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# Transformative Service Model by using Wearable Device for Aging Society in Thailand

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Japan Advanced Institute of Science and Technology

Doctoral Dissertation

# Transformative Service Model by using Wearable Device for Aging Society in Thailand

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# Abstract

Wearable Technology is equipped with sensor technology, and GPS can directly use to collect health data and enhances one's location specification. The wearable device has been deemed a tool that could improve the well-being of seniors. Due to the current situation and future trends, the rapid development of wearable technology and the internet of things (IoT) cannot be overlooked because the personal data from wearable technology are considered sharable Big Data. Many services could exploit the technology and network for better stakeholder well-being in the aging society. According to Service Dominate Logic, the service using the wearable device creates value in society and the ecosystem. The use of wearable technology has been forecasted to grow continuously. In the case of Thailand, it is expecting an aged society by 2025. The studies on wearable technology adoption for the elderly and its contribution to senior healthcare services are very limited.

The main objective of this research is to propose a service model for using wearable devices in aging society. The research is divided into two main parts. The first part aims to understand the expectation of multiple stakeholders. To propose the senior healthcare service system is the main objective. This study determined the key factor for adopting wearable technology devices from knowledge and experience sharing, which empowers to know that stakeholder's voice and expertise is valued. The second part gathers the understanding and attitude towards the propensity to use wearable technology with awareness in aging society. The hypothesis of this study was constructed from a technology readiness and elaboration likelihood model with functions and features of wearable technology devices. The study was conducted through a quantitative survey given to the seniors, family members and caregivers. The results of this research identified the effect of positive and negative attitudes on awareness of wearable technology devices.

By integrating the findings of two studies, this dissertation proposes a healthcare services model using wearable devices. The model consists of the positive attitudes toward understanding wearable technologies, the significant effect on expectations for creating positive experiences, trust in wearable devices, and self-confidence in the maintenance of own health. Although, the positive attitude motivate stakeholder to propose the expected value co-creation capability among society. Then, value co-creation can improve the senior healthcare service system and stakeholder well-being.

In summary, the framework of the drive cycle model for wearable technologies in senior healthcare service systems can be served as a guideline for both academic research and practical applications. It helps to construct a Senior Health service with concern for the well-being of the human in an aging society and co-creation value through stakeholders' utilization of wearable technology. The process, key considerations, and Senior healthcare service system were summarized as crucial contributions to this study. Moreover, the importance of understanding the expectation and attitudes of multiple stakeholders is a significant part of the success of wearable technology adoption in an aging society.

**Keywords:** transformative service model, wearable technology devices, senior healthcare service system, value co-creation, well-being

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# Terminology

**Wearable Technology Devices**
Any kind of electronic device designed to be worn on the user's body. Such devices can take many different forms, including jewelry, accessories, medical devices, and clothing or elements of clothing.

**Smartwatch**
The wearable is worn on the body in a standard fixed location for continuously touching the wearer’s skin and thus can monitor physical signals.

**Tracker**
The wearable is consisted of a GPS module, a vibration sensor, a GSM (Global System for Mobile) module, and a voice recorder module.

**Smartglasses**
The wearable is displayed computer-generated information about the wearer’s visual field. Besides providing optical output, smart glasses can be fitted with acoustic sensors to provide acoustic work.

**Technology Adoption**
The process of accepting, integrating, and using new technology in society.

**Elderly**
The elderly are people who are old

**Aging Society**
The Age of entry into the elderly. The proportion over 60.

**Aged Society**
The proportion over 60 years old.

**A super-age society**
The proportion over 65 years old.

**Well-Being**
The state of being happy, healthy, or prosperous.

**Attitude of Propensity**
An attitude of mind especially one that favors one alternative over others.

**Awareness in Aging Society**
All those experiences that make a person aware that his or her behavior, level of performance, or ways of experiencing his or her life have changed as a consequence of having grown older

**Stakeholder Expectation**
Process is the initial process within the SE engine that establishes the foundation from which the system is designed, and the product is realized.

**Grounded Theory**
A systematic methodology that has been largely applied to qualitative research conducted by social scientists.

**Coding**

The pivotal link between collecting data and developing an emergent theory to explain these data.

**CSFs**
Critical Success Factors

**Seniors**
a person older

**Formal Caregivers**
Who are paid to give care, for example, a nurse.

**Informal Caregivers**
Who are not paid to provide care, for example, a son.

**Health Preservation Functions**
Functions to record of health condition, the monitoring of health conditions, and the sending of emergency alerts.

**Location Functions**
Function for real-time location tracking using GPS.

**Daily Tasks Function**
Function for reminding the wearer of scheduled activities and send alerts at appropriate times.

**Design Feature**
"Look and feel", layout, design, navigation, feature set, functionality and overall structure, sequence and organization, except that Design Features shall not include WebMD Marks.

**Attitude of propensity to use technology**
The concept of technology readiness was used to measure people's inclination to adopt new technology.

**Structural equation modelling (SEM)**
A multivariate statistical analysis technique that is used to analyze structural relationships.

**Positive Attitudes to Understand Wearable Technologies**
Positive attitudes to understand wearable technologies is the offered functions of the wearable devices that may lead to positive outcomes for the user and his or her family members.

**Expectations for creating positive experiences**
Expectations for creating expectations for creating positive experiences are an essential requirement by using wearable technologies.

**Trust on wearable devices**
To believe on wearable technologies such as the accuracy of information from wearable technologies that can use to treatment.

**Self-confidence on maintenance of own health**
The offered functions of the wearable devices that may lead to positive outcomes related to the health of the user.

**CMIN/DF**
The minimum discrepancy divided by its degrees of freedom used to identify the acceptable fit between the hypothetical model and the sample data.

**GFI**
The goodness of fit index which determine the sample size effects, the adjusted goodness of fit index.

**AGFI**
The adjusted goodness of fit index used to compare the fit of a target model to the fit of an independent.

**CFI**
The comparative fit index, used to determine the non-normal distribution.

**RMSEA**
The root-mean-squared error of approximation that yields the effect of model complexity by the number of degrees of freedom for testing the model.

**Transformative Service Model**
Model of relationship with service provider, and consumers.

**Senior Healthcare Service System**
The process applied to hospitalized patients older than 65 years at the discharge and care transition stages.

**Value Co-Creation**
The joint creation of value by the company and the customers, allowing the customers to co-construct the service experience to suit their context

# Chapter 1
# Introduction

## 1.1 Research Background

This is an increasing trend of the aging population around the world. In 2015, there were 600 million elderly people in the world. However, in 2030 and 2050, the number of seniors is predicted to be 1 and 1.5 billion, respectively. Separated into continents, Asia has the highest ratio of 61% of the aging world population. In 2015, Thailand ranked third on the list of Asian countries with the highest number of aging populations. The nation contains about 10% of the senior people in the total population (United Nations, 2015). The figure is expected to rise to 19% in 2030. Due to the increase of old citizens, the healthcare service trend keeps climbing. The quality of life and well-being of the seniors are being considered.

Technology has been developed to support and satisfy the aging society's perspective. Especially technologies that should be concerned in aging society is the Internet of Things (IoT) with Big Data analysis. This thing can be used to share and record personal data. All recorded data can be shared and exchanged with other people and devices.

Improvement of technology is necessary to assist the caregiver in looking after the elderly (Kelly, 2016). One of the technologies that we have to pay attention to is wearable devices.

The device can benefit general customers and be developed for a specific group of people. Wearable Technology with sensor technology that can directly collect health data and GPS enhances one's location specification. The wearable device has been deemed a tool to enhance seniors' well-being. For example, the device can detect the event that we would like to track, such as the falling of a senior (Vilcahuamán & Rivas, 2017) and monitor personal data at all times (Park & Jayaraman, 2003). For the elderly and caregivers, the wearable device can help drive earlier intervention, create more proactive healthcare treatment and bring valued peace of mind to the users (Prinable et al., 2017). Nevertheless, not all seniors feel comfortable using such technology. It is either because they do not trust it or do not understand how to use it.

The wearable device focused on this paper include 1) Smartwatch, 2) Tracker, and 3) Smart glasses. Smartwatches, which have been described as networked computers with an array of sensors (Wang et al., 2017), touch the wearer's skin continuously and thus can monitor physical signals. Moreover, they are worn on the body in a standard fixed location. Trackers consist of a GPS module, a vibration sensor, a GSM (Global System for Mobile) module, and a voice recorder module. The GPS module detects the wearer's location, and the vibration that occurs when the wearer falls is detected by the vibration sensor (Fauziah et al., 2019). Smart glasses display computer-generated information about the wearer's visual field. Besides providing optical output, smart glasses can be fitted with acoustic sensors to provide acoustic work. A hands-free mobile telephony application and a voice-controlled interface are used for inputting commands and information (Levin et al., 2016). The technologies used in these wearable devices are continuously being improved in terms of quality, accuracy, and functionality, making such devices more and more well-suited for aging societies.

Healthcare and senior care services can be applied with the wearable technology and network for better stakeholder well-being in the aging society. According to Service Dominate Logic, the service by using the wearable device can create value into society and ecosystem.

Regarding the research background, wearable technology adoption in senior healthcare is essential to improve and prepare service for stakeholder in an aging society. Based on the problems of lack on workforce and technology in Thailand to support senior healthcare knowledge management for All stakeholders in aging society, there is need to identify and develop service model by using wearable technology devices to enhance the quality to provided care service towards the well-being of stakeholder in Thailand.

## 1.2 Research Objectives and Research Questions

Wearable technology adoption in aging society research is mainly considered on the expectation of seniors, which is a focus on the technology readiness and influencing factor of wearable technology. This research integrated the attitude toward propensity to use technology with influencing factors for wearable technology devices to transform the service model by using wearable devices to improve the well-being of stakeholders in aging society.

This study aims to integrate the transformative service model from stakeholder insight by transforming the stakeholder expectation and attitudes. The research objective is separated into two parts based on the research problem represented in figure 1.1.

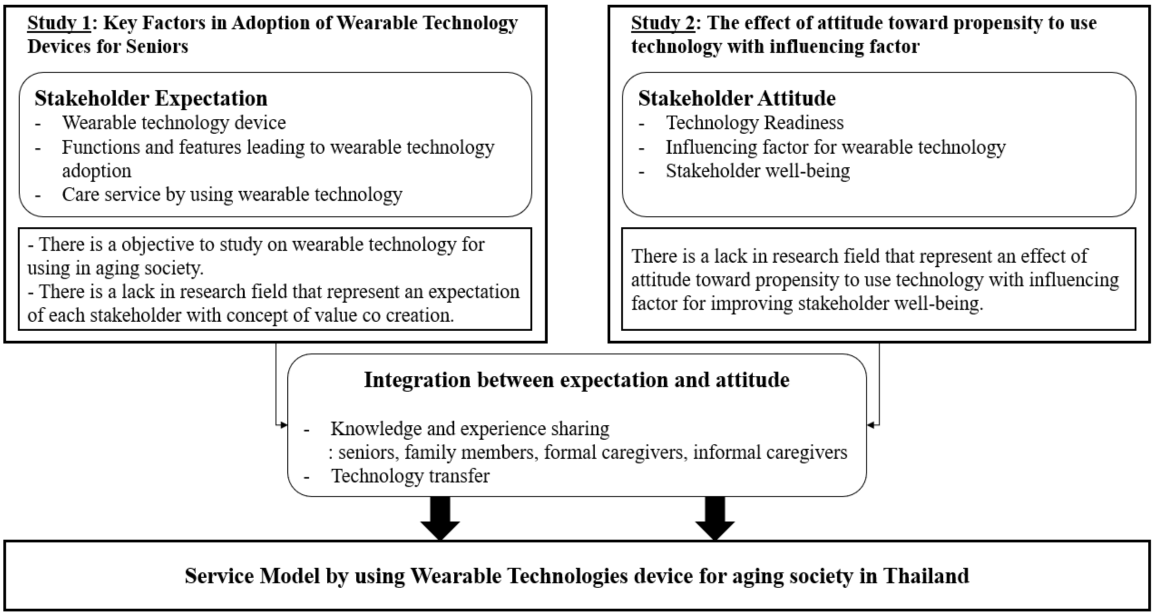



**Figure 1.1** Research problem and related studies

The first objective aims to identify the critical success factors (CSFs) in adoption of the device that are related to improving the well-being of senior, family members and caregiver that learns from interviewing by sharing knowledge and experience among stakeholders.

The second objective aims to identify the effect of attitude toward propensity to use technology with awareness for improving stakeholder well-being.

Research questions in this research can be explained as follow;

**Major Research Question (MRQ):**

How to integrate the expectation and attitudes of wearable technologies to propose the Senior healthcare service system using wearable technologies?

**Subsidiary Research Questions (SRQ):**

1. What are the critical success factors (CSFs) in adopting the device related to improving the well-being of multiple stakeholders?
2. What are the effects of attitude toward propensity to use technology with awareness for improving stakeholder well-being?
3. What are the potential effects on co-create values of stakeholders in the senior healthcare service system by using wearable devices?

## 1.3 Structure of the Study

This research can be divided into two main stages to propose the care service model by using wearable technology devices in an aging society, as demonstrated in Fig. 1.2. In order to construct a new service model. The first stage aims to study the service model component, which identifies the service provider, technology service, and service receiver. Then, the expectation of wearable technology devices is studied to present the functions and features of wearable technologies which satisfy to stakeholder perspective. To understand stakeholder insight, not only can stakeholder expectation conclude the requirement that leads to success for wearable technology, but stakeholder attitude also identifies the propensity to use technology. That reason motivated me to study in the second stage to mention the effect of attitude toward propensity to use technology with awareness of wearable technology devices. After that, the integration between stakeholder expectation and attitude is created service model by using wearable technology devices for aging society in Thailand.

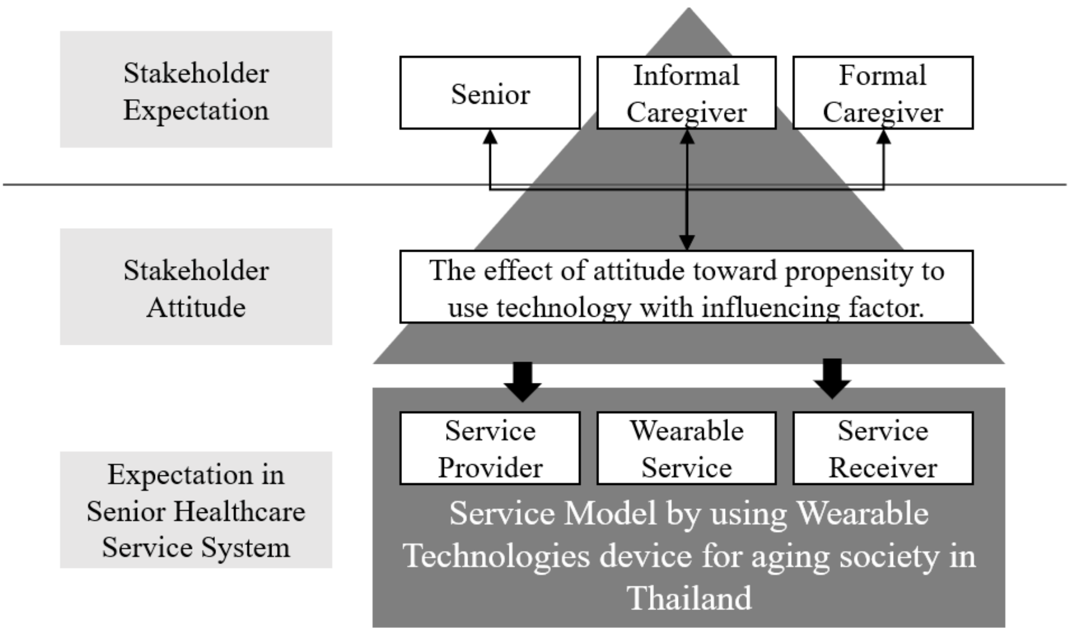



**Figure 1.2** Research structure

## 1.4 Structure of dissertation

This dissertation is structured in six chapters, including an introduction, literature reviews, research methodology, the expectation of multiple stakeholders in Thailand's aging society, a service model for using wearable technology devices in aging society in Thailand, and a conclusion. The detailed information of each chapter is demonstrated as follows.

Chapter 2 Literature review – This part consists of five topics to create a service model by using wearable technology devices for aging society in Thailand. The first topic is an overview of the aging society. This topic covers all situations of global, Asian and Thailand aging society. The essential purpose of this part is to mention the increasing trend of seniors that affects human well-being. According to that problem, society requires innovation. So, the second part focuses on that topic, including wearable technology and service innovation. The next issue is stakeholder expectation. For understanding the expectation of multiple stakeholders, knowledge management by knowledge and experience sharing is the solution for review.

Chapter 3 Research Methodology – This part is related to research methods used in each study based on structured and research objectives.

Chapter 4 Expectations of Multiple Stakeholders in Thailand Aging Society – The part separates into two sub-study for creating the service model using wearable technology devices for aging society in Thailand. The first study, "The critical success factors (CSFs) in Adoption of Wearable Technology Devices", aims to present the multiple stakeholders' expectations of using wearable technology devices. The second study, "The Effect of Attitude of Propensity to Use Technology on awareness for Wearable Technology devices in Aging Society, " aims to suggest the positive and negative attitudes that affect the functions and features of wearable technology devices.

Chapter 5 Service Model by using Wearable Technology devices for aging society in Thailand – The service model by using wearable technology devices for aging society in Thailand presents this part by integrating the result of the sub-study in Chapter 4. The service models include "Drive Cycle Model for Wearable Technologies in Senior Healthcare Service System", "Senior healthcare service system", and "Expectation in Senior Healthcare Service System by

Using Wearable Technologies" for each stakeholder (senior healthcare, senior, and family member).

Chapter 6 Conclusion – includes answers to research questions, academic implications, and practical implications. The chapter explains the findings and solutions of this study.

# Chapter 2
# Literature reviews

## 2.1 Overview of Aging Society

Regarding the infographic as fig. 2.1, we could see an increasing trend in aging population around the world. As of 2015, there were 600 million people; in 2030, the number of seniors will rise to 1 billion, and by 2050 the number will reach 1.5 billion people! Separated into the Continent sector, Asia is the highest ratio as 61% of the world's aging population (United Nations, 2015).

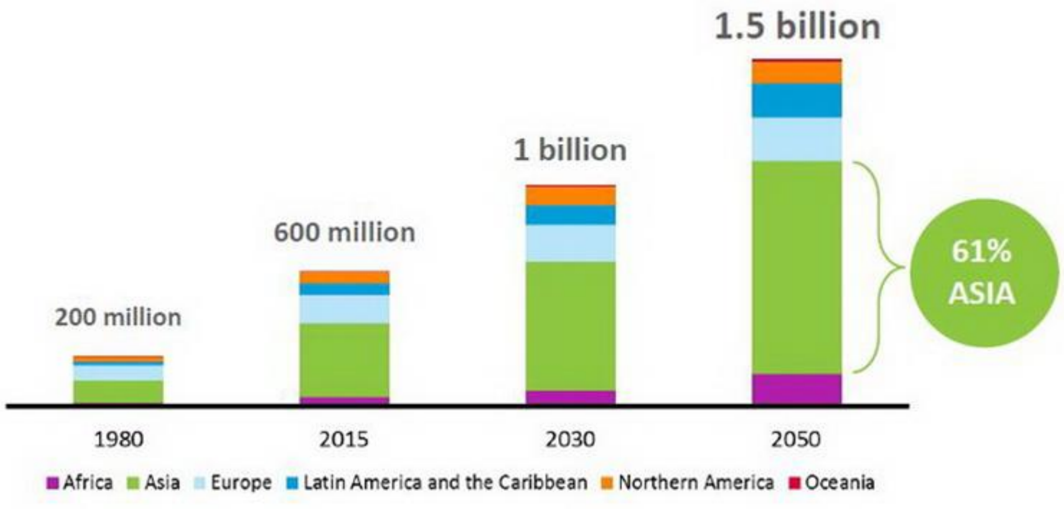



**Figure 2.1** World Population aged 65 years old and up

(United Nation Department of Economic and Social Affairs; Word Population Prospects, the 2015 Revision)

Talking about the country level in fig 2.2, the Top of three countries with seniors over 65 years old with the total population of 120 billion people is the highest in Japan. The proportion of consumers elderly over 65 years old in 2015 is 26% and foresee the number of elderly will increase to 30% in 2030. The second ranking in Singapore. The proportion was 12% in 2015 and expects to grow by 23% in 2030. Lastly, Thailand is the third in Asia, with 10% in 2015, and intends to increase by 19% in 2030 (United Nations, 2015).

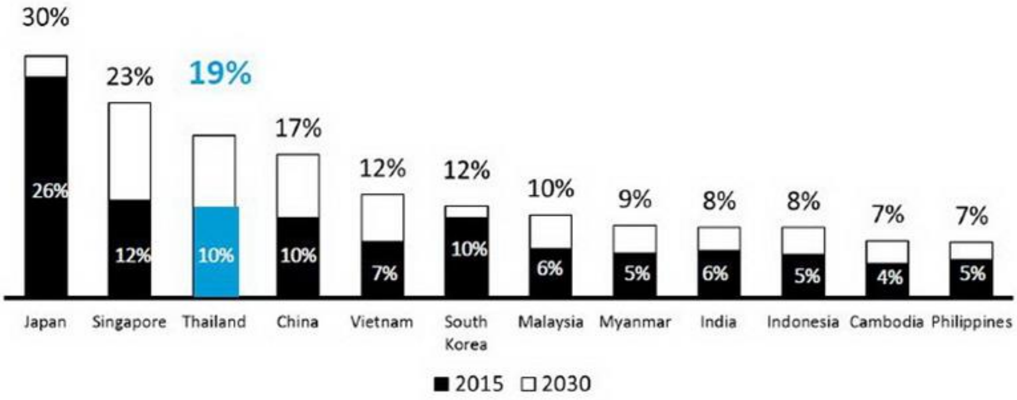



**Figure 2.2** Population aged 65 years old and up to Total Population (%)

(United Nation Department of Economic and Social Affairs; Word Population Prospects, the 2015 Revision)

Most developed countries are defined as an elderly or older person or senior in aging society who is 65 years old and older. However, that concept does not use in other countries' situations. According to the UN agreed cutoff is 60 years old and older to refer to the older population. The definition of senior in Thailand is also defined as a population of older people or seniors in society who are 60 years old and older.

Starting from the knowledge of the Elderly Society to match understanding. The United Nations divides the elderly into three categories:

1. Aging Society. The Age of entry into the elderly. The proportion over 60 is more than 10% of the population or over 65 years old more than 7%.
2. Aged Society with the elderly ultimately. The proportion over 60 years old, over 20% or over 65 years old and more than 14%
3. A super-age society is full of elderly. The proportion over 65 years old, more than 20%

Thailand is just the 1st level, in the early stages of entering the elderly society. But do not be discouraged because, in a few years, Thailand will enter the second level rapidly. As per a slower marriage. It will affect infertility, or maybe not.

According to the National Statistical Office, as shown in Fig. 2.3, 95% of the elderly are aged 60-69. They're still healthy and enable to take care of themselves. But at 70-79, the self-care ability decreases by only 88%. Then, at over 80 years old, only 69% can care for themselves. That shows a key factor that marketers need to concern more about, mentioning the main character of the consumer demand. It is different from other groups, so the production of any goods and services must understand the concerns of the elderly and the physical assistance for the elderly. If the manufacturer and service support consumers by focusing on the mention issues through their products and services, it indeed brings a high growth potential (*National Statistical Office of Thailand*, 2015).


**Figure 2.3** Self-Sufficiency in Old Age among Thai population (%)
(*National Statistical Office of Thailand*, 2015)

The view from the government. The Ministry of Commerce is also concerned about this trend. It has implemented projects such as 60 + Project to support and let entrepreneurs realize the changes that will occur. The weakness of Thai entrepreneurs is no new developments in innovation, even in the past. Many private sectors will accelerate but not enough to meet demand. If it is a national agenda. Entrepreneurs will produce more targeted products and services.

The rate of population aging in the 21st century will exceed that of the previous century. For the reason that life expectancy is rising, the number of people aged 60 years and above has tripled from its number in 1950 to 600 million in 2000. In 2006 it surpassed 700 million, and it is projected to reach around 2 billion by 2050 (United Nations, 2009). For the entirety of recorded human history, the world has never seen as aged a population as it currently exists globally.

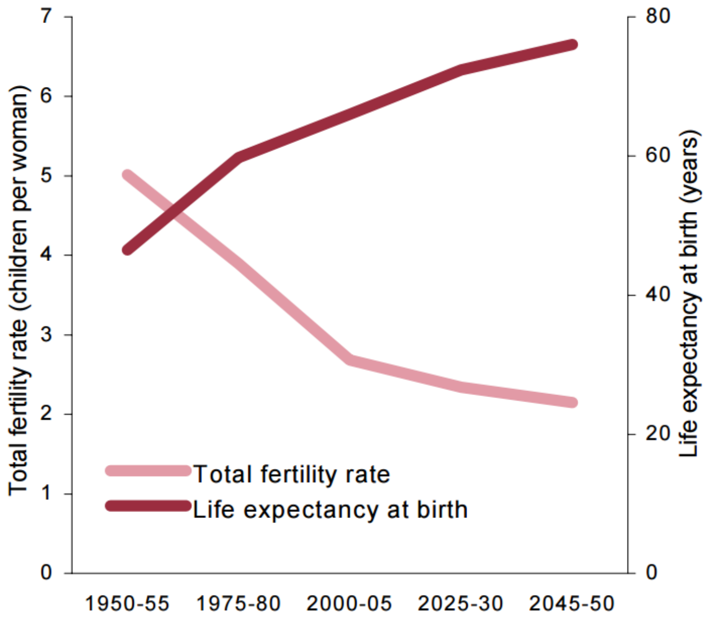



**Figure 2.4** Trends of declining infertility rate and increasing life expectancy (United Nations, 2002).

Population aging is a process known as the "demographic transition" in which mortality and fertility decline from higher to lower levels. Decreasing fertility along with lengthening life expectancy, shown in Figure 2.4, has reshaped the age structure of the populations in most regions of the planet by shifting the relative weight of populations from younger to older groups. Fertility decline has been the primary determinant of population aging. Over the last half-century, the total fertility rate decreased globally by almost half, from 5.0 to 2.7 children per woman. Moreover, in the next half-century, it is expected to drop to the replacement level of 2.1 children per woman.

From the past to the present, an effort on lifespan extension has been a continuing and challenging mission. Nowadays, increased longevity is the most remarkable success story in humanity and healthcare service. This means an improvement in health and well-being. Healthcare Technology Management has been developed to manage numerous kinds of systems in the hospital and connect them with medical devices (Vilcahuamán & Rivas, 2017). The research field believes that the technologies used in the hospital can be developed and adopted to create countless benefits to the patient and users of technology. However, the healthcare system's success will be lower than healthcare by 2030 (Pentland (Sandy), 2004) because the latter is equipped with sensors for detecting sound, images, body motion, and ambient light levels, it has a secure internet connection and can share audio and image files. MIThril system, Memory glasses, and MIThril-based sociometer were examples of healthcare technology. The literature concluded that medical technology would become wearable. The uses of wearable technology were summarized (Steven Kohn, 2018). The "quantified self" movement of the wearable device was discussed. It emphasizes how the wearer can track and observe their health. The wearable technology not only leads to the patient's health improvement but also collects and verifies data (J. Lee et al., 2016) from the wearer. As seen in the literature about the benefit of wearable technology, it can be used by all generations, including seniors.

## 2.2 Wearable Technology

### 2.2.1 Wearable technology devices for seniors

The world's population are trending toward becoming aging society. Moreover, the absolute number of elderly people is rising sharply. At the same time, wearable technologies are being developed to support and satisfy ageing societies' requirements. Wearable technology devices can be grouped into three categories based on their role: prevention of disease and maintenance of health, patient management, and disease management (Min & Jake, 2019). The critical wearable technology applications for seniors are fall identification and prevention. Wearable devices have great potential for preventing falls by seniors.

People who have suffered a stroke are also candidates for using wearable technologies. Moreover, wearable devices can be used efficiently as a health monitoring system during daily routines in many places and situations. For example, wearable devices have been developed to monitor cardiovascular health and enable the use of mHealth applications for cardiac patients (MacKinnon & Brittain, 2020). A low-power wearable electrocardiogram (ECG) monitoring system has been developed (Winokur et al., 2013). A wearable patch-style heart activity monitoring system was developed for recording ECG signals (Yang et al., 2008). future trend in wearable technologies that is getting much attention is wearable drug delivery systems for blood pressure management (Yetisen et al., 2018), which is an example of using AI in healthcare.

The availability of wearable sensor technologies is leading to a rapid accumulation of human subject data, and machine learning is emerging as a technique to apply those data to clinical predictions (Saeb et al., 2016). As machine-learning algorithms are increasingly used to support clinical decision-making, it is important to make reliable and accurate predictions. Inaccurate predictions can mislead both clinicians and data scientists. Cross-validation (CV) is the standard approach to evaluating the accuracy of machine-learning algorithms on the part of the data algorithm, but it may not be seen during training (Saeb et al., 2019). Even though wearable technologies have been developed to support seniors' lives, in terms of technology management, the application of wearable devices in aging societies has not been successful so far (Malwade et al., 2018). Adoption of wearable technologies has not been fully achieved, and efficient results as expected have not been obtained as evidenced by the fact that around 50% of users stop using wearables within six months of purchase (Teena, 2014). Not only have the opinions of seniors been investigated, but those of each group of stakeholders in an aging society have been investigated.

### 2.2.2 Wearable Technology for Enhancing the Quality of Human life

The well-being of people was separated into three groups by the World Health Organization as follows; 1) physical well-being, 2) mental well-being 3) social well-being (Björnfot & Bakken, 2013). Technology plays a vital role in improving human life (Park & Jayaraman, 2003). This literature focused on a study of Smart Shirt, which can monitor the vital sign of humans by convenience. Nevertheless, the specific Parkinson's disease group used wearable technology to collect the data for analysis and treatment of the patient to improve their quality of life (Van Uem et al., 2016). In another research, the author did not specify a type of wearable technology but focused on applying the technology for communication (J. Lee et al., 2016). Wearable technology can monitor and measure physical activities and physiological statistics. In addition, it can sense environmental status, collect real-time data, sign alarms for communication, and manipulate and control external systems. Moreover, Features that can contribute to the influencing factors included band, functionality, hand-free, compatibility, interface, GPS, GPS accuracy, voice recognition accuracy, tech novelty, messaging & social media application, and look and feel by interviews from the student group and working group (Adapa et al., 2018). This literature review concerns two technologies: Smartwatch and Smart Glasses. The influencing factor for both wearable technologies is explained by a set of ladders comprised of three main layers. Another method was a Web-Based Survey conducted to find Key Features for a Wearable Device for Continuous Monitoring of Breathing. The data collection was conducted by student and staff volunteers. The objective was for this study was to find the critical design features. The result of this research identifies the fundamental design of a user-acceptable that can improve the quality of life for asthma populations. The innovations are not only about humans and computers and between humans and machines but also all the demands from existing data analysis, context-aware technology, wireless sensor networks and ambient intelligence applications. This chapter briefly describes the main technological trends in the current wearable technology field (Fig. 2.5).

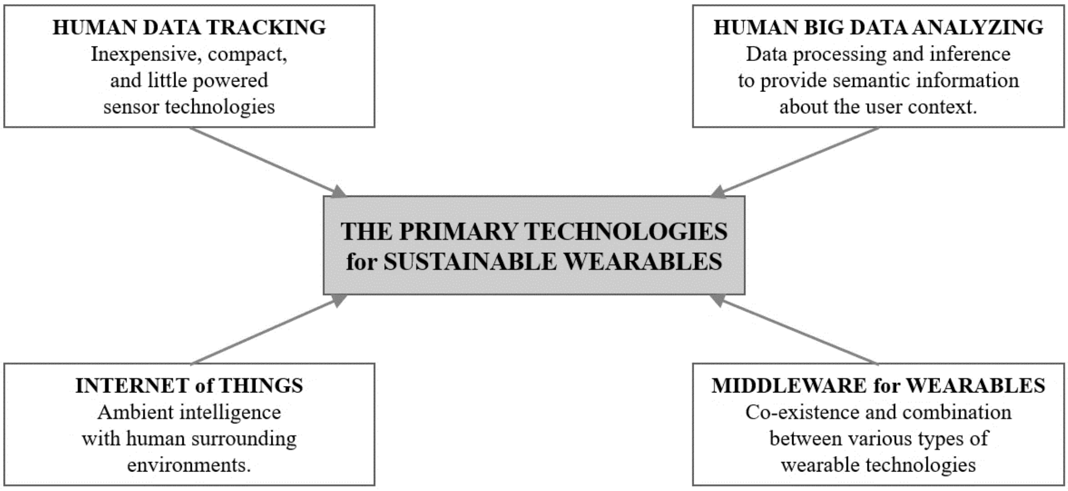



**Figure 2.5** Primary technological keywords for development of sustainable wearables

(J. Lee et al., 2016)

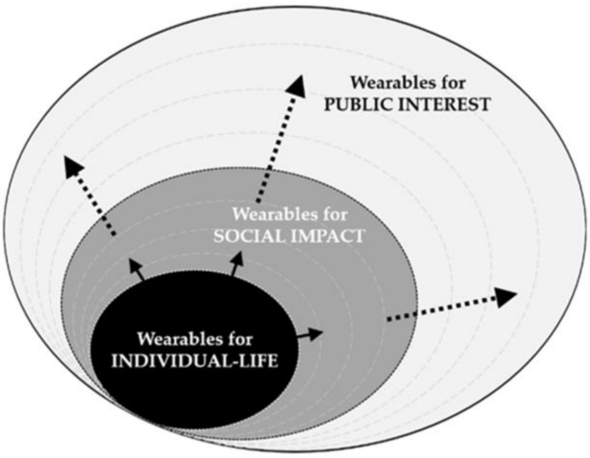



**Figure 2.6** The concept of sustainable wearables to enhance the quality of human life.

(J. Lee et al., 2016)

Furthermore, the literature asserted that aspects of life could be improved with the quality of the wearable device. These aspects include sustainability viewpoints for social public interest and safety exceeding the physical body and environmental state measurement while tracking and monitoring. At the same time, the device tracks and monitors variable results and data. The model of Fig. 2.6 may explain this approach.

According to the literature review on this part, the functions and features of wearable technologies are active for improving the well-being of people in aging society and able to apply in terms of senior healthcare services for increasing life confidence of seniors, reduce the task of family members for taking care of their seniors, and decrease the workload of caregivers.

## 2.3 Healthcare Service System

Technologies and communication systems in many countries have developed to support people's daily lives to achieve faster and easier living. Developments in technologies are driven by many industries and have changed people's lifestyles into those of technology consumers (Li et al., 2007; Selwyn, 2004; Tyrer et al., 2006). A new concept called "innosumer" focuses on technology and consumer for the aging market (Peine et al., 2014). In modern society, older people are innovative consumers who exchange service value in the technology market and use technology to support themselves daily.

Healthcare technology developments support the daily life of people for faster and easier living by changing the lifestyle of people in technology consumers (Li et al., 2007; Selwyn, 2004; Tyrer et al., 2006). A complementary perspective on the relationship between healthcare technology and aging market focuses on the elderly as co-creator of the transformation for technological change and consumption. Many pieces of research 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 (Djellal & Gallouj, 2005; Jung et al., 2013; H. J. Lee et al., 2009; Lu et al., 2005; Pantelopoulos & Bourbakis, 2010; Taboada et al., 2011). Healthcare technology for the elderly is significant to aging market, especially in developing countries.

Wearable technology might be the most crucial type of technology for the elderly because it can always be with you and has the possibility of saving your life. The primary benefits are safety, security and healthcare, with devices issuing warnings, allowing us to monitor our health, and summon help if needed (Barry, 2019).

The wearable technology applications are grouped into three categories based on their roles. For example, wearable devices designed for weight control and physical activity monitoring are listed in the section on the prevention of diseases and maintenance of health. In addition, there are sections on patient management and disease management.

**Table 2.1** The application related Senior Healthcare

| Categories of Wearable Technologies | Roles of Wearable Technologies | Application related Senior Healthcare |
|---|---|---|
| Prevention of Diseases and Maintenance of Health | Fall Identification and Prevention | (Barry, 2019) developed a solution to recognize walking and activities. |
| | | (Awais et al., 2016) compared and evaluated the performance of wearable sensors in classifying physical activities for older adults in real-life and in-lab scenarios. |
| Patient Management | Patients with Stroke | (Burridge et al., 2017) developed wearable devices with embedded inertial and mechanomyography sensors, algorithms to classify functional movement, and a graphical user interface to present meaningful patient data to support a home exercise program. |
| Disease Management | Heart Disorders | (He, 2012) designed Textile-based wearable devices for the covert recording of ECG, respiration and accelerometric data and to assess the 3D sternal with Seismocardiogram (SCG) in daily life. Researchers also created a portable and continuous ballistocardiogram (BCG) monitor that is wearable in the ear. |
| | | Wearable devices have been developed to monitor cardiovascular and enable mHealth applications in cardiac patients. Low-power wearable ECG monitoring systems have been developed (Winokur et al., 2013). |
| | Blood Disorders | A new wearable cerebral blood flow (CBF) meter is potentially useful for estimating cephalic hemodynamics and objectively diagnosing cerebral ischemic symptoms of patients in a standing posture (Fujikawa et al., 2009). |
| | | (Iwasaki et al., 2015) detected site-specific blood flow variations in people while running using a wearable laser doppler flowmeter. |

Regarding the development of wearable technologies applications, they are not enhanced to be useful for healthcare, especially senior healthcare services. Lack of understanding of the expectation of stakeholders in healthcare service system should be considered for achieving in terms of adoption of wearable technology.

# Chapter 3
# Research Methodology

## 3.1 Study structure

The literature reviews and research problems discussed in Chapters 1-2 show the importance of improving the senior healthcare service system using wearable technology devices. The lack of understanding of wearable technology devices supports senior healthcare knowledge management for seniors, family members and health providers. To achieve the primary research question that focuses on " How to design a service model by using wearable technology devices for aging society in Thailand, which concerns the well-being of stakeholders in aging society?".

We divided this dissertation into two sub-studies that include topics of the understanding expectation and understanding attitude of stakeholders to integrate for proposing a service model. Study 1 aims to find expectations on wearable technology devices are studied to present the functions and features of wearable technologies which satisfy to stakeholder perspective. Then in study 2, the objective of the study is to verify the effect of the attitude of propensity to use wearable technology devices with awareness in aging society. Figure 3.1 represents related research methods that are used in this dissertation. In order to achieve all research questions, the applied methods involve in-depth interviews on knowledge and experience sharing with multiple stakeholders, hypotheses, questionnaire surveys, statistical analyses, and conceptual service modelling. These methods are used to support related objectives, emphasizing the specific research scope and thorough consideration of limitations in research studies.

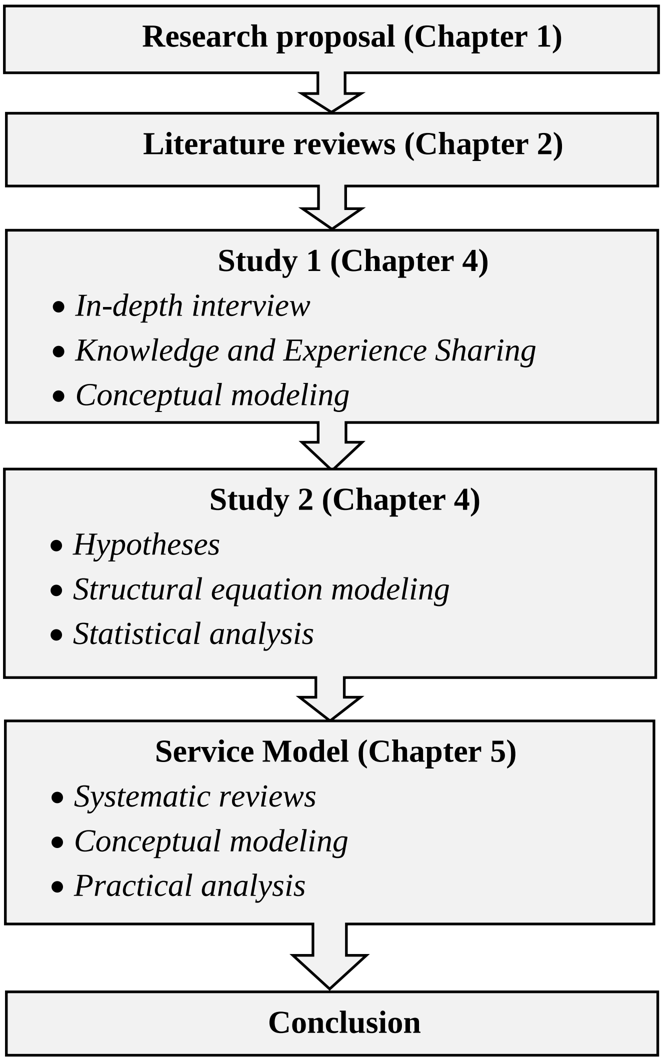



**Figure 3.1** Related studies and methods used in dissertation

# 3.2 Research Methods

### 3.2.1 Study 1: The critical success factors (CSFs) in Adoption of Wearable Technology Devices

In the first study, we separate the research methodology into three steps to explore related details of stakeholders' expectations by using wearable technology to improve their well-being. A case study was executed to identify the key factor in the adoption of wearable technology devices for seniors, family members and formal caregivers. In specific detail, we conducted interview questions Appendix A with physicians, nurses, and physical therapists who worked at hospitals and senior care in Thailand to share their knowledge and experience of their work in order to adopt wearable devices to decrease their workload. Moreover, the interview question also conducts with seniors and their family members to understand their requirements to improve their well-being and increase life confidence. Related methods are as follows:

- First step: We conduct an in-depth interview with the interviewers, which lasts about 50 minutes each. They were conducted by phone with the formal caregivers and in-person with the family members and seniors. The conversations were audio-recorded and transcribed verbatim.

- Second step: The data collection started with an interview of the first physical therapist and memo writing after the interview. After that, the conversation was data analysis by using grounded theory. This step used theoretical sampling to identify individuals in each target group for interviewing. And a theory was produced by mapping the concept from All stakeholders.

- Last step: The conceptual modelling approach was adopted to represent the critical success factors (CSFs) in the adoption of wearable technology for All stakeholders in order to increase the life confidence and well-being of seniors, decrease the workload of informal caregivers and support family members in taking care of their seniors.

### 3.2.2 Sub-Study 2: The Effect of Attitude of Propensity to Use Wearable Technology devices with Awareness in Aging Society

The sub-study 2 (explained in Chapter 4) is focused on the effect of the attitude of propensity to use wearable technology devices with awareness in aging society. Methods in this sub-study include hypotheses, questionnaire survey, statistical analysis, and structural modelling. It focuses on attitudes toward adopting wearable technology devices. The research methods used in this section can be divided into 4 steps:

- First step: hypotheses and a structural model developed in this sub-study were applied to study the attitude of propensity to use wearable technologies in the target group (senior, family members and formal and informal caregivers). The questionnaire was developed based on technology readiness, elaboration likelihood model and wearable technology devices to support seniors in Thailand (Appendix B and C). The topics were related to attitude and awareness. Factors related to positive attitudes toward understanding wearable technology, expectations for creating positive experiences, trust in wearable devices, and self-confidence in the maintenance of own health. Moreover, the hypotheses in using mobile technology for healthcare activities were also taken into account.

- Second step: a questionnaire survey was administered to respondents who were people in aging society. This process was to understand stakeholders' attitudes of propensity to use wearable technology devices with awareness in aging society.

- Third step: in this sub-study, statistical analysis was applied to analyze the questionnaire survey results. The analyses aimed to identify the attitude of propensity to use wearable technology devices with awareness. Descriptive statistics function was used to explain the findings and results from the survey that classified groups of respondents by senior, family members of senior, formal caregiver, and informal caregiver.

- Last step: structural modelling or SEM was developed to represent relationships of related factors and identify the connection to the attitude of propensity to use wearable technology devices. The fit indexes were used to verify the developed model.

# Chapter 4
# Expectation of Multiple Stakeholder in Thailand Aging Society

In order to propose the new service model by using the wearable device for aging society in Thailand, we employ two studies in different aspects and methodologies, as shown in Table 4.1. The objective of two sub-studies is to understand the stakeholder expectation, which is the key factor in adopting wearable devices that affect the quality of senior and caregiver life. The sub-study learns from sharing knowledge and experience among stakeholders passed through interviewing with formal caregivers, family members and seniors. The sub-study 2 focuses on the attitude of propensity to use wearable technologies to improve stakeholder well-being. The empirical study of 360 stakeholders (Senior, formal caregivers & family members 120 each) in the Thai aging society is conducted to explore the effect of awareness.

**Table 4.2** Validation methods to understand the stakeholder

| Validation part | Stakeholders | Aspect | Methodology |
|---|---|---|---|
| Sub-study 1 | 27 stakeholders | Stakeholder Expectation | In-depth interview |
| Sub-study 2 | 360 stakeholders | Stakeholder Attitude | Empirical study |

## 4.1 Sub-study 1: Stakeholder Expectation

### 4.1.1 Introduction

The trends toward aging populations and advancing technologies will continue to accelerate during the 21st century (Ministry of public health, 2013). For seniors unable to take care of themselves, it is critical that family members and formal caregivers (physicians, nurses, physical therapists, and so on) pay extra attention to them. Since the costs of senior care provided by formal caregivers are very high, families with senior members may feel financial pressure, especially if the person has a chronic condition. Wearable technologies have been expected to reduce these costs in private homes (Wang et al., 2017). Propitiously, the advent of and advances in wearable technologies have opened the door to developing feasible devices for senior care. Linking senior care systems with such wearable technologies will improve the well-being of the stakeholders (seniors, family members, caregivers, and so on).

The different viewpoints among stakeholders are valuable for considering all opinions (Giguere et al., 2018). Not only senior is key stakeholders, but caregivers are also stakeholders in senior care, so their needs should also be considered.

### 4.1.2 Methodology

Grounded theory is best defined as a research strategy to generate theory from data (Khan, 2014). The first task in step 3 of Fig. 1, Coding, is essential in the grounded theory approach. According to (Charmaz, 2006) p. 46), Coding is the pivotal link between collecting data and developing an emergent theory to explain these data. Through Coding, you define what is happening in the data and begin to grapple with what it means,' Coding occurs in stages; the researcher first generates as many ideas as possible inductively from early data (Srizongkhram et al., 2018). The second task in step 3, writing a memo after each case-based interview, focuses on the critical success factors (CSFs) in the adoption of the device that are related to improving the quality of life for senior and caregiver that learns from interviewing by sharing knowledge and experience among stakeholders. During interviews, the researcher identifies keywords from the interviewees' various opinions and differentiable descriptions. Those keywords represent the features affecting the adoption of wearable technologies. Next, in step 4 in fig. 4.1, we begin coding theoretically by using theoretical sampling. After that, we analyzed data and coded it from knowledge and experience sharing. The Coding identified the situation by separated stakeholders, and the relationships among them also consider in this analysis. The centrally focused codes, which means naming data segments with labels for each wearable technology, were summarized and analyzed using the grounded theory approach (Barney, 1992). The challenges identified the critical success factors (CSFs) in the adoption of wearable technology to adopt wearable technology construct from knowledge and experience sharing conceptual with the multiple-stakeholder views proposed.

The process used to identify the critical success factors (CSFs) in adopting wearable technology devices using the grounded theory approach is illustrated in Fig. 4.1. the first step is the explanation of wearable technology devices and the research objectives to the interviewees. Then data collection started with an interview of the first physical therapist and memo writing after the interview. The third step was theoretical sampling of the analyzed data. Afterwards, theoretical sampling was used to identify individuals in each target group to interview. The output creates a theoretical sample which is the fourth step. Then, theoretical sampling was used to identify individuals in each target group to interview. A theory was finally produced by mapping the concept from All stakeholders with the third step.

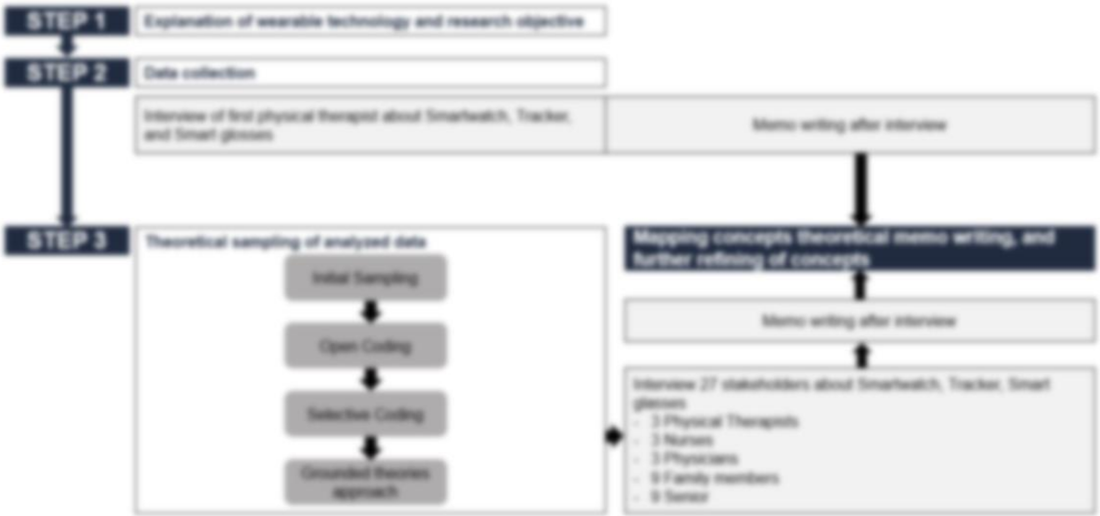



**Figure 4.1** Process used to identify the critical success factors (CSFs) in adoption of wearable devices

#### *4.1.2.1 Interviewees*

To improve the quality of senior care and services, the seniors and their caregiver should be concerned [Giguere et al. (2018)]. The difference in perceptions among stakeholders can lead to success for wearable technology adoption. For the type of caregiver was categorized into 2 types, there are included formal caregiver and informal caregiver [Jacobs, M. et al. (2015)]. For the sampling size of phenomenological that related to study on the experience of people, Creswell (1998) recommends 5 – 25 and Morse (1994) suggests at least six. In this study, we were collected the data from 9 participants for each group to cover the sampling size as recommended. The data were generated from interviews with people in three main groups of stakeholders: formal caregivers (three physicians, three physical therapists, and three nurses from different hospitals), informal caregivers (nine family members with different responsibilities for taking care of seniors), and seniors (nine in four family groups).

#### *(a) Formal Caregivers*

Interviews were conducted with three physicians, three physical therapists, and three nurses with various years of experience who worked at different facilities in Bangkok and outside Bangkok. Details about them and the ratio of seniors as patients are summarized in Table 4.3.

**Table 4.3** Details about Formal Caregivers

| Interviewee | Ratio of seniors as patients | Years of experience in difference healthcare areas | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | In Bangkok | | | Outside Bangkok | | | Total (Years) |
| | | GH | PH | HC | GH | PH | CN | |
| Neurologist | 50% | 1 | - | - | - | - | - | 1 |
| Ophthalmologist | 80% | 1 | - | - | 1 | 1 | - | 3 |
| Internist | 50% | 4 | - | - | 3 | - | - | 7 |
| Physical Therapist 1 | 100% | - | - | 2 | - | - | - | 2 |
| Physical Therapist 2 | 100% | 1 | 2 | - | - | - | - | 3 |
| Physical Therapist 3 | 90% | - | 3 | - | - | - | 1 | 4 |
| Nurse 1 (Department of Internal Medicine) | 40% | - | 8 | - | - | - | - | 8 |
| Nurse 2 (ICU for Neurosurgery) | 80% | 10 | - | - | - | - | - | 10 |
| Nurse 3 (Nurse Manager of Stroke Center) | 50% | 24 | - | - | - | - | - | 24 |

**GH: Government Hospital, PH: Private Hospital, HC: Home Care, CN: Clinic

### *(b) Family Member*

Interviews were conducted with nine informal caregivers responsible for different numbers of seniors with diverse relationships and living arrangements. The details are summarized in Table 4.4, where "Together" means the caregiver lived with the seniors, and "Separate" means they lived apart.

**Table 4.4** Details about Family members

| Interviewee | No of seniors for whom responsible | Seniors' relationships (age) | | | | Living arrangement |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | |
| Family Member 1 | 2 | F (66) | M (65) | - | - | Together |
| Family Member 2 | 3 | A (65) | GM (83) | GF (84) | - | Together |
| Family Member 3 | 4 | F (67) | M (65) | A (66) | GM (85) | Together |
| Family Member 4 | 2 | F (68) | M (65) | - | - | Together |
| Family Member 5 | 2 | F (67) | M (66) | - | - | Separate |
| Family Member 6 | 3 | F (70) | M (64) | A (66) | - | Together |
| Family Member 7 | 2 | F (66) | M (65) | - | - | Separate |
| Family Member 8 | 1 | F (75) | - | - | - | Separate |
| Family Member 9 | 1 | M (69) | - | - | - | Together |

**F: Father, M: Mother, A: Aunt, GF: Grandfather, GM: Grandmother

### *(c) Seniors*

Interviews were conducted with nine seniors living in four family groups. The first group had only one senior, who was 65 years old active living alone, and able to perform routine activities. Her hobbies are travelling around the world and exercise with many sports. The second group included two seniors, the parents of informal caregiver 1, with whom they lived. The third group included three seniors, the aunt, grandmother, and grandfather of informal caregiver 2, with whom they lived. The fourth group included three seniors, the father, aunt, and grandmother of informal caregiver 3. The father (senior 7) lived alone in another province, far from Bangkok. The aunt (senior 8) lived with the informal caregiver in Bangkok. The grandmother (Senior 9) lived with the formal caregiver in the same distant province. The details are summarized in Table 4.5.

**Table 4.5** Details about Senior

| Family group | Interviewee | Age | Able to perform routine activities | Living arrangement |
|---|---|---|---|---|
| 1 | Senior 1 | 65 | Yes | Living alone |
| 2 | Senior 2<br>Senior 3 | 66<br>65 | Yes<br>Yes | Stay with family member<br>Stay with family member |
| 3 | Senior 4<br>Senior 5<br>Senior 6 | 65<br>83<br>84 | Yes<br>Yes<br>No | Stay with family member<br>Stay with family member<br>Stay with family member |
| 4 | Senior 7<br>Senior 8<br>Senior 9 | 67<br>65<br>85 | Yes<br>Yes<br>No | Living alone<br>Stay with family member<br>Stay with formal caregiver |

#### *4.1.2.2 Data generation*

The interviews with stakeholders were aimed at exploring several factors that solicit different stakeholders' opinions on the adoption of wearable devices. These include the views and experiences of formal caregivers in different healthcare settings, the informal caregivers with different responsibilities, and of seniors with different lifestyles. The interviews last for about 50 minutes each and followed a semi-structured guide (Appendix A), They were conducted by phone with the formal caregivers, and in-person with the informal caregivers and seniors in the same period of time. The interviews were audio-recorded and transcribed verbatim.

### 4.1.3 Results

As shown in Fig 4.1, the results are obtained steps 3. Once step 3 was completed for all interviewed stakeholders, the critical success factors (CSFs) in the adoption of wearable technology were identified.

Not only one stakeholder identifies during the interview about the critical success factors (CSFs) in adoption of the wearable technology devices that could separate by mention the critical success factors (CSFs). The interviewees recommended using health preservation functions, location functions, daily tasks functions, and design features as the keywords for a group of factors. The interviewees provided useful insights, as exemplified by the following statements.

> *In my opinion, adoption can be achieved by identifying the keywords by group because it is easy to understand and contribution for developer such as the feature of smartwatch can answer all health's question or cover all question about my location.* (senior 3)
>
> *Many things can be used to convince people to adopt wearable technologies. You should separate the keywords by group for easy summarization such as by health, location, routine, daily tasks, and design.* (family member 1)
>
> *Actually, the factors promoting the use of wearable technology can be grouped by using by using the keywords such as "health," "location," ... something like that.* (ophthalmologist)
>
> *Easy for understand, you can separate the factors by using keywords um… "health preservation," and "daily tasks," or example.* (physical therapist 1)

In order to explain the element of the critical success factors (CSFs) in the adoption of wearable technology. In this study, we focused on three kinds of wearable technology devices (smartwatch, tracker and smartglasses. Our findings are presented separately for each.

### *4.1.3.1 Smartwatches*

The critical success factors (CSFs) in the adoption of smartwatches are health preservation, location, and daily task functions. Descriptions of each function are presented in.

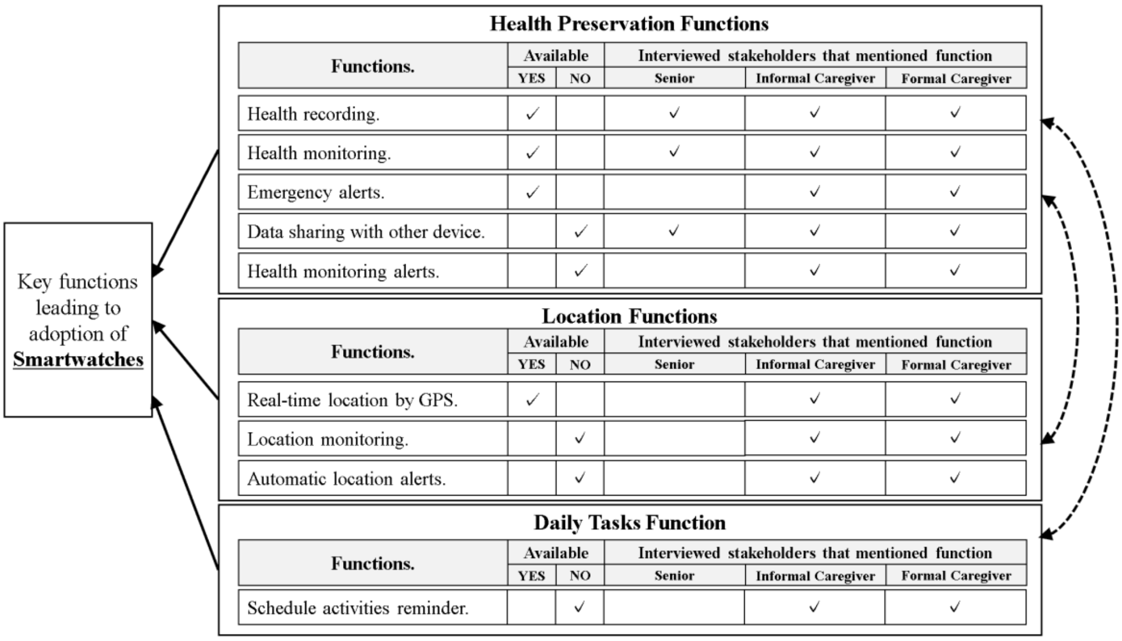



**Figure 4.2** Conceptual framework of key functions in adoption of smartwatches.

- Health Preservation Functions

Health preservation functions lead to the adoption of smartwatches from multiple stakeholder viewpoints. Both formal and informal caregivers mentioned that health preservation functions are the critical success factors (CSFs) in the adoption of smartwatches that were identified in this study. It discusses the roles of functions in the adoption of smartwatches, mentions the functions generally available on smartwatches, and presents representative statements from the interviewed stakeholders.

The health preservation functions that are critical in the adoption of smartwatch from the viewpoints of multiple stakeholders in an aging society are the recording of health condition, the monitoring of health conditions, and the sending of emergency alerts. These functions are generally available on smartwatches. The sharing of data with other devices and the sending of health alerts are generally not available. Moreover, the accuracy of their applications should be concern when connect with another devices.

Health recording and health monitoring were the primary functions mentioned by all groups of interviewed stakeholders as represented by these statements from the interviewees.

> *I hope that smartwatches can record my health data such as heart rate and blood pressure with accuracy and that I can review my health status in real time.* (senior 1)

> *Health data are very important for my parents, so it would be good if a smartwatch could record their health data. I could then check their health data on the device.* (family member 6)

> *A smartwatch should be used to monitor heart rate, blood oxygen, vital signs, etc., which are key signals of unexpected symptoms. A smartwatch is suitable for all seniors.* (neurologist)

> *A smartwatch is good in terms of the functions that can save the life of a senior. The recording can be used to monitor the health status and thereby improve the quality of treatment because the physician can use the historical health data to decide on treatment.* (nurse 1)

The sending of an emergency alert when a senior experience an unexpected event was mentioned by both caregiver groups.

> *Emergency SOS is an essential function on a smartwatch for connecting with other people when an unexpected event occurs, such as a senior falling down when alone.* (family member 2)

> *The most important thing for the elderly is that the smartwatch has emergency mode and includes SMS notification. That will help a lot if the person has an accident.* (nurse 3)

Data sharing with other devices is a key to adoption of smartwatches. Because the device will fail if it can record all personal device, but it cannot share and connect with another device. The need for and the benefit of data sharing were mentioned by all groups of interviewed stakeholders. Nevertheless, in practice of Thailand is still pending issue to developing about data sharing between wearable devices with other devices.

> *My health data should be shared with my daughter and my son so they can help me monitor my health status and advise me on taking care of myself. My location should be automatically tracked and shared with important contacts to enable them to find me in case of an unexpected situation.* (senior 5)

> *The data from a smartwatch should be shared with me to enable me to follow up on the status of the senior for whom I care.* (family member 5)

> *The data from a senior's smartwatch should be shared with the hospital to enable the staff to check the health history and use it to improve the quality of treatment.* (internist)

Alerts were mentioned by a caregiver and a nurse as important for monitoring a senior's health information and predicting abnormal signals from the data history, enabling the appropriate person to be notified.

> *I would like to know about abnormal health conditions in advance so that a treatment plan can be prepared in a timely manner for the senior for whom I care.* (family member 6)

> *AI can use the data recorded by a patient's smartwatch to predict abnormal patterns. This technology should be added to enable forecasting a senior's health condition.* (nurse 2)

All groups of interviewed stakeholders stated that health preservation is the critical success factors (CSFs) in the adoption of smartwatches because being able to check his or her health data on the device would improve the senior's sense of well-being. The informal caregivers focused on being able to monitor the senior's health condition from the data recorded on the device. The formal caregivers focused on how the recorded data could be used to improve the treatment process. These findings explain why the health preservation functions were judged to be the most important ones in the adoption of smartwatches, as shown by their placement shown in Fig. 4.2.

- Location Functions

Both the formal and informal caregivers mentioned that location functions are critical in the adoption of smartwatches. Smartwatches generally have a function for real-time location tracking using GPS but not for monitoring locations and sending location alerts automatically.

The real-time location tracking function can be used to find the senior wearer. It was deemed important by both the formal and informal caregivers for taking care of seniors and helping them in a timely manner, as represented by these statements

> *When I'm not with the seniors for whom I care, I could check their location anytime.* (family member 2)

> *It could notify to the emergency contact and send the location of the senior needing help in a timely manner.* (neurologist)

A location monitoring function could be used to check the senior's environment by using a camera added to the smartwatch, as mentioned by formal and informal caregiver.

> *I could view my parent's environment through a camera in the smartwatch.* (family member 8)

> *If we could see the environment of a senior who suffered an accident, we could help senior more easily than by finding the location on a map. So, adding a camera to smartwatches would be very helpful.* (nurse 3)

An automatic location alert function could be used to inform the appropriate person of an unexpected evident event.

> *If an accident occurred, an alert and message could automatically be sent to me and appropriate organization (hospital, fire department, etc.).* (family member 7)

> *A message could automatically be sent to family members if the senior wearer leaves the "safe zone."* (physical therapist 2)

The location functions come to the second point from the opinion of the informal and formal caregivers. They would reduce the workload required for senior care. They would enable informal caregivers to check the location of seniors in real time as well as give formal caregivers more confidence about the safety of senior residing outside of senior care. The location functions were judged from the comments to be the second most important functions, as shown by their placement in Fig 4.2.

- Daily Tasks Function

A daily tasks function would remind the wearer of scheduled activities and send alerts at appropriate times. This capability was identified by both types of caregivers who said that it would reduce their workload. Moreover, if would motivate the senior wearer to initiate the activities.

> *A senior wearer can perform scheduled routine activities such as taking medication, visiting a doctor, and exercising as program record on the device.* (family member 2)

> *A senior wearer can make use of the daily tasks function of a smartwatch not only at home but also while in the hospital or in senior care for such activities as taking medication, going for treatment, and sleeping. This would reduce the workload of the formal caregiver.* (physical therapist 3)

Not all of the informal and formal caregiver mentioned the daily tasks function. Only informal caregiver 2 and nurse 2 mentioned it. It was thus judged to be the third most important of the functions, as shown by its placement at the bottom in Fig. 4.2.

The neurologist mentioned that the health preservation and location functions are related, as shown by a dashed-line arrow in Fig. 4.2. This is because the recorded health data could be used for forecasting abnormal events, such as a fall. That is, recorded location data could be used to investigate abnormal signals from the health data.

> *The health data record is correlated with the location of the senior wearer. If the smartwatch detected an abnormal situation, it could send the wearer's location to the senior's family as well as send as alert signal.* (neurologist)

Physical therapist 3 mentioned that the health preservation and daily task functions are also related, as shown by the other dashed-line arrow in Fig. 2. All the recorded activities are also recorded as health data, so they could be used as well for deciding upon the course of treatment and the course of physical therapy.

> *All activities of a senior wearer such as routine activities, exercise, and training should be recorded because the data could be used together with the health data for treatment.* (physical therapist 3)

*4.1.3.2 Trackers*

The critical success factors (CSFs) in the adoption of Trackers are location features, health preservation functions, and design feature. They are detailed in fig 4.3.

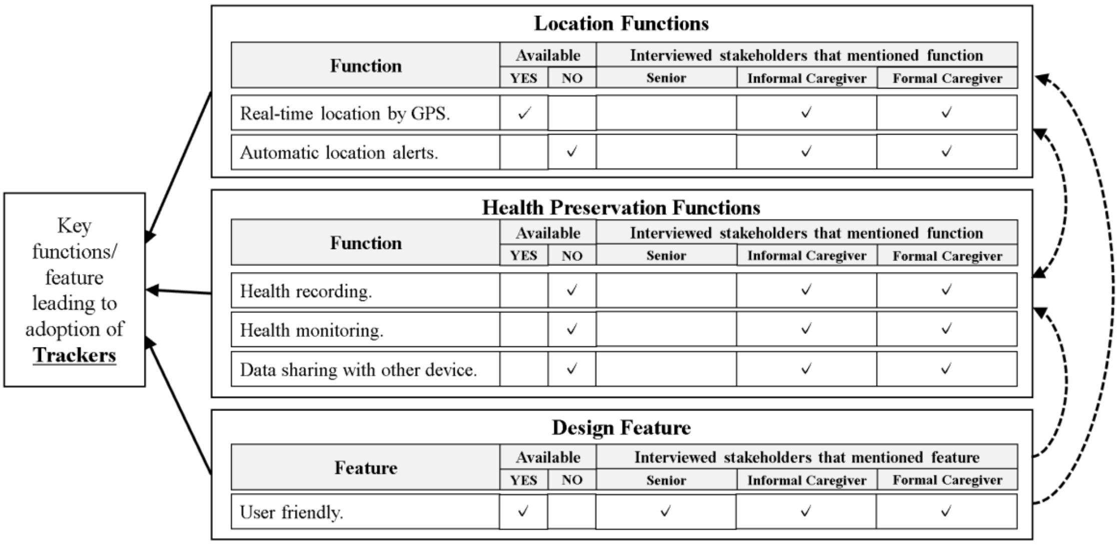



**Figure 4.3** Conceptual framework of the key factor in adoption of Trackers.

- Health Preservation Functions

The location functions were identified by both formal and informal caregivers as the key to the adoption of trackers. While tracking location in real time remains the primary function of trackers, both types of caregivers commented about adding a function to send location alerts automatically.

The tracking location in real time function is good because it enables a caregiver to determine the location of senior, as evidenced by these comments.

> *It can show my parent' location.* (family member 3)
>
> *The current location of a senior can be check by using a tracker.* (ophthalmologist)

A function to send location alerts automatically would enable the appropriate person to be automatically notified if a fall is detected. Although trackers in general can be used to send a signal by touching the SOS button, both types of caregivers mentioned the need for automatic alerts because a senior may not be able to push the button if an unexpected event occurs.

> *It would be good if an alert was automatically sent to me if my mother or father.* (family member 1)

> *A senior may not be able to push the button after falling. There should be an automatic alert function.* (nurse 1)

The location functions were the first ones mentioned by all caregivers as a factor in the adoption of trackers. We thus judged that they were the most important ones in the adoption of trackers, as reflected in their placement at the top in Fig. 4.3.

- Health Preservation Functions

Both type of caregivers mentioned to the adoption of health preservation functions is critical to the adoption of trackers; they could support health recording, health monitoring, and data sharing with other devices.

Health recording could be used record the movements of the senior such as by recording hand and leg movements.

> *It should record hand and leg movements.* (family member 1)

> *Falling is a big problem for seniors. It's like another illness. If we could determine the risk of falling from recorded movement data for a senior, we could better determine when fall occurs.* (physical therapist 1)

Health monitoring is still not supported by trackers as the available technology only supports location finding. Both types of caregivers recommended that health monitoring functions should be developed for trackers to enable fall detection. They agreed that trackers are suitable for senior fall detection and that it would be better to know when a fall has occurred.

> *I could check information on the movements of the senior for whom I care.* (family member 3)

> *Hand and leg movement patterns could be recorded and used for identifying the risk of falling.* (nurse 2)

Data sharing with another device is another crucial feature. Both types of caregivers mentioned the importance of sharing data after it is recorded for us in the next step.

> *The movement data for the senior for whom I care should be shared with me, a formal caregiver, a hospital, and/or a senior care facility for determining the senior's risk of falling.* (family member 3)

> *AI analysis should be used to analyze the row movement data and forecast the risk of the senior falling.* (neurologist)

These health preservation functions were considered second in importance to caregivers because of these features are not available on trackers. They were recommended on the basis of their knowledge about and experience with taking care of seniors. Only good design was not enough if the wearable cannot represent more benefit. The health preservation functions were judged from the comments to be in Fig. 4.3.

- Design Feature

All the interviewed stakeholders liked the user-friendly design of trackers.

> *Just keep it likes my key so that it's very easy to use.* (senior 6)
>
> *It seems easy to use; I would like to try it.* (senior 8)
>
> *It's not a complicated device. It's user-friendly*. (family member 9)
>
> *I saw this device for my patient. I think, it is user-friendly for senior*. (physical therapist 3)

The design feature of trackers is why the interviewees liked it. However, they will adopt them only when health data as well as location data can be provided. This feature is thus considered a support factor and was judged the least important factor, as shown by its placement at the bottom in Fig. 4.3

The location and health preservation functions are related, as shown by a dashed-line arrow in Fig. 4.3, because health data collected by of collected by a tracker could be used to record the movements of seniors. In the analysis step, both health data and location data are needed to investigate the risk of falls, which was identified by the internist.

> *... if it can forecast senior fall events from the movements recorded by the health preservation functions. Moreover, the location of the fall is essential information for investigating the abnormal situation.* (internist)

Design is the most important for health preservation function and location function because all functions need the uncomplicated using as preferred from the senior and family member.

> *User-friendliness will lead to adoption.* (senior 4)
>
> *Design should be a key concern during the development process because user-friendliness is very important.* (family member 2)

#### *4.1.3.3 Smartglasses.*

The critical success factors (CSFs) in the adoption of smartglasses are design features, daily tasks feature, and health preservation functions. They are detailed in Fig 4.4.

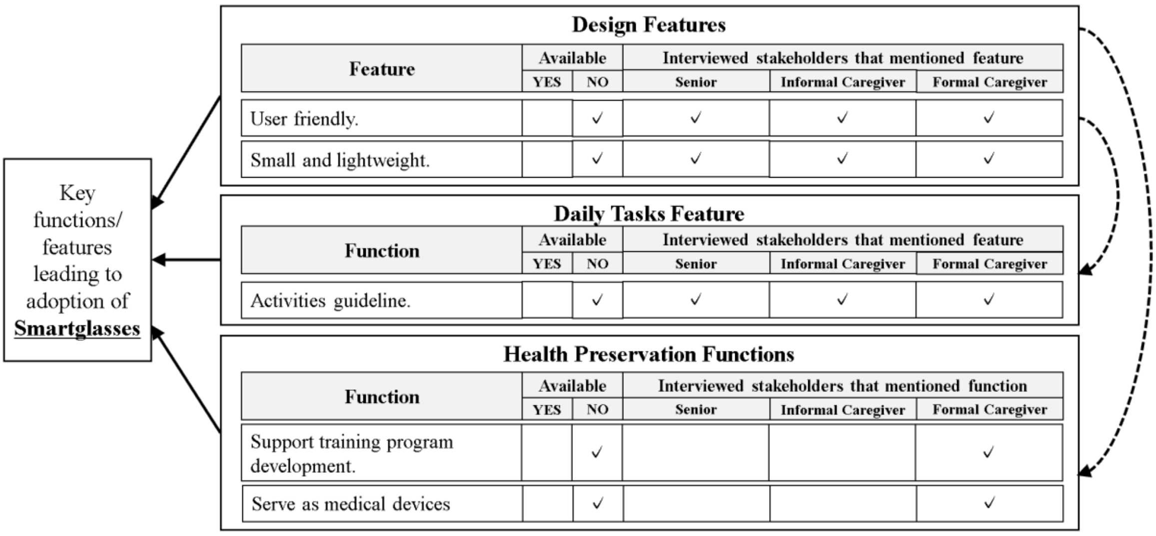



**Figure 4.4** Conceptual framework of the critical success factors (CSFs) in adoption of Smartglasses.

- Design Features

All groups of interviewed stakeholders identified two important smartglasses design features: user-friendly and small and lightweight.

> *I cannot understand the function of smartglasses. They look like big and bulky. I don't like them.* (senior 2)
>
> *The functions of smartglasses are difficult to understand and use. If they can order by voice control are attractive features for adoption.* (senior 9)
>
> *They are used for entertainment in my understanding. How can I get my parents to use them as they are very big and difficult to wear? I think my mom won't like them.* (family member 1)
>
> *In my opinion, smartglasses are the best device suitable for seniors, but the functions are specific and complicated.* (physical therapist 3)

The design features are the main problem in getting seniors to wear smartglasses. The interviewees focused on the need for a good design. A good design will lead to adoption of smartglasses, so the design features were judged to be the most important factor, as shown by their placement at the top in Fig. 4.4.

- Daily Tasks Feature

The daily tasks feature was mentioned by all group of interviewed stakeholders, particularly the development of activities guidelines that will help seniors better perform their daily activities.

> *I would wear them if they could help me do more activities by myself.* (senior 7)
>
> *My father, aunt, and grandmother do not want to stay in bed all the time. If smartglasses can help give them confidence in performing activities that would be great.* (family member 3)
>
> *Smartglasses can support recognition object and cognitive task, which would help the elderly to have a smart and comfortable daily life.* (ophthalmologist)

The daily tasks feature of smartglasses was focused upon by all groups of interviewed stakeholders. Senior would be able to perform routine activities more comfortably by using them. The caregivers expected that the adoption of smartglasses would reduce their workload. This feature was judged to be the second most important factor in the adoption of smartglasses, as reflected by its placement in Fig. 4.4.

- Health Preservation Functions

Health preservation functions were suggested by formal caregivers for providing professional services. A physical therapist proposed developing training programs by using smartglasses. The nurse manager in the stroke center, who has experience in using smartglasses as a member of an emergency team, proposed using them to check the condition of seniors and then send real-time image to a doctor for making treatment decision.

Physical therapy training is one of the expectations that can be provided by smartglasses. A physical therapist mentioned that a training course could be provided for seniors, and training activities could be recorded using augmented reality (AR) and virtual reality (VR) technologies. The goals of physical therapy for seniors are to make daily tasks and activities more manageable and to make seniors as independent as possible. A training program could help seniors practice routine activities. AR technology uses a camera to capture images of the real-world environment and re-displays them in an augmented view through the eyepieces (Grifatini, 2010). AR imagery is projected through or reflected off the surfaces of the smart glass lens pieces (Arthur, 2012; Benedetti, 2012; Liz, 2012). A VR display is projected directly onto the retina of a viewer's eye, resulting in bright images with high resolution and high contrast. The viewer sees what appears to be a conventional display floating in space (Tidwell et al., 1995). A training program using AR and VR technologies could be embedded in a microchip in a garden and shows the wearer the distance to various objects. In this way, AR and VR technologies could be used to create new physical training services by providing a video record on the lens of the smartglasses, this idea was recommended by a physical therapist.

> *If AR and VR were used in smartglasses to develop training programs, seniors would be able to do more activities by themselves. Moreover, using smartglasses for new training programs could become a new business.* (physical therapist 3)

Smartglasses could be used as a medical device for investigating initial symptoms. They could be used like a camera for receiving real-time picture and then connecting to the Internet and sending them to a physician for use in deciding on treatment. However, Internet support for smartglasses is not yet available. The nurse manager said, “I hope 5G can provide such support. Her experience with using smartglasses supports her belief that they can provide more benefits.

> *Smartglasses would help me when triaging both seniors and general patients.*
> (nurse 3)

Health preservation was suggested as a specific function for caregiver. Their objective in the adoption of smartglasses is to reduce their workload and improve their well-being as well as that of the seniors for whom they care. Regarding this requirement is just a specific requirement for some group of All stakeholders, the health preservation functions were judged to be the least important in the adoption of smartglasses, as shown by their placement at the bottom in Fig. 4.4.

The relationships shown by the dashed-line arrows in Fig 4, indicate that the design features are the key reason for smartglasses not being highly rated by the interviewed stakeholders. Therefore, the focus when developing new smartglasses should be on design for the daily task feature and the health preservation functions, as mentioned by a physical therapist.

> *Although the functions are well suited for seniors, smartglasses are not comfortable. Their adoption depends on improving their design.* (physical therapist 3)

### 4.1.4 Summary

Despite the growing trend towards aging populations, the features and functions of wearable technology devices are still not well-suited for the stakeholders in the aging societies. To address this gap, this study identified the critical success factors (CSFs) in the adoption of wearable technology devices for seniors in Thailand by using a grounded theory approach to analyzing data generated from interviews with multiple stakeholders in the healthcare context.

The overall contribution of the wearable technology devices to care services is improvement in the self-confidence of stakeholders. They could give seniors more confidence about health preservation by enabling them to perform daily tasks on their own. They could also give caregivers more confidence in taking care of seniors by providing features and functions for health checking, location detection, and physical activity measurements. These functions would enable them to monitor and follow up on the health data for seniors.

We identified the detailed characteristics of the interviewed stakeholders' opinions for three devices. Health preservation was mentioned for smartwatches. According to the caregivers, not only is health preservation important, but location functions and a daily task feature are also important for smartwatches. For trackers, the location tracking function is the most important because it enables a senior's movements to be monitored, especially unexpected events like falling. For smart glasses, the existing design make them complicated to use; wearing comfort and voice control are attractive features for All stakeholders.

Several challenges to adopting wearable technology devices were identified. While most smartwatches have health preservation, location, and daily task functions, there are concerns about their applications' accuracy and ability to connect with other devices. Senior fall is monitored by the forecast and alarm, which tracker can serve, senior movement data must be sufficient in smartwatches. Improving the vision of seniors is the main requirement of smartglasses. Vision sharpness and image transferability are also required. Concerns regarding all devices are sensor accuracy for live data recording and the speed of Internet connections for data transfer and stakeholder communication. Finally, the cost of wearable technology devices is a concern as it directly affects their adoption. However, this study only mentions the expectation of multiple stakeholders in Thailand. In terms of market research, not only are the expectation from stakeholders which is the main point of concern, but the attitude to use technology is also a vital issue to focus on for the success of wearable technology adoption in the senior healthcare system for an aging society as research on the sub-study 2.

# 4.2 Sub-study 2: Stakeholder Attitude

### 4.2.1 Introduction

The concept of technology readiness was used to measure people's inclination to adopt new technology (Shirahada et al., 2019). The concept can help us comprehend the behavior of the elderly such that their enthusiasm may be affected positively by technology readiness. On the other hand, human skepticism emerges from the negative side of technology. This behavior notion related to wearable devices is applicable because these new devices have not been regarded as useful to seniors and caregivers until now. So, technology readiness shows the attitude on the positive and negative sides.

To motivate the stakeholder to adopt new technologies, the elaboration likelihood model (ELM) of persuasion (Periodical, 2007) is a dual process theory describing the change of attitudes. The ELM was developed by Richard E. Petty and John Cacioppo in 1980 (Kruglanski et al., 2012). The model aims to explain different ways of processing stimuli, why they are used, and their outcomes on attitude change. The ELM proposes two major persuasion routes: the central and peripheral routes.

### 4.2.2 Methodology

To identify the influence factors of wearable technology devices that affect from the attitude of propensity to use wearable technology in aging society, the researcher conducted the hypotheses as Figure 4.5.

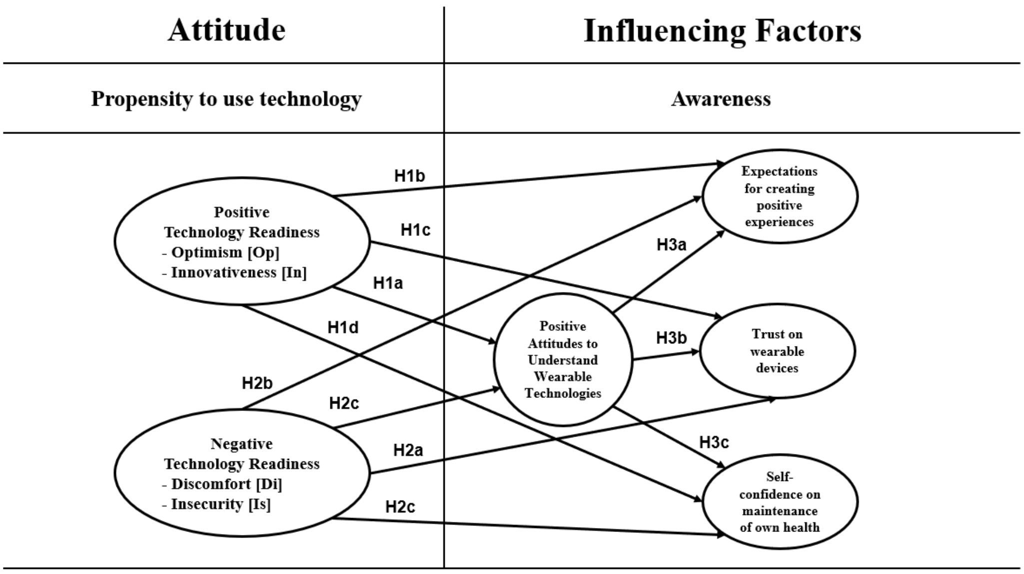



Figure 4.5 Model Hypothesis

This study uses Structural equation modelling (SEM), a powerful, multivariate technique found increasingly in scientific investigations to test and evaluate multivariate causal relationships. It can evaluate the model construct relationships simultaneously (AmirAlavifar and Anuar, 2012). SEM permits complicated variable relationships to be expressed through hierarchical or nonhierarchical, recursive or non-recursive structural equations to present a complete picture of the entire model. In addition, many applications are embedded in SEM, including causal model or path analysis, confirmatory factor analysis, second-order factor analysis, covariance structure models, and correlation structure models (AmirAlavifar and Anuar, 2012; Hox and Bechgrer, 1998). The advantages of SEM include more flexible assumptions and confirmatory factor analysis to reduce measurement error by having multiple indicators per latent variable. Moreover, SEM can test models with various dependents, test coefficients across multiple subject groups, and handle complex pattern data. Because SEM can model complex relationships between multivariate data, the sample size is an important issue. Two popular assumptions are that you need more than 200 observations or at least 8 times the number of variables in the model. As a result, larger sample size is always desired for SEM.

#### *4.2.2.1 Attitude of propensity to use technology*

The concept of technology readiness was used to measure people's inclination to adopt new technology (Shirahada et al., 2019). In this study, the attitude of propensity to use technology was conducted in a questionnaire item to comprehend the behavior of the elderly such that their enthusiasm may be affected positively by the technology readiness to awareness of wearable technology adoption as H1. On the other hand, human skepticism emerges from the negative side of technology to influencing factors for wearable technology adoption as H2. The hypotheses are as follows.

- H1: Positive technology readiness affects awareness of wearable technologies.
    - H1a: Positive technology readiness affects the positive attitudes to understand wearable technologies.
    - H1b: Positive technology readiness affects the expectations for creating positive experiences.
    - H1c: Positive technology readiness affects the trust on wearable devices.
    - H1d: Positive technology readiness affects the self-confidence on maintenance of own health.

- H2: Negative technology readiness affects the awareness of wearable technologies.
    - H2a: Negative technology readiness affects the positive attitudes to understand wearable technologies.

H2b: Negative technology readiness affects the expectations for creating positive experiences.

H2c: Negative technology readiness affects the trust on wearable devices.

H2d: Negative technology readiness affects the self-confidence on maintenance of own health.

#### *4.2.2.2 Awareness of wearable technologies*

***(a) Positive Attitudes to Understand Wearable Technologies***

Positive attitudes to understand wearable technologies is the offered functions of the wearable devices that may lead to positive outcomes for the user and his or her family members. For example, the wearable device is served as a communication device which allows the user to contact and communicate with his/her family members.

The primary concern from the family members' perspective is improving senior well-being (Carmines & Mciver, 1981). Moreover, the family member is leading supporter who makes decision about new technology for taking care of their senior (Prinable et al., 2017). So, the factor that related to improve well-being for senior and their family could represent by positive attitudes to understand wearable technologies.

The positive attitudes to understand wearable technologies is the connection between attitude of propensity to use technology and awareness of wearable technologies as represent by H3. The hypotheses are as follows.

- H3: The positive attitudes to understand wearable technologies affects the awareness of wearable technologies.

  H3a: The positive attitudes to understand wearable technologies affects the expectations for creating positive experiences.

  H3b: The positive attitudes to understand wearable technologies affects the trust on wearable devices.

  H3c: The positive attitudes to understand wearable technologies affects the self-confidence on maintenance of own health.

***(b) Expectations for creating positive experiences***

Expectations for creating expectations for creating positive experiences are an essential requirement by using wearable technologies. That comes from 2 factors, including interest and passion factor and rewarding factor as follows.

Interest and Passion factor: the positive outcomes created from the wearable devices having the functions that allow the users to gain new experience, meet new companions and be involved in the activities with the other people.

Rewarding factor: this may refer to the benefits that the user obtained from the function that allows him/her to connect, communicate and share information with other kinds of devices such as cellphone, tablets and laptops. This factor also takes into account the positive feeling of the user just for possessing a wearable device.

***(c) Trust on wearable devices***

Trust on wearable devices: this latent refers to believe on wearable technologies such as the accuracy of information from wearable technologies that can use to treatment.

***(d) Self-confidence on maintenance of own health***

Self-confidence on maintenance of own health value for health: the offered functions of the wearable devices that may lead to positive outcomes related to the health of the user. For instance, the user may use a wearable device to check and follow up his or her health information.

***4.2.2.3 Questionnaire development and data collection***

At the beginning of the questionnaire, respondents are given a short introduction to wearable devices by introducing three products. These products are Smartwatch, Tracker, and Smartglasses. After that, the survey method was used for collecting data. This questionnaire contains eight demographic questions, and 37 questions for measuring the attitude of propensity to use technology on positive and negative side. For the influencing factors of adoption wearable technology, these factors are 1) Positive attitudes to understand wearable technologies 2) Expectations for creating positive experiences 3) Trust on wearable devices and 4) Self-confidence on maintenance of own health. Respondent checks the influence factors of wearable technology devices that affect from attitude of propensity to use wearable technology. The technology readiness that is used in the questionnaire are 12 items from TRI1.0 (Parasuraman, 2000). The questions are adopted from previous literature (Björnfot & Bakken, 2013). All items are measured using a 5-point Likert scale anchored by “Strongly agree” and “Strongly disagree”. Detail of questionnair survery are shown in Appendix B for senior and Appendix C for family members and caregivers.

In order to confirm the consistency of questionnaire, confirmatory factor analysis (CFA) is applied to confirm items in each part of the questionnaire. The CFA was analyzed by SPSS program version 22. The items with factor loading on Appendix D shows the reliable of all questions with Cronbach's α of more than 0.60 (Gusmerotti et al., 2016).

#### *4.2.2.4 Data analysis*

This structural equation modelling analysis was performed by using SPSS Amos 22 software. This methodology is useful for grouping the influencing factor and understanding the relationship between factors that cannot be observed directly.

For the measurement in this research, we concern about four frequently used variables that are 1) the minimum discrepancy divided by its degrees of freedom (CMIN/DF) used to identify the acceptable fit between the hypothetical model and the sample data (Steiger, 1980), 2) the goodness of fit index (GFI) which determine the sample size effects, the adjusted goodness of fit index (AGFI) used to compare the fit of a target model to the fit of an independent, and 4) the comparative fit index (CFI), used to determine the non-normal distribution (J. Lee et al., 2016), 5) the root-mean-squared error of approximation (RMSEA) that yields the effect of model complexity by the number of degrees of freedom for testing the model (Van Uem et al., 2016), Finally, the chi-square value and used to calculate a p-value. That proves the null hypothesis that the predicted model and observed data are equal (Schumacker & Lomax, 2010).

### 4.2.3 Results

According to attracting and retaining stakeholders' attention is challenging, understand stakeholder attitudes is the point to satisfy the requirement from stakeholder insight. The result in this part will be presented the effect of attitude toward propensity to use technology with influencing factor for each stakeholder in aging society.

#### *4.2.3.1 Demographic Data*

Descriptive analysis was conducted to summarize the demographic data of the respondents. Table 4.6 shows the demographic data from 360 respondents in Thailand.

**Table 4.6** Demographic data from 360 respondents in Thailand

| Variable | Detail | Number of people | | |
|---|---|---|---|---|
| | | **Seniors** | **Family Members** | **Caregivers** |
| Sex | Male | 38 | 44 | 15 |
| | Female | 82 | 76 | 105 |
| Age | 21-30 Years | - | 35 | 81 |
| | 31-40 Years | - | 55 | 31 |
| | 41-50 Years | - | 16 | 8 |
| | 61-60 Years | - | 14 | - |
| | > 60 Years | 120 | - | - |
| Education | Junior and high school | 25 | 4 | 5 |
| | Bachelor's degree | 58 | 74 | 101 |
| | Master's degree | 31 | 41 | 14 |
| | Doctoral degree | 6 | 1 | - |
| Wearable Device Interested | Smartwatch | 81 | 72 | 75 |
| | Tracker | 21 | 25 | 31 |
| | Smartglasses | 18 | 23 | 14 |

#### *4.2.3.2 Stakeholder Attitude*

- All stakeholders

This study uses Structural Equation Modelling (SEM) through AMOS 22.0 distributed by SPSS to analyse the research hypotheses.

Table 4.7 showed the results for overall fits of the proposed model. The chi-square results were divided by the degrees of freedom; this means that the proposed model was acceptable (CMIN/DF = 1.114), as the acceptable value was less than 3. The GFI (Goodness of Fit Index) and AGFI (Adjusted Goodness of Fit Index) were used with maximum likelihood estimation for missing data, as the value should be greater than 0.8. The values were GFI=0.942 and AGFI=0.892, which both were acceptable for fits of models. CFI (Comparative Fit Index) were used to compare the fit of a target model to the fit of an independent as the value should be greater than 0.9. CFI from the model was 0.997. RMSEA is a corrected statistics value that gave a penalty for model complexity, calculated as root mean squared error of approximation. RMSEA from the proposed model was 0.018 that was less than 0.08. Accordingly, all fit indexes were acceptable for the proposed model in the effect of attitude toward propensity to use technology with influencing factor (P-value=0.063). Therefore, we accept all hypotheses relating to the effect of attitude toward propensity to use technology with influencing factor for stakeholder in aging society. Positive technology readiness, and negative technology readiness (H1-2) and the correlations of the Positive attitudes to understand wearable technologies factors (H3) affected the attitude toward propensity to use technology. Positive attitudes to understand wearable technologies (H3) affected the expectations for creating positive experiences, trust on wearable devices, and self-confidence on maintenance of own health factors. For the structural equation model are shown on Appendix E.

**Table 4.7** Overall fit index of structural model (All stakeholders)

| Fit index | Criteria | Result |
|---|---|---|
| P-value | > 0.050 | 0.063 |
| $X^2$/d.f. (CMIN/d.f.) | < 3.000 | 1.114 |
| GFI | > 0.800 | 0.942 |
| AGIF | > 0.800 | 0.892 |
| CIF | >0.900 | 0.997 |
| RMSEA | < 0.080 | 0.018 |

To summarize the results of SEM, from Figure 4.6, eight paths are significant with p-value less than 0.05. The significant paths consist of H1a, H1b, H1c and H2d, testing the effect of positive technology readiness to positive attitudes to understand wearable technologies, expectations for creating positive experiences, trust on wearable devices and Self-confidence on maintenance of own health for health. H2c representing testing the effect of negative technology readiness to trust on wearable devices. H3a, H3b and H3c representing the path from positive attitudes to understand wearable technologies to expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health.

Positive technology readiness is directly positive to positive attitudes to understand wearable technologies, expectations for creating positive experiences, trust in wearable devices and self-confidence in the maintenance of own health. In contrast, the negative technology readiness is directly positive to trust in wearable devices. The factor of positive attitudes to understand wearable technologies can be interpreted to have an indirect effect on expectations for creating positive experiences, trust in wearable devices and self-confidence in maintenance of own health.

**Figure 4.6** A result from Structural Equation Modelling of All stakeholders

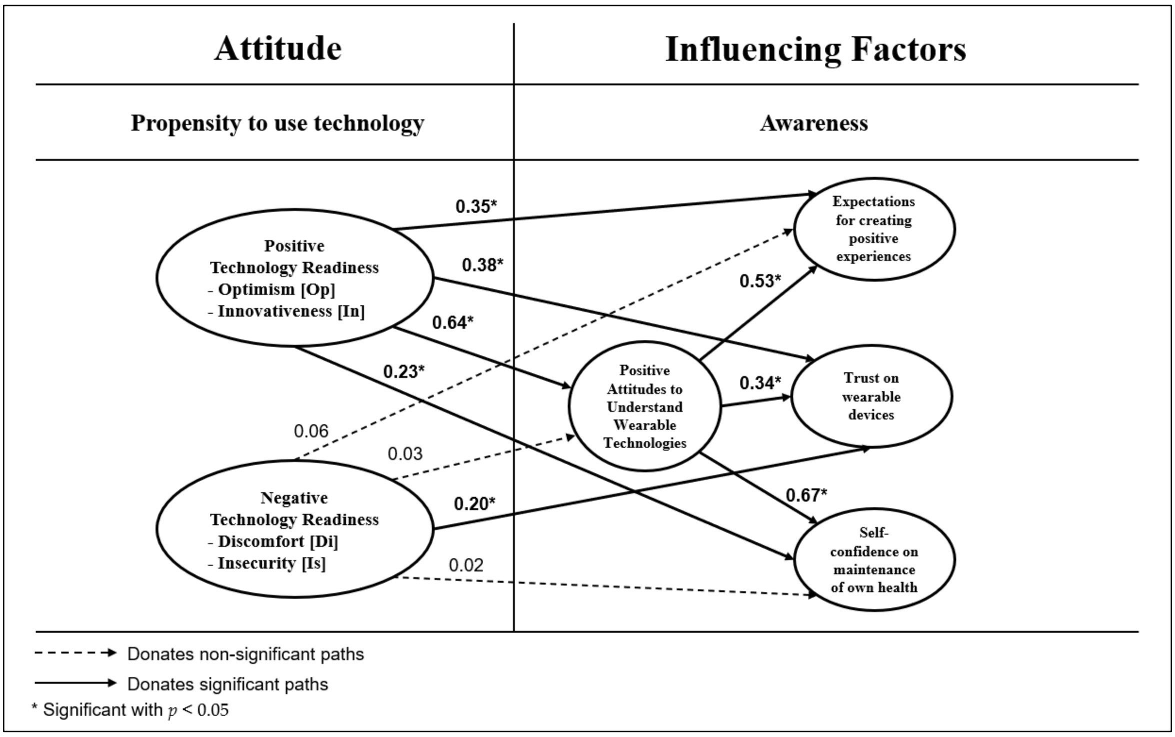


**Table 4.8** Results from Structural Equation Modelling (All stakeholders)

| Variable (To) | Variable (From) | Standardized Estimate | Standard error | t-ratio | p-value | Squared Multiple Correlations (R2) |
|---|---|---|---|---|---|---|
| Positive TR | Positive Attitudes to Understand Wearable Technologies | 0.639 | 0.065 | 10.623 | 0.000* | 43.00% |
| Positive TR | Expectations for creating positive experiences | 0.353 | 0.052 | 7.070 | 0.000* | 69.30% |
| Positive TR | Trust on wearable devices | 0.380 | 0.067 | 6.356 | 0.000* | 60.20% |
| Positive TR | Self-confidence on maintenance of own health | 0.233 | 0.049 | 4.684 | 0.000* | 72.60% |
| Negative TR | Positive Attitudes to Understand Wearable Technologies | 0.031 | 0.062 | 0.556 | 0.579 | 43.00% |
| Negative TR | Expectations for creating positive experiences | 0.056 | 0.040 | 1.466 | 0.143 | 69.30% |
| Negative TR | Trust on wearable devices | 0.203 | 0.054 | 4.244 | 0.000* | 60.20% |
| Negative TR | Self-confidence on maintenance of own health | 0.019 | 0.039 | 0.493 | 0.622 | 72.60% |
| Positive attitudes to understand wearable technologies | Expectations for creating positive experiences | 0.528 | 0.046 | 11.059 | 0.000* | 69.30% |
| Positive attitudes to understand wearable technologies | Trust on wearable devices | 0.341 | 0.054 | 6.559 | 0.000* | 60.20% |
| Positive attitudes to understand wearable technologies | Self-confidence on maintenance of own health | 0.672 | 0.046 | 13.170 | 0.000* | 72.60% |

* Significant with $p < 0.05$

The results in Table 4.8 shows that, under 95% confidence level, in term of positive technology readiness (Positive TR) affects the positive attitudes to positive attitudes to understand wearable technologies, expectations for creating Expectations for creating expectations for creating positive experiences, trust on wearable devices, and self-confidence on maintenance of own health with the p-value of 0.000 ($p < 0.05$). For the negative technology readiness (Negative TR) affects the trust on wearable devices with the p-value of 0.000 ($p < 0.05$). For the positive attitudes to understand wearable technologies affects the expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health with the p-value of 0.000 ($p < 0.05$).

After the SEM model for All stakeholders were analysed, we also separate the individual model of stakeholder for compare about the different attitude toward propensity to use technology with influencing factor. The result was presented as follows.

- Senior

Table 4.9 showed the results for overall fits of the proposed model. The chi-square results were divided by the degrees of freedom; this means that the proposed model was acceptable (CMIN/DF = 2.409), as the acceptable value was less than 3. CFI (Comparative Fit Index) were used to compare the fit of a target model to the fit of an independent as the value should be greater than 0.9. CFI from the model was 0.905. Therefore, we accept all hypotheses relating to the effect of attitude toward propensity to use technology with influencing factor for stakeholder in aging society. For the structural equation model are shown on Appendix F.

**Table 4.9** Overall fit index of structural model (senior)

| Fit index | Criteria | Result |
|---|---|---|
| $X^2$/d.f. (CMIN/d.f.) | < 3.000 | 2.409 |
| CIF | >0.900 | 0.905 |

To summarize the results of SEM, from Figure 4.7, nine paths are significant with p-value less than 0.05. The significant paths consist of H1a, H1b, H1c and H2d, testing the effect of positive technology readiness to positive attitudes to understand wearable technologies, expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health. H2c and H2d representing testing the effect of negative technology readiness to trust on wearable devices and self-confidence on maintenance of own health. H3a, H3b and H3c representing the path from positive attitudes to understand wearable technologies to expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health.

The positive technology readiness is directly positive to positive attitudes to understand wearable technologies, expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health, while the negative technology readiness is directly positive to trust on wearable devices and self-confidence on maintenance of own health. The factor of positive attitudes to understand wearable technologies can be interpreted to have an indirect effect to expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health.

**Figure 4.7** Result from Structural Equation Modelling of Senior

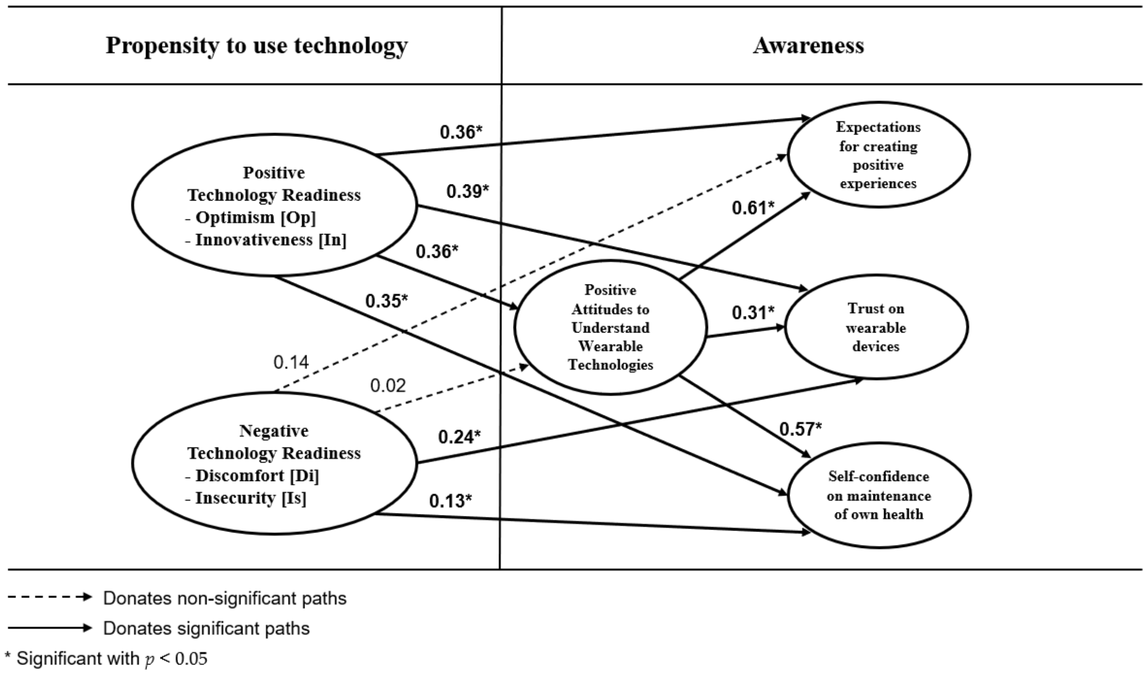


**Table 4.10** Results from Structural Equation Modelling (Senior)

| **Variable (To)** | **Variable (From)** | **Standardized Estimate** | **Standard error** | **t-ratio** | **p-value** | **Squared Multiple Correlations (R2)** |
|---|---|---|---|---|---|---|
| Positive TR | Positive attitudes to understand wearable technologies | 0.360 | 0.117 | 3.449 | 0.000* | 20.60% |
| Positive TR | Expectations for creating positive experiences | 0.356 | 0.076 | 5.400 | 0.000* | 70.80% |
| Positive TR | Trust on wearable devices | 0.387 | 0.103 | 4.513 | 0.000* | 56.30% |
| Positive TR | Self-confidence on maintenance of own health | 0.347 | 0.068 | 5.372 | 0.000* | 73.40% |
| Negative TR | Positive attitudes to understand wearable technologies | 0.143 | 0.126 | 1.326 | 0.185 | 20.60% |
| Negative TR | Expectations for creating positive experiences | 0.022 | 0.075 | 0.357 | 0.721 | 70.80% |
| Negative TR | Trust on wearable devices | 0.244 | 0.106 | 2.882 | 0.004* | 56.30% |
| Negative TR | Self-confidence on maintenance of own health | 0.133 | 0.067 | 2.180 | 0.029* | 73.40% |
| Positive attitudes to understand wearable technologies | Expectations for creating positive experiences | 0.611 | 0.069 | 9.127 | 0.000* | 70.80% |
| Positive attitudes to understand wearable technologies | Trust on wearable devices | 0.309 | 0.077 | 4.300 | 0.000* | 56.30% |
| Positive attitudes to understand wearable technologies | Self-confidence on maintenance of own health | 0.568 | 0.059 | 9.009 | 0.000* | 73.40% |

* Significant with $p < 0.05$

The results in Table 4.10 shows that, under 95% confidence level, in term of positive technology readiness (Positive TR) affects the positive attitudes to understand wearable technologies, expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health with the p-value of 0.000 ($p < 0.05$). For the negative technology readiness (Negative TR) affects the trust on wearable devices and self-confidence on maintenance of own health with the p-value of 0.000 ($p < 0.05$). For the positive attitudes to understand wearable technologies affects the expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health with the p-value of 0.000 ($p < 0.05$).

- Formal Caregiver

Table 4.11 showed the results for overall fits of the proposed model. The chi-square results were divided by the degrees of freedom; this means that the proposed model was acceptable (CMIN/DF = 1.604), as the acceptable value was less than 3. CFI (Comparative Fit Index) were used to compare the fit of a target model to the fit of an independent as the value should be greater than 0.9. CFI from the model was 0.945. Therefore, we accept all hypotheses relating to the effect of attitude toward propensity to use technology with influencing factor for stakeholder in aging society. For the structural equation model are shown on Appendix G.

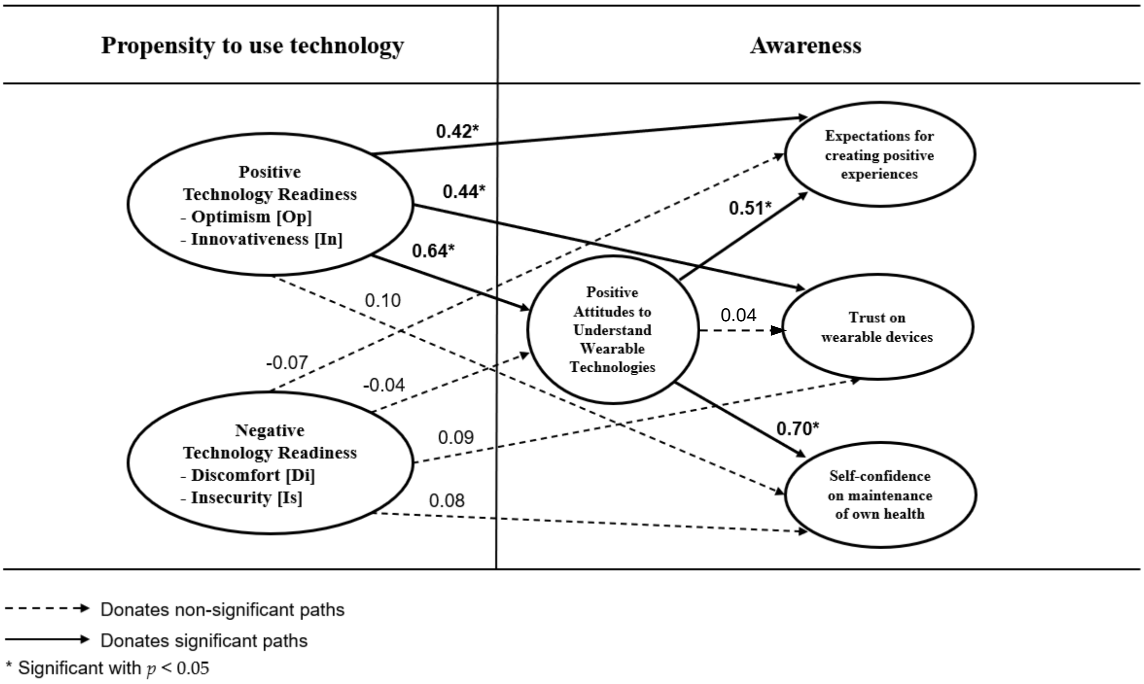
**Table 4.11** Overall fit index of structural model (formal caregiver)

| Fit index | Criteria | Result |
|---|---|---|
| $X^2$/d.f. (CMIN/d.f.) | < 3.000 | 1.604 |
| CIF | >0.900 | 0.945 |

To summarize the results of SEM, from Figure 4.8, six paths are significant with p-value less than 0.05. The significant paths consist of H1a, H1b, and H1c testing the effect of positive technology readiness to positive attitudes to understand wearable technologies, expectations for creating positive experiences and trust on wearable devices. H3a, H3b and H3c representing the path from positive attitudes to understand wearable technologies to expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health.

The positive technology readiness is directly positive to positive attitudes to understand wearable technologies, expectations for creating positive experiences, and trust on wearable devices. For the factor of positive attitudes to understand wearable technologies can be interpreted to have an indirect effect to expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health.

**Figure 4.8** Result from Structural Equation Modelling of Formal Caregiver




The results in Table 4.12 shows that, under 95% confidence level, in term of positive technology readiness (Positive TR) affects the positive attitudes to understand wearable technologies, expectations for creating positive experiences and trust on wearable devices with the p-value of 0.000 ($p < 0.05$). For the positive attitudes to understand wearable technologies affects the expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health with the p-value of 0.000 ($p < 0.05$).

**Table 4.12** Results from Structural Equation Modelling (formal caregiver)

| Variable (To) | Variable (From) | Standardized Estimate | Standard error | t-ratio | p-value | Squared Multiple Correlations (R2) |
|---|---|---|---|---|---|---|
| Positive TR | Positive attitudes to understand wearable technologies | 0.640 | 0.106 | 6.234 | 0.000* | 38.70% |
| Positive TR | Expectations for creating positive experiences | 0.423 | 0.076 | 4.952 | 0.000* | 66.20% |
| Positive TR | Trust on wearable devices | 0.438 | 0.097 | 4.419 | 0.000* | 63.30% |
| Positive TR | Self-confidence on maintenance of own health | 0.098 | 0.084 | 1.157 | 0.247 | 62.50% |
| Negative TR | Positive attitudes to understand wearable technologies | -0.041 | 0.102 | -0.409 | 0.682 | 38.70% |
| Negative TR | Expectations for creating positive experiences | -0.074 | 0.054 | -1.223 | 0.221 | 66.20% |
| Negative TR | Trust on wearable devices | 0.093 | 0.075 | 1.231 | 0.218 | 63.30% |
| Negative TR | Self-confidence on maintenance of own health | 0.083 | 0.065 | 1.268 | 0.205 | 62.50% |
| Positive attitudes to understand wearable technologies | Expectations for creating positive experiences | 0.509 | 0.071 | 6.197 | 0.000* | 66.20% |
| Positive attitudes to understand wearable technologies | Trust on wearable devices | 0.398 | 0.084 | 4.554 | 0.000* | 63.30% |
| Positive attitudes to understand wearable technologies | Self-confidence on maintenance of own health | 0.698 | 0.087 | 7.748 | 0.000* | 62.50% |

* Significant with $p < 0.05$

- Family Members

Table 4.13 showed the results for overall fits of the proposed model. The chi-square results were divided by the degrees of freedom; this means that the proposed model was acceptable (CMIN/DF = 1.396), as the acceptable value was less than 3. CFI (Comparative Fit Index) were used to compare the fit of a target model to the fit of an independent as the value should be greater than 0.9. CFI from the model was 0.965. Therefore, we accept all hypotheses relating to the effect of attitude toward propensity to use technology with influencing factor for stakeholder in aging society. For the structural equation model are shown on Appendix H.

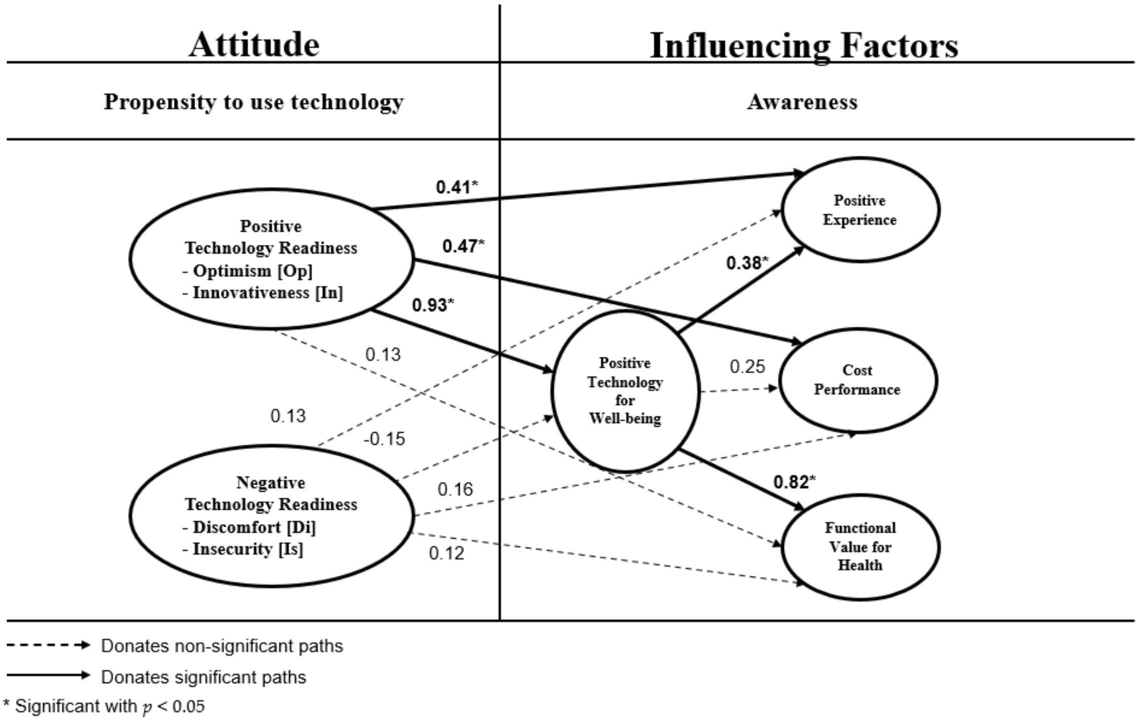
**Table 4.13** Overall fit index of structural model (family member)

| Fit index | Criteria | Result |
|---|---|---|
| $X^2$/d.f. (CMIN/d.f.) | < 3.000 | 1.396 |
| CIF | >0.900 | 0.965 |

To summarize the results of SEM, from Figure 4.9, nine paths are significant with p-value less than 0.05. The significant paths consist of H1a, H1b, and H1c testing the effect of positive technology readiness to positive attitudes to understand wearable technologies, expectations for creating positive experiences and trust on wearable devices. H2b and H2c representing the path from negative technology readiness to expectations for creating positive experiences and trust on wearable devices, while the positive attitudes to understand wearable technologies as H2a shows negative relationship. H3a, H3b and H3c representing the path from positive attitudes to understand wearable technologies to expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health.

The positive technology readiness is directly positive to positive attitudes to understand wearable technologies, expectations for creating positive experiences, and trust on wearable devices. The negative technology readiness is directly positive to expectations for creating positive experiences, and trust on wearable devices, while the positive attitudes to understand wearable technologies shows negative relationship. The attitude of negative technology readiness can be interpreted to have an indirect effect to the positive attitudes to understand wearable technologies. For the factor of positive attitudes to understand wearable technologies can be interpreted to have an indirect effect to expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health.

**Figure 4.9** Result from Structural Equation Modelling of family member




The results in Table 4.14 shows that, under 95% confidence level, in term of positive technology readiness (Positive TR) affects the positive attitudes to understand wearable technologies, expectations for creating positive experiences and trust on wearable devices with the p-value of 0.000 ($p < 0.05$). For the negative technology readiness (Negative TR) affects the positive attitudes to understand wearable technologies, expectations for creating positive experiences and trust on wearable devices with the p-value of 0.082, 0.054 and 0.059 ($p < 0.10$), respectively. For the positive attitudes to understand wearable technologies affects the expectations for creating positive experiences, trust on wearable devices and self-confidence on maintenance of own health with the p-value of 0.000 ($p < 0.05$), 0.058 ($p < 0.10$) and 0.000 ($p < 0.05$), respectively.

**Table 4.14** Results from Structural Equation Modelling (family member)

| Variable (To) | Variable (From) | Standardized Estimate | Standard error | t-ratio | p-value | Squared Multiple Correlations (R2) |
|---|---|---|---|---|---|---|
| Positive TR | Positive attitudes to understand wearable technologies | 0.925 | 0.138 | 8.460 | 0.000* | 72.00% |
| Positive TR | Expectations for creating positive experiences | 0.414 | 0.149 | 3.153 | 0.002* | 70.50% |
| Positive TR | Trust on wearable devices | 0.473 | 0.200 | 2.912 | 0.004* | 63.30% |
| Positive TR | Self-confidence on maintenance of own health | 0.134 | 0.158 | 0.902 | 0.367 | 79.30% |
| Negative TR | Positive attitudes to understand wearable technologies | -0.149 | 0.106 | -1.739 | 0.082 | 72.00% |
| Negative TR | Expectations for creating positive experiences | 0.132 | 0.076 | 1.923 | 0.054 | 70.50% |
| Negative TR | Trust on wearable devices | 0.161 | 0.102 | 1.885 | 0.059 | 63.30% |
| Negative TR | Self-confidence on maintenance of own health | -0.120 | 0.077 | -1.603 | 0.109 | 79.30% |
| Positive attitudes to understand wearable technologies | Expectations for creating positive experiences | 0.385 | 0.097 | 3.574 | 0.000* | 70.50% |
| Positive attitudes to understand wearable technologies | Trust on wearable devices | 0.252 | 0.130 | 1.893 | 0.058 | 63.30% |
| Positive attitudes to understand wearable technologies | Self-confidence on maintenance of own health | 0.818 | 0.118 | 5.815 | 0.000* | 79.30% |

* Significant with $p < 0.05$

#### *4.2.3.3 Compared survey result among multiple stakeholders*

The result in table 4.15 revealed of summary coefficients direct effect and indirect effect of the model the structural equation modelling analysis the effect of attitude toward propensity to use technology with influencing factor in Thailand aging society. The positive attitudes to understand wearable technologies, expectations for creating positive experiences, and trust on wearable devices are significant effect to the positive attitude toward propensity to use wearable technology for All stakeholders, while the self-confidence on maintenance of own health is significant effect to the positive attitude for seniors. In term of negative attitude, trust on wearable devices is a significant effect for the senior and family member. Moreover, the positive attitudes to understand wearable technologies and expectations for creating positive experiences are significant effect to the negative attitude for the family member. For the senior, self-confidence on maintenance of own health is a significant effect on the negative attitude. In this study, the negative attitude for influencing factor for the formal caregiver was unshown on the result.

**Table 4.15** The comparison among multiple stakeholders on the summary coefficients direct effect and indirect effect of SEM model.

| **Influencing Factors** | **Standardized Effects** | **All stakeholders** | | **Senior** | | **Formal Caregiver** | | **Family Member** | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Negative TR** | **Positive TR** | **Negative TR** | **Positive TR** | **Negative TR** | **Positive TR** | **Negative TR** | **Positive TR** |
| Positive Attitudes to Understand Wearable Technology | Total Effects | 0.031 | **0.639*** | 0.143 | **0.360*** | -0.041 | **0.640*** | **-0.149** | **0.925*** |
| | Direct Effects | 0.031 | **0.639*** | 0.143 | **0.360*** | -0.041 | **0.640*** | **-0.149** | **0.925*** |
| | Indirect Effects | 0.000 | **0.000*** | 0.000 | **0.000*** | 0.000 | **0.000*** | **0.000** | **0.000*** |
| Expectations for creating positive experiences | Total Effects | 0.073 | **0.690*** | 0.11 | **0.576*** | -0.095 | **0.749*** | **0.075** | **0.770*** |
| | Direct Effects | 0.056 | **0.353*** | 0.022 | **0.356*** | -0.074 | **0.423*** | **0.132** | **0.414*** |
| | Indirect Effects | 0.017 | **0.337*** | 0.087 | **0.220*** | 0.087 | **0.220*** | **-0.057** | **0.356*** |
| Trust on wearable devices | Total Effects | **0.214*** | **0.598*** | **0.289*** | **0.498*** | 0.077 | **0.692*** | **0.123** | **0.707*** |
| | Direct Effects | **0.203*** | **0.380*** | **0.244*** | **0.387*** | 0.093 | **0.438*** | **0.161** | **0.473*** |
| | Indirect Effects | **0.011*** | **0.218*** | **0.044*** | **0.111*** | 0.044 | **0.111*** | **-0.038** | **0.234*** |
| Self-confidence on maintenance of own health | Total Effects | 0.040 | **0.662*** | **0.214*** | **0.551*** | 0.054 | 0.544 | -0.242 | 0.891 |
| | Direct Effects | 0.019 | **0.233*** | **0.133*** | **0.347*** | 0.083 | 0.098 | -0.12 | 0.134 |
| | Indirect Effects | 0.021 | **0.429*** | **0.081*** | **0.204*** | 0.081 | 0.204 | -0.122 | 0.757 |

### 4.2.4 Summary

To identify the influence factors of wearable technology devices that affect the propensity to use wearable technology in an aging society. The result of this study was separated into two attitudes. The positive attitude represents the trust in the wearable that can improve their well-being. On the other hand, the negative attitude represents the unbeliever in that wearable technology device value.

Regarding the result of the positive attitude from all stakeholders related to positive attitudes to understanding wearable technology, expectations for creating positive experiences, and trust in wearable devices. On the negative side, only the result from seniors mentioned that self-confidence in maintaining own health is related to negative technology readiness.

Increased longevity is the most remarkable success story for humanity and healthcare services. Wearable technologies management focuses on the critical success factors (CSFs), expectedly self-confidence in the maintenance of own health that led to the adoption of wearable technology devices by seniors in crucial to favorable outcomes. In comparison, the result of this study showed a negative attitude to this topic. It might be the main point why wearable technology adoption cannot achieve in senior healthcare services.

In terms of success in wearable technologies adoption in senior healthcare services, self-confidence in maintaining own health is the priority to change the attitude from negative to positive technology readiness.

# Chapter 5
# Service Model by using Wearable Technology devices for aging society in Thailand

## 5.1 Modules

### 5.1.1 Expectation from Multiple Stakeholder

The result from the expectation of multiple stakeholders from sub-study one was integrated with the awareness of wearable technology devices adoption from sub-study 2. The expectations were regrouped to positive attitudes to understand wearable technology, expectations for creating positive experiences, trust in wearable devices, and self-confidence in the maintenance of own health. The modules of expectation were presented as follows.

#### *5.1.1.1 Senior Healthcare*

Senior healthcare expectations are positive attitudes to understand wearable technology, expectations for creating positive experiences, trust in wearable devices, and self-confidence in the maintenance of own health. Descriptions of each function are shown in fig. 5.1.

**Positive Attitudes to Understand Wearable Technologies**
- Real-time location by GPS.
- Location monitoring.
- Automatic location alerts.
- Emergency alerts.

**Expectations for creating positive experiences**
- Data sharing with other device.
- Activities guideline.
- Support training program development.
- Serve as medical devices

**Trust on wearable devices**
- User friendly.
- Small and lightweight.
- Voice control.

**Self-confidence on maintenance of own health**
- Health recording, monitoring and alarming.
- Schedule activities reminder.

**Figure 5.1** Expectation on Wearable Device Service for Senior Healthcare

#### *5.1.1.2 Senior*

Senior expectations are positive attitudes to understand wearable technology, expectations for creating positive experiences, trust in wearable devices, and self-confidence in maintaining own health. Descriptions of each function are shown in fig. 5.2.

**Positive Attitudes to Understand Wearable Technologies**
- Emergency alerts.

**Expectations for creating positive experiences**
- Data sharing with other device.
- Activities guideline.

**Trust on wearable devices**
- User friendly.
- Small and lightweight.
- Voice control.

**Self-confidence on maintenance of own health**
- Health recording, monitoring and alarming.

**Figure 5.2** Expectation on Wearable Device Service for Senior

#### *5.1.1.3 Family Members*

Family member expectations are positive attitudes to understand wearable technology, expectations for creating positive experiences, trust in wearable devices, and self-confidence in maintenance of own health. Descriptions of each function are shown in fig. 5.3.

**Positive Attitudes to Understand Wearable Technologies**
- Real-time location by GPS.
- Location monitoring.
- Automatic location alerts.
- Emergency alerts.

**Expectations for creating positive experiences**
- Data sharing with other device.
- Activities guideline.

**Trust on wearable devices**
- User friendly.
- Small and lightweight.
- Voice control.

**Self-confidence on maintenance of own health**
- Health recording, monitoring and alarming.
- Schedule activities reminder.

**Figure 5.3** Expectation on Wearable Device Service for Family Members

### 5.2.1 Attitude of expectation from multiple stakeholder

The result of understanding the attitude toward the propensity to use wearable technology in study 2, shows the positive and negative attitudes to the expectation of multiple stakeholders by focusing on the model to separate the main concern into two topics. The first topic is the non-significant function of a positive attitude toward the propensity to use technology, which represents unsure on wearable technology can support the expectation. The second topic is the significant function of negative attitude toward propensity to use technology, which represents unbelieve that wearable technology can support the expectation.

The attitude of senior healthcare shown unsure on wearable technology can support the expectation related to self-confidence on maintenance of own health as fig 5.4.

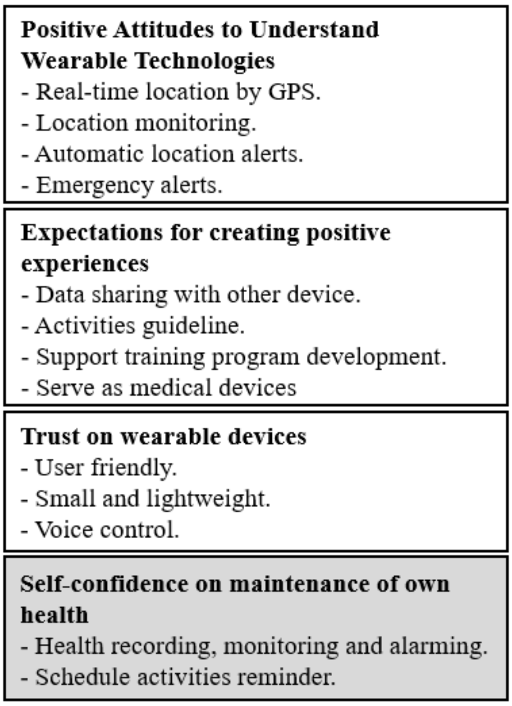



**Figure 5.4** Attitude of senior healthcare with expectation

Gray box: Unsure on wearable technology can support the expectation

The attitude of seniors showing unbelieve in wearable technology can support the expectation related to trust in wearable devices and self-confidence in maintenance of own health, as fig 5.5.

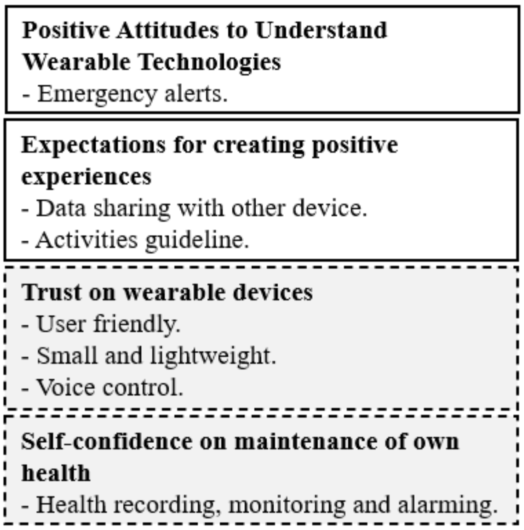



**Figure 5.5** Attitude of senior with expectation

Light grey with dash line box: Unbelieve in wearable technology can support the expectation

The attitude of family members showing unbelieve in wearable technology can support the expectation related to positive attitudes to understand wearable technology, expectations for creating positive experiences, and trust in wearable devices. Moreover, the perspective mentioned unsure about wearable technology can support the expectation related to self-confidence in maintenance of own health, as fig 5.6.

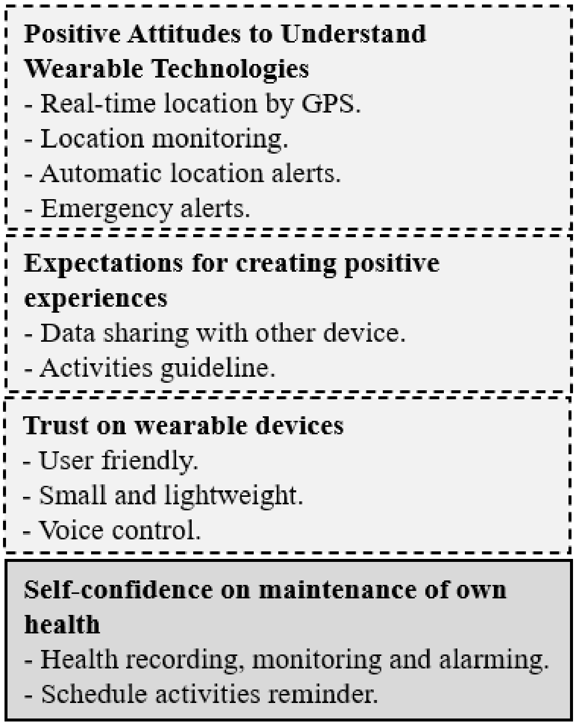



**Figure 5.6** Attitude of senior with expectation

Light gray with dash line box: Unbelieve on wearable technology can support the expectation

Gray box: Unsure on wearable technology can support the expectation

## 5.2 Wearable tech-based Senior healthcare service system

To motivate the stakeholder to adopt wearable technologies as the concept of elaboration likelihood model (ELM) of persuasion, the senior healthcare service system was proposed Senior healthcare service system by using wearable technologies as fig. 5.9. For the element, there including technology adoption mechanism as service providers, seniors, and family caregivers. And also include the healthcare value co-creation relationship when understanding the attitude of formal caregivers, informal caregivers, and senior, as shown in figure 5.7 and 5.8.

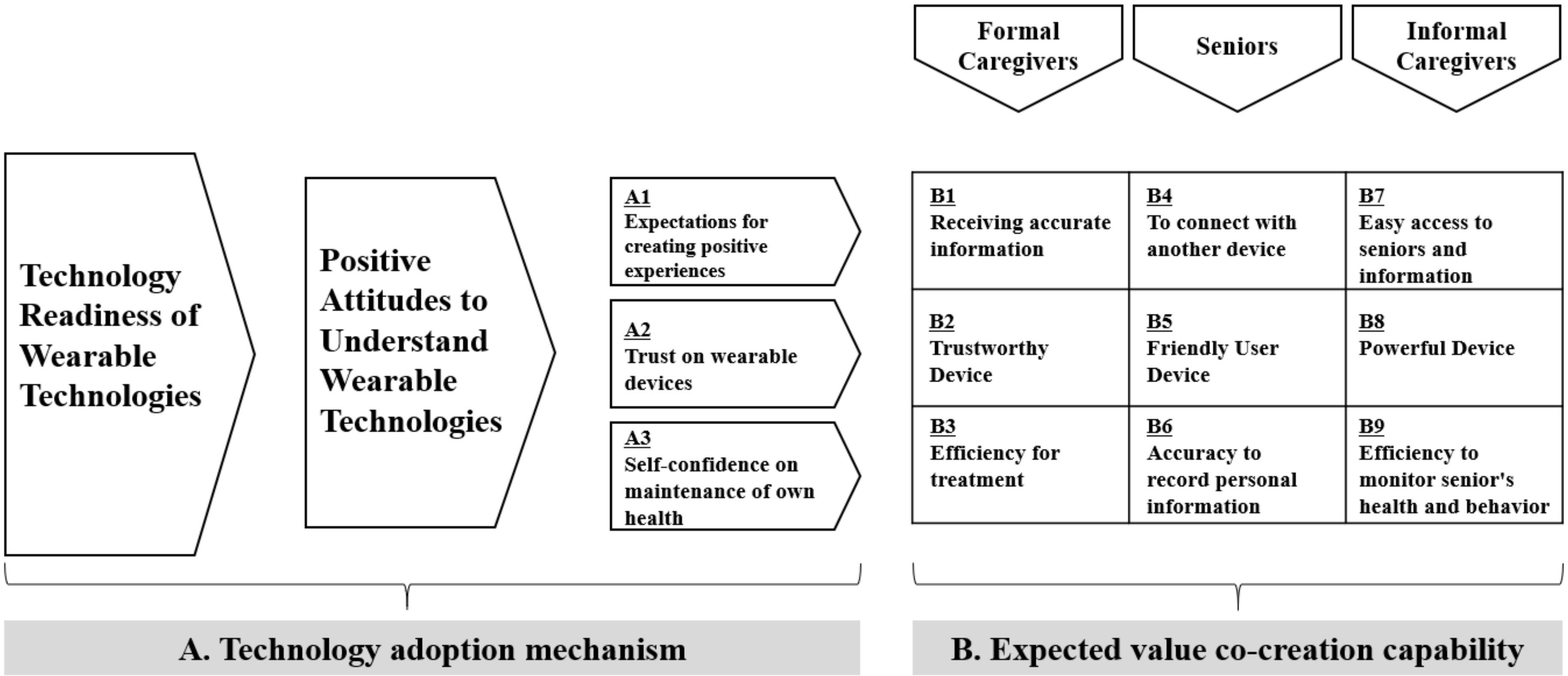



**Figure 5.7** Model of Relationship between Expectation and Expected value co-creation capability by using wearable technologies

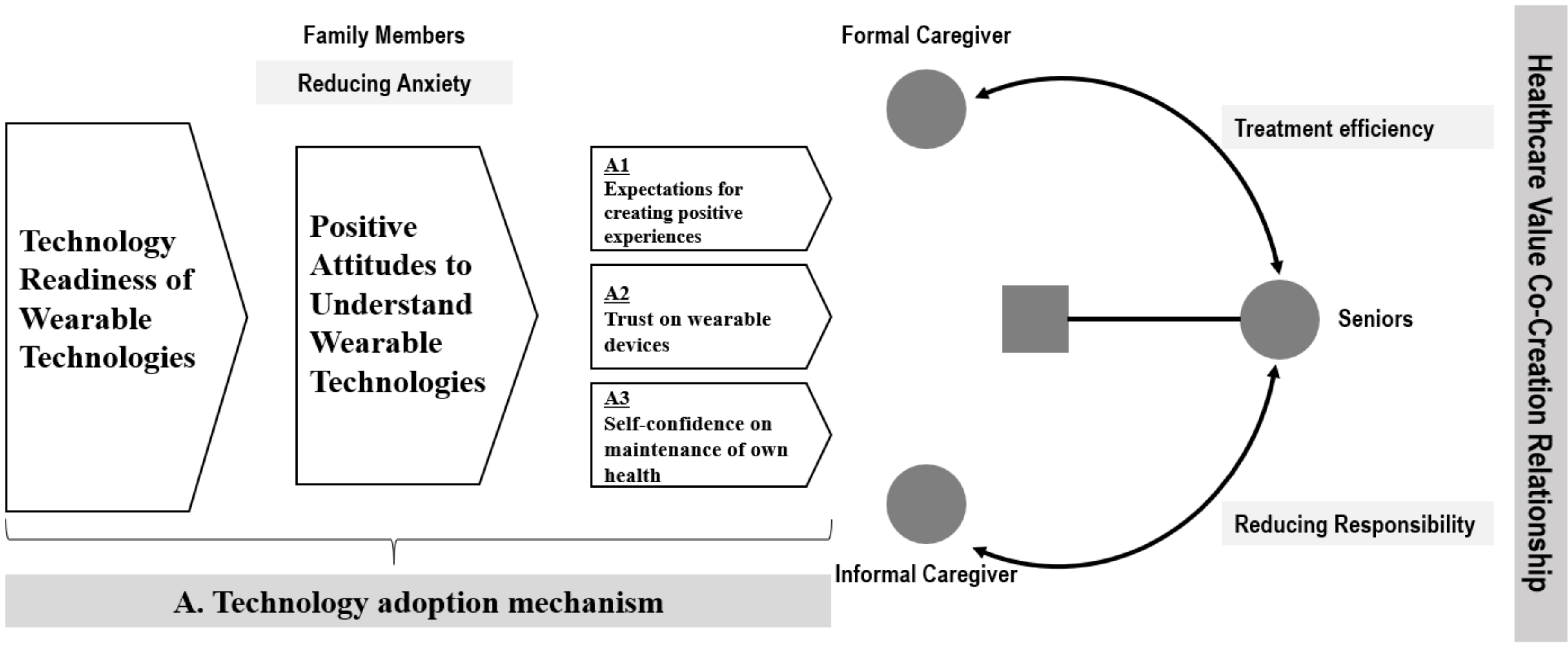



**Figure 5.8** Transformative Senior Healthcare Service from Stakeholder Expectation Model

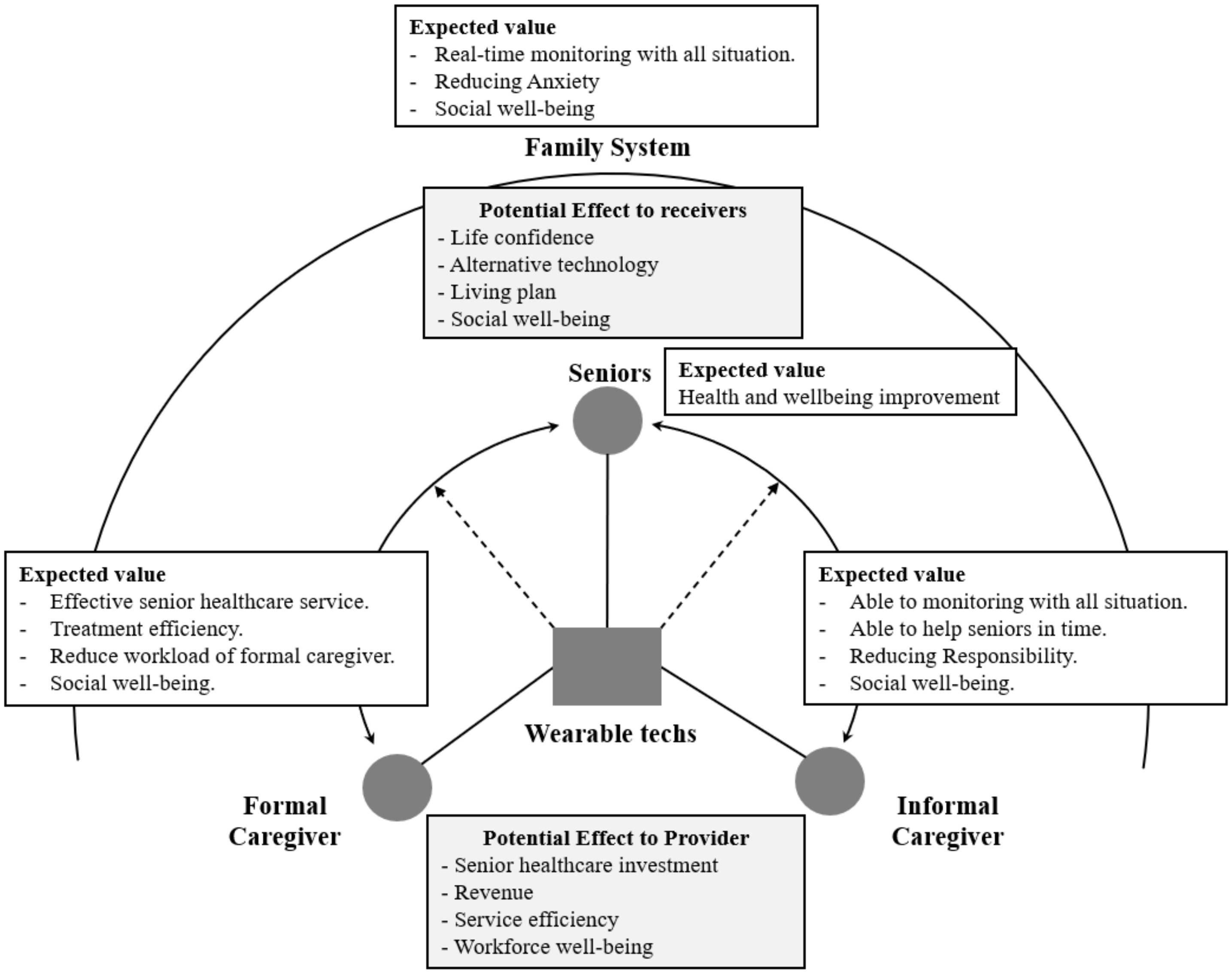



**Figure 5.9** Senior healthcare service system by using wearable technologies

To expand the healthcare value co-creation relationship can be represented in fig. 5.8. The co-creation value of wearable technology for senior healthcare, including effective senior healthcare, reduces the caregiver's workload and improves social well-being and life confidence. The potential effect on the service provider includes senior healthcare investment, revenue, service efficiency, and workforce well-being. The potential impact on the service receiver has life confidence, alternative technology, living plan and social well-being.

All model was integrated to represent the element for each stakeholder, as fig. 5.9 (senior healthcare service), fig 5.10 (senior), and fig. 5.11 (family member).

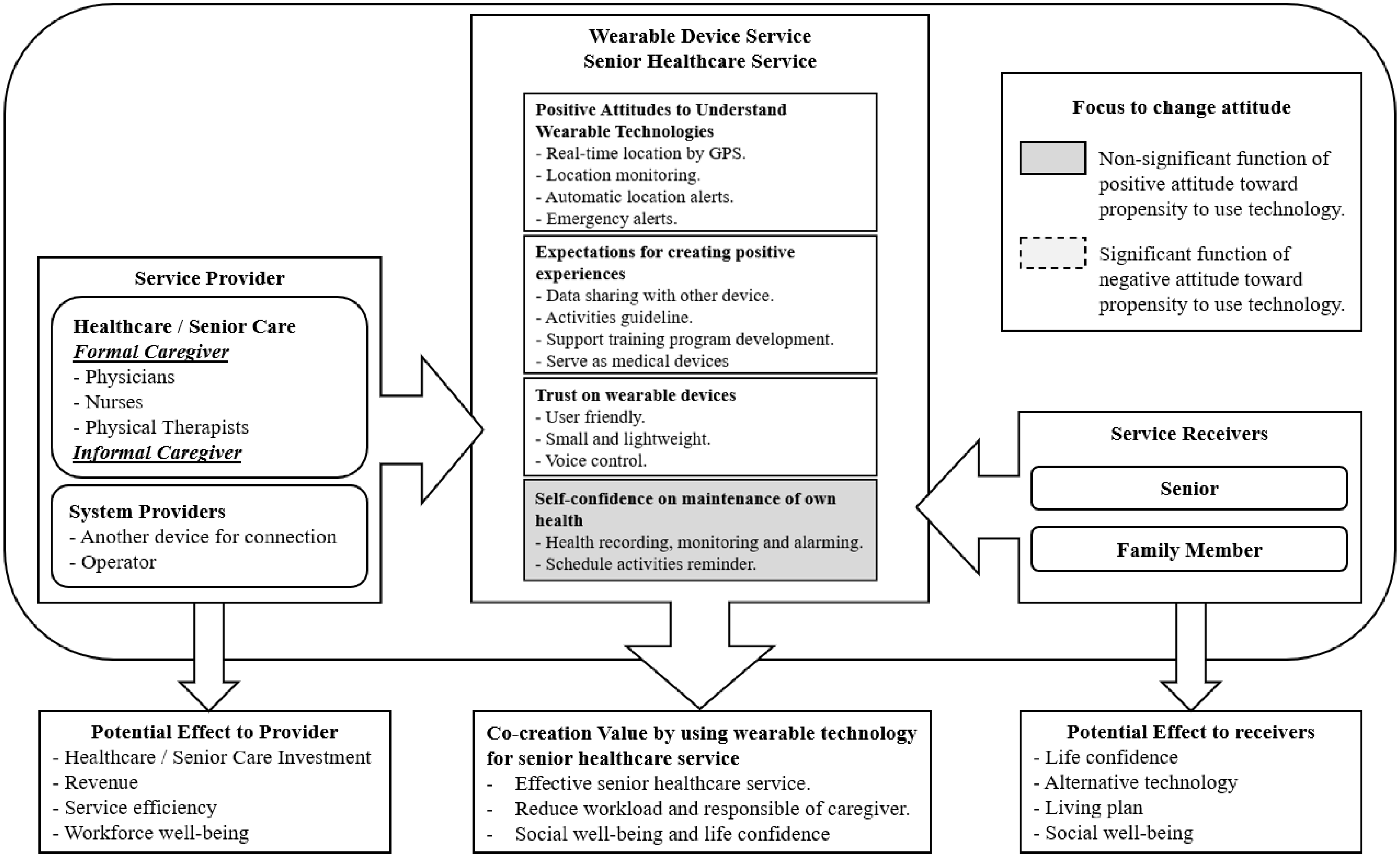



**Figure 5.10** Provider Expectation in Senior Healthcare Service System by Using Wearable Technologies

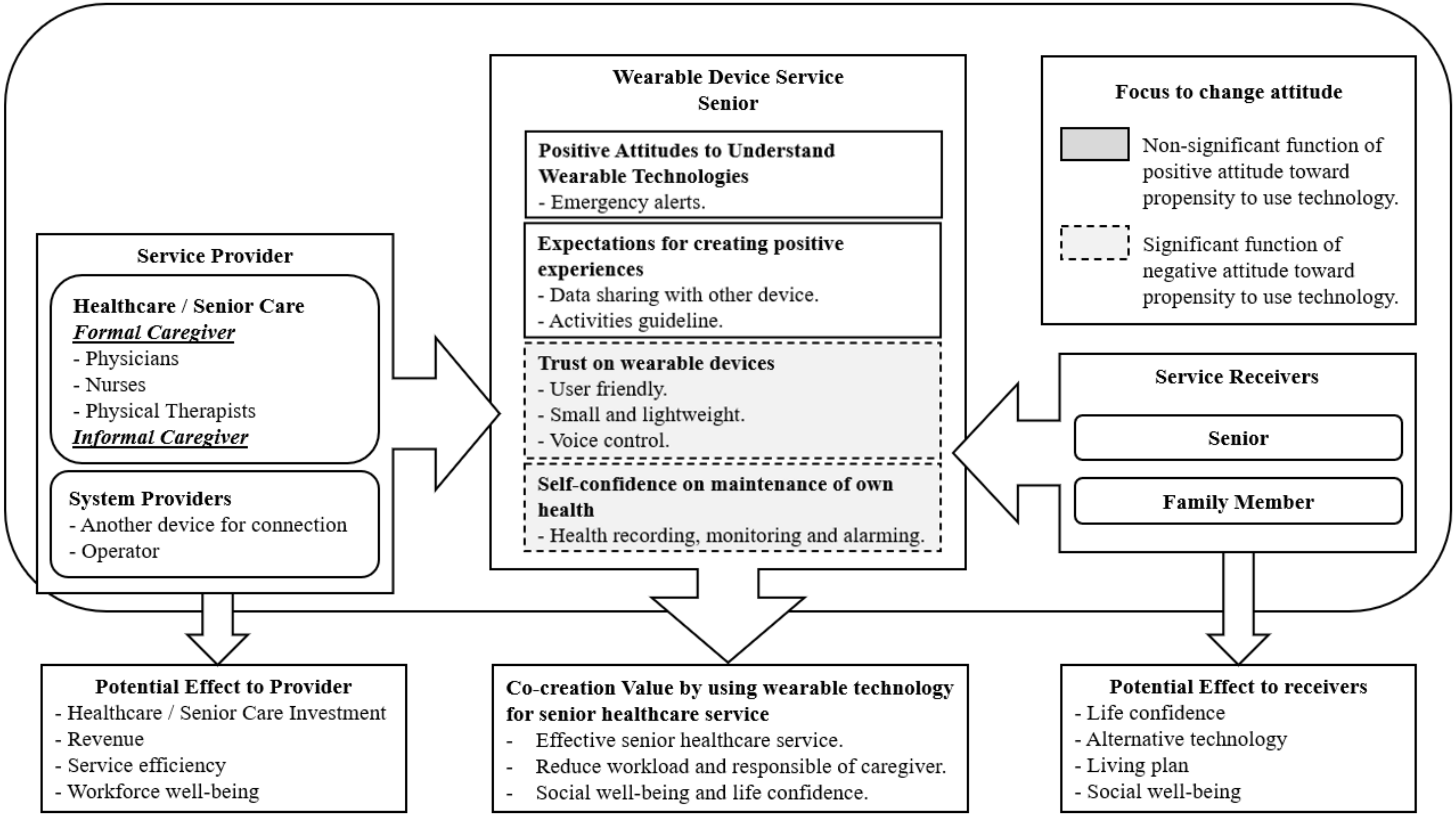



**Figure 5.11** Senior Expectation in Senior Healthcare Service System by Using Wearable Technologies

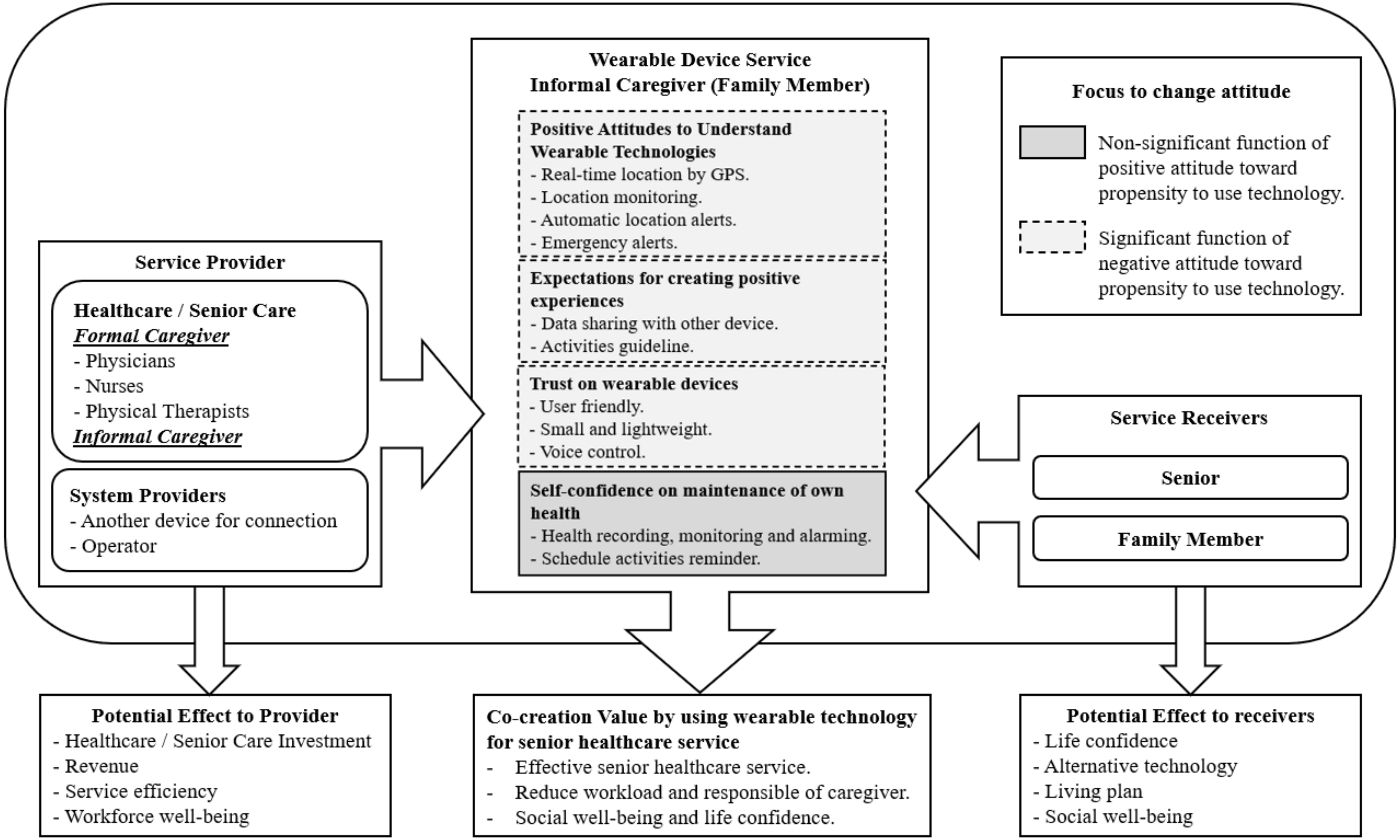



**Figure 5.12** Family Member Expectation in Senior Healthcare Service System by Using Wearable Technologies

# Chapter 6
# Conclusion and Discussion

## 6.1 Answer for research questions

### 6.1.1 SRQ 1: What are the critical success factors (CSFs) in adoption of the device that are related to improving the well-being for multiple stakeholders?

The critical success factors (CSFs) in adopting wearable technology devices for seniors in Thailand by using a grounded theory approach to analyzing data generated from interviews with multiple stakeholders showed characteristics of the interviewed stakeholders' opinions for three devices. Health preservation was mentioned for smartwatches. According to the caregivers, health preservation is important, and location functions and a daily task feature are also important for smartwatches. For trackers, the location tracking function is the most important because it enables a senior's movements to be monitored, especially unexpected events like falling. For smartglasses, the existing design makes them complicated to use; wearing comfort and voice control are attractive features for All stakeholders.

To integrate the expectations of multiple stakeholders from sub-study one and the awareness of adoption of wearable technology devices from sub-study 2. The expectations were regrouped to positive attitudes to understand wearable technology, expectations for creating positive experiences, trust in wearable devices, and self-confidence in the maintenance of own health.

And the result can present the detail of expectations for All stakeholders by giving a simple figure.

### 6.1.2 SRQ 2: What are the effects of attitude toward propensity to use technology with awareness for improving stakeholder well-being?

The concept of technology readiness was used to measure people's inclination to adopt new technology (Shirahada et al., 2019). That can represent both positive and negative technology readiness. The result of this study was separated into two attitudes. The positive attitude represents the trust in a wearable device that can improve their well-being. On the other hand, a negative attitude means an unbeliever in the value of wearable technology devices.

After analyzing the result with the expectation of multiple stakeholders from the SRQ 1, that shows the positive and negative attitudes to the expectation of various stakeholders by focusing on the model to separate the main concern into two topics. The first topic is the non-significant function of a positive attitude toward the propensity to use technology, which represents unsure on wearable technology can support the expectation. The second topic is the significant function of negative attitude toward propensity to use technology, which represents unbelieve that wearable technology can support the expectation.

The detail of attitude can guide the significant reason why the wearable technology adoption in senior healthcare service cannot succeed in the past and identifies the way to motivate the right way to achieve wearable adoption in the future.

### 6.1.3 SRQ 3: What are potential effects on co-create values of stakeholders in senior healthcare service system by using wearable device?

During the interview, multiple stakeholders in aging society discussed the value of co-creation by using wearable technology devices in terms of different opinions for All stakeholders. The potential effects of co-create values were discussed and mentioned during the in-depth interview.

The result of this part can describe by being separated in terms of service provider and service receiver. The service provider is senior healthcare services, including the potential effect from formal and informal caregivers, for the service receivers are seniors and family members.

The co-creation value of using wearable technology for senior healthcare, including effective senior healthcare, reduces the caregiver's workload and improves social well-being and life confidence. The potential effect on a service provider, there are including senior healthcare investment, revenue, service efficiency, and workforce well-being. The potential effect on service receivers, there are included life confidence, alternative technology, living plan and social well-being.

### 6.1.4 MRQ: How to integrate expectation and attitude of wearable technologies to propose the Senior healthcare service system by using wearable technologies?

According to the positive attitudes to understand wearable technologies, the significant effect on expectations for creating positive experiences, trust in wearable devices, and self-confidence in the maintenance of own health. Although, the positive attitude motivate stakeholder to propose the expected value co-creation capability among society, as shown in figure 5.9. Then, value co-creation can improve the senior healthcare service system and stakeholder well-being.

In terms of integration, the model of the relationship between expectation and expected value co-creation capability by using wearable technologies, as shown in figure 5.7, was integrated with expectation and attitude toward propensity to use wearable technology for creating transformative senior healthcare service from the stakeholder expectation model, figure 5.8. After that, the primary model of the senior healthcare service system using wearable technologies was proposed to represent all elements in the senior healthcare service system in figure 5.9. Moreover, the summarized expectation model for each stakeholder is shown in figures 5.10-5.12. In conclusion, figure 6.1 summarizes all findings that answer all research problems.

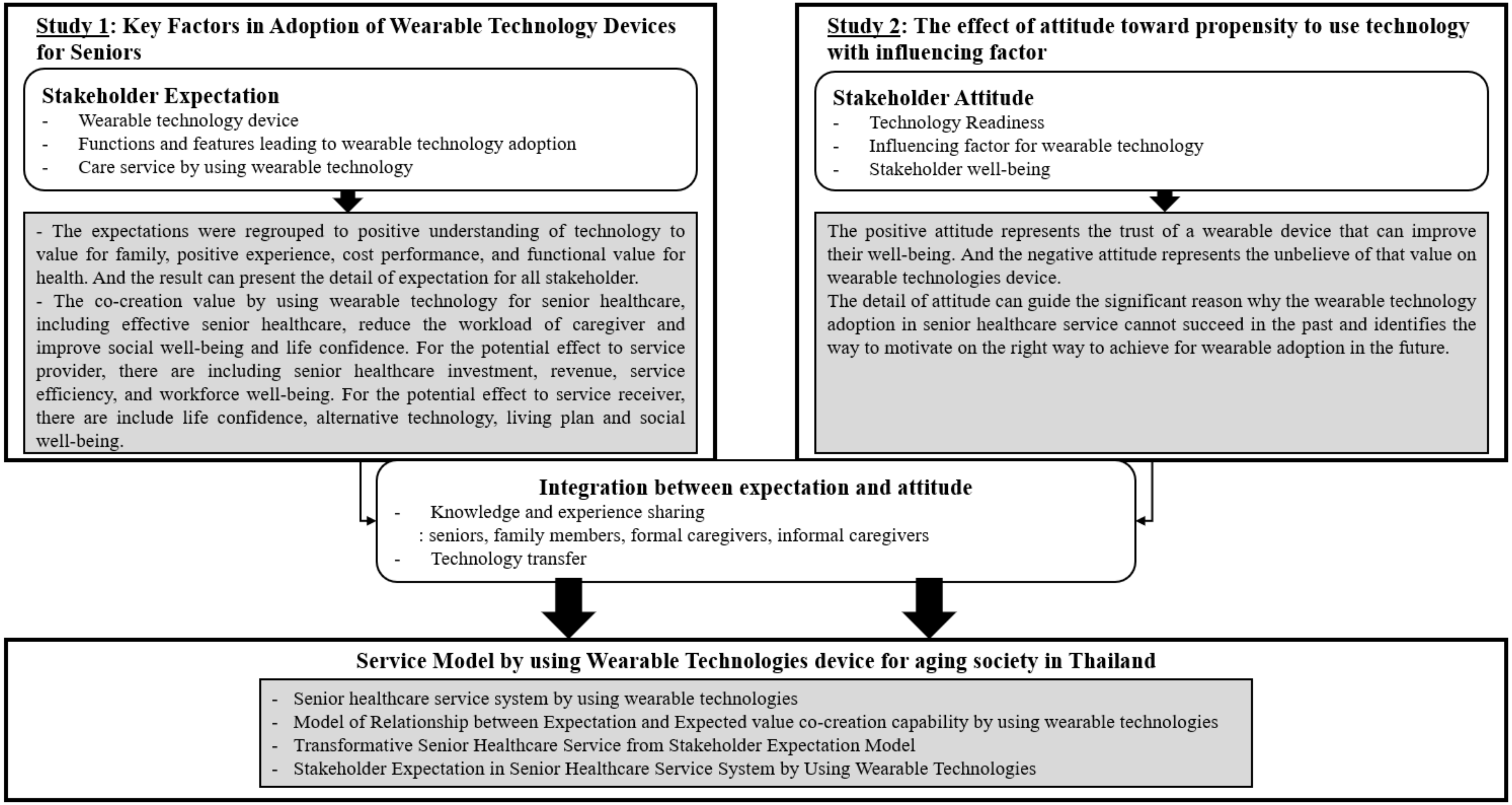



**Figure 6.1** Conclusion of research problems

## 6.2 Academic Implications

### 6.2.1 Contribution to Domestic Research

The services for senior focuses on increasing the number of senior populations in society. Not only should the seniors' well-being be concerned, but stakeholders also need to pay attention to improving the quality of life in an aging society.

Quality of health is the priority of the senior mentions to create and develop many kinds of technologies for the senior and stakeholders. Personal health data is a vital requirement that hopes the accuracy system for collecting the data that can create value for services. One of the technologies which can raise and exchange data from other people and devices is Wearable Technology.

Knowledge management is a fundamental approach that identifies multi-stakeholder views to adopt wearable devices in an aging society, leading to the success of technology adoption and well-being. Knowledge and experience sharing in aging societies support seniors and caregivers to share and exchange knowledge and experience on wearable device adoption to improve their well-being and change care services to be professional.

Knowledge sharing is one of several knowledge management processes, including knowledge creation, acquisition, codification, and sharing. It is considered similar to knowledge transfer and use (Alavi & Leidner, 2001; Bock & Kim, 2002; Davenport et al., 1988; Kankanhalli et al., 2005).

Experience is related to knowledge. Webster's dictionary states that experience is "knowledge or practical wisdom gained from what one has observed, encountered, or undergone". In literature, the experience is defined as "valuable, stored, specific knowledge that was acquired by an agent in a previous problem-solving situation" and is useful for future re-use by the agent (Bergmann, 2002; Random House, 2001). Both definitions imply that humans can only gain experience, and it may be stored tacitly. Another important criterion is that experience is always gained in a context (context-dependent). With this relation, the experience should be considered part of knowledge management.

One of the exciting research projects is called "Smart Living Platform", which uses wearable technology for collecting data from senior. The data is transferred to the dashboard (Center Server) for management in the next step. The smart living project aims to research the connecting system for collaborating the network among stakeholders to create the wellness of the ecosystem. On the technical research side, Wearable Technologies Conference was conducted in Thailand every year to share the product of wearable technology and service platform from Thailand business and other countries. This conference collaborated with NECTEC Wearable Technologies AG. Inside of business project shows an exciting "Complete Your Living Experience Project" that is contributed by real estate company and hospital. This project provides the wearable device and helps centre for taking care of their caregiver for 24 hours, notify system for connecting with family member included in the wearable device in case the wearer suffers a fall, or the wearable device detects any unusual movement and emergency bottom prepared to immediately notify the hospital, family or juristic person after the wearer pushes the button.

According to ongoing research and project, as mentioned above, Thailand aims to provide infrastructure for supporting wearable technology, develop innovative wearable technology for using in aging society, and provide an IoT platform for connecting many kinds of technologies to be successful for the smart city. However, the service model using a wearable device to improve well-being in aging society is still not concerned. So, this research aims to focus on this point to construct the service model for the way to success for professional service by using the wearable device to satisfy stakeholder requirements and cover the influence factors for adopting this technology. Furthermore, this service model will be the prototype of service innovation by using a wearable device.

### 6.2.2 Contribution to International Research

As medical records continue moving to electronic formats, there will be an opportunity for the data from wearable devices to plug directly into patients' electronic health records due to many kinds of research for studying to improve the wearable technology such as sensor technology, recording system, a channel for connecting and transferring data, and smart functions in the wearable technology. On the other hand, healthcare is used to determine services, and the healthcare usefulness of a step count remains an advantage. Wearable technology adoption in healthcare services still has exciting topics for research.

Leading-edge hospitals and clinics have already used wearable technologies to transform resident training and emergency medicine communication, providing a critical advantage in today's competitive healthcare market. The opportunity keeps expanding.

The evidence from the patient engagement survey shows that 49 percent of patients globally wear or would be willing to wear technology that tracks fitness, lifestyle, and vital signs. The doctor's survey shows that healthcare administrators can leverage wearables to achieve more significant cost savings and operational efficiencies. Sixty-two percent of physicians say patients' wearables contribute to the accuracy of records and 36 percent say wearables help decrease cost.

An example of the research for creating service by using the wearable device is the Stanford Medical School conducted a study comparing students who use Google Glass while operating on dummies and students who exercise using traditional means. Those who use Google Glass markedly better-improving recognition of specific key indicators ten times faster while reducing reliance on conventional monitors by nearly 90 percent. Many pieces of research-specific services use wearable technology but not involves stakeholders' requirements in their services.

From the viewpoint of service-dominant logic (S-D Logic), the co-creation concept is intended to capture the essential nature of value creation between participators. The use and integration of resources among partners allow the co-creation concept to involve all the beneficiaries (Vargo & Lusch, 2004, 2008). The concept supports service exchange through the interaction of service providers and consumers who actively participate in the service system. The increasing aging population reflects the need for adequate care services and the well-being of the elderly.

This research proposes a service model for seniors and caregivers using wearable devices. Not only is one side valuable for seniors shown in the previous research, but stakeholder value is also identified and summarized.

## 6.3 Implications

Theoretical implications

The main objective of this study is the CSFs leading to the adoption of wearable technology devices (smartwatch, tracker, and smart glasses). It considered the opinions (related to professional services) of multiple stakeholders in an aging society, including those of formal caregivers. The CSFs in adopting wearable technology devices are summarized in Table 6.3.1. Health preservation functions lead to the adoption of smartwatches from multiple stakeholder viewpoints. Both formal and informal caregivers mentioned that health preservation functions are CSFs in adopting smartwatches. Dehghani et al. [2018] identified the anthology as contributing to the intention to keep using smartwatches. This perspective it directly related to health preservation functions. Moreover, Adapa et al. [2018] identified health preservation functions as the critical success factors (CSFs) influencing the adoption of smartwatches. The formal and informal caregivers mentioned that location functions are critical in adopting smartwatches. Smartwatches generally have a function for real-time location tracking using GPS but not for monitoring locations and sending location alerts automatically. A daily tasks function would remind the wearer of scheduled activities and transmit signals at appropriate times. Both types of caregivers identified this capability to reduce their workload. Moreover, it would motivate senior wearers to initiate the activities. Besides health preservation, Dehghani et al. [2018] considered the daily tasks function. Both caregivers identified the location and health preservation functions as keys to adopting trackers. Moreover, the location function seems essential for considering how to promote technology adoption for practitioners. All stakeholders mentioned the design features of trackers as the critical factor in their adoption. While previous studies recognized the essential features of trackers, they did not explicitly cover adopting this technology in an aging society. Our research has closed this gap in understanding the adoption of trackers in an aging society. All stakeholders indicated that the design features are essential for smartglasses. The design features are the central issue in getting seniors to wear smartglasses.

Similarly, Adapa et al. [2018] found that health improvement expectancy is related to the health preservation functions, which is a critical factor in the intention to continue using. Degerli and Yildirim [2020] identified design is as a CFS for wearable medical devices, and design needs to evolve and be developed further.

**Table 6.3.1** Critical success factors in adoption of wearable technology devices

| Technology adoption | CSFs | Wearable devices | Stakeholders | Relevant studies |
|---|---|---|---|---|
| | Health preservation functions | Smartwatches Trackers Smart glasses | S/FC/IC FC/ IC FC | Dehghani *et al.* [2018] <br>• Adapa *et al.* [2018] <br>• Lee and Lee [2020] |
| | Location functions | Smartwatches Trackers | FC/IC FC/IC | |
| | Daily tasks functions | Smartwatches Smart glasses | FC/IC S/FC/IC | Dehghani *et al.* [2018] |
| | Design feature | Trackers Smart glasses | S/FC/IC S/FC/IC | Adapa *et al.* [2018], Degerli and Yildirim [2020] |

*Note*: S: Seniors, FC: Formal caregivers, IC: Informal caregivers.

Practical implications

As medical records continue moving toward electronic formats, there comes a time when data from a wearable device can be plugged directly into a patient's electronic health record. This will come about through the many research efforts to improve wearable technologies, including sensors, recording systems, channels for connecting and transferring data, and smart functions. On the other hand, in terms of healthcare, these wearable devices are not integrated into services. This means numerous advantages of these technologies to healthcare services that are still available to be exploited. Wearable technologies were developed to improve training and create a new communication method for emergency medicine in leading-edge hospitals and clinics. This indicates that such technologies could provide critical advantages in today's competitive healthcare market. The opportunities keep expanding.

A survey displayed that 49% of worldwide patients wear or inclination to use a device that possesses health and lifestyle measurement function [Nielsen (2014)]. Benefits from wearable devices include the reduction of cost and operational improvement. A medical survey showed 62% the physicians believed that the use of wearable devices by patients would improve record-keeping accuracy. Moreover, 36% of the physicians believed that their use would reduce costs.

An example of the research being conducted on creating services by using wearable devices can be found at the Stanford Medical School [Sullivan (2014)]. In one study conducted there, student performance was compared between students wearing Google Glass and students using conventional monitors on the same task. Recognition of physical something by the Google Glass wearers was ten times faster. Moreover, 90% of users can reduce their reliance on conventional monitors. Many studies have specified services suitable for wearable technology but failed to involve stakeholder requirements in those services.

One of the more exciting research projects in Thailand is the Smart Living Project" uses wearable technology for collecting data from seniors [Bangkok Post Public Company (2021)].

The data is transferred to an intelligent living platform for managing seniors' healthcare. The project aims to develop connection systems that support collaboration among stakeholders to create ecosystem wellness.

A wearable technologies conference is held annually in Thailand to share information about wearable technology products and service platforms developed by companies in Thailand and other countries. This conference is a collaboration between National Electronics and Computer Technology Center (NECTEC) and Wearable Technologies Asia. An exciting project in Thailand called \Complete Your Living Experience Project" has been collaboratively conducted by a real estate company and a hospital (who asked that their names be kept confidential). This project provides an established help center that uses a wearable device to support senior care 24 hours a day and a notification system to alert a family member if a senior fall or exhibits unusual movements. The wearer can press a button on the device to immediately notify the hospital, family or juristic person in case of emergency.

As shown by the ongoing research and projects described above, Thailand aims to develop a smart city that provides an infrastructure supporting wearable technology, promotes technological innovation aimed at its aging society, and provides an IoT platform for cross-device connections. However, the requirements of stakeholders are not being considered. Our research is the first of its kind to consider the stakeholders in an aging society (seniors, formal caregivers, and informal caregivers). Their contributions notably advance the understanding of the CSFs in adopting wearable technology devices, which are promising technology products of today and the future. Our findings should prove useful to researchers working to develop and refine the body of relevant knowledge and the designers and managers of wearable technology devices as they attract more users and improve user satisfaction and the user experience.

## 6.4 Limitation and future work

This research focuses on senior healthcare services using a wearable device in Thailand. The developed models represent expectations and attitudes toward propensity to use wearable technology from people’s perceptions in the case of Thailand. Despite the analyzed results explained in this research, there are a few limitations to suggestions for further study.

Wearable technologies management focuses on the critical success factors (CSFs) that lead to the adoption of wearable technology devices by seniors in crucial to favorable outcomes. However, even if technologies are developed that improve the well-being of seniors and caregivers, their sustainable implementation still depends on several factors, including infrastructure and government policies. Governments thus face several challenges presented by aging societies is an interesting area of research for studying.

Based on technology readiness, this research mainly focuses on the functions and features of smartwatch, tracker, and smartglasses. In terms of covering the senior healthcare service system, the readiness of technologies inside the service provider are the gap in this research. Moreover, the stakeholder that focuses on this research only mentions senior, family member, and caregiver. It is not enough in terms of a sustainable senior healthcare service system. Every sector should concern.

Moreover, the number of users is not the focus of this research. The result depends on stakeholder explanation rather than tech itself.

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# Appendix

## Appendix A

### Sub-study 1: Interview Guide

Before each interview, the three wearable technologies were introduced and pictures of corresponding devices were shown to the interviewee.

Questions for caregivers

***Question 1***: If you have to adopt smartwatches, what would be the critical success factors (CSFs) in adoption of the device that are related to improving the quality of life for you and the seniors for whom you care?

***Question 2***: If you have to adopt trackers, what would be the critical success factors (CSFs) in adoption of the device that are related to improving the quality of life for you and the seniors for whom you care?

***Question 3***: If you have to adopt smartglasses, what would be the critical success factors (CSFs) in adoption of the device that are related to improving the quality of life for you and the seniors for whom you care?

The questions for seniors

***Question 1***: If you have to adopt smartwatches, what would be the critical success factors (CSFs) in adoption of the device that are related to improving the quality of your life?

***Question 2***: If you have to adopt trackers, what would be the critical success factors (CSFs) in adoption of the device that are related to improving the quality of your life?

***Question 3***: If you have to adopt smartglasses, what would be the critical success factors (CSFs) in adoption of the device that are related to improving the quality of your life?

Questions for All stakeholders

The interviewer first showed cards with pictures of the three devices to the interviewee.

***Question 4***: Please rate these devices in the order you would prefer to use them, with 1 being the most preferred and 3 being the least preferred?

- Which device do you like the most?
- Which device do you prefer to use the most?

((If it is not the one you like the most, why do you prefer to use it the most?)

***Question 5***: Why do you prefer the device you rated 1 over the device you rated 2? And why is the device you rated 3 the least preferred?

- How will the wearable technology devices affect the way well-being is created?

***Question for physicians, nurses and physical therapists***

How will the wearable technology devices change/affect the way of professional services?

# Appendix B

## Sub-study 2: Questionnaire for senior

**Questionnaire**
**The Attitude of Propensity to Use Wearable Technology devices with Awareness**

**Wearable Devices for consideration in this questionnaire**

**Smart Watch**


The Smartwatch is a portable device designed to be worn on the wrist the same as a traditional watch. It also has functions as smartphone which are touchscreens, support application, and record heart rate and other vital signs.

**Smart Glasses**

The Smart Glasses is a wearable computer glasses that can be used to recorded information along the side or whatever that wearer sees. There are many types of wearable devices that have difference functionality. This questionnaire aims to determine the critical factors that affect the expectation of the caregiver for adopting wearable device technology based on their well-being.

**Tracker**


The Tracker is a wearable device that can be used to detect people/object movement and provide a timely recorded location for further processing.

**General Information**

| | | | |
|---|---|---|---|
| Sex | □ Male | □ Female | |
| Age | □ Less than 20 yrs. | □ 21-30 yrs. | □ 31-40 yrs. |
| | □ 41-50 yrs. | □ 51-60 yrs. | □ More than 60 yrs. |
| Education | □ Primary School | □ Secondary School | □ Bachelor degree |
| | □ Master's Degree | □ Doctoral Degree | |

**Technology Wearable Device**

Please select the wearable device that you currently use.

*(You can answer more than one choice.)*

□ Do not use any wearable device

□ Smart Watch □ Smart Glasses

□ Tracker □ Other .........................

Please select the wearable device that you know. *(You can answer more than one choice.)*

□ Smart Watch □ Smart Glasses

□ Tracker □ Other .........................

In your opinion, do you feel that the wearable device contributes your well-being to be better?

□ Yes □ No □ Not sure

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Do you think factors of wearable technology can be used to support your expectation to improve well-being?

Give score 5 (highest) if you think that factor is strongly affecting and give score 1 (lowest) if you think the factor is weakly affecting.

| Propensity to use technology | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Positive Technology Readiness** | | | | | |
| Wearable technology gives me more control over their daily lives. | | | | | |
| I find new wearable technologies to mentally stimulating. | | | | | |
| Wearable technology that use the newest technologies are much more convenient to use. | | | | | |
| I find that I have fewer problems than other people in making technology work for me. | | | | | |
| In general, I am among the first in my circle of family to acquire new technology when it appears. | | | | | |
| I can usually figure out wearable technologies without help from others. | | | | | |
| **Negative Technology Readiness** | | | | | |
| Sometimes, I think wearable technologies are not designed for use by ordinary people. | | | | | |
| There is no such thing as a manual for a wearable technology product and service that is written in plain language. | | | | | |
| Many new wearable technologies have health or safety risks that are not discovered until after people have used them. | | | | | |
| I don't feel confident doing daily activities by using wearable technology. | | | | | |
| I worry that personal information from wearable technology will see by other people. | | | | | |
| Whenever wearable technology gets automated, I need to check carefully that the product is not making mistakes. | | | | | |

| Awareness | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Positive Attitudes to Understand Wearable Technology** | | | | | |
| I can send the message to family members about activities what I do, the location where I stay, and my emotion or current status. | | | | | |
| I can contact family members in real-time by using wearable device. | | | | | |
| My family members who I allowed; they can access to my health information. And they can use the data for taking care me. | | | | | |
| My family members can get the emergency alarm when an accident or abnormal situation occurs. | | | | | |
| My family members can be tacking my location. Although, they cannot contact me by verbal. | | | | | |
| **Expectations for creating positive experiences** | | | | | |
| I can connect wearable device with hospital's device or caregiver's device for using my personal information to taking care of me. | | | | | |
| I can connect wearable device with another device in real-time. | | | | | |
| I can specify the detail of information that can access from other. | | | | | |
| I feel comfortable when using wearable technology. | | | | | |
| I can share my experience with wearable technology to the social media. | | | | | |
| I can get a new experience for connecting with another person by using technology novelty of wearable device. | | | | | |
| I can communicate with another person by more comfortable when using the wearable device. | | | | | |
| I can connect wearable device with other device by efficiency. | | | | | |
| I can motivate myself to health improvement while using the wearable device. Because of not only I can exercise by alone but also, I can join with another person. | | | | | |
| I feel happy and safety while using the wearable device because it can inform my status and can share with my caregiver. | | | | | |
| **Trust on wearable devices** | | | | | |
| I can use the wearable technology for communicating with other people and connect with another device all day. Because of the battery's the wearable device is a long-life product. | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| I can fast learn about instruction for using the wearable device to connect with other. Because of it was designed by a friendly user. | | | | | |
| I can communicate with other while I swim, or I walk in the rain. Because of it has the waterproof function. | | | | | |
| I can use the wearable technology for communicating with other people and connect with another device by efficiencies such as hearing, fast response, and signal for connecting. Because of it is the excellent communication tools. | | | | | |
| I can use an application and function of the wearable device in term daily life, and health information looks like it is "One Stop Service". | | | | | |
| **Self-confidence on maintenance of own health** | | | | | |
| I can record the personal physical information for analyzing the movement of body, bodywork, and sleep tracking. Then, I can access to check all data by myself. | | | | | |
| I can monitor fitness metrics such as distance walked or run, calories consumed, and measuring heart rate. Health improvement was motivated for setting up the goal from exercise. | | | | | |
| I can use a digital coach application to planning my activity, follow status, and alarm when that time is the plan. So, all of that can increase my healthiness. | | | | | |
| I do not forget to take a medicine on time because wearable device can alarm me. | | | | | |
| I do not forget to do activities as plan because wearable device can alarm me and inform what should I do. | | | | | |

If the wearable device match to your expectation, do you want to adopt the wearable device for your life?

□ Yes □ No

# Appendix C

## Sub-study 2: Questionnaire for family members and caregivers

**Questionnaire**

**The Attitude of Propensity to Use Wearable Technology devices with Awareness**

**Wearable Devices for consideration in this questionnaire**

**Smart Watch**


The Smartwatch is a portable device designed to be worn on the wrist the same as a traditional watch. It also has functions as smartphone which are touchscreens, support application, and record heart rate and other vital signs.

**Smart Glasses**

The Smart Glasses is a wearable computer glasses that can be used to recorded information along the side or whatever that wearer sees. There are many types of wearable devices that have difference functionality. This questionnaire aims to determine the critical factors that affect the expectation of the caregiver for adopting wearable device technology based on their well-being.

**Tracker**


The Tracker is a wearable device that can be used to detect people/object movement and provide a timely recorded location for further processing.

## General Information

| | | | |
|---|---|---|---|
| Sex | □ Male | □ Female | |
| Age | □ Less than 20 yrs. | □ 21-30 yrs. | □ 31-40 yrs. |
| | □ 41-50 yrs. | □ 51-60 yrs. | □ More than 60 yrs. |
| Education | □ Primary School | □ Secondary School | □ Bachelor degree |
| | □ Master's Degree | □ Doctoral Degree | |

## Technology Wearable Device

Please select the wearable device that you currently use to support for taking care the elderly.

*(You can answer more than one choice.)*

□ Do not use any wearable device

□ Smart Watch □ Smart Glasses

□ Tracker □ Other .........................

Please select the wearable device that you know. *(You can answer more than one choice.)*

□ Smart Watch □ Smart Glasses

□ Tracker □ Other .........................

In your opinion, do you feel that the wearable device contributes elderly well-being to be better?

□ Yes □ No □ Not sure

Do you think factors of wearable technology can be used to support the elderly (more than 60 years old) well-being?

Give score 5 (highest) if you think that factor is strongly affecting and give score 1 (lowest) if you think the factor is weakly affecting.

| **Propensity to use technology** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|
| **Positive Technology Readiness** | | | | | |
| Wearable technology gives me more control over their daily lives. | | | | | |
| I find new wearable technologies to mentally stimulating. | | | | | |
| Wearable technology that use the newest technologies are much more convenient to use. | | | | | |
| I find that I have fewer problems than other people in making technology work for me. | | | | | |
| In general, I am among the first in my circle of family to acquire new technology when it appears. | | | | | |
| I can usually figure out wearable technologies without help from others. | | | | | |
| **Negative Technology Readiness** | | | | | |
| Sometimes, I think wearable technologies are not designed for use by ordinary people. | | | | | |
| There is no such thing as a manual for a wearable technology product and service that is written in plain language. | | | | | |
| Many new wearable technologies have health or safety risks that are not discovered until after people have used them. | | | | | |
| I don't feel confident doing daily activities by using wearable technology. | | | | | |
| I worry that personal information from wearable technology will see by other people. | | | | | |
| Whenever wearable technology gets automated, I need to check carefully that the product is not making mistakes. | | | | | |

| Awareness | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Positive Attitudes to Understand Wearable Technology** | | | | | |
| The message of activities, location, and emotion or status can be sent to the family members by wearable device. | | | | | |
| The wearable device can be used to contact family members in real-time. | | | | | |
| The wearable device allows authorized family members for accessing to wearer' health information which the data will be used to take care of the wearer. | | | | | |
| The notification message from the wearable device will be sent to the family members when an accident or abnormal situation occurs. | | | | | |
| The location of wearer is tracked by the wearable device, and then, information will be sent to the family member. Although, they cannot contact the wearer verbally. | | | | | |
| **Expectations for creating positive experiences** | | | | | |
| The technology novelty of wearable device is created a new experience for connecting between wearer and another. | | | | | |
| The features of wearable device can help the wearer to contact other people easily. | | | | | |
| The connection between the wearable device and another device is efficient. | | | | | |
| The features of wearable device motivate wearer to achieve improved health. Ex. wearer can join to exercise with other people. | | | | | |
| The wearer feels happy while using the wearable device because it can connect unlimitedly with other. | | | | | |
| The integrated data from wearer with hospitals' or caregivers' device will be used in the elderly care. | | | | | |
| The wearable device can connect with other devices in real-time. | | | | | |
| The secured information is set by the wearer to allow to connect with other. | | | | | |
| The wearer feels comfortable while using wearable technology. | | | | | |
| The personal experience of wearable technology can be shared to social media. | | | | | |
| **Trust on wearable devices** | | | | | |
| The wearable device can be used to communicate with other people and connect with another device continuously because it has long battery life. | | | | | |

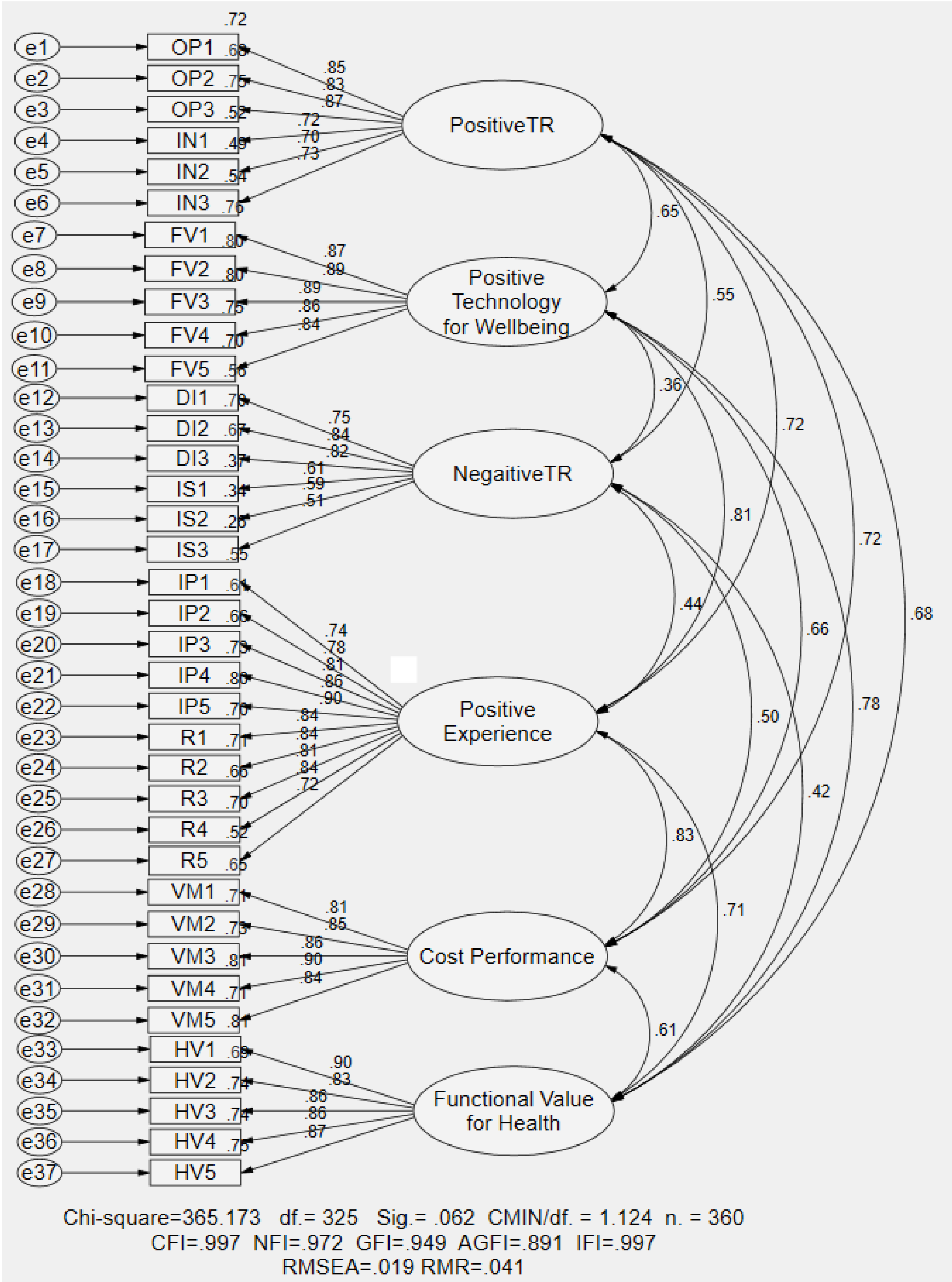
| | | | | | |
|---|---|---|---|---|---|
| The wearable device is easily used to connect with other because it has a user-friendly design. | | | | | |
| The wearable device has the waterproof function that the wearer can connect with other while swimming or raining. | | | | | |
| The wearable device is the excellent communication tools. | | | | | |
| The wearable device enhances daily life and health through “One Stop Service” user interaction. | | | | | |
| **Self-confidence on maintenance of own health** | | | | | |
| The personal information is recorded by the wearable device for analyzing the movement of the body, bodywork, and sleep tracking. The data is available for checking by the wearer. | | | | | |
| The fitness metrics; walk/run distance, calories consumed, and measured heart rate, are monitored by the wearable device. Health improvement is motivated for setting up the goal from exercise. | | | | | |
| The digital coach application from the wearable device can be used for activity planning, follow status and alarm the wearer to do activity. So, all of that increase wearer' healthiness. | | | | | |
| The wearable device can be used to alarm wearer to take medicine. | | | | | |
| The wearable device can be used to alarm wearer to do activities as planed and inform the action of the wearer. | | | | | |

If the wearable device match to your expectation, do you want to adopt the wearable device for supporting you to take care of your senior?

□ Yes □ No

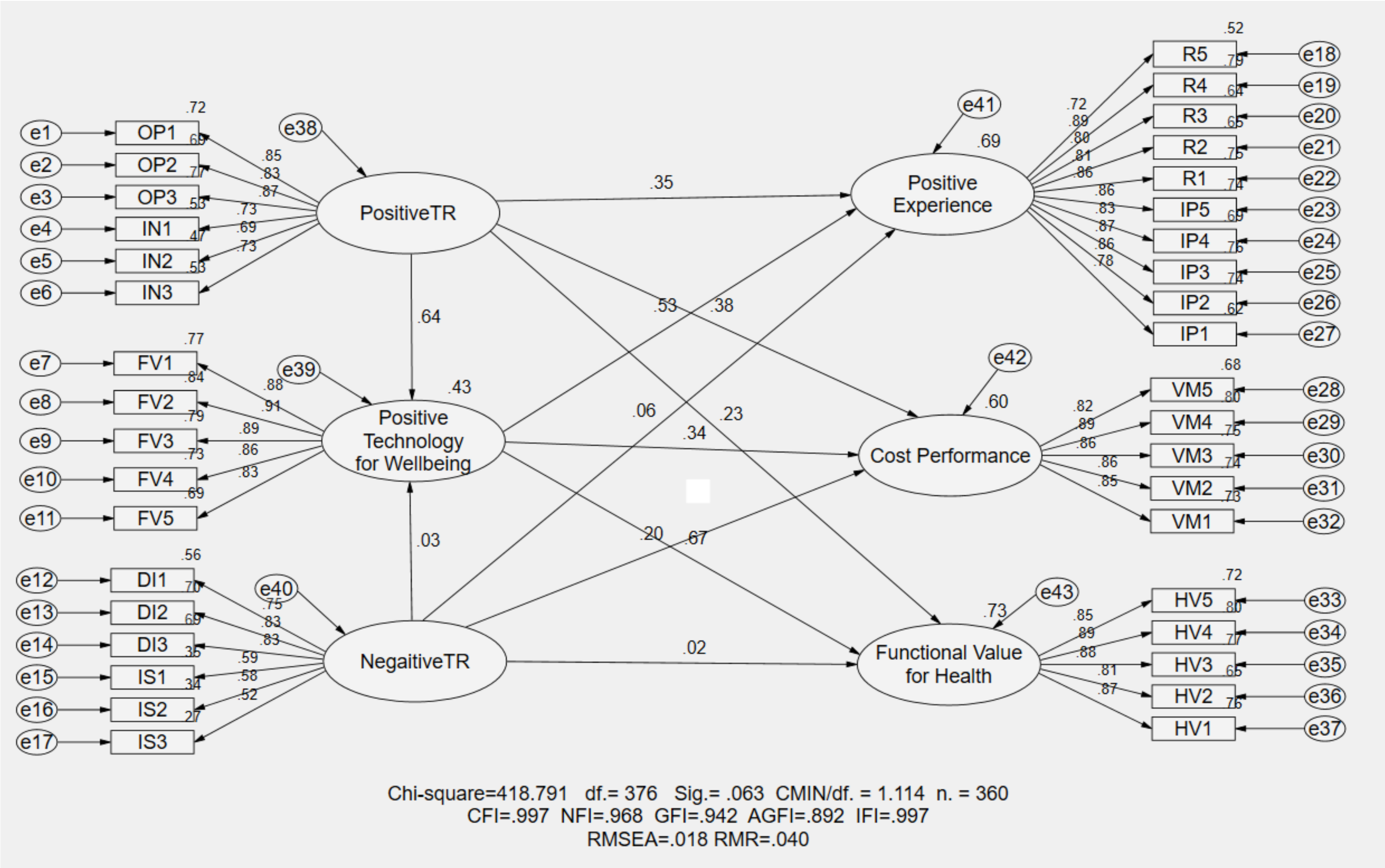
# Appendix D

## Sub-study 2: Result of confirmatory factor analysis (CFA)



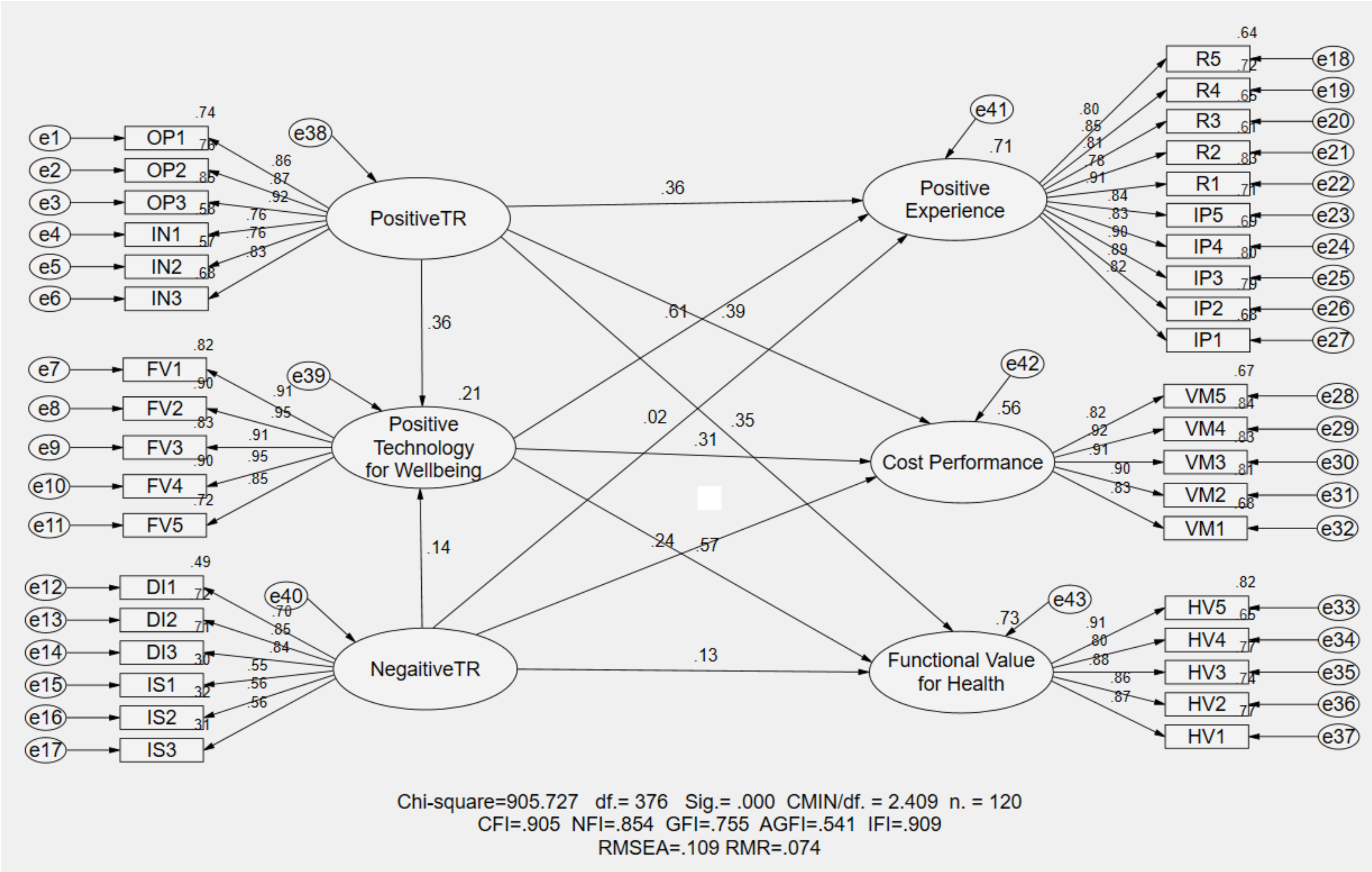
# Appendix E

## Sub-study 2: Structural Equation Model for All stakeholders



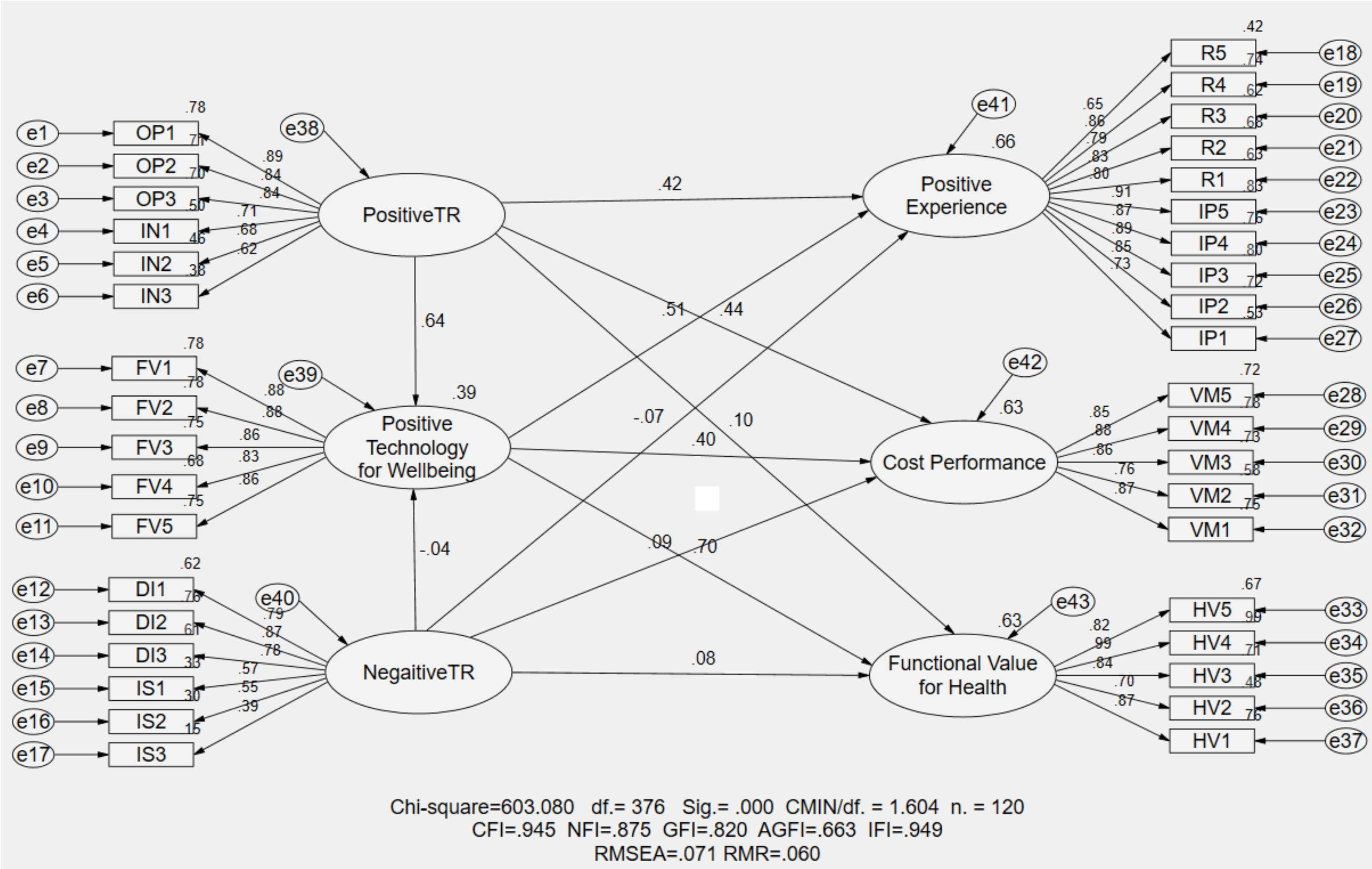
# Appendix F

## Sub-study 2: Structural Equation Model for Senior



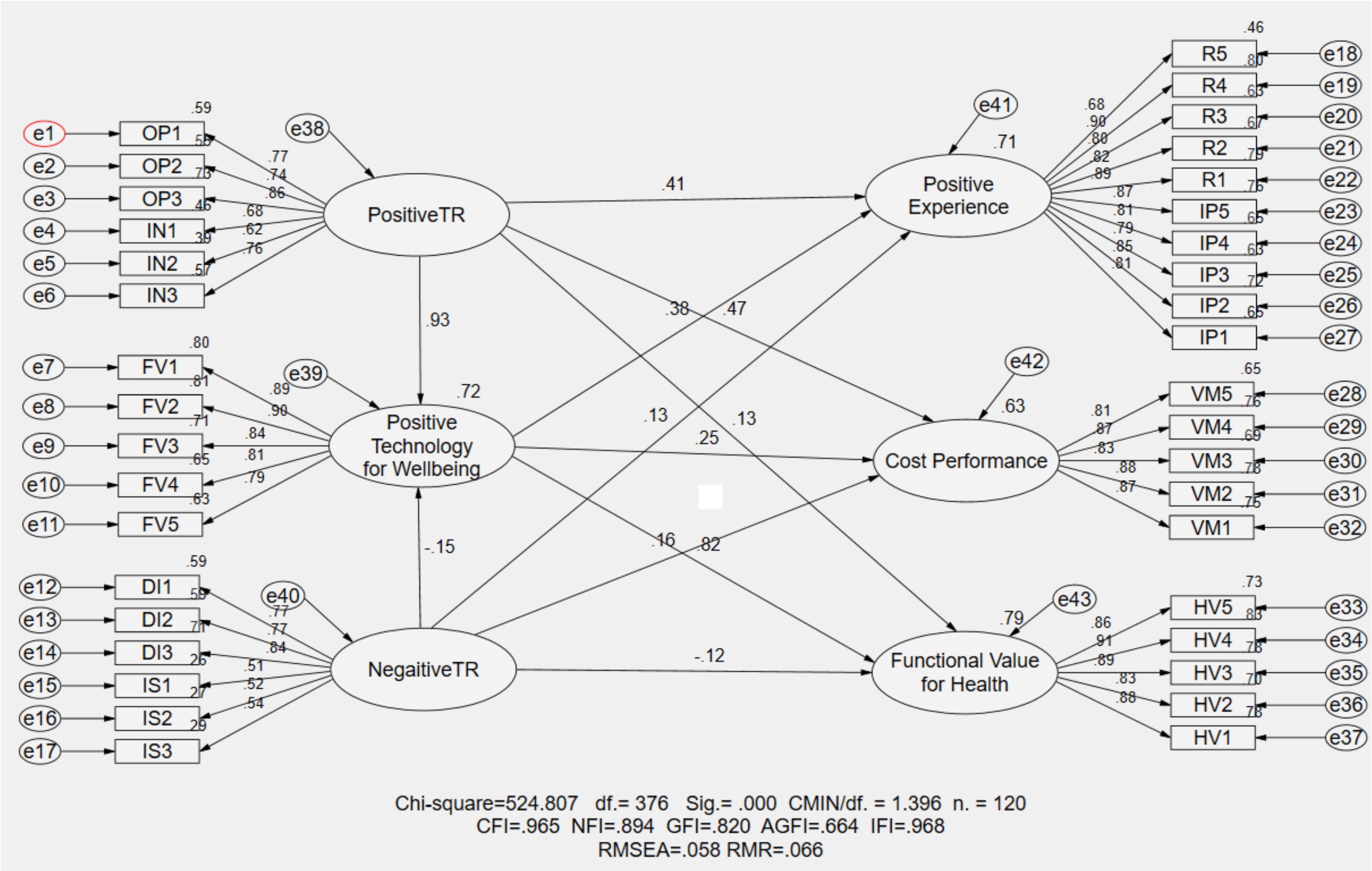
# Appendix G

## Sub-study 2: Structural Equation Model for Caregiver



# Appendix H

## Sub-study 2: Structural Equation Model for Family Members



# List of Contribution

**International journal**

Shayarath Srizongkhram, Navee Chiadamrong, and Kunio Shirahada. “Critical Success Factors in Adoption of Wearable Technology Devices for Seniors in Thailand”, International Journal of Innovation and Technology Management, 2021, DOI: 10.1142/S0219877021500206

**International conferences**

Shayarath Srizongkhram, Navee Chiadamrong, and Kunio Shirahada. (2018). “Critical Factors for Adoption of Wearable Technology for the Elderly: Case Study of Thailand”, PICMET’18, Hawaii, USA, August 19 - 23, 2018