

Technology Challenges to Healthcare Service Innovation in Aging Asia: Case Study of Emergency Medical Service System

Sukkird Vatcharapong^{1,2}, Kunio Shirahada¹

¹Japan Advanced Institute of Science and Technology, Japan

²SIIT Thammasat University, Thailand

Abstract--The trend of the aging populations in Asia countries will increase at an average of 10% in 2009 to 30% in 2050. Healthcare service is a principal social right and an essential mechanism for the well-being of the elderly. The emergency medical support system is a critical process for providing healthcare service for physical conditions related to aging and for help in life threatening cases. There is a need to provide flexible applications that enable the elderly to communicate their desires with others in a reasonable amount of time. This research is aimed at identifying the technological challenges that face healthcare services in terms of the emergency medical service system created to support elderly patients' demands. We conduct a questionnaire survey for statistical analysis based on secondary data from the World Health Organization (WHO) and use systematic reviews to identify the needs of healthcare technology related to aging based on the service system. In addition, as a case study, we conducted a questionnaire survey given to healthcare service providers who work in hospitals in Thailand to identify current situation of EMSS and relative available technology for system improvement. The findings show that healthcare technology priorities and emergency service modeling are positively significant factors influencing healthcare service innovation for selected countries. This paper will increase the confidence of elderly people and their families through the preparation of alternative service systems with all service providers.

I. INTRODUCTION

The trend of the aging population in Asia is rising from 10% in 2009 to 30% in 2050. The increase in elderly people is caused from the unstable growth of population in many countries caused by developed healthcare quality and different life styles of people that have late married, are living alone, and have a decreased rate of fertility. The growth in the number of elderly people will have an effect on society, the economic, consumption, healthcare services and people [1-2]. Many factors need to be prepared in order to support aging populations, including mobility, physical condition, and daily life. The main factors are related to health policy, promotion, and service infrastructure [3-5]. In the 21st century, technology and service innovation drives the economic and society through a variety of applications involving education, communication, entertainment, and healthcare. Many technologies and innovations are aimed at supporting the well being of the aging population for simple use with universal design, examples of which can be found in smart homes, smart cities and mobile applications [6-9].

Healthcare service is essential for the well-being of elderly people for personal care, nursing, life threatening illness, health consulting, and contingency help. Lack of a

workforce in healthcare sectors and limited of funding are the main problems in developing countries. Technology needs to be designed and decision need to made to support the requirements of the aging population on the basic of their respective countries [10-13]. Many pieces of research are aimed at trying to develop and focus on possible technologies that can be applied to healthcare services, from basic needs in daily life to special help [14-19]. Emergency medical service is a critical healthcare service for aging people that needs to be prepared and provided for all possible cases, from physical condition help to life threatening cases on a 24 hours basis. These services need to provide a flexible application that enables the elderly to communicate their desires with others in reasonable time. It is important to improve emergency medical system and services.

From the viewpoint of service-dominant logic (SDL), the co-creation concept is intended to capture the essential nature of value creation; it always involves the beneficiary's participation through use, and integration with other resources [20-21]. It supports services exchanged through the interaction of service providers co-operating together with consumers who are active participants in the service system. The trend of aging populations has an effect on Asian societies, especially on healthcare services and the well-being of people. There is a need to improve the quality of emergency medical services by have a service perspective and developing new technologies. This research identifies the technological challenges that face healthcare services in terms of the emergency medical healthcare service system (EMSS) to support elderly patients' demands. We conducted a statistical analysis with the secondary data from the World Health Organization (WHO). We then perform systematic reviews to identify the need for aging healthcare technology based on the service system. For a case study, we conducted a questionnaire survey given to healthcare service providers who work in hospitals in Thailand to identify current situation of EMSS and relative available technology for system improvement. Conceptual modeling is developed to represent a framework for EMSS for elderly people on the basic of the value co-creation concept.

II. LITERATURE REVIEWS

A. Aging Society and Technology

Aging society refers to the population of elderly people in society who are 60 year olds and older. Their increase is caused from changes in lifestyle, a shirking birthrate, and the increasing quality of health over the last 20 year. The trends

of aging society will incur economic and social cost through changing services and market demand. Governments and societies should prepare and plan to support the growth of these trends [2-4]. Technologies and communication systems in many countries developed in order to support the daily life of people for faster and easier living. Technology development is driven by many industries and changes the lifestyle of people into one of technology consumers [22-24]. A complementary perspective on the relationship between technology and aging focuses on elderly as active consumers and co-creator of the transformation of technological change and consumption. One piece of research focuses on technology and aging by using a new concept called “innosumer” for the aging market [25].

Healthcare is an industry that tries to use mobile technology and communication systems for elderly people. It supports well-being and life quality through security and confidence. Mobile phones are promising tools for improving the quality of life for the elderly. Mobile functionalities and applications can satisfy their requirements and needs and improve their quality of life [26-32]. These components should be taken into account when defining the current and future roles of mobile applications in an aging society. One piece of research focused on the needs and expectations in using technology for elderly people separated by using the criteria in table 1. For example, the criteria can be used to help elderly adults stick to medication, reminder and exercise plans, and it can even identify and alert professionals to potential health problems.

TABLE 1 EXPECTATION ON TECHNOLOGY FOR ELDERLY [26].

Need and Expectation	Note
Feeling safe and secure	Connected to the usability of the technology
Memory and daily life activity aids	Appointment reminder, alarm, address book, diary, medication reminder, and caller ID complemented
Communication device	Enables contacts with friends and family
Freedom of movement	Involves both self-determination and empowerment
Enjoyment, self-actualization, healthier independent life	Intrinsic motivations. Services that promote their physical and mental well-being

In modern societies, elderly people have access to technology and applications that support their health and social care. Technological applications are necessary in order to learn and share experience on services between providers, elderly and family. Aging healthcare services provide through e-services that essential to life quality and increase available of service on time in any place [33-35]. This can improve the effectiveness of health system by building up technologies and providing the general needs of aging people. Aging people’s need of support varies significantly between individuals and social. The individual preferences of elderly people can differ depending on their ability to live at home through appropriate technology and their environment.

Moreover, technologies can also improve the physical health and independence of seniors. For instance, mobile devices can connect medical professionals with seniors to monitor and review their chronic conditions.

Today, information and communication technology development depends on the ability of the internet and the infrastructure of each country that can support the demands of elderly people to communicate with their needs include family, caregivers, friends, or hospitals. The Internet stands to change and expand the ways in which respite care services for family and caregivers communicate with elder members [36-38]. They can set the essential information on cloud memory that guides people to secure quality care for their seniors, which can be achieved with a simple search on the Internet done in minutes. Moreover, they can plan time with technology when providing healthcare to recipients for taking care, resting, monitoring and communicating. Technology can make efficient use of limited time and provide quality of life for both healthcare providers and recipients.

B. Emergency Medical Service System

An emergency medical service system (EMSS) can be defined as “a comprehensive system which provides the arrangements of personnel, facilities and equipment for the effective, coordinated and timely delivery of health and safety services to victims of sudden illness or injury” [39]. The aim of EMS emphasizes providing timely care to victims of sudden and life-threatening injuries or emergencies in order to prevent needless mortality or long-term morbidity. The function of EMS can be simplified into four main components: accessing emergency care, care in the community, care on transportation routes, and care upon arrival to receiving care at a health care facility [40]. EMSS can provide service that supports the needs of elderly people through integrated information and communication technology. Availability of the EMSS will increase confidence of life in aging societies. Actors in EMSS need to prepare and become active to support all possible cases in 24 hrs basis.

The impact of an aging society on the demand for EMSS must be addressed that prepare for the increased need of pre-hospital emergency training and proper technology that are required for treating a larger number of elderly and presumably sicker patients [41-45]. In aging societies, elderly people need to find information and make decisions about providers of medical and social services to maintain their daily life by considering reasonable selection, cost, and time [46]. As health problems increase, physical and cognitive abilities decline. EMSS can build market mechanisms that increase an individual’s responsibility. It may need to offer some kind of care coordinator who is available and can act in the interest of the elderly person with the appropriate quality providers. Incoming trends of smart homes and pervasive healthcare (ubiquitous), and household devices may have a positive impact on daily lives by reducing the burden of several tasks and enriching social interaction and emergency communication. There is a large variety of assistive devices

such as alarms, sensors, detectors, and life style monitoring devices, which can help in emergencies [47].

In 2012, a report from WHO was published concerning the emergency situations of elderly people who are increasing worldwide and who remain one of the most seriously affected groups [48] Until now, the needs and contributions to these issues were generally overlooked by public organizations in terms of policy and practice. There are specific health and social factors that can separately affect elderly people and have an impact on them during an emergency situation. These include physical health, mental health, functional status and disability, lifestyle habits, nutrition, family and social relations, economic situation, and gender considerations. Awareness of the needs and contributions of elderly people should consider these issues to ensure that these people at risk can be identified before, during, and following an emergency situation. For example, impairments that in normal circumstances do not interfere with daily functioning can quickly become handicaps that overwhelm the person's capacity to cope in an emergency situation. An elderly person with arthritic knees, diminished vision, and poor hearing can rapidly become incapable of getting food or receiving messages to flee from danger. WHO provide aging health promotion approaches for developing countries (figure 1) related to cultural change, structural change (Government), intersectional approaches (Hospital), community-based approaches, family-based approaches, and individual approaches. These approaches are based on technology and actors in EMSS that are related to the living of elderly people through their role in health promotion.

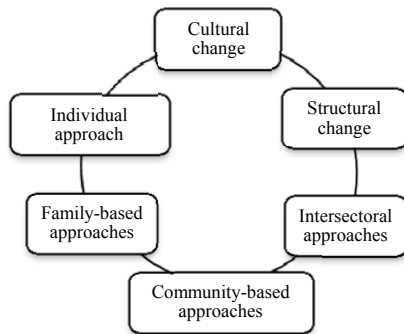


Figure. 1 Health Promotion for Elderly People Approaches [49]

III. RESEARCH METHODOLOGY

A. Research procedures

In this section, we separate research methodology in-to three steps to explore related details of technological challenge for EMSS in aging Asia. Healthcare policy and technology for elderly people needs to be classified by the readiness of countries that should prepare them through socialization and healthcare innovation to support those who need them. We conducted a statistical analysis as a first step by using the secondary data from WHO that focused on the

increase of the aging population and the healthcare system in Asia. The analysis shows the situation of healthcare services in Asia by workforce, infrastructure, and technology in the health system. After that, we used systematic reviews on technological research that focus on elderly people, which can identify the needs of technology aimed for aging people based on EMSS and findings in the statistical analysis. This step separates technological challenge facing EMSS based on income and level of healthcare systems and facilities. In the final step, conceptual modeling is used to represent the framework of actors in EMSS for elderly people on the basic of the value co-creation concept. It is focused on the co-create value from the interaction between provider and receiver through appropriate technology, in order to increase the service quality and well-being of elderly people. For a case study, we conducted a questionnaire survey given to healthcare service providers who work in hospitals in Thailand to identify current situation of EMSS and relative available technology for system improvement. Descriptive statistics were used to explain findings and results from survey. We used worksheets in Microsoft Excel for data analysis.

B. Data collection and measurements

For data collection, we sent questionnaires to the head-nurse of emergency department in hospitals, The questionnaire was divided in-to two parts: hospital and technological application in EMSS. The first part focuses on the hospital characteristics from type, level, and number of beds, number of patients and number of registered nurses in the emergency department. The second part concerns the technical applications for principle monitoring and communication that provide service inside and outside hospital. In this part, the questions focus on technology and applications with patients, sharing healthcare databases between department and hospital, and communication devices for EMSS. For data collection for this survey, we selected 40 hospitals, that is, 25 public hospitals and 15 private hospitals from the city and the countryside area in a developing country. This questionnaire survey is choice to select option or response based on questions. Each question had at least one choices that respondents could choose, and some questions had more than one choice.

IV. RESEARCH RESULT

A. Asia Health System Situation

According to WHO statistics in 2012, elderly people are the fastest-growing age group worldwide. By 2050, there will be two billion people or nearly one out of every four people whose age is over 60 years old [50-51]. This aging population is occurring fastest in less-developed countries, which have consequently had less ability than developed countries to prepare the infrastructure and tools to deal with this major social transition. In 2050, most of elderly people will be living in countries that will have difficult to facing these

challenges. Therefore, WHO aimed at increasing access to medical and assistive devices for elderly people in low- and middle income countries. They need to find out what these countries need and the barriers to the lack of access in order to identify possible solutions. For this reason, the WHO scheme is focused on research, development and production of appropriate devices for low- and middle-income countries that are designed for ageing populations in poor settings.

The Asian health system is a factor in sustaining the well-being of elderly people through physical and mental healthcare. The health system from the WHO perspective, focus on the health workforce, infrastructure, and technology, represents the ability and workload ratio with the number of resources and the population in each country. WHO health statistic reports in 2013 showed that the health systems of Asia have lack of healthcare resource in low-to medium income countries, which are 90% of Asia populations [52]. These groups include countries from Eastern Asia, South Asia, and South-East Asia. Most of them are developing countries that try to improve service quality in healthcare services for their people. The workforce ratio by persons per population of 10,000 during 2005-2012 for physicians, nurses, and pharmacists are 5.5, 9.9, and 4.2 for developing countries and 21.4, 41.4, and 21.5 for developed countries. These ratios affect the workload of the health workforce and service quality of health systems. Therefore, Asian countries should prepare their health systems to face with healthcare service demand from the aging population's growth.

Statistics on healthcare expenditure from WHO are also a factor that relates to life quality of people. WHO collects and measures these statistics on the basis of gross domestic product (GDP) of each country. They measure the statistics from 194 member states to find the status and policy of countries that provide budgets to sustain healthcare system. Healthcare expenditure from their report focuses on the ratio of investment from government and private sectors, which in Asia have an average healthcare expenditure as percentage of GDP in 2010 at 3.6% for developing countries and 12.4% for developed countries. Healthcare expenditure ratios from

governments in Asia are 34.7% and 55.5% for developing countries and developed countries respectively. Both healthcare expenditure statistics showed that the ability of developing countries is lower than that of developed countries. Thus, they need to find appropriate technology to increase the quality of their healthcare service systems on the basic of the limit of capital expense, infrastructure, and workforce.

B. EMSS Technological Challenge

From the result of the health system situation of Asian countries, we can classify Asian countries into three groups by the ability of the healthcare system: there are low ability, medium ability, and high ability. In each group, the level of technology for EMSS is different in that it affects the application, complexity, and cost of technology. Regarding reviews on technology and application for elderly people, table 2 explains ideas about EMSS clustering based on the ability in health system and income of countries. Technological application can be supported by group income from basic requirement, communication, health plans and monitoring, online updates, position tracking, and other. However, the basic requirements of elderly people must be support in order to communicate their needs with providers in EMSS. The technological challenges of these countries related to decision making to use appropriate technology are based on their ability.

For EMSS investment, knowledge about limits and cost of technology should be share between governments, service providers, and service receiver. This will have an effect on the effective of EMSS to provide service to elderly people in all groups and locations. In some countries, elderly people may separate in-to groups on the basic of their ability and technological infrastructure in each area. For example, in big cities and the countryside, they may use different kinds of technology to support daily life and communication in emergency cases. In big cities, they can use internet based devices to support social life and response in EMSS when need any help. In the countryside, they may have a limit on

TABLE 2 EMSS CLUSTERING BASED ON ABILITY IN HEALTH SYSTEM

Groups	Ability of health system	
	Application	Technology
Low income	Support basic emergency requirements with basic technology <ul style="list-style-type: none"> • Contact hospital in emergency case • Family and Caregiver communication 	Public phone Basic phone Mobile phone
Medium income	Multi-purpose support in EMSS without auto active response <ul style="list-style-type: none"> • Health plan, records, and communication with hospital • Self monitoring for basic health conditions • Family and caregiver communication • Position tracking 	Public phone and basic phone Mobile phone and smart phone Tablet and computer Global positioning system (GPS) Internet and wireless technology
High income	Multi-purpose support in EMSS with auto active response <ul style="list-style-type: none"> • Auto update health plan, records and communication with hospital • Auto monitoring for basic health condition (alert, alarm, and request) • Online communication with auto detected sensor • Real-time position tracking 	Mobile technology Robot and Intelligence sensor Smart home system Pervasive healthcare (ubiquitous) Internet based technology

tele-communication and technology that they need for support that relies on basic phones or mobile phones for EMSS. However, after the cost of technology and infrastructure can be supported, they may shift to use advanced devices that can support their need in daily life. From this research, we found that the cost and application of communication devices are key factors for expanding healthcare services for elderly people, to overcome limitations in the technology of countryside areas. EMS can be made available to people through technology and systems that designed to support segments of customers. The design and accessibility of devices are significant criteria that need to be focused on order to make the devices easy to learn and use. Moreover, privacy and security technology are interesting issues to think about when developing medical devices that are for personal use for personal information stored on technological based devices.

C. EMSS model based on value co-creation concept

EMSS as healthcare service that needs rethinking of its concept from pro-active to active service for maintaining the growth of aging populations. From the current situation of the emergency healthcare services in developing countries that provide service to incoming patients from covered regions without technological support system. Governments of these countries should develop policy and trained workforces to use appropriate technology for communication and service activities. In figure 2, this research presents an EMSS model based on the value co-creation concept by using technology to support the service system. We focused on the value that increases service quality and the well-being of elders through information and knowledge sharing in EMSS. In the EMSS

model, service receivers includes elder people, family, and caregivers are active customers that need to share information about health condition of patients and response service activities together with service providers. This model separates service providers into healthcare service providers (hospital and EMS agent) and system service providers (mobile company and technical support agent). Service providers are essential for designing system and technical support with health records that makes the records available on EMSS. Tele-communication infrastructure is a technology that is related in value co-creation between actors in a system through communication, suggestions, monitoring, reminders and alerts, health plans and record, and tele-healthcare.

This model was developed to support elderly requirements that may concern health reminders, alerts, monitoring, and emergency requests. It used communication device as medical service device by make on time contact during provider and patient. It operated like the information sharing concept in supply-chain management in which actors in a system co-create value together to support their need and efficiency. Table 3 shows details on the roles in an EMSS from a service viewpoint with which we expect to find actors co-create value in a practical EMSS. Participation of actors will increase healthcare service quality through the mobility and accessibility of customers. Regarding the WHO policy on active aging, elderly people in EMSS model as active patients who are ready to co-create value that have an effect to their well-being in modern society with health and mental confidence. Consequently, Asian countries should determine healthcare service innovations that are provided to their people through technological investment based on ability and infrastructure.

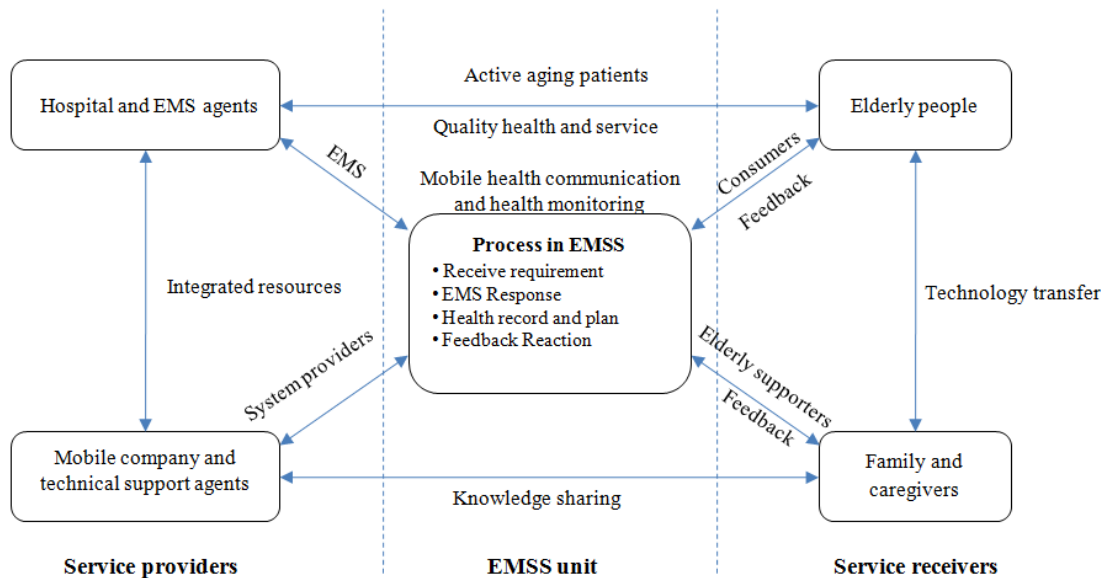


Figure 2 Emergency Medical Service System (EMSS) Model

TABLE 3 ROLES IN EMSS FROM SERVICE VIEWPOINT

Actors	Requirements	Roles of Technology	Co-created Value
Service Receiver <ul style="list-style-type: none"> • Elderly • Family and Caregivers 	<ul style="list-style-type: none"> • Emergency request • Health monitoring • Health reminder and alerts 	<ul style="list-style-type: none"> • Update health status • Report errors to system • Communicate to provider 	<ul style="list-style-type: none"> • Well-being • Life confidence • Self-monitoring
Service Provider <ul style="list-style-type: none"> • Hospital and EMS agent • Mobile company • Technical support center 	<ul style="list-style-type: none"> • Health record • Health plan • Tele-health 	<ul style="list-style-type: none"> • Health database management • Activities suggestion • Interface with patient 	<ul style="list-style-type: none"> • Service quality • Effective healthcare • Service accessibility

D. EMSS Situation and Technological Challenges in Thailand

In this part, we describe the result from the survey on the EMSS in Thailand that focused on medium- to large sized of hospitals, the data of which was collected from the head nurse of emergency room. We observed the current technology in the EMSS that is used to support principle healthcare monitoring and communication activities for inside and outside hospital. We got 30 responses (75%) from 19 public hospitals (76%) and 11 private hospitals (73.3%). The questionnaire was separated in two part: hospital and technological application. In the first part, the hospitals were for primary care (20%), secondary care (13%) and tertiary care (67%). From the survey results, 80% of hospitals had a number of beds higher than 150 and had a number of registered nurse higher than 10 nurses. The number of patients was more than 200 per day (70%), and the number of patients in emergency department was more than 50 patients per day (70%). The second part is related to the technological application in the EMSS that included these monitoring activities: blood pressure, heart rate, temperature, classify type of patient, input and review health record. Most of them used mobile medical devices to support their activities in emergency cases with all patients, but those devices did not link the results to the system (80%). Health records were paper based and not shared with other hospitals (93%). In emergency cases inside hospitals, they used emergency devices (63%) and phone (100%), outside the hospital, used phone and mobile radios.

Mobile applications for smart phones in 2013 are available on Google Play (Android) and the App-store (iOS). Although they had many applications to support EMSS, they also were not used in general practices. They can be used for monitoring, position tracking, sugar in the blood, heart rate, health alert, health plan, and other purpose in medical services. These technologies can support in the EMSS, but it effectively affects from skill and experience of users with the health applications. In Thailand, we did not find available service providers or hospitals that linked their EMSS through real-time healthcare services. For this point, the government and private sector should focus on active aging in order to develop healthcare service with smart phone applications and mobile medical devices based on the infrastructure and limitation of technology. Additionally, technical support and skilled workforce in EMSS are the main factors that need to be set up for aging populations. From the service viewpoint and feasible technologies in Thailand, creating Internet based

devices is a challenge to overcome in order to provide applications in healthcare services for the elderly people. Regarding the growth of the smart phone market, providers can provide various applications from basic monitoring to online EMSS with hospitals. Mobile medical devices may be available and easy to use for the elderly and their family through smart phones and personal medical devices. Finally, Electronic health record is important information that need to attached with these devices or available in online database to improve service quality.

V. CONCLUSION

In 2050, most elderly people will be living in less-developed and developing countries in Asia, which have healthcare system that will face difficulties and challenges to providing appropriate care. Healthcare service systems of many countries in Asia are faced with the problem of a lack of workforce and quality of service to support the growth in a number of aging people. Although, this problem is caused from an unbalanced workload and the income of the workforce healthcare service, the healthcare industry and government in Asia need to provide an emergency medical service system (EMSS) to support elderly people that need health support in any case. Thus, the World Health Organization (WHO) guides many countries that are of low- and middle-income to help them increase access to medical and assistive devices for elderly people. They try to offer the advantage of technology that can support and provide healthcare services on time to elderly people through communication and technology. Technological challenges that face an EMSS set up for elder people are the need to make decisions for investment on the basic of infrastructure, the economic and the ability of the healthcare system. Applications on internet based devices are technologies that are valuable for designing and developing functions for aging service expansion. This makes service accessible available to people in coverage areas through smart phones and mobile medical devices. The EMSS clustering result will guide investors and related actors in the system to focus on communication channels between elderly people and their providers, which includes family, caregivers, hospitals, and EMS agent depending on the ability. Doing so will support the growth in number of aging people and help them to live with confidence through the appropriate technology.

ACKNOWLEDGEMENT

We would like to thank Sirindhorn International Institute of Technology (SIIT) and Japan Advanced Institute of Science and Technology (JAIST), who provided the SIIT-JAIST scholarship to the first author in the Ph.D. program. Moreover, we thank all respondents from hospitals in Thailand who were kind enough to participate in the questionnaire.

REFERENCES

- [1] Peterson, P. G., Gray dawn: How the coming age wave will transform America and the world. New York: Times Books, pp.3, 1999
- [2] Niehaves, B., "Iceberg ahead: On electronic government research and societal aging" *Government Information Quarterly*, vol. 28, pp. 310–319, 2011
- [3] Stockdale, A., MacLeod, M., "Pre-retirement age migration to remote rural areas" *Journal of Rural Studies*, Vol. 32, pp. 80-92, 2013
- [4] Wright, S.D., Lund, D.A., "GRAY AND GREEN?: Stewardship and Sustainability in an Aging Society" *Journal of Aging Studies*, Vol. 14, pp. 229-249, 2000
- [5] Richards, N., Warren, L., Gott, M., "The challenge of creating 'alternative' images of ageing: Lessons from a project with older women" *Journal of Aging Studies*, Vol. 26, pp. 65-78, 2012
- [6] Obi, T., Ishmatova, D., Iwasaki, N., "Promoting ICT innovations for the ageing population in Japan" *International journal of medical informatics*, Vol. 82, pp.47–62, 2013
- [7] Wu, J.H., Wang, S.C., Lin, L.M., "Mobile computing acceptance factors in the healthcare industry: A structural equation model" *International journal of medical informatics*, Vol. 76, pp. 66–77, 2007
- [8] Davis, S. Crothers, N., Grant, J., Yong, S., Smith, K., "Being involved in the country: Productive ageing in different types of rural communities" *Journal of Rural Studies*, Vol. 28, pp. 338-346, 2012
- [9] Wiredu, G.O., "User appropriation of mobile technologies: Motives, conditions and design properties" *Information and Organization*, Vol. 17, pp.110-129, 2007
- [10] Patrick, K., Griswold, W.G., Raab, F., Intille, S.S., "Health and the Mobile Phone" *American Journal of Preventive Medicine*, Vol. 35, No. 2, pp.177-181, 2008
- [11] Moor, N., Graaf, P.M., Komter, A., "Family, welfare state generosity and the vulnerability of older adults: A cross-national study" *Journal of Aging Studies*, Vol. 27, pp. 347-357, 2013
- [12] Mercado, R., Paez, A., Newbold, K.B., "Transport policy and the provision of mobility options in an aging society: a case study of Ontario, Canada" *Journal of Aging Studies*, Vol. 18, pp. 649-661, 2010
- [13] Peckham, M., "Developing the National Health Service: a model for public services" *The Lancet*, Vol. 354, pp. 1539–1545, 1999
- [14] Taboada, M. Cabrera, E., Iglesias, M.L., Epelde, F., Luque, E. "An Agent-Based Decision Support System for Hospitals Emergency Departments" *Procedia Computer Science*, Vol. 4, pp. 1870–1879, 2010
- [15] Lee, H.J., Lee, S.H., Ha, K., Jang, H.C., Chung, W., Kim, J.Y., Chang, Y., Yoo, D.H., "Ubiquitous healthcare service using Zigbee and mobile phone for elderly patients" *International journal of medical informatics*, Vol. 78, pp. 193–198, 2009
- [16] Pantelopoulous, A., Bourbakis, N.G., "A Survey on Wearable Sensor-Based Systems for Health Monitoring and Prognosis" *IEEE Transaction on Systems, Man, and Cybernetics*, Vol. 40. No. 1, pp. 1-12, 2010
- [17] Jung, E., Eun, S., Jeong, B., Park, D.K., "A Study on the Realization of Mobile Homecare Nursing Service Based on Effective Security" *International Journal of Smart Home*, Vol.7, No.5 (2013), pp.225-238, 2013
- [18] Djellal, F., Gallouj, F., "Mapping innovation dynamics in hospitals" *Research Policy*, vol. 34, pp. 817–835, 2005
- [19] Lu, Y.C., Xion, Y., Sears, A., Jacko, J.A., "A review and a framework of handheld computer adoption in healthcare" *International Journal of Medical Informatic*, Vol. 74, pp. 409-422, 2005
- [20] Vargo, S.L., Lusch, R.F., "Evolving to a new dominant logic for marketing" *Journal of Marketing*, Vol. 68, pp. 1–17, 2004
- [21] Vargo, S.L., Lusch, R.F., "Service-dominant logic: continuing the evolution" *Journal of Academy of Marketing Science*, Vol. 36, pp. 1–10, 2008
- [22] Harry W. Tyrer, H.W., Alwan, M., Demiris, G., He, Z., Keller, J., Skubic, M., Rantz, M., "Technology for Successful Aging" *Proceedings of the 28th IEEE EMBS Annual International Conference*, New York City, USA, Aug 30-Sept 3, pp.3291-3293, 2006
- [23] Selwyn, N., "The information aged: A qualitative study of older adults' use of information and communications technology" *Journal of Aging Studies*, Vol. 18, pp. 369–384, 2004
- [24] Li, S., Schellenbach, M., Lindenberger, U., "Assistive Technology for Successful Aging: Perspectives from Developmental Behavioral and Neuroscience" *Dagstuhl Seminar Proceedings*, Assisted Living Systems - Models, Architectures and Engineering Approaches, 2008, <http://drops.dagstuhl.de/opus/volltexte/2008/1468>
- [25] Peine, A., Rollwagen, I., Neven, L., "The rise of the "innosumer"-Rethinking elder technology users" *Technological Forecasting & Social Change*, Vol. x(x), pp. xxx-xxx, 2013(Inpress), <http://dx.doi.org/10.1016/j.techfore.2013.06.013>
- [26] Plaza, I. Martin, L., Martin, S., Medrano, S., "Mobile applications in an aging society: Status and trends" *The Journal of Systems and Software*, Vol. 84, pp. 1977–1988, 2011
- [27] Mendonça, E.A., Chen, E.S., Stetson, P.D., McKnight, L.M., Lei, J., Cimino, J.J., "Approach to mobile information and communication for health care" *International Journal of Medical Informatics*, vol. 73, pp. 631-638, 2004
- [28] Liu, C., Zhu, Q., Holroyd, K.A., Seng, E.K., "Status and trends of mobile-health applications for iOS devices: A developer's perspective" *The Journal of Systems and Software*, Vol. 84, pp. 2022–2033, 2011
- [29] Ngai, E.W.T., Gunasekaran, A. "A review for mobile commerce research and applications" *Decision Support Systems*, Vol. 43, pp. 3-15, 2007
- [30] Junglas, I., Abraham, C., Ives, S. "Mobile technology at the frontlines of patient care: Understanding fit and human drives in utilization decisions and performance" *Decision Support Systems*, Vol. 46, pp. 634-647, 2009
- [31] Chatterjee, S., Chakraborty, S., Sarker, S.a, Sarker, S.b, Lau, F.Y., "Examining the success factors for mobile work in healthcare: A deductive study" *Decision Support Systems*, Vol. 46, pp. 620-633, 2009
- [32] Standing, S., Standing, C., "Mobile technology and healthcare: the adoption issues and systemic problems" *Int. J. Electronic Healthcare*, Vol. 4, No. 3, pp.221-235, 2008
- [33] Sintonen, S., Immonen, M., "Telecare services for aging people: Assessment of critical factors influencing the adoption intention" *Computers in Human Behavior*, Vol 29, pp. 1307–1317, 2013
- [34] Petrovic, K., "Respite and the Internet: Accessing care for elder adults in the 21st Century" *Computers in Human Behavior*, Vol. 29, pp. 2448–2452, 2013
- [35] Kishimoto, Y., Terada, S., Tateda, N., Oshima, E., Honda, H., Yoshida, H., Yokota, O., Uchitomi, O., "Abuse of people with cognitive impairment by family caregivers in Japan(across-sectional study)" *Psychiatry Research*, Vol. 209, pp. 699–704, 2013
- [36] Maass, W., Varshney, U., "Design and evaluation of Ubiquitous Information Systems and use in healthcare" *Decision Support Systems*, Vol. 54, pp. 597-609, 2012
- [37] Chan, A.T.S. "WWW_smart card: towards a mobile health care management system" *International Journal of Medical Informatic*, Vol. 57. pp. 127–137, 2000
- [38] Halteren, A.V., Bults, R., Wac, K., Konstantas, D., Widya, I., Dokovsky, N., Koprnikov, G., Jones, V., Herzog, R., "Mobile Patient Monitoring: The MobiHealth System" *The Journal on Information Technology in Healthcare*, Vol. 2. No. 5, pp. 365–373, 2004
- [39] Moore, L., "Measuring quality and effectiveness of prehospital

2014 Proceedings of PICMET '14: Infrastructure and Service Integration.

- EMS” *Prehospital Emergency Care*, Vol. 3, No. 4, pp. 325-331, 1999
- [40] Razzak J.A., Kellermann A.L., “Emergency medical care in developing countries: is it worthwhile?” *Bulletin of the World Health Organization*, Vol. 80, No.11, pp. 900-905, 2002
- [41] McConnell, M.C., Wilson R.W., “The Demand for Prehospital Service in an Aging Society” *Social Science & Medicine*, Vol. 46, pp. 1027-1031, 1998
- [42] Shah, M.N., “The Formation of the Emergency Medical Services System” *American Journal of Public Health*, Vol 96, No. 3, pp.414-423, 2006
- [43] Wright, A., Sittig, D.F., “A framework and model for evaluating clinical decision support architectures” *Journal of Biomedical Informatics*, Vol. 41, pp.982-990, 2008
- [44] Lee, W.B., Wang, Y., Wang, W.M., Cheung, C.F., “An unstructured information management system (UIMS) for emergency management” *Expert Systems with Applications*, Vol. 39, pp.12743–12758, 2012
- [45] Sheehan, B., Nigrovic, L.E., Dayan, P.S., Kuppermann, N., Ballard, D.W., Alessandrini, E., Bajaj, L., Goldberg, H., Hoffman, J., Offerman, S.R., Mark, D.G., Swietlik, M., Tham, M, Tzimenatos, L., Vinson, D.R., Jones, G.S., Bakken, S. “Informing the design of clinical decision support services for evaluation of children with minor blunt head trauma in the emergency department: A sociotechnical analysis” *Journal of Biomedical Informatics*, Vol. 46, pp.905–913, 2013
- [46] Meinow, B., Parker, M.G., Thorslun, M., ”Consumers of eldercare in Sweden: The semblance of choice” *Social Science & Medicine*, Vol. 73, pp. 1285-1289, 2011
- [47] Mckee, K., Matlabi, H., Parker, S.G. “Elder People’s Quality of Life and Role of Home-Based Technology, *Health Promotion Perspectives*, Vol. 2, No. 1, pp.01-08, 2012
- [48] Ageing and Life Course: Elder persons in emergencies, <http://www.who.int/ageing/projects/emergencies/en/index.html>
- [49] Aging and Health: A health promotion approach for Developing Countries, World Health Organization Philippine, pp. 41-55,
- [50] Connecting and caring: innovations for healthy ageing, <http://www.who.int/bulletin/volumes/90/3/12-020312/en/index.html>
- [51] The health-care challenges posed by population ageing, <http://www.who.int/bulletin/volumes/90/2/12-020212/en/index.html>
- [52] World Health Statistics 2013, pp. 120-142, World Health Organization, Italy, 2013