's key medical data that existed in different locations into a longitudinal medical record so that health care providers could retrieve it from anywhere at any time, thereby reducing voluminous paper-based records, avoiding duplicate medical tests, optimizing medical resources and containing costs in the long run (Infocomm Media Development Authority, 2016b). Being two major health care providers or health clusters in Singapore, Singapore Health Services (SingHealth) and National Health Group (NHG) adopted different approaches for their EMR Systems (Sinha et al., 2013, p.259). For SingHealth, a single-instance EMR system that covered the entire cluster was adopted to allow a doctor in any SingHealth institution to access patient's medical information generated by any other SingHealth institution (Lee et al., 2006, p.1). Examples of patient's medical information included "patient's biodata, laboratory investigation results, hospital inpatient discharge summaries and other relevant treatment procedures" (Lim, 2000). For NHG, a Cluster Patient Record Sharing system was adopted to integrate and share patient's medical information across periphery institutions (Lee et al., 2006, p.1; Sinha et al., 2013, p.260). Its patients "only need[ed] to register the first time that they [were] seen at an NHG institution and not at subsequent visits to any other NHG institution" (Lim, 2000). However, the EMR Systems in these two clusters "were essentially independent of each other" (Low and Li, 2015, p.6) that exchange of health data across these two clusters was impossible (Sinha et al., 2013, p.260). In the early 2000s, the government identified the initiative for sharing EMR across clusters (Low and Tan, 2016, p.346). The pilot Electronic Medical Record Exchange (EMRX) system, which was built under the direction of the MOH (Low and Li, 2015, p.6), was launched on 1 April 2004 to allow both clusters to view and share hospital inpatient discharge summaries online (Low and Li, 2015, p.6; Low and Tan, 2016, p.347). Over the year, other digitized records became available in the EMRX system, including allergies, lab, radiology reports and medication (Low and Tan, 2016, p.347). In 2005, a new EMRX which ran on Microsoft Biztalk was launched to make more documents available and extend access to more institutions (Low and Tan, 2016, p.347). In 2006, the new EMRX made immunisation data of Health Promotion Board (HPB) and school health records available and in 2007, the access to EMRX was extended to community hospitals (Low and Tan, 2016, pp.347-8). Nevertheless, major drawbacks of the EMRX were that it was "essentially a document-level exchange" (Sinha et al., 2013, p.264) without any technical compatibility to exchange diagnostic images, such as X-rays, or have disease surveillance, within the EMRX framework (Sinha et al., 2013, p.264; Rowlands, 2012). Besides, it was unable to "apply decision support because of structural and semantic inconsistencies between EMRX documents" (Rowlands, 2012).

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The Development of the National Electronic Health Record (NEHR) System

In 2009, the government initiated a major project to develop a NEHR (Accenture, 2012, p.1), which fell under the National Infocomm Plan known as the Intelligent Nation (iN2015) Masterplan (Liau, 2010; Sinha et al., 2013, p.261). The iN2015 Masterplan was a 10-year plan to transform a provider-centric and fragmented health care delivery system into a more integrated and patient-centred health care delivery system via ICT (Infocomm Development Authority of Singapore et al., 2006, p.81). A NEHR system was “envisioned to connect healthcare providers across the continuum of care as well as to the patients in the community” (Healthcare Information and Management Systems Society, 2010, p.69) and fulfill the MOH’s vision of ‘one Singaporean, one health record’ (Ministry of Health, 2010). The NEHR system would be staged across many years (Ministry of Health, 2015a). In 2010, the MOH awarded the contract to an Accenture consortia to implement a first phase of NEHR (Ministry of Health, 2010). With investment of S\$176 million (US\$128.9 million) (Ministry of Health, 2010; Liau, 2010), the first phase of NEHR was launched in 2011 to provide physicians with “a summary care record for each patient including problem lists, medications, discharge and event summaries, allergies, immunizations, investigations, and procedures” (Accenture, 2012, p.1). Since its implementation, the NEHR system has been progressively enhanced, including “a re-designed user interface and customized care setting views to better support clinical workflows” (Ministry of Health, 2015a) and “data augmentation to expand the breadth of patient centric information to support decision making” (Ministry of Health, 2015a). At present, the NEHR can be accessed by 56 community health care providers, all community hospitals and about 40 per cent of GP clinics (Ministry of Health, 2015a) and “over 760,000 patient record searches are made monthly” (Ministry of Health, 2017a). To encourage faster and wider digitisation of medical records, the government since 2015 has provided more than S\$2million to private and Voluntary Welfare Organization (VWO) health care providers through the Centre-Based and Home-Care IT Enablement Programme Fund (Bhunia, 2017a). Implementing the NEHR has several advantages, including “better integration and transfers from acute hospitals to primary care and vice versa” (Low and Li, 2015, p.6) and achieving cost savings and proper disease management because duplicate or unnecessary tests are eliminated and medical errors are reduced (Ministry of Health, 2010).

The Development of Online Health Portals

While ICT was utilized to improve the operational efficiency of health care providers and facilitate medical information sharing among clinicians, it was also used by the government for health education and promotion (Lim, 2000). Developed by the HPB, an Internet-based health education portal known as HPB Online (<http://www.hpb.gov.sg>) was launched in April 2001 to provide “both corporate and health information through a variety of static and interactive platforms” (Vijaya et al., 2006, p.8). The portal made use of text, pictures, sounds and video clips to provide different types of services (Vijaya et al., 2006, p.13). Firstly, there were interactive online programmes to promote healthy lifestyle. For example, Info Food Search let users “obtain the energy and nutrient composition of more than 6,000 food items, analyse recipes and assess their daily diet of up to seven days” (Vijaya et al., 2006, p.9). Besides, a number of interactive games were offered by the portal to let users obtain health knowledge in an interesting way (Vijaya et al., 2006, p.9). Secondly, users could download, install and make use of some health care software, such as fitness calculators, from their own computers (Vijaya et al., 2006, p.10). Thirdly, users could obtain different types of health information by reading articles on diseases/

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ailments, downloading health education materials, clicking international websites (e.g. the website of WHO) recommended by the portal or submitting queries on health to “Ask An Expert” section, which would be answered by health experts online (Vijaya et al., 2006, p.9). The portal had become more and more popular over time, which was visited by local people and people from Australia, Canada, the United States (US) and the United Kingdom (UK) (Vijaya et al., 2006, p.11). The monthly number of page-views “increased from 100,591 in January 2002 to 390,092 in December 2004” (Vijaya et al., 2006, p.10) and the number of monthly visits “increased markedly from 11,650 in January 2002 to 70,341 in December 2004” (Vijaya et al., 2006, p.10). In 2009, HPB Online was revamped in the following ways to enhance its simplicity and user-friendliness. Firstly, health information was organized according to various target groups, such as youths, older adults, men, women, and health care professionals (Health Promotion Board, 2009a). Secondly, easy-to-use online health tools, such as the BMI calculator, recipe analyser and mobile diet tracker, were provided for users to facilitate personal health management (Health Promotion Board, 2009a). Thirdly, registered users were allowed to personalise their own health page according to their preferences and needs (Health Promotion Board, 2009a). Fourthly, Web 2.0 features such as blogs, forums, vodcasts, podcasts and widgets were incorporated into the portal (Health Promotion Board, 2009b, p.50) to “encourage and link the public in their quest towards a healthier lifestyle” (Health Promotion Board, 2009a).

In late 2013, the HPB conceived the idea of building a one-stop health information and services portal with a mobile application (Chambers, 2015) and started developing the portal in May 2014 (GovTech, 2017). During the design phase, focus group discussions were conducted by HPB to understand what the public would like to have in the portal (Chambers, 2015). Those participated in the focus groups included “parents-to-be; parents of young kids; the health conscious; those diagnosed with a condition; and the recently screened” (Chambers, 2015). In January 2016, the new online portal known as HealthHub was launched. It could be accessed via the Internet (<https://www.healthhub.sg>) or via “a downloadable mobile app on both iOS and Android devices” (GovTech, 2017). HealthHub provided health data and information drawn from multiple IT systems, including the NEHR System, National Immunisation Registry, School Health System, and School Dental System (GovTech, 2017). HealthHub let users get 24/7 access to health-related content, personalized health records and e-services (e.g. viewing medical appointments and checking lab test results) (GovTech, 2017). It allowed parents to “view their children’s health records, such as immunisation records, dental health records and referral letters” (GovTech, 2017). In November 2016, HealthHub extended its service to allow “care receivers to grant designated carers access to their personal medical records and appointments” (Lee, 2016). This feature was believed to “provide convenience and administrative support for about 210,000 regular carers of family members and patients” (Lee, 2016). In order to attract people to use HealthHub and make healthy living more rewarding, HealthHub offered reward points - Healthpoints - to users who shared health articles, events and apps through social media (Chambers, 2015). Healthpoints earned from a certain period of time or accumulated to a certain level could then be converted into NTUC LinkPoints to “offset grocery bills, redeem vouchers and other deals offered by participating partners” (Ministry of Health, 2015b). The launch of HealthHub has attracted lots of users. “As of end January 2017, the HealthHub website has had 8.5 million page views — and over 84,000 Singaporeans have downloaded the app” (GovTech, 2017). Every month, HealthHub “has an average of 530,000 page views” (Ministry of Health, 2017b). HealthHub brought lots of benefits to different segments of the population. It was able to “increase health literacy, encourage the adoption of healthy habits and to nudge Singaporeans to take greater ownership of their own health and wellness” (Ministry of Health, 2015b). In 2016, the performance of HealthHub

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was highly recognized and thereby winning seven ICT awards, including Mob-Ex Awards, Frost & Sullivan Asia Pacific Best Practices Awards and ASEAN ICT Awards (Health Promotion Board, 2017).

The Development of Telehealth

To further embrace the benefits of digital transformation, the government in recent years has promoted the innovative use of ICTs to provide integrated and seamless health care services to patients, especially the elderly (Smart Nation Singapore, 2017a). In 2014, the government launched the Smart Nation initiatives, with an aim to use information technology (IT) extensively and systematically to make the economy more productive, people's lives more convenient and sustainable, and society more connected and responsive to people's needs (Lee, 2014). It strived to merge IT into five key domains: transport, home and environment, business productivity, health and enabled ageing, and public sector services (Smart Nation Singapore, 2017b). In the aspect of health and enabled ageing, the government strongly advocated Telehealth, which was the use of ICTs to bring care beyond hospitals to the community (Integrated Health Information Systems, 2017a). Telehealth was adopted to deliver home health, consultation, rehabilitation services, and chronic disease monitoring and management (Smart Nation Singapore, 2017a). From June to November 2014, the Housing and Development Board (HDB) piloted the Smart Elderly Monitoring and Alert System (Semas) in 12 rental flats (Yeo, 2015 March 17). Semas used motion sensors to track everyday activities of the elderly, including an old people's "current location, sleeping patterns, and even the duration spent in the toilet" (Koh, 2015 March 17). It alerted caregivers of the elderly via text messages and alarms when abnormalities such as an unusually long period of inactivity were detected (Yeo, 2015 March 17; Smart Nation Singapore, 2017a). It also came with a portable, wireless panic button which allowed the elderly to send alerts to their caregivers in time of distress (Koh, 2015 March 17; Yeo, 2015 March 17; Smart Nation Singapore, 2017a). After a six-month trial, Semas received positive feedback from households, including comments that Semas was "non-intrusive" (Loh, 2016 April 23), "elder-friendly and easy to use" (Yeo, 2015 March 17). From April 2016, the HDB introduced Semas to about 3,200 households in Singapore (Smart Nation Singapore, 2017a). According to HDB's chief executive officer Cheong Koon Hean, the introduction of Semas "enhance[d] the safety of elderly residents and offer[ed] their children greater peace of mind" (Yeo, 2015 March 17).

In 2016, a pilot mobile app known as Health Marketplace SG was launched to link up discharged patients with a nurse living or working close to them to provide home nursing services, such as wound dressing and changing patient's urinary catheter (Khalik, 2016 October 21; Chan, 2017 May 30; Toh, 2017 May 30). Singapore General Hospital (SGH) and KK Women's and Children's Hospital (KKH) have been participating in this 'match-a-nurse' pilot, with about 140 nurses from SGH and KKH being on this programme and completing about 75 patient visits (Chan, 2017 May 30). The launch of this mobile app could benefit patients who were bed-bound or wheelchair because they could receive care at home without visiting the hospital frequently (Khalik, 2016 October 21). The mobile app will be further enhanced over the next three years to provide more home care services, "ranging from personal care services, medical transportation, meals-on-wheels and therapist services" (Toh, 2017 May 30).

In April 2017, a Smart Health Video Consultation (SHVC) for healthcare was implemented for selected services at KKH, SGH, Tan Tock Seng Hospital and Institute of Mental Health (IMH) to enable post-discharge patients or patients with mobility issues to consult their doctors at home (Bhunias, 2017b). Examples of selected services at KKH included "follow-up services for paediatric eczema pharmacy consultation, paediatric home care services, lactation consultation, and speech" (Bhunias, 2017b). For

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other participating hospitals, patients could “communicate with their doctors on issues such as post-stroke needs, communicable diseases and cancer” (Phua, 2017a April 12). SHVC could be accessed via computer or smartphone (Phua, 2017a April 12). It adopted two-factor authentication and end-to-end encryption to ensure security of each video consultation session (Phua, 2017a April 12). With high quality audio and video, the SHVC platform enabled health care professionals to assess patients’ conditions more accurately and had video conferencing with multi-disciplinary care teams (Bhunias, 2017b). Besides, it was a cloud-based platform allowing “annotation, file sharing and display of medical reports or images for reference during the consultation” (Bhunias, 2017b). SHVC was expected to benefit both doctors and patients. For doctors, SHVC could help them “monitor patients more regularly than traditional face-to-face appointments” (Phua, 2017a April 12) and “save time travelling to and from nursing homes” (Phua, 2017a April 12). For patients, SHVC enabled patients to rest at home, reduce caregiver absence from work and reduce patient’s exposure to communicable diseases (Phua, 2017a April 12).

In May 2017, a national pilot for Smart Health TeleRehab (SHTR) was rolled out to enable patients recovering from conditions such as stroke, falls and fractures, lower limb joint replacements and amputations (Bhunias, 2017c; Integrated Health Information Systems, 2017b; Phua, 2017b May 5) to carry out physiotherapy exercises at home. For patients who were suitable for using SHTR after assessment made by their therapists or doctors (Integrated Health Information Systems, 2017b), they could open an app known as Smart Health TeleRehab on an iPad (Phua, 2017b May 5). After putting on neck and limb sensors, patients accessed video demonstrations of exercises prescribed by their therapists who customized the level of difficulty, exercise angles and the number of repetitions of each exercise (Bhunias, 2017c; Phua, 2017b May 5). Patient’s motor movements would then be detected and measured by SHTR with wearable sensors and algorithms (Bhunias, 2017c). Being a user-friendly system, SHTR provided instructions in five languages: English, Mandarin, Bahasa Melayu, Tamil and Tagalog (Bhunias, 2017c). Besides, it contained some useful features to guide patients to complete their exercises, including coloured bars to indicate if patients could achieve desired exercise angle (Phua, 2017b May 5), “countdown timer for hold positions” (Bhunias, 2017c), “a counter for the number of repetitions completed” (Phua, 2017b May 5), and “a star indicator to show how accurately the exercise was completed” (Bhunias, 2017c). After the patient’s completion of exercises, SHTR would send a record of the patient’s performance to the therapist to review via dash boards (Phua, 2017b May 5). The therapist could quickly review the patient’s performance and compliance via Exercise Charts and evaluate seated and standing ability of the patient via Balance Charts (Bhunias, 2017c). Meanwhile, SHTR also contained a video conferencing feature to enable patients to remotely consult their therapists (Integrated Health Information Systems 2017b). At present, SHTR is used by suitable patients of NTUC Health and TOUCH Home Care (Bhunias, 2017c). By the end of 2017, SHTR will be available to suitable patients of 12 other institutions in Singapore (Phua, 2017b May 5). SHTR is expected to bring “greater convenience for patients and increased productivity for therapists and service providers” (Bhunias, 2017c). It can prevent patient’s conditions from deteriorating further and help them recover faster by carrying more physiotherapy exercises and thereby requiring fewer therapy sessions (Phua, 2017b May 5).

In late 2017, a Vital Signs Monitoring (VSM) System will be launched to facilitate home-based chronic disease management (Ministry of Health, 2016). The VSM System will allow health care personnel to remotely and regularly monitor vital signs such as the weight, blood pressure and blood glucose of patients with heart or pulmonary diseases, diabetes and hypertension (TODAY 2017 May 30; Ministry of Health, 2017a). It will enable patients to get more timely advice and intervention online without scheduling an appointment with physicians at hospitals (TODAY, 2017 May 30; Ministry of Health, 2017a).

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THE IMPACT OF DIGITAL HEALTH ON TRADITIONAL HEALTH CARE SYSTEM AND DOCTOR-PATIENT RELATIONSHIP

A historical review of the development trajectory of digital health in Singapore since the 1980s shows that the government has made unremitting efforts to develop and implement different digital health programmes. After over three decades of development, digital health is able to transform a provider-centric and fragmented health care system into a more integrated and patient-centric health care system. Digital health not only increases internal connectivity among medical, supportive and administrative departments in a hospital, but also increases external connectivity among local and overseas medical practitioners and researchers, different hospitals, clinics and other relevant government agencies. With digital health, the operational efficiency of health care providers is greatly improved. The administrative costs and turnaround time for preparing, transmitting and processing health information decrease. Health data can be collected and retrieved in a more accurate, efficient and timely manner. The productivity of doctors increases due to the reduction of voluminous paperwork, duplicate medical tests and medical errors. With digital health, the delivery of health care services has become more customer-oriented. Repeated form filing when visiting different hospitals can be avoided. There is shorter waiting time. Travelling time and costs can also be saved via Telehealth.

Over the past few years, several international surveys on digital health have indicated that most of the doctors and patients in Singapore have positive views on adopting and utilizing digital health. In late 2012, Accenture conducted an online survey of 3,700 doctors' adoption, utilization and attitudes toward health care information technology (IT) across eight countries: Singapore, the US, the UK, Canada, France, Germany, Spain and Australia (Accenture, 2013). The survey found that there was an increase in health care IT and health information exchange (HIE) adoption among primary and secondary care doctors in Singapore from 2011 and 2012 (Accenture, 2013, p.5). In Singapore, the number of doctors electronically entering patient notes either during or after consultations increased from 41 percent in 2011 to 52 percent in 2012 while the number of doctors having electronic access to clinical data about patients who were seen by different health organizations also increased from 32 percent in 2011 to 49 percent in 2012 (Accenture, 2013, p.3). When comparing with other countries surveyed, Singapore showed the largest increase in doctors electronically receiving clinical results that populated patients' EMR (40 percent) and the largest increase in doctors electronically sending prescription to pharmacies (36 percent) from 2011 to 2012 (Accenture, 2013, pp.1-2). In 2015, Accenture conducted a survey of 2,619 doctors' attitude toward health care IT across six countries: Singapore, the US, the UK, Norway, Australia and Brazil (Accenture, 2015). The survey found that of all the countries surveyed, Singapore had the highest percentage of doctors thinking that they were more proficient using EMRs in their clinical practices in 2015 than they were in 2013 (86 percent) (Accenture, 2015, p.16). Besides, Singapore had the lowest percentage of doctors finding their organizations' EMR systems hard to use (42 percent) (Accenture, 2015, p.23). In the survey, Singapore had the highest percentage of doctors saying that EMR and HIE had a positive impact on reducing medical errors (88 percent) (Accenture, 2015, p.27). And Singapore had the second highest percentage of doctors saying that EMR and HIE had a positive impact on the quality of treatment decisions (85 percent) and health outcomes for patients (80 percent) (Accenture, 2015, pp.25-6).

In 2014, McKinsey conducted Digital Patient Survey of thousands of patients in Singapore, UK and Germany. The survey found that respondents in Singapore had higher frequency of using electronic channels to get health care services than respondents in the UK and Germany in the last 12 months.

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While 55 percent respondents in Singapore used website/online portal to interact with the health system (e.g. doctors, hospitals, pharmacies) for at least three times and above, only 49.5 percent respondents in the UK and 34 percent respondents in Germany did so (Biesdorf and Niedermann, 2014). While 48 percent respondents in Singapore used smartphone apps to interact with the health system for at least three times and above, only about 22 percent respondents in the UK and about 9 percent respondents in Germany did so (Biesdorf and Niedermann, 2014). The use of email to interact with the health system was popular in these three places. However, the percentage of respondents using email to interact with the health system for at least three times and above was higher in Singapore (38 percent) than the UK (34 percent) and Germany (31 percent) (Biesdorf and Niedermann, 2014). Nevertheless, respondents in these three places still used tradition channel to obtain health care service. In Singapore, about 22 percent respondents obtained services through health care branch for at least three times and above in the last 12 months while 16 percent respondents in Germany and 43 percent respondents in the UK did so (Biesdorf and Niedermann, 2014). In the 2014 McKinsey's Digital Patient Survey, respondents in Singapore ranked three criteria that could increase their frequency of using online services, which were increased awareness of online services, wider range of value-added services, and width/clarity of information available (Biesdorf and Niedermann, 2014).

In 2016, Accenture conducted health care innovation and transformation survey of 2,250 citizens in Singapore, Japan and Australia. The survey showed that the percentage of citizens' technology confidence in Singapore (60 percent) was lower than that of in Australia (75 percent), but was much higher than that of in Japan (36 percent) (Accenture, 2016a, p.14). In the survey, Singapore had the highest percentage of citizens feeling positive about technology replacing traditional health care services (54 percent), compared with 49 percent in Japan and 41 percent in Australia (Accenture, 2016a, p.15). Besides, Singapore had the highest percentage of citizens considering the use of a virtual assistant in improving their health, compared with 65 percent in Australia and 59 percent in Japan (Accenture, 2016a, p.23). Also, citizens in Singapore showed the greatest willingness to pay for a home health-monitoring kit if such kit allowed them to have faster access to treatment (57 percent), allowed doctors to better manage their health (50 percent), allowed them to be involved in their own health care plans (44 percent), allowed them to accumulate 'reward points' for healthy lifestyle choices (48 percent) and entitled them to discount on gym membership, health coaching and healthy food (42 percent) (Accenture, 2016a, p.21). The survey showed that citizens in Singapore had confidence in and greater openness to the adoption of health care technology to obtain better quality of medical care and they would adopt health care technology more if there were rewards and incentives, such as 'reward points' and discount.

In 2016, Accenture conducted another survey of 935 Singaporean consumers on patient engagement. The survey showed that over half of the respondents had positive views on digital health. In the survey, 57 percent of respondents wanted their primary doctors to have full access to their electronic health records (EHRs) and 90 percent of respondents agreed that they received better care when doctors could access and used their EHRs (Accenture, 2016b, pp.3-4). Besides, 66 percent of respondents believed that the benefits of accessing electronic medical information outweighed the risk of privacy intrusion, compared to 53 percent in 2014 (Accenture, 2016b, p.4). Also, 63 percent of respondents believed that health care technology was important to manage their health (Accenture, 2016b, p.7). Among respondents who said that health care technology was important, 39 percent of them believed that it helped them better understand their condition(s) and medication(s) and 31 percent believed that it helped save time (Accenture, 2016b, p.7). From the above, it showed that many respondents saw the benefits of digital health. Nevertheless, the survey found that most of the respondents still valued the traditional, in-person

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visits, with 72 percent of respondents preferring traditional over virtual visits (Accenture, 2016b, p.8). While respondents thought that traditional and virtual visits had their own advantage, over half of the respondents surveyed thought that traditional, in-person visits was better than virtual visits in terms of providing quality care to patients (64 percent), diagnosing problems faster (55 percent) and engaging patients in their health/health care decisions (53 percent) (Accenture, 2016b, p.8). But respondents thought that virtual visits was better than traditional, in-person visits in terms of money and time, with over half of the respondents thinking that virtual visits could reduce medical costs to patients (58 percent) and accommodate patients' schedules (56 percent), and 41 percent of them thinking that virtual visits could provide timely care to patients (Accenture, 2016b, p.8). Another finding of this survey was that older Singaporeans aged 55 years and above had positive attitude about digital health and many of them used digital health tools. In this survey, there was a total number of 935 Singaporean consumers, of which 93 percent aged 55 years and above (Accenture, 2016c, p.8). Among these older Singaporeans, the majority of them (84 percent) considered technology to be "somewhat" or "very important" to managing health (Accenture, 2016c, p.5). Websites (56 percent) and mobile apps (40 percent) were top two digital health tools used by older Singaporeans to manage their health care (Accenture, 2016c, p.4). Only 20 percent of older Singaporeans surveyed used EHRs to manage their health care (Accenture, 2016c, p.4). The survey also found that the majority of older Singaporeans would choose a health care provider who offered email or text reminders for preventive or follow-up care (83 percent) and online appointment management (82 percent) (Accenture, 2016c, p.5). The survey showed that older Singaporeans would choose a health care provider who could utilize IT to provide value-added services for them.

The survey results show that while respondents recognize the benefits brought by digital health, many of them think that the traditional, in-person visit still has existence values. Indeed, the government has no intention to use digital health to replace traditional, face-to-face medical care. Instead, digital health is served as an alternative channel to deliver health care services and patients have freedom to choose whether they want to seek medical care through a traditional or digital channel. With digital health, doctors are better informed with a patient's medical condition through accessing the EMR online and thereby making better treatment decisions. For patients, digital health serves as a convenient channel for patients to communicate with the doctors. Patients in Singapore were more active in using website or online portal to interact with doctors, hospitals and pharmacies. There is no doubt that digital health facilitates the communication between doctors and patients by breaking down the physical and time boundaries. Emails can be used for non-urgent enquiries and served as a reminder for follow-up care or online appointment management. But in-person visits are still preferred for urgent or serious illnesses. At this stage, digital health has unavoidably brought some changes to doctor-patient relationship. It is because digital health empowers patients to contribute in treatment decisions when patients have greater accessibility of online information about their medical conditions (Robinson, 2013, p.79). Traditionally, there is an inherent power imbalance in a doctor-patient relationship (Nimmon and Stenfors-Hayes, 2016, p.114). Doctors were in position of power in the doctor-patient relationship because of their medical training and credentials (Nimmon and Stenfors-Hayes, 2016, p.114). They had "an inherent responsibility to act in the patient's best interest" (Nimmon and Stenfors-Hayes, 2016, p.114) when making decision about medical treatment. Patients put their trust in doctors and seldom challenged a doctor's decision because they were not equipped with the professional medical knowledge like that of the doctors. With digital health, however, doctors are no longer the only source of information patients can rely on (Lim, 2000). Communication is no longer just "a unidirectional flow of information from health professional to patient" (Robinson, 2013, p.79) because patients have become more well-informed through browsing

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information on the Internet or HealthHub. Patients become more active in having dialogue with doctors and it becomes more common that information flows back from patients to doctors (Robinson, 2013, p.79). With digital health, patients want to “play a bigger role in managing their own health” (Lim, 2000). In Singapore, some patients would discuss Internet information with their doctors when seeking medical care at clinics (Lim, 2000). If patients obtain online information from a valid source and interpret the information accurately, they may be able to ask the right questions when seeing doctors. Communication gaps can be bridged and doctors can communicate with patients more easily because patients are equipped with some medical knowledge online. However, if patients obtain irrelevant information and interpret such information inaccurately, they may ask inappropriate questions when seeing doctors. This may lead to a time-consuming and less efficient consultation and harm doctor-patient relationship. However, based on the existing survey results, doctors and patients seem to be positive about the impact of digital health on doctor-patient relationship.

IMPLICATIONS OF DIGITAL HEALTH IN SINGAPORE FOR OTHER COUNTRIES

The development of digital health is an ongoing process. It requires political leaders to have strong political will and long-term commitment to create conditions for the continuous development of digital health and support and promote the use of digital health to its full potential. In Singapore, the government incorporates the idea of developing digital health into the nation’s IT strategic plans. It facilitates the development of digital health by building a robust technological infrastructure backbone. Recognizing that the development and advancement of the use of telemedicine involves heavy financial investment and substantial research and development (R&D), the government since 1991 has made sustained effort to increase its financial commitment to research and innovation. It invested S\$2 billion in the National Technology Plan (1991-1995) (National Research Foundation, 2017a), which was Singapore’s first directed and definitive 5-year science and technology plan to boost R&D activities (Agency for Science, Technology and Research, 2011, p.2). In 2016, the government invested S\$19 billion for its sixth 5-year plan known as Research Innovation Enterprise 2020 Plan (RIE2020), with Health and Biomedical Sciences being one of the major strategic thrusts (National Research Foundation, 2017a). Under the RIE2020, S\$4 billion was allocated to the strategic thrust of Health and Biomedical Sciences (National Research Foundation, 2017a), with part of the funding being used to support research on transforming and enhancing the efficiency of health services delivery, such as digital delivery of health services (National Research Foundation, 2017b). To further increase its financial commitment to research and innovation, the government in 2014 established the National Health Innovation Centre Singapore, which provided “the publicly-funded clinical research sector of Singapore with translational funding and strategic guidance to accelerate healthcare innovation” (National Health Innovation Centre Singapore, 2015). In May 2017, the government invested S\$150 million into a national programme called AISG, with a target to come up with 100 artificial intelligence projects to provide solutions in the field of health care, finance and city management solutions over the next five years (Jamal, 2017). One of the national-scale projects was about building an intelligent platform that would allow patients with diabetes to monitor and manage their medical conditions from home (Loke, 2017). The fiscal incentives provided by publicly funded R&D not only boost the quantity and quality of research on digital health, but also encourage researchers, experts and industry to devote themselves to generating new knowledge and turning it into new products that can improve the operational efficiency of health care delivery and the lives and

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wellbeing of people. Apart from providing financial support to R&D, the government also “work[ed] closely with the private sector to promote health tech innovation” (Greene, 2016). For example, EDBI, the corporate investment arm of the Economic Development Board partnered with Royal Philips to seek effective use of telehealth so that patients could be empowered with greater responsibility over their health (Lawrence, 2016). They jointly invested in digital health companies that worked on population health management tools, with EDBI using its local and regional stakeholder connections in Asia to aid these companies and Royal Philips offering mentorship to them (Lawrence, 2016). The advantage of public and private sector collaboration is that bringing in technical expertise from the private sector can supplement limited public sector capabilities. Bringing the complementing skills of public and private sectors together helps give a boost to the digital health business and industry.

The development of digital health is also facilitated by the provision of a clear legal and regulatory framework. Over the past few years, the Singaporean government and professional organizations have promulgated regulation and issued guidelines in order to govern the delivery of digital health services. There are lots of stakeholders in the health care community, including medical practitioners, nurses, health workers, pharmacists, physiotherapists, hospital administrators, and patients. To better assess the impacts of regulation on affected parties, balance the opposing interests and ensure compliance, the government actively sought the opinions of stakeholders by conducting public consultation or bringing in experts or representatives from professional bodies during the regulatory process. It made sure that the public was adequately informed and sufficient time was given to the public to give useful feedback to the government. Public consultation can increase public awareness of digital health and lead to a higher level of acceptance of the legislation. Besides, there is an improved understanding among stakeholders of their rights and responsibilities under the legislation. It helps increase compliance rate and reduce the cost of enforcement. For example, after conducting three rounds of public consultation, the government promulgated Personal Data Protection Act 2012 (PDPA) to govern the access to and collection, use, disclosure and care of personal data stored in electronic and non-electronic forms (Personal Data Protection Commission, 2017). PDPA, which complemented sector-specific legislative and regulatory frameworks and came into operation in July 2014 (Personal Data Protection Commission, 2017), introduced an additional layer of obligations for healthcare institutions to put in place reasonable security arrangements to safeguard patient data, especially when such data was transferred from one health care provider to another and from Singapore to overseas (Yeo and Gaw, 2013, p.2). Another example is that the MOH in January 2015 issued National Telemedicine Guidelines (NTG) to establish the initial strategic direction for Telemedicine in Singapore (Ministry of Health, 2015c, p.8). NTG was developed with the guidance of the National Telemedicine Advisory Committee (NTAC), which comprised leading Telemedicine practitioners of Singapore and representatives from professional bodies such as Academy of Medicine, Singapore (AMS) and College of Family Physicians (Ministry of Health, 2015c, p.8). In the development of NTG, references were made to international precedents, including the US, Canada, Australia and Japan (Ministry of Health, 2015c, p.8). This helped ensure that NTG met international standards and thereby increasing public confidence. NTG aimed to provide health care providers with a holistic approach to execute the appropriate delivery of Telemedicine services through the domains of ‘Clinical Standards and Outcomes’, ‘Human Resources’, ‘Organisational’, and ‘Technology and Equipment’ and outline principles to address the safety of both health care providers and patients (Ministry of Health, 2015d, p.1). In September 2016, Singapore Medical Council published the latest version of Ethical Code and Ethical Guidelines (ECEG). In the section of Good Clinical Care, ECEG stated that the idea of providing Telemedicine responsibly required medical practitioners to “provide the same qual-

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ity and standard of care as in-person medical care” (Singapore Medical Council, 2016, p.19). Medical practitioners should have sufficient information and training to manage patients through telemedicine, provide telemedicine only with patient’s knowledge and consent, and ensure confidentiality of patient’s personal data shared electronically (Singapore Medical Council, 2016, p.19). In late 2016, the Health Sciences Authority (HSA), which was a statutory board of the MOH to regulate health products, conducted public consultation on proposed regulatory guidelines for Telehealth devices (Health Sciences Authority, 2017a). In August 2017, the HAS issued Regulatory Guidelines for Telehealth Devices, which applied to Telehealth products, including hardware devices, software and mobile applications (Health Sciences Authority, 2017b, p.6). The Guidelines provided “clarity on the types of Telehealth Products that [were] regulated as medical devices, as well as its current regulatory approach and requirements for such Telehealth Products” (Health Sciences Authority, 2017c).

Recognizing that it is important to protect the privacy of individuals and data security online, the government has taken some security measures to protect patients’ health care data online. The NRIC system, which “is used extensively in Singapore, for verification of identity and other transactions” (Woon, 2014, p.212), is used to safeguard the retrieval of NPMI data. Another security measure is the use of Singapore Personal Access (or SingPass). SingPass, which was launched in 2003, “is the online equivalent of the identity card” (Central Provident Fund Board, 2003). It “is a gateway to hundreds of digital services offered by more than 60 government agencies” (Singapore Personal Access, 2017). It is “automatically issued to Singaporeans who register for their identity cards at the age of 15” (Central Provident Fund Board, 2003). With SingPass, users only have to remember one password when transacting with government agencies online (Central Provident Fund Board, 2003; Singapore Personal Access, 2017). They can use SingPass to access HealthHub and their medical records. Since the use of SingPass is simple and convenient (Central Provident Fund Board, 2003), it makes citizens feel safe and encourages them to use digital health. Other measures to encourage citizens to use digital health services and networks are providing incentives and customer-oriented, value-added services for the users. The case study of Singapore shows that the government boosted the user rate of HealthHub by offering reward points to users to redeem vouchers and offset grocery bills and providing customer-oriented, value-added services through introducing one-stop health information and services portal, 24/7 access to health-related content, interactive online programmes, easy-to-use online health tools and website personalization. It shows that customer-orientation, user-friendliness, and ease of use are essential components to enhance users’ personal digital experience and increase public acceptance to use digital health networks and services.

From the above, the case study of Singapore shows that there are lots of factors shaping the successful development and implementation of digital health. These include strong political will and long-term commitment of political leaders, a robust technological infrastructure backbone, the government’s continuous financial commitment to R&D, the provision of a clear legal and regulatory framework, convenient and easy-to-use security measures, and a user-friendly, customer-centric design of digital health portal and services. The case study of Singapore shows that the development of digital health is not simply a technological issue. It involves lots of inputs from the government and stakeholder engagement. The government plays an important role in facilitating the development of digital health. The government acts as a service provider, financier, regulator and facilitator. Meanwhile, health care providers, in response to the government’s digital health initiatives, utilize digital health in different ways. Patients and the general public, gradually shows an increased interest in using digital health to improve their health and take ownership of their health. Singapore has a centralized political system. The ruling party’s long

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reign of paternalism and ruling elites' adoption of a top-down model of policy making (Luk, 2014, p.92) facilitate the development digital health policy. In many countries, the development of digital health is still in its infancy and the idea of digital health is still very new. To let the idea of digital health take hold and being endorsed by the general public and stakeholders in the health care community, the government and political leaders must have strong political will and commitment to create conditions for the development and advancement of digital health and engage stakeholders in the policy making process so that such policy can be tailored to suit the expectations and special needs of stakeholders. Another important thing is that the government and political leaders are able to link digital health to some positive impacts, such as customer-orientation, better quality of care and shortened waiting time, thereby enhancing the psychological readiness and confidence in using digital health.

FUTURE RESEARCH DIRECTIONS

At present, there is still the lack of study on digital health in Singapore. Under the 2014 Smart Nation initiatives, Telehealth has been strongly advocated by the government. Different pilot Telehealth programmes are rolled out in phases and they are under regular review. It is expected that Telehealth programmes can be extended to benefit more segments of population. Future research directions can evaluate the outcomes of these Telehealth programmes and examine users' perspective on these Telehealth programmes. It can examine whether the implementation of digital health helps solve the challenges caused by ageing population. Comparative studies on digital health between Singapore and other countries can also be conducted in order to examine whether cross-national differences lead to different design and application of digital health.

CONCLUSION

To conclude, the government in Singapore has made unremitting efforts to develop digital health and promote the use of it. The development of digital health is an ongoing process that requires regular reviews. It requires strong political will and long-term commitment of the government and stakeholder engagement so that digital health can be utilized to its full potential and meet the expectations and special needs of users. Looking forward, it is anticipated that digital health can play an important role in tackling the increasing health care needs caused by rapidly ageing population.

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KEY TERMS AND DEFINITIONS

HealthHub: A one-stop portal introduced by the Singaporean government to allow users to have 24/7 access to personal health records and health-related information.

MediNet: An integrated computer network introduced by the Singaporean government to link the health care community with all relevant government agencies.

National Electronic Health Record: A patient data exchange system that allows medical practitioners to have access to a patient's health record so that more accurate treatment decisions can be made for their patients.

Personal Data Protection Act: A legislation promulgated in Singapore in 2012 to govern the access to and collection, use and disclosure of electronic and non-electronic personal data.

SingPass: A security measure that is used in Singapore for verification of identity when people have online transaction with government agencies.

Smart Elderly Monitoring and Alert System: A sensor system that tracks daily activities of the elderly in their homes and alert their caregivers via text messages if abnormalities are detected.

Smart Nation: An initiative launched by the Singaporean government in 2014 to solve problems, create more opportunities and make society more connected through the extensive use of information technology.

Telehealth: The use of information and communication technologies to obtain health care services remotely.