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Users' Intention on Adoption of Smartphone Based Healthcare Service Using an Integrated Model of HBM and TAM

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This thesis is a result of four year hard work and research. The content of the thesis are always censored in a sense that only the success stories are told. The preliminary work, such as the numerous discussions concerning the u-healthcare, mobile applications, diabetics are carefully filtered out during the writing of the thesis. Unfortunately these are the aspects that made my PhD period as it was: instructive, intensive, exciting, exhaustive, frustrating, fascinating, but most of the time I simply enjoyed it.

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ABSTRACT

현대인의 라이프스타일 변화로 인해 한국은 물론 전세계적으로 높은 사망률을 차지하고 있는 만성질환 가운데 하나가 당뇨병이다. 그러나 당뇨병의 경우 혈당관리가 중요하며 이와 관련된 혈당관리 시스템이 제안되고 있다. 그러한 혈당관리시스템 가운데 스마트폰을 활용한 방법이 최근 주목받고 있으며 건강관리, 질병치료의 효과적인 것으로 밝혀지고 있다. 그러나 스마트폰 활용시스템의 경우 시스템의 기술적인 측면에 연구가 집중되어 있으며, 시스템의 사용자 측면에서 접근한 연구는 다소 미흡한 상태이다. 따라서 본 연구에서는 스마트폰 활용시스템 사용자 관점에서 실증연구를 수행한다.

본 연구의 목적은 크게 세가지로 구분한다. 첫째, 건강행위이론의 대표적인 모델인 건강신념모형이 스마트헬스케어 수용에 있어 설명력을 확인한다. 둘째, 통합된 연구모형을 통해 스마트헬스케어 수용에 있어 주 요인을 밝히고, 변인들 간의 구조적 관계를 검증한다. 셋째, 집단 간 구조적 관계 검증을 통해 시스템 사용대상에 따른 차이를 검증한다.

이러한 연구목적을 달성하기 위한 자료수집은 두 가지 측면에서 이루어졌다. 첫째, 스마트폰 사용집단인 젊은 소비자층의 경우 스마트폰 시스템에 대한 활용가능성은 높게 인식되지만 당료병에 대한 주의도가 낮은 특징이 있다. 둘째, 현재 당뇨병을 경험하고 있는 대상의 경우 주로 노년층이며, 이들의 경우 스마트폰 활용도가 낮다. 따라서 본 연구에서는 이러한 연구대상의 특징을 모두 고려하여 스마트폰 활용도가 높은 젊은 소비자 층과 당뇨병을 경험하고 있는 노년층 모두 자료를 수집하였다. 따라서 자료수집은 우선 젊은 소비층을 대상으로 500부를 배부하여 회수하였으며, 노년층의 경우는 300부를 배부하여 회수하였다. Partial least square - structural equation model (PLS-SEM) 방법을 본 연구에 적절하다고 보아 SmartPLS 2.0 소프트웨어를 사용하여 실증분석을 실행하였다.

그 결과 젊은 소비층 대상인 경우 지각된 민감성이 지각된 유용성과 사용용이성에 유의한 영향이 있는 것으로 나타났으나, 사용의도에 영향이 없는 것으로 나타났다. 지각된 심각성은 지각된 용이성에만 유의한 인과 관계가 있는 것으로 나타났고 지각된 유익성 변수는 유일하게 모든 내생변수인 지각된 유용성과 사용용이성 그리고 사용의도까지 유의한 영향이 있는 것으로 나타났다. 지각된 장애성은 부(-)의 영향을 갖고 있어야 하지만 본 연구에서는 지각된 유용성과 사용의도에 정(+)의 영향이 있는 것으로 나타났다. 건강 자기효능감 변수는 지각된 유용성과 사용의도에 전혀 영향이 없지만 지각된 사용용이성과 유의한 인과 관계가 존재한 것으로 나타났다. 나머지 주관적 교범, 기술 자기효능감, 그리고 지각된 유희성 변수들이 유의한 영향이 있는 것으로 나타났다. 노년층 집단의 경우는 지각된 민감성이 지각된 유용성과 사용용이성에 유의한 영향이 있지만 사용의도에 영향이 없는 것으로 나타났고 지각된 심각성은 지각된 유용성과 사용의도와 유의한 인과 관계가 있었고 지각된 유익성이 젊은층 집단과 같이 모든 내생 변수에 높은 인과 관계가 있는 것으로 나타났다. 지각된 장애성은 지각된 유용성과 사용의도에 유의한 부(-)의 영향이 있고 지각된 사용용이성에 정(+)의 영향이 있었다. 건강 자기효능감의 모든 경로가 유의하지 않는 것으로 나타났다. 기술 자기효능감, 지각된 외부통제, 그리고 지각된 유희성이 유의한 인과 관계를 보였다. 본 연구의 첫째 목적이 건강신념모형이 스마트헬스케어 수용에 있어 설명력을 확인하는 것이며, 분석 결과를 보면 이 모형이 스마트헬스케어 수용에 있어 다소 낮은 설명력을 갖고 있다. 이는 기존 건강행위를 받아드리는 데에 많은 노력과 시간을 투자하는 반면에 스마트폰 활용시스템은 노력과 시간을 덜해주는 효과가 있기 때문에 이 모형에서의 주 요인인 지각된 민감성, 심각성, 그리고 건강 자기효능감 변수들이 무의미한 것으로 보인다. 둘째, 인과 관계의 유의성과 영향의 크기를 고려하여 주 요인을 선정하여 새 모형을 제시하였다. 이 모형의 외생변수로는 지각된 유익성과 장애성, 주관적 교범, 지각된 외부통제, 지각된 유희성 변수를 설정하여 매게 변수로는 지각된 유용성과 용이성 그리고 종속변수로 사용의도를 설정하였다. 셋째, 스마트폰 당뇨관리 시스템 수용에 있어 대상에 따른 차이가 없는 것으로 보인다.

보다 나은 연구를 위한 연구자의 노력에도 불구하고 본 연구는 크게 3가지

한계점이 있다. 첫째, 표본의 다양성인데 데이터 수집을 제주특별자치도에서만 하였고 전국 사용자를 포함하지 못한 점이다. 둘째, 시스템의 최신성인데 이 시스템은 아직 한국에서는 잘 알려지지 않은 관계로 시스템에 대한 비디오를 활용하여 설명했음에도 불구하고 시스템에 대한 이해도가 다소 낮은 응답자가 있었다. 셋째, 변수 선정인데 연구모형에 포함되지 않았지만 사용자 수용을 정확하게 설명할 수 있는 변수들이 있을 것이다. 그러나 그 모든 변수를 한 논문에 다 포함하지 못한 점이 마지막 한계점이라 할 수 있다.

마지막으로 본 논문을 통해 제시된 새로운 모델이 스마트폰 혈당관리 시스템 수용에만 사용되는 것이 아니라 다양한 스마트헬스케어, 유헬스케어 서비스 수용을 예측 또는 설명하는데 사용될 수 있을 것으로 기대된다. 또한 오프라인 환경에서의 장애성과 온라인 환경에서의 장애성에 대한 깊이 있는 연구도 이뤄지는 것이 중요할 것으로 보인다.

CHAPTER I

INTRODUCTION

With rapid development of information technology (IT) including internet and wireless communication network, the day when ubiquitous technology operates absolutely comes not so far (Tran et al., 2012). This ubiquitous technology would change the whole society even more than what you imagine. Particularly, it is expected to change more effective and efficient way in healthcare called ubiquitous healthcare (u-Health) (Kim et al., 2011). This u-Health terminology is commonly used in South Korea (S. Korea) and diverse terminology such as e-health, mobile health, telemedicine, telehealth, and home healthcare are been used in USA or European countries (DACOIRI, 2010). The u-Health refers the new healthcare system in integration between information communication technology (ICT) and healthcare area (DACOIRI, 2010).

In recent, S. Korea demographic statistics shows that the highest proportion of rising elderly population in the world (Yu et al., 2009). Such demographic changes lead to consequent increase in chronic diseases and according to the report chronic diseases shares more than 80% of all other diseases in 2001 in S. Korea (Cho, 2010). In September 2012, the World Health Organization (WHO) released the most recent statistics that show about 347 million people worldwide have diabetes and diabetes deaths will increase by two thirds between 2008 and 2030 (WHO, 2013). Thus, the medical costs are a large burden on society in near future. As one of the solutions, u-Health has emerged not only in S. Korea but also in other countries.

1.1. Purpose Statement

The primary purpose of this study is to identify health belief model (HBM)'s explanation power on adoption of smartphone based blood glucose system and to explore the key factors. This system is the smartphone application which provides a function to manage user's blood glucose. However, there are a very few research related with acceptance of this system. In this term, the study attempts to explain and predict both healthy and unhealthy people's health behavior using an integrated model with HBM and technology acceptance model 3 (TAM). The HBM is the one of most cited models in medical and nursing area and is seen to have well explanation power behavioral intention of smart healthcare. TAM is the one of adequate model in examining acceptance of IT. TAM3 is the latest version of the TAM and included largest number of independent variables.

We collected data from two different groups including ordinary people (healthy group) and elder people (diabetes patients group). It is critical that determining certain drivers on health behavior as comparing two different groups. And a final model will be proposed as reviewing results of them.

1.2. Overview of Dissertation

This dissertation is divided into six chapters. The introduction section provides a general overview of the study topic, the research questions, and the document in general.

Chapter 2 provides the literature review. This chapter reviews the theoretical and empirical literature pertaining to smart healthcare, information technology adoption, and healthcare behavior research.

Chapter 3 presents the theoretical model with specific hypotheses that will be tested in this research. The constructs used in the model and hypotheses are developed and defined. The constructs used in this study adapted from the HBM including the perceptions of barriers, benefits, susceptibility, severity, and health self-efficacy; and from the TAM including the subjective norm, results demonstrability, technology self-efficacy, perceptions of external control, anxiety, perceived enjoyment, perceptions of usefulness and ease of use, and intention.

Chapter 4 discusses the research methodology used in this study. The design of the research is described and the rationale for this approach is presented. Additionally, the research constructs are designed and operationalized.

Chapter 5 describes the full data collection and survey procedures, the validation of the measurement instrument used, and the analysis and results of the study.

Chapter 6 provides overall conclusions of the study. This chapter contains summary of the study, implications for practical and research, limitations and future research.

CHAPTER II

LITERATURE REVIEW

This chapter provides a literature review of smart healthcare (s-Health), and two research domains that a relevant to this study; technology acceptance theories and health behavior theories.

Figuring out s-Health, it is important to discuss about u-Health service. It will be reviewed s-Health's development process, current status, and introducing services in S. Korea.

To capture the conceptual theory of technology acceptance research, an overview of the four most prominent user behavior models was completed. These are the a) Theory of Reasoned Action, b) Theory of Planned Behavior, c) Technology Acceptance Model, and d) Unified Theory of Acceptance and Usage of Technology.

The final research area is based on health behavior research that stems from the health care field. Health behavior theory has been used for years to measure the success of health promotion measures. This overview covers the conceptual foundation of The Health Belief Model, which provides the foundation for this research.

2.1. Ubiquitous healthcare (u-Health) service

Before discussing s-Health, it is important to propose ubiquitous technology and healthcare because of their deep relationships.

Ubiquitous healthcare (u-Health) is an integrated concept with ubiquitous technology and health or medical care sector (Kim, 2011; Choi et al., 2010). Mark Weiser, a chief technology officer at Xerox Palo Alto Research Center (PARC), prospected about future technology that "the most profound technologies are those that disappear" and "they weave themselves into the fabric of everyday life until they are indistinguishable from it" (Weiser, 1991) and first proposed 'ubiquitous computing' concept in 1988. While ubiquitous computing has been defined by numerous researchers, Mark Weiser defined it as "the method of enhancing computer

use by making many computers available throughout the physical environment, but making them effectively invisible to the user" (Weiser, 1993). On the other hand, Marcia Riley have noted that "a paradigm shift where technology becomes virtually invisible in our lives". It is also used various terminologies such as pervasive computing (Satyanarayanan, 2001), disappearing computing, and invisible computing (Prante et al., 2004). In today, after two decades of Weiser's introduction of ubiquitous technology, ongoing development of information communication technology (ICT) has been approaching to be close real ubiquitous concept and applied in plenty of areas such as medical and healthcare.

ICT in healthcare provides great opportunities like reducing medical cost, enabling more accurate data process, and patient-centered service. Johnston et al.(2000) implies that adopting tele-monitoring is able to get reduced 27% of medical cost in chronic diseases. According to the report of Samsung Economic Research Institute (SERI), even tele-monitoring system alone possibly cut down 1.5 trillion won in elderly people medical cost from total 5.6 trillion won of National Health Insurance cost in S. Korea (Kang et al., 2007). And u-Health has emerged as one of the solution of these economic and social demands.

u-Health is defined by numerous researchers and institutions. u-Health refers high value-added convergent industry with IT and advanced medical technology (Park, 2009) and Varshney (2005) defines "healthcare to anyone, anytime, and anywhere by removing locational, time and other restraints while increasing both its coverage and quality" and "prevention, healthcare maintenance and checkups, short-term monitoring (or home healthcare monitoring), long-term monitoring (nursing home), personalized healthcare monitoring, incidence detection and management, and emergency intervention, transportation and treatment" in broad. Brown et al. (2007) describes it more technically "u-Healthcare uses a large number of environmental and patient sensors and actuators to monitor and improve patients' physical and mental condition". And Omary et al. (2011) present benefits of u-Health "once a ubiquitous healthcare service is in place, then the ubiquitous healthcare information system will be always be on and hence promising better health and well-being for the general population". On the other hand, Kim et al. (2011) propose that "health management and medical services that utilize wired/wireless networking such as

remote monitoring and are capable of use at any given time and place". Arnrich et al. (2010) focuses on more pervasive healthcare and define from two perspectives: " i) as the application of pervasive computing technologies for healthcare, and ii) as making available everywhere, anytime and to anyone". Despite defined pervasive and ubiquitous healthcare separately, they indicate "the ultimate goal of pervasive healthcare is to become a mean for achieving u-Health" (Arnrich et al., 2010).

This convergent technology likely brings evolution in healthcare delivery system, unlike traditional hospital-centered system, and enables users to access it in anytime and anywhere. Therefore, healthcare service paradigm is shown in figure 2.1 (Kim, 2011), it has converted from traditional patient-centered to public health and from provider-centered to user-centered.

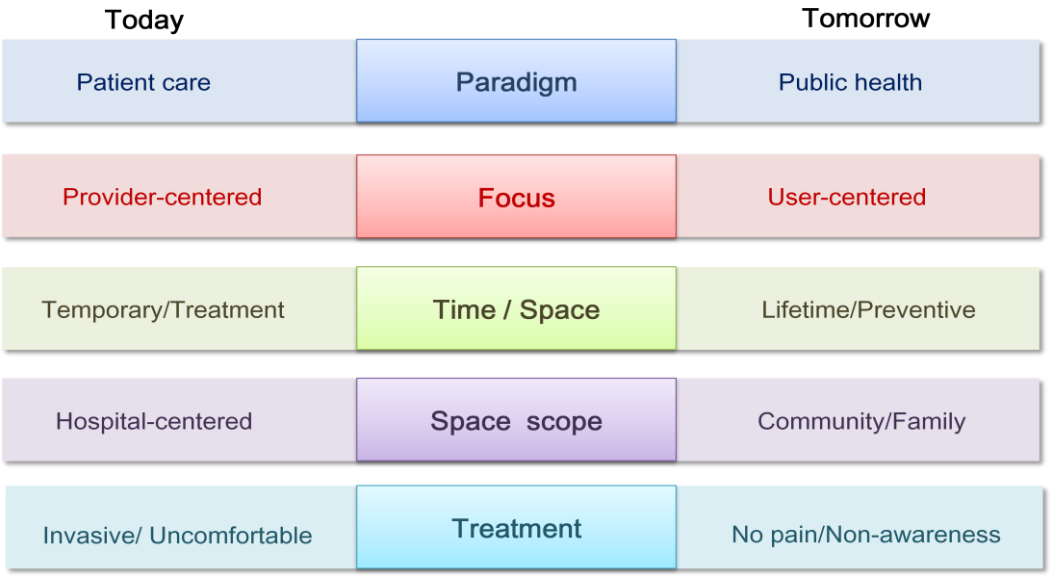

Figure 2.1. Healthcare paradigm (Kim, 2011)

Moreover, S. Korea is turning from aged to post-aged society unexpectedly in short-term. SERI reports that Korea has taken only 26 years switching to post-aged society and set with highest speed in switching population record in the world (Lee, 2011). Figure 2.2 is shown aging process in several countries including S. Korea.

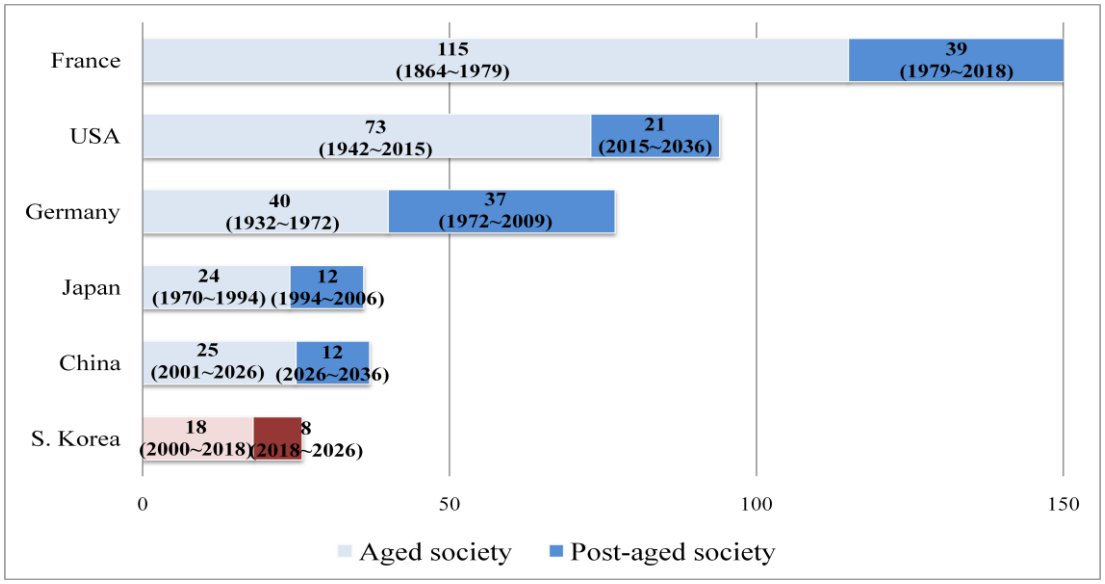

Figure 2.2. The progression of aging in countries (Lee, 2011)

It is caused by two main reasons; low fertility rate and high life expectancy. While the average birthrate does not surpass 1.22 per woman (age 15~29) in Korea and 2.01 in USA, 1.99 in France, 1.37 in Japan, and 1.36 in Germany (Lee, 2011). Life expectancy rate is the highest (18.4%) in the world, 67.4 years in 1986 reached 79.8 years by 2008 (Lee, 2011). More than 75% of health care costs are due to chronic conditions (CDC, 2009). World Health Organization (WHO) implies "chronic diseases are by far the leading cause of mortality in the world, representing 63% of all deaths" (WHO, 2013).

u-Health service has been promoted in many countries as an effective alternative in both industry and public health services. In S. Korea, started with simple tele-medicine service within hospital in 1994, and u-Health trial services based on strong networking technology (wired/wireless) were implemented in 2006 (Kim, 2011).

2.2. Smart healthcare (s-Health) service

An emergency of smart phones has generated amazing changes and shifts in many societies due to their computer functions such as e-mail and web browsing (Handel, 2011). A first smartphone was designed by IBM in 1992 (Handel, 2011), and popularized with Apple's iPhone in 2009 (Yu, 2010). In today, their markets have rapidly grown as shown in Figure 2.3. It shares nearly 33 million numbers of users

out of 55.3 million in S. Korea (KCC, 2013).

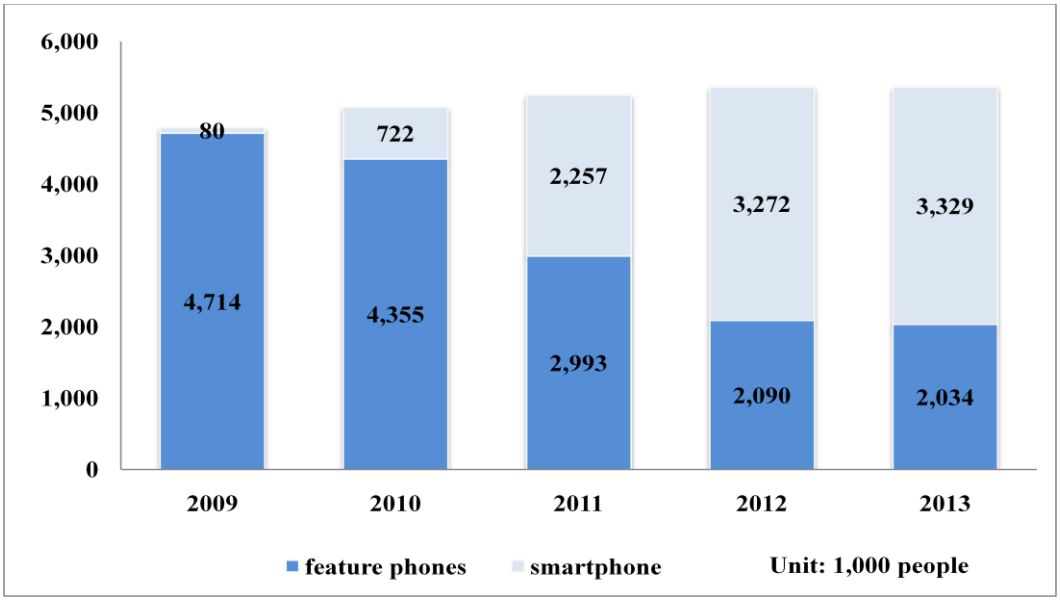

Figure 2.3. Smart phone market share in S. Korea (KCC, 2013)

Particularly, ICT is applied in healthcare same as Figure 2.4. Starting with internal hospital systems and next step is hospital to hospital health information exchange. In 2006, u-Health project provides hospital to hospital and to patients' health delivery services. And in 2011, using the smartphones or smart devices make possible more integrated healthcare services in market (Song, 2011). Widespread of intelligent devices (smartphones, tablet PC, and smart TV) based on strong wired/wireless communication allow you to access more sophisticated and intelligent systems in public services and society. In this flourishing smart era, it opens more effective and convenient way to access integrated medical & healthcare services such as tele-treatment, diagnoses, health information, welfare even prevention through the smartphones.

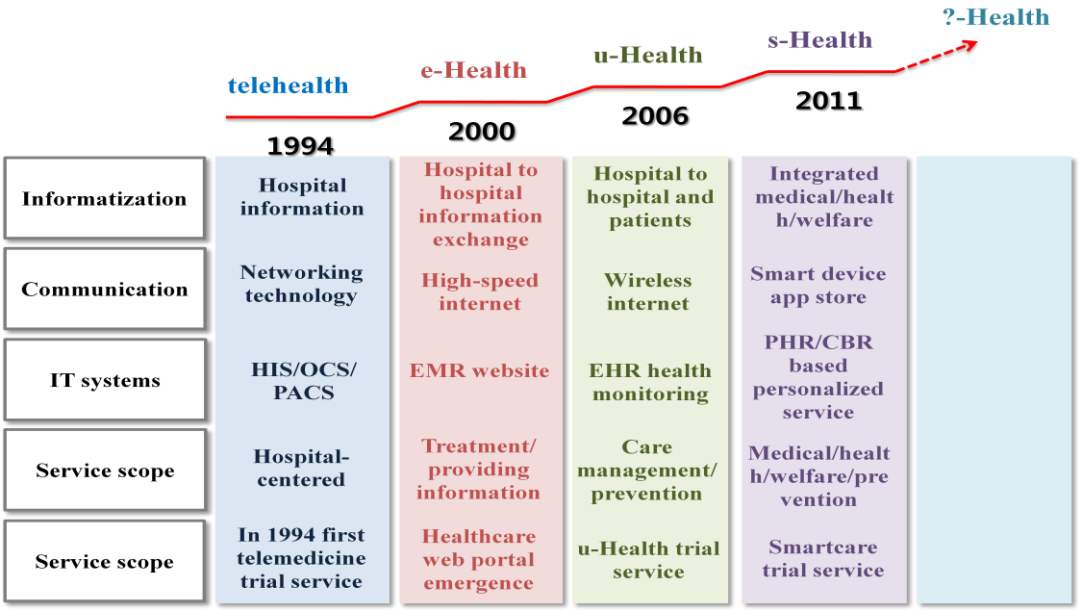

Figure 2.4. The evolution in healthcare (Song, 2011)

It means the smartphones based healthcare service is available for not only patients but also healthy people who want to prevent themselves from disease occurrence. Since, no standardized definition for the s-Health service globally, the Global Observatory for eHealth (GOe), a publication of the WHO, defines “mHealth or mobile health as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices” (WHO, 2011). In the other hands, the wide use of u-Health concept in S. Korea; tele-medicine, tele-health, and e-health concepts are more commonly used in other countries such as the US, Japan, and the UK. Similarly, with emergency of the smartphones the concept of the s-Health is developed in S. Korea, but it is called as smartphone based healthcare service or mhealth etc., in other sources. Liu et al., (2011) implies that “mHealth is an umbrella term the covers areas of networking, mobile computing, medical sensors and other communication technologies within healthcare” and they cite Istepanian et al., (2004)’s definition; “mobile computing, medical sensor, and communications technologies for health care”.

In this study, we follow Kim (2011)'s definition proposed in the report of the National Information Society Agency (NIA) which is "s-Health using the latest technology with terabytes of memory enables monitoring patients' health in anytime & anywhere and analyzes the data and provides personalized health service in real-time" (Kim, 2011). Korea Institute for Health and Social Affairs (KIHSA) reviews seven main features in s-Health such as intelligent, holistic, complex, bi-directional, seamless, open, and green (Song, 2011) as shown in Table 2.1.

Category	Detail
Intelligent	Providing more personalized and sophisticated healthcare service based on intelligent way of information process
Holistic	Having full functions such as safe, standardized, secured, and private smart technologies are applicable in all healthcare services
Complex	Providing integrated service including medical care, welfare, and security
Bi-directional	No separation between provider and consumer seems like prosumer form (provider to consumer health information exchange, but yet more provider-centered)
Seamless	Reusing existing information or personal health record (PHR) and producing new knowledge based on case based reasoning (CBS) system in seamless way
Open	Without restriction and open system, when enabling free knowledge communication without control then only actual s-Health is possible.
Green	More green IT (power-saving, subminiature platform etc.)

Table 2.1. The main features in s-Health service (Song, 2011)

In S. Korea, u-Health service has aroused as effective solution in coping current healthcare demands such as well aging and well dying. Accordingly, various kinds of the demonstration projects have continuously implemented by joint of hospitals and ICT companies or public agencies. It aims to improve environment in hospital and remote health care provision, and it is also included healthcare devices development. Furthermore, it makes sure that u-Health could be classified according to target group such as patients care, public care, and elder people. Lee (2010) makes up three

types of u-Health service; u-Medical, u-Wellness, and u-Silver. The details of classifications;

- u-Medical; is limited by Medical Service Act because of its scope such as diagnosis, treatment provision, and environmental support.
- u-Wellness; it is possibly new context in health care area because it targets both healthy and unhealthy people by promoting health and supporting healthy environment and focuses on more prevention than treatment.
- u-Silver; focusing on elderly people's (healthy, unhealthy, and high risk group) diagnosis, treatment provision, moreover, security management service and independent life support.

Unfortunately, Medical Service Act does not currently allow all u-Health services except of remote consulting (Kim, 2011).

Category	Main projects	Number (total/present)	Institutions
u-Medical	Remote treatment for suburban residents, prisoners, the military, and the police (1998-2009)	49/5	Ministry of Health and Welfare, Ministry of Justice, Ministry of Public Administration and Security, A local government
u-Silver	Senior citizens living alone, sanatorium (2006-2009)	4/2	Ministry of Health and Welfare, A local government
u-Wellness	Public health promotion (2007)	2/2	A local government

Table 2.2. The projects of public institutions (Kim, 2011)

As aforementioned, s-Health is emerging as next healthcare model even it is restricted by law to commercialize in public. It has been foreseen to have a great ripple effect in healthcare market in every side, if regulatory relief and some upgrades could happen. Kim (2011) firstly proposes a concept of s-Health and separates it from u-Health, it is shown in Figure 2.5. In u-Health, while u-Wellness aims more health maintenance, u-Medical focus on treatment of diseases and u-Silver includes both elderly people health maintenance and treatment. In contrast, s-

Care, s-Medical works as u-Wellness, u-Medical relatively, and s-Health covers them in s-Health.

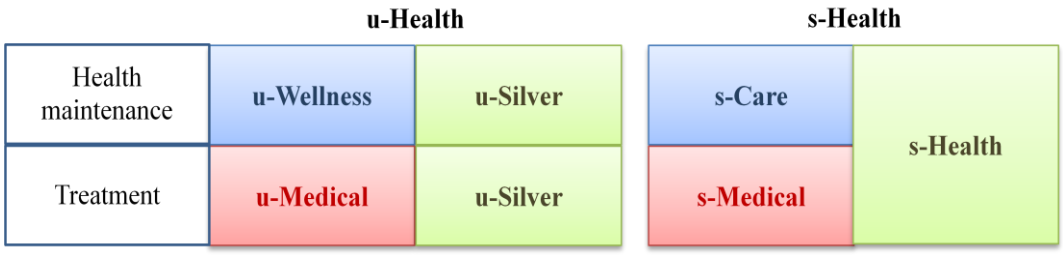

Figure 2.5. u-Health and s-Health (Kim J. , 2011)

In 2010, an s-Care demonstration project by Ministry of Knowledge Economy (MKE) is expected as an effective health delivery method and provides remote advice, guidelines. It also connects with other hospitals for chronic condition care such as high risky group with hypertensive and diabetes gathering their biometric information captured with smartphones or other smart devices (Figure 2.6).

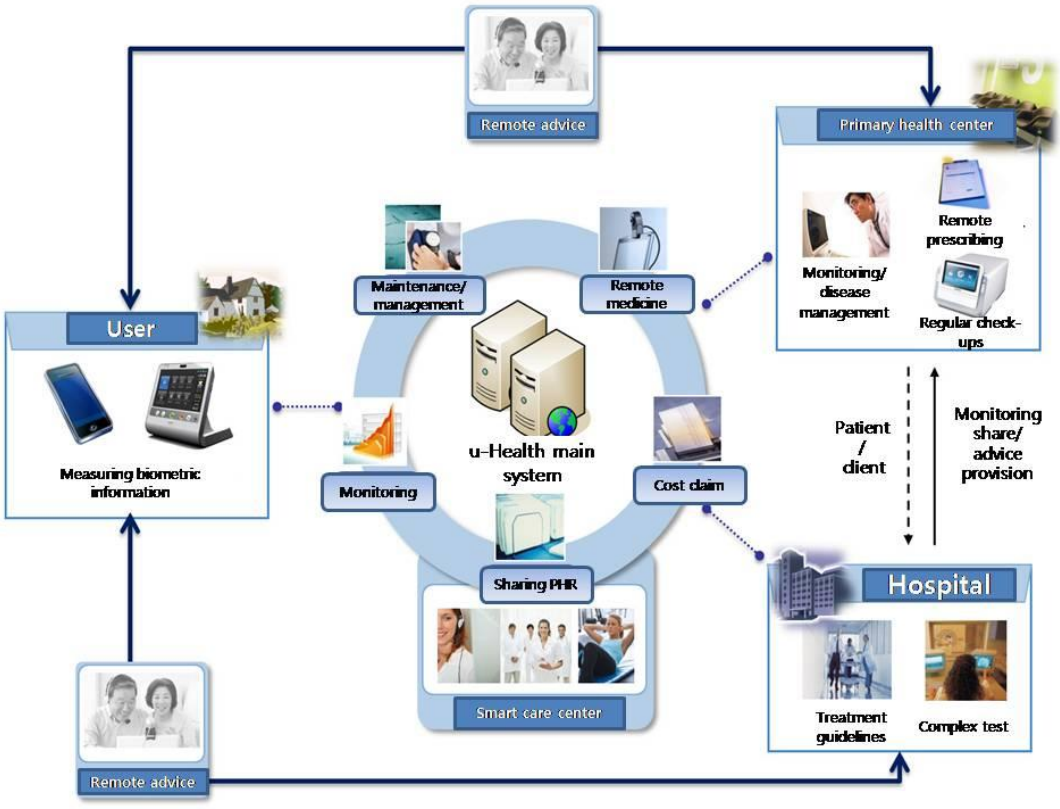

Figure 2.6. The model of s-Care service demonstration project by MKE[1]

Similar type of projects is introduced in Europe also. Newcastle University and iXscient Ltd. have developed cancer diagnostics - breast cancer recurrence monitoring, cervical cancer case finding, and colorectal cancer diagnostics etc., and known as SmartHEALTH integrated project in the UK (McNeil, 2010). The simple conceptual diagram is shown in Figure 2.7.

[1] Ministry of Knowledge Economy is converted to Ministry of Trade, Industry, and Energy in 2013

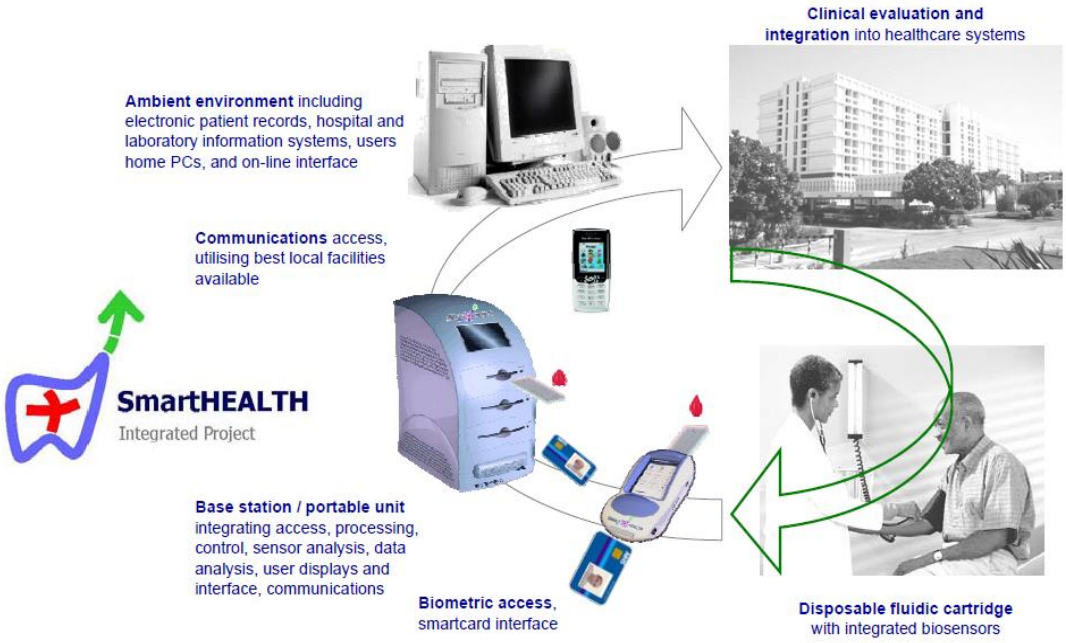

Figure 2.7. SmartHEALTH integrated project in UK (McNeil & Wenn, 2010)

In very recent, SD biosensor Inc has launched "SD GlucoNavii NFC" to which data is automatically sent when the near field communication (NFC) blood glucose measuring device is clapped over on the back of a smartphone (SD biosensor Inc, 2013). It enables to share the data family and health professionals through text messages and manages information more effectively. In the UK, a more convenient blood glucose meter, iBGStar, has been released and it possess advanced functions including connectable to the Apple's iPhone or iPod touch, easy one step measurement, and display blood information on iBGStar Diabetes manager app (Sanofi, 2013). Thus, the smart phones' applications and tools could be an effective option in reducing the progression of diabetes (Tran et al., 2012). Since the imaginary system used in the study is smart phone application for diabetes care, we overview related studies. Franc and his colleagues examine the role of telemedicine in diabetes using meta-analysis and concluded with "web or cell-phone based interventions are an effective method for continuing the educational, motivational and monitoring activities of patients with diabetes" (Franc et al., 2011). In particular, Tran reviews that ongoing development in smart phone apps enables users

effectively manage their blood sugar and overall health (Tran et al., 2012). Boulos et al. reports that there are lots of health promoting interventions but they will only be used by those who have already reached a decision to try to change their behavior (Boulos et al., 2011). It is well known that these systems support more benefits for patients and users health, but many of them are still neglected by users due to plenty of reasons. Thus, there are considerable studies tried to find out the barriers and motivators adopting new ICT but few raise ICT in healthcare rigorously smart phone healthcare because of its newness. In this term, this study attempts to determine the adoption in smartphone based diabetes care application using two models such as TAM and HBM.

2.3. Technology Acceptance Research

This section includes an overview of four behavior research models such as a) Theory of reasoned action (TRA), b) Theory of planned behavior (TPB), c) Technology acceptance model (TAM), and d) Unified theory of acceptance and usage of technology (UTAUT) and a selection of the published articles pertaining to TAM.

2.3.1. Theory of Reasoned Action (TRA)

The Theory of reasoned action (TRA) originates from the field of social psychology. Figure 2.8 shows a model of TRA, which was developed by Ajzen & Fishbein, 1980. Behaviors are indicated by intentions and the intentions are affected by both a one's attitude and subjective norm. Attitude has two antecedent factors like a one's behavioral beliefs and outcome evaluations and subjective norms are formed by normative beliefs and motivation to comply.

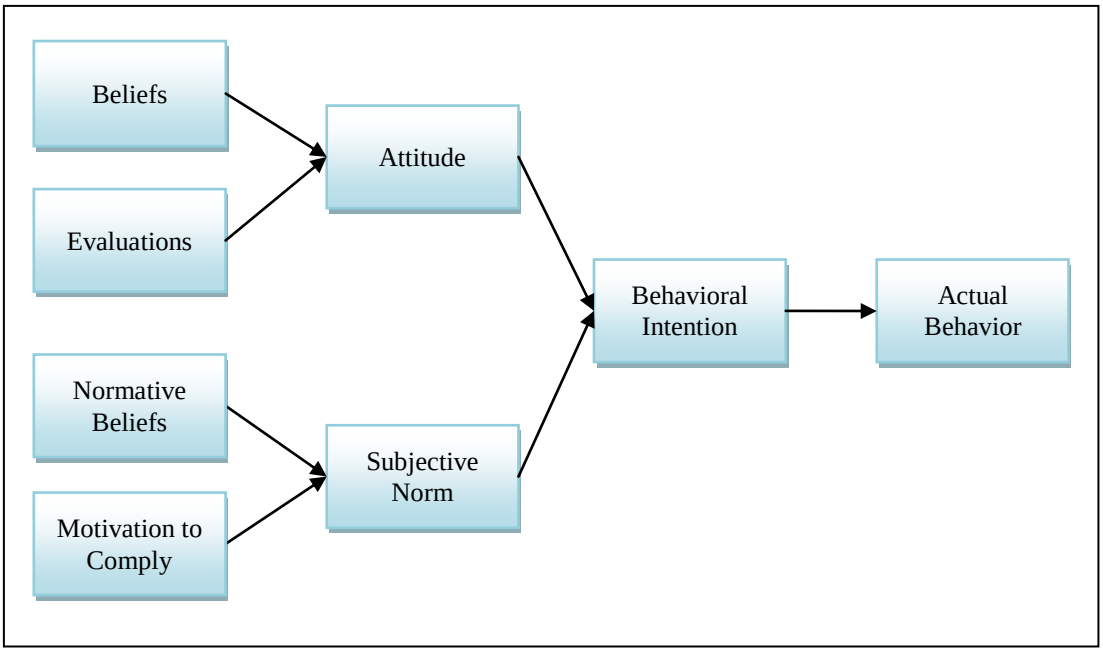

Figure 2.8. Theory of Reasoned Action (Ajzen & Fishbein, 1980)

TRA is design to explain virtually any human behavior (Ajzen & Fishbein, 1980), and thus should be appropriate to determine the indicators of computer usage behavior as a special case (Davis et al., 1989). This research could stimulate application of TRA in study of IT usage behavior (Ö zer et al., 2011; Jackson et al., 1997; Leonard et al., 2007; Hsu et al., 2008; Rehman et al., 2007). Sheppard et al. (1988) conduct a meta-analysis of TRA studies (30 different studies and 11,566 participants) and determine there is strong correlation between intentions and actions. In 1989, Davis et al. applied TRA to the study of individual acceptance of technology and found that the variance explained was largely consistent with previous studies using TRA to model behavior. In TRA, one's behavioral intention to use has two core direct influencer; attitude toward behaviors and subjective norms. The attitude toward behaviors is defined as "an individual's positive or negative feelings about performing the target behavior" (Fishbein & Ajzen, 1975). The subjective norm is based on "the person's perception that the most of the people who are important to him think he should or should not perform the behavior in question" (Fishbein & Ajzen, 1975).

2.3.2. Theory of Planned Behavior (TPB)

Ajzen later extended the TRA to include a measure of perceived behavioral control (PBC) (Ajzen, 1991). PBC gives direct influence to both intention and behavior as shown in Figure 2.9.

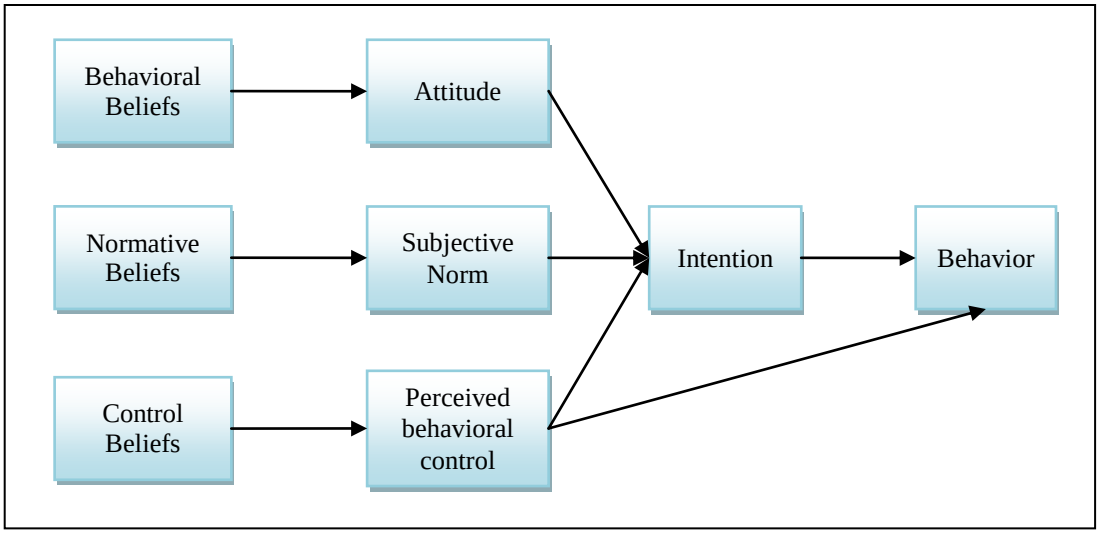

Figure 2.9. Theory of Planned Behavior (Ajzen, 1991)

Ajzen presents that behavior is also highly associated with individual's conditions whether he or she is under volitional control or not. Because, intention-behavior relationships is strong when he or she is under complete volitional control. In contrast, when there is no complete volitional control PBC have direct influence on behavior. Ajzen (1991) argues that the PBC and self efficacy which "is concerned with judgments of how well one can execute coursed of action required to deal with prospective situations" (Bandura, 1982) are equal concepts. However, several authors suggest that self-efficacy and PBC are entirely synonymous (Terry, 1993; de Vries et al., 1995; White et al., 1994; Terry et al., 1995). Intentions is also influenced by two other variables attitude and subjective norms same as TRA. There are three kinds of salient beliefs; behavioral beliefs which are assumed to influence attitudes toward the behavior, normative beliefs which constitute the underlying determinants of subjective norms, and control beliefs which provide the basis for perceptions of behavioral control (Ajzen, 1991). There are number of meta-analysis in TPB, Armitage et al., (2001) conclude with TPB is suitable as a predictor of intentions and

behavior.

2.3.3. Technology Acceptance Model (TAM)

In 1985, Technology acceptance model (TAM), proposed by Fred Davis, and was included actual system use that could be explained by use motivation, which was influenced by system features and capabilities (Davis, 1985). He refines it several times and develops most critical two constructs such as perceived usefulness and perceived ease of use in the TAM (Davis, 1989). In 1996, Venkatesh and Davis proposed the final TAM by eliminating the attitude construct and introducing the behavioral intention construct (Chuttur, 2009) as shown in Figure 2.10 (Venkatesh & Davis, 1996). The perceived usefulness and perceived ease of use are influenced by external variables and have direct effects on behavioral intention (BI). BI is related with actual use. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). Perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). Research in psychology and TAM itself suggest that users' intention to use is the single best predictor of actual system usage (Davis & Venkatesh, 1996). Behavioral intention and actual system use constructs are adapted from TRA.

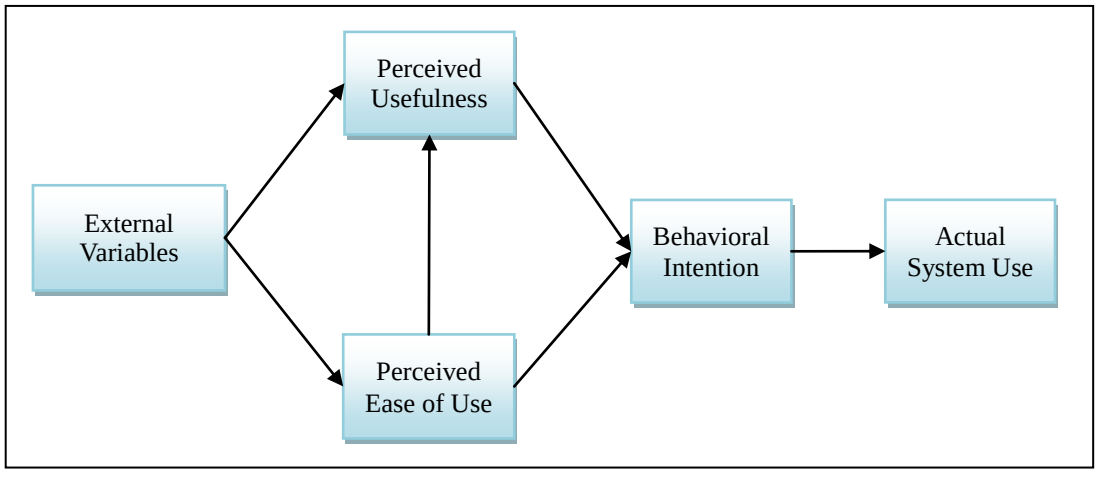

Figure 2.10. Technology Acceptance Model by Venkatesh in 1996

The TAM has become one of the most attracted models and is highly cited in information systems community (Chuttur, 2009). TAM has proven to be among the most effective models in the information systems literature for predicting user acceptance and usage behavior (Davis & Venkatesh, 1996).

2.3.4. Unified Theory of Acceptance and Usage of Technology (UTAUT)

Venkatesh and his colleagues formulated a unified theory of acceptance and usage of technology (UTAUT) by reviewing eight competing models including the theory of reasoned action, the technology acceptance model, the motivational model, the theory of planned behavior, a model combining the TAM and the TPB, the model of PC utilization, the innovation diffusion theory, and the social cognitive theory (Venkatesh, et al., 2003). It has found seven constructs had significant direct influence on intention or usage. Figure 2.11 presents the UTAUT. Performance expectancy, effort expectancy, and social influence as dependent variables have direct effect on behavioral intention and facilitating conditions are direct determinant of usage behavior. The model included moderating constructs like gender, age, experience as well voluntariness of use.

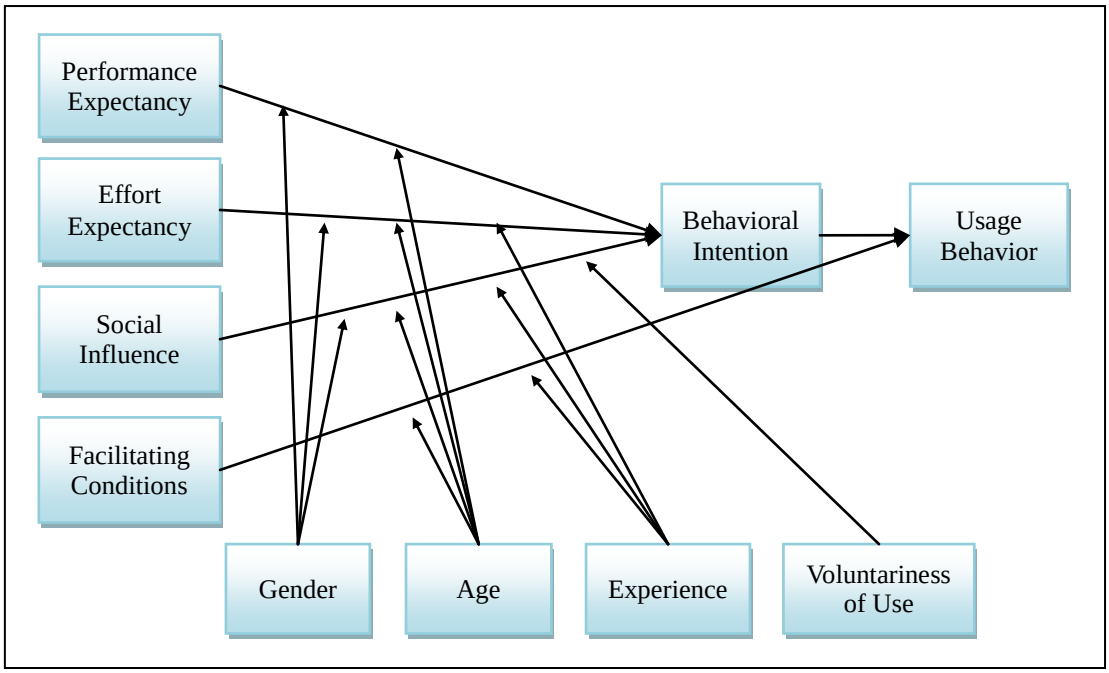

Figure 2.11. Unified Theory of Acceptance and Usage of Technology by Venkatesh

It will look into more detail about the constructs' definitions and explanations by Venkatesh et al. (2003). Performance expectancy is defined that "the degree to which a person believes that using a particular system would enhance his or her job performance" and found that the strongest predictor of intention. There are many constructs pertain to performance expectancy, but perceived usefulness can be seen to possess more similar characters. Effort expectancy is defined as "the degree of ease associated with the use of the system". It has similarity with perceived ease of use of the TAM and is the one of critical constructs in the UTAUT. Social influence is defined as "the degree to which an individual perceives that important others believe he or she should use the new system". This construct were already indicated as subjective norm in TRA, TAM2 etc. Facilitating conditions are defined as "the degree which an individual believes that an organizational and technical infrastructure exists to support use of the system". This definition captures concepts embodied by three different constructs: perceived behavioral control, facilitating conditions, and compatibility.

2.3.5. Previous research

Such TAM popularity works same way in the healthcare literatures. Since understanding acceptance of the health information systems (HIS) is as critical as its investment in development and implementation. Holden et al. (2010 reviewed a utilization of TAM in healthcare based on 16 data sets and indicated that TAM could probably explain and predict clinician end users acceptance and it has shown great interest in it in healthcare. In research of Yarbrough et al. (2007), it was discussed physicians technology acceptance by reviewing 18 published articles. A goal of their study was to find out barriers that make physicians hesitant to embrace new technologies in a healthcare setting and time, organizational issues, system issues, and personal characteristics were as the significant barriers. These two could be seen as the main TAM meta-analysis in healthcare. As one of the eldest and highly cited article, Hu et al. examined and tested TAM's explanation power in individual physician acceptance of telemedicine technology (Hu, et al., 1999). In the result, perceived usefulness was gained as more crucial indicator for physicians than

perceived ease of use and TAM was generally appropriate application in healthcare context. It was conducted first national level of study which was determined the key factors in adoption by community health centers in Thailand (Kijsanayotin et al., 2009). The study applied UTAUT model and was demonstrated high level of health IT acceptance and use by health centers personnel. Wu et al. suggested that characteristics of users and technologies used in healthcare environment such as hospitals are dissimilar in customary commercial context (Wu et al., 2007). Thus, they included mobile health system (MHS) specific factors such as compatibility, self-efficacy, technical support, and training. All dependent factors had strong relation with perceived usefulness and perceived ease of use, except of technical support and training. As above, there is a body of studies with TAM targeted only health professionals and technologies are applicable by them alone (Chismar et al., 2003; Ketikidis et al., 2012; Dunnebeil et al., 2012). The 29 published articles which examined acceptance of health informatics using TAM or its family models such as UTAUT were reviewed for getting deeper insight and determine critical constructs.

	Study	Technology	Population	Sample size/method	Variables
1.	(Ketikidis et al., 2013) (Health Informatics Journal)	e-health, electronic health records	Health professionals	133 (Multiple Linear regression, ANOVA)	TAM2
2.	Tung et al., (2008) (Int J of Med Info)	Electronic logistics information systems	Nurses	258 (LISREL)	P.cost, Compatibility, Trust, TAM
3.	Dunnebeil et al., (2012) (Int J of Med Info)	E-health in ambulatory care	Physicians	117 (PLS)	Social Influence, Att, TAM
4.	Pynoo et al.,(2012) (Int J of Med Info)	PACS	Physicians	46 (T1, T2, and T3)	Per ex, Eff ex, Social inf, facilitating cond, BI, Use
5.	Chismar et al., (2003) (proceedings)	Internet-based health applications	Physicians	89 (Regression analysis)	TAM2
6.	(Mohamed et al., 2011) (proceedings)	E-health web based service	Randomly selected	50	PC skills, e-health Tech design, Tangibility, trust, SN, Uncertainty avoidance, power distance, masculinity, TAM
7.	Hu et al., (1999)	Telemedicine	Physicians	421 (LISREL)	Att, TAM

	(J of Man Info Systems)	technology			
8.	Terrizzi et al., 2012) (AMCIS proceedings)	Integrated electronic health records	Professionals	31 (Path analysis)	Access to shared info, Trust, TAM
9.	Boonchai et al., (2009) (Int J of M Info)	Health IT	Professionals(CHC)	1607 (PLS)	UTAUT
10.	Yu et al., (2009) (Int J of M Info)	Health IT applications	Caregivers	134 (AMOS)	TAM2
11.	Schaper et al., (2007) (Int J of M Info)	Health IT	Occupational therapists	600 (PLS)	Tech, implementation, and individual context, BI, Use
12.	Chau et al., (2002) Information & Management	Telemedicine tech	Physicians	408 (LISREL)	Integrated model TAM, TPB
13.	Wu et al., (2007) (Int J of M Info)	Mobile healthcare systems	Professionals	123 (LISREL)	Compatibility, Self-eff, tech support, training, TAM
14.	Yarbrough et al., (2007) (Med Care Res Rev)		Physicians	19 (Meta analysis)	TAM
15.	Wu et al., (2008) (Int J for Qual in Hcare)	Adverse event reporting system	Professionals	290 (LISREL)	Management support, Trust, SN, TAM
16.	Pare et al., (2006) (J Am Med Inform Assoc)	Clinical information system	Physician	91 (Linear Regression)	Hands-on activities, Overall responsibility, Comm activities, Psychological ownership, TAM
17.	Djamasbi et al., (2009) (J of Info Tech Theory and App)	Telepathology system	Professionals	39 (Linear Regression)	Positive and Negative effect, TAM
18.	Xue et al., (2009) (Int J Med Inform)	Female-focused healthcare apps	Healthcare (241) and non healthcare workers (830)	1071 (Regression analysis)	Output qual, Result Demon, SN, Image, TAM
19.	Holden et al.,(2010) (J Biomed Informatics)	Health information technology	Healthcare professionals	16 (Meta analysis)	TAM
20.	Hung et al., (2012) (Int J Med Inform)	Medline system	Physicians	224 (PLS)	Per Innov, Self-Eff, Fac Cond, PB Control, SN, Interpersonal Inf, TAM
21.	Lai et al., (2008) (J Am Med Inform Assoc)	HIV TIDES prototype	PLWHAs	32 (ANOVA)	TAM2, Job relevance, Socio-demo
22.	Gadd et al., (2011) (J Am Med Inform Assoc)	Health information exchange	Professionals	150 (Stata/SE)	QUIS questions, TAM

23.	Aggelidis et al., (2009) (Int J Med Inform)		Professionals	283 (AMOS)	Anxiety, Self-eff, Social inf, Training, Facilitating Condition, TAM
24.	Marton et al., (2012)(Journal of Documentation)	Health website	Information seekers	4 articles (meta analysis)	
25.	Lim et al., (2011) (In J Med Inform)	Mobile phone applications/web	Singaporean women	175 (Correlation and hierarchical regression analysis)	Self-eff, tech anxiety, TAM
26.	Lanseng et al., (2007) (In J Serv Industry Management)	Internet based medical self-diagnosis apps	Age of 18 to 65 normal people	160 (LISREL)	Trust in service provider, TAM
27.	Or et al., (2011) (J Am Med Inform Assoc)	Interactive web-based health information system(Health Care website)	Home care patients with chronic cardiac disease	124 (Mplus v 5)	UTAUT, patient centered factors
28.	Wilson et al., (2004) (J Am Med Inform Assoc)	Provider's e-health apps	Patients	163(AMOS 4)	TAM, Motivational model, Integrated model
29.	Klein (2007) (European Journal of Information Systems)	Internet based patient-physician portals	Patients	294 (PLS analysis)	Com self-eff, Personal innov, , Healthcare need, primary care, TAM

Table 2.3. Review of articles TAM applied in healthcare

Therefore, we found out some limitations as reviewing the above articles. The limitations are as follows;

i. Most of the studies focused on health professionals' acceptance not patients or ordinary users.

ii. Because of organizational use, the issues related with acceptance and use are mandatory but voluntary.

iii. In term of the purpose of HIS use, the health professionals do not use it for their own health performance but do for their work effectiveness.

TAM was developed to explain workers adoption in ICT for their work effectiveness and productivity (Venkatesh & Davis, 2000). However, there are several kind of healthcare interventions developed for end-users who want to improve and perform their own health. In this term, TAM is expected to be able to

explain and predict not only healthcare providers but also common users or patients' acceptance. As one of the few patient acceptance studies, Or et al.,(2011) applies UTAUT model explaining home care patients' acceptance of a web-based interactive self-management technology and extracted the four variables including perceived behavioral control, subjective norm, perceived ease of use, and perceived usefulness from UTAUT and patient-centered factors such as perceived upper extremity functional ability, perceived visual functional status, health information seeking preference, and healthcare knowledge. As the result, perceived ease of use, perceived usefulness, subjective norm, and healthcare knowledge have shown significant effect on behavioral intention and effective use. As one of the interesting approach, Wilson et al.,(2004) proposed an integrated model of TAM and motivational model (MM) and assumed that the integrated model would be a better fit than TAM and MM alone. Satisfaction with medical care, information-seeking preference and internet dependence which were shown as the significant antecedent factors and the integrated model failed to indentify better fitness of its constituent models.

There is such obvious contrast between numbers of studies in patients' acceptance and providers. The objective of this study is set to indentify whether TAM could validate patients acceptance in smart phone based health care system. Since, the study is the complex topic with IT and healthcare, it is applied two models TAM, a representative model in ICT, and HBM, highly utilized in healthcare context.

2.4. Health Belief Model (HBM)

Since 1950, Health belief model (HBM) has been emerged as one of the critical model in health behavior theory. Initially, the HBM were designed by U.S Public Health Service and tried to give explanation why people did not engage actively for preventing their diseases (Hochbaum, 1958). The HBM was focused to account for health behaviors which seek a chance to decrease disease occurrence using individual perceptions and beliefs (Hochbaum, 1958). There are key constructs such as susceptibility, severity, benefits, and barriers to a behavior, cues to action, and most recently self-efficacy. In the first, Hochbaum (1958) presented the HBM in order to clarify participants' beliefs taking tuberculosis test. And, he gained the significant outputs through his research. In today, popularity of this model works not only in health or medical context but also in various health behaviors researches such as preventive healthcare using smartphone application (Peck et al., 2012) and computer security behavior (Claar et al., 2012).

The key constructs of the HBM follow as;

Perceived Susceptibility:

Perceived susceptibility is one of the critical constructs in accepting one's health behavior. If perceived risk is high, it is faster to take a behavior related to reduce that risk. Generally, he or she starts taking action when he or she believes that there is great chance to occur disease. However, it works opposite in some cases. He or she does not feel to do anything when he or she believes there is no risk in his or her health. For instance, it could be related with one's demographics. Particularly, while young people do not easily perceive chances of disease occurrence on them, elder people or those who have experienced are rather sensitive about the diseases. Perceived susceptibility construct has originated from this psychology of human.

Perceived Severity:

Perceived severity is the construct about seriousness of his or her belief in diseases/illness. Perceived severity is basically based on health or medical information and knowledge, but it could come from a person struggling with disease. For instance, the flu is believed as a simple disease and few days taking rest and medication is enough to recover it. But if one suffers from asthma flu could be rather

serious problem. And also on the other hand, the simplest flu could be a sever issue for a pregnant woman who cannot take medicine easily or for a person is going for a long trip.

Perceived Benefits:

Perceived benefits is a construct about one's perceptions or beliefs that if new health behavior is accepted for decreasing occurrence and worsening of diseases. In the other hand, it is faster to get new behavior which is believed to help reducing chances to get diseases. Would he/she do regular exercise if it was no effect on health? Would he/she tries to cook in the home if it wasn't believed homemade food was healthier than fast-food? Possibly the answer is NO (Hayden, 2009). It is not always easy to take new healthier behavior and preventive care. It would be complicated, needed long term patience, and even tolerance. Nevertheless, if this is believed as a critical factor in preventing diseases and detecting a cancer early, anyone tends to accept this new behavior regardless of its inconvenient. This construct is based on this psychological character of human being.

Perceived Barriers:

Since, all kind of changes never happen easily, perceived barriers construct is last exogenous variable in the HBM. It is individual's evaluation that there would be obstacles to start new behavior. Janz et al. (1984) have claimed that barriers are the one of most significant factor in explaining behavioral changes. According to Centers for Disease Control and Prevention (2004), in order to change old behavior, it should be believed benefits of new behaviors outweigh far old behaviors. This could only motivate people to adopt new behavior beyond barriers.

Modifying Variables:

Demographic variables which mostly affect on individuals perceptions and beliefs include modifying variables. And, it contains more factors such as culture, education, past experience, skill, and motivation etc. For instance, if a mother suffers from breast cancer, it cannot be avoided her daughter concern because breast cancer mostly inherits genetically. The past experience becomes her modifying variable.

Cues to Action:

In addition of four perceptions and modifying variables, cues to action construct are included in the HBM too. It could be experience, person, or things that make

peoples behaviors to change. For instance, these contain family's illness, the mass media campaigns, and advice from others etc. Watching TV or listening radio news how prevent food-borne illness or reading instructions on raw meat pack about safe food-handling behaviors are called as cues to action.

Self-efficacy:

In 1988, self-efficacy construct was added into the HBM (Rosenstock et al., 1988). "Self-efficacy is the belief in one's own ability to do something" (Bandura, 1977). In general, he/she doesn't try to do something new unless he/she believes that they can do it. He/she would not attempt to adopt new behavior if they have doubts in handling, even he/she does know how useful it is. Umeh et al. (2001) determined a critical reason in not performing breast self examination is a fear of incorrectness of while doing breast self examination (Umeh et al., 2001) The HBM is shown as figure 2.12.

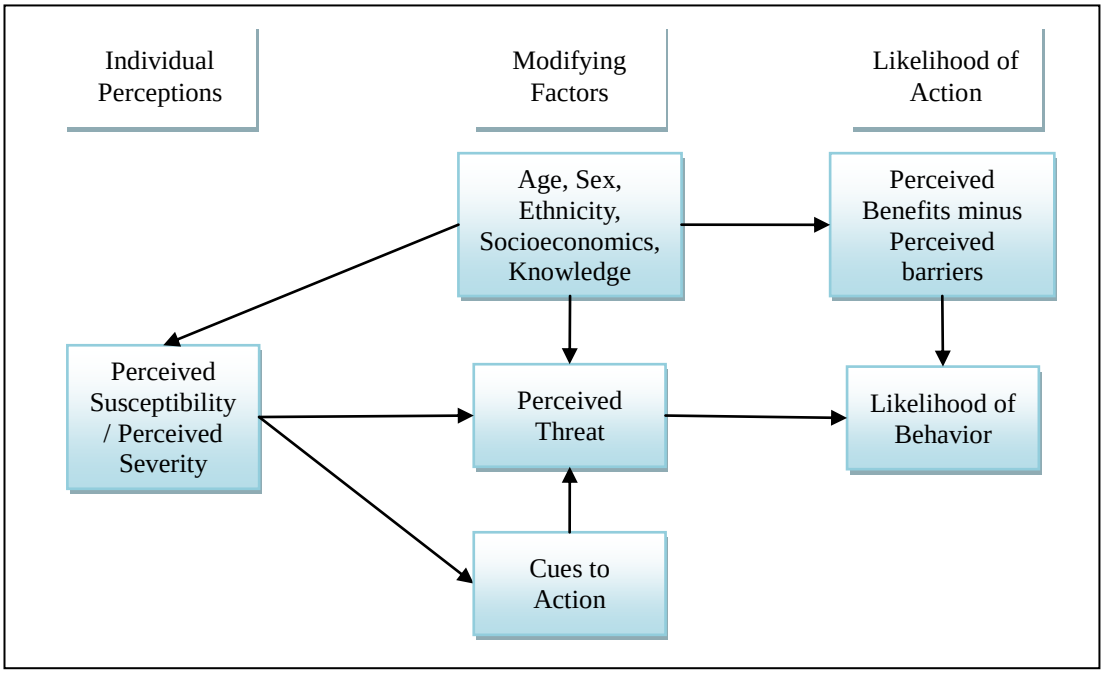

Figure 2.12. Health Belief Model by Stretcher and Rosenstock (1997)

CHAPTER III

RESEARCH MODEL DEVELOPMENT

This chapter presents a research model and the formulation of several research hypotheses. This study will explore the determinants from both health belief model (HBM) and technology acceptance model (TAM), and eventual purpose is proposing the new model in smart healthcare.

3.1. Core Constructs

In this section, the development of the core constructs of the research model is discussed. These constructs include perceived barriers, perceived benefits, perceived susceptibility, perceived seriousness, and health self-efficacy from the HBM and subjective norm, results demonstrability, technology self-efficacy, perceptions of external control, anxiety, perceived enjoyment, perceived usefulness, perceived ease of use, and intention from the TAM.

Perceived Susceptibility (SUS)

Initially, Rosenstock (1966) defined the construct perceived susceptibility as "subjective risks of contracting a condition" (Rosenstock, 1966). Perceived susceptibility is expected to play an important role in this study as the critical construct in the HBM. In the healthcare context, perceived susceptibility refers to one's perceived likelihood of the occurrence of disease. When an individual believes that diabetes is vulnerable, he/she starts to take action such as checking blood glucose. Thus, we assume one will be likely to approach with smartphone applications providing blood glucose care. However, it could be great differences between young and old people's perceptions and beliefs about blood glucose care. That's why data is collected from both groups old and young. And, the first sets of hypotheses come from this assumption.

While this construct is widely identified and utilized in medical care field, it is

rather new concept in ICT field. Even more, there is a few research works perceived susceptibility takes place as the exogenous variable in TAM. Thus, there is no proof found relationships between perceived susceptibility and endogenous variables including perceived usefulness, perceived ease of use, and intention in TAM. In this term, it has decided to determine which path is significantly related. The hypotheses for this construct are as follows:

H1-1 - *Perceived susceptibility of diabetes is positively related to perceived ease of use in smart blood glucose system.*

H1-2 - *Perceived susceptibility of diabetes is positively related to perceived usefulness of smart blood glucose system.*

H1-3 - *Perceived susceptibility of diabetes is positively related to intention use of smart blood glucose system.*

Perceived Severity (SEV)

The construct perceived severity refers to "one's perception of the seriousness of a given health problem" (Claar, 2011). This construct works equally as critical as perceived susceptibility in HBM as well as this study. Elder people who have high blood glucose are likely to believe that it causes complications of diabetes and get habit faster than healthy people do. And also, beliefs about diabetes affects on their entire lifestyles and family. Specifically, economic problems make it more serious including visiting a hospital in order to care of blood glucose. In this term, we assume that elder people readily have interested and tend to approach smartphone applications which help to manage their blood glucose. The second sets of hypotheses come from this assumption. As mentioned above, there are no appropriate bases of path relationships between perceived severity and endogenous variable of TAM. Thus, this study approaches to identify the significant relations among them. The hypotheses for this construct are as follows:

H2-1 – *Perceived severity of diabetes is positively related to perceived ease of use in smart blood glucose system.*

H2-2 – *Perceived severity of diabetes is positively related to perceived usefulness of smart blood glucose system.*

H2-3 – *Perceived severity of diabetes is positively related to intention to use smart*

blood glucose system.

Perceived Barriers (BAR)

The perceived barriers construct refers to the "one's belief in benefits compared to the perceived benefits costs of action" (Claar, 2011). Although individual believe a new behavior reducing threat in health, it may to take action inconvenient and unpleasant. A new behavior is difficult to be accepted easily by someone (Janz et al., 1984). When elder people don't know about features of new technologies as well as its application, they are likely to be ignored by them. In this term, perceived barriers must be a crucial factor and have to be identified drastically. There are certain differences in barriers between offline and online environment. For instance, the problems occurred in offline healthcare environment such as inconvenience of hospital treatment or unfriendliness of health professionals are no more significant obstacles in online environment. However, different kind of potential barriers still exist in online healthcare environment such as unreliability of service or lack of knowledge. And, it is assumed that barriers will be related to three endogenous variables of TAM. The hypotheses for this construct are as follows:

H3-1 – *Perceived barriers of smart blood glucose system is negatively related to perceived ease of use.*

H3-2 – *Perceived barriers of smart blood glucose system is negatively related to perceived usefulness.*

H3-3 – *Perceived barriers of smart blood glucose system is negatively related to intention to use.*

Perceived Benefits (BEN)

Perceived benefits construct refer to "one's perception of the relative effectiveness of an action to reduce the disease threat" (Claar, 2011). For this study, the perceived benefits are elder people's beliefs that when they use this smartphone based blood glucose application, it helps to manage their blood glucose and even prevent from getting any blood related conditions. Generally, it is common concept that an individual tries to accept new behavior promoting health condition. In this term, we assume that elder people under control of hospital are likely to adopt smartphone

application by themselves or with someone's help. Perceive benefits will be related to three endogenous variables of TAM. The hypotheses for this construct are as follows:

H4-1 – *Perceived benefits of smart blood glucose system is positively related to perceived ease of use.*

H4-2 – *Perceived benefits of smart blood glucose system is positively related to perceived usefulness.*

H4-3 – *Perceived benefits of smart blood glucose system is positively related to intention to use.*

Health Self-Efficacy (HSE)

Self-efficacy construct is most recently added in the HBM. The construct comes from social cognitive theory and refers to "one's self confidence in his/her ability to perform a behavior to produce the desired outcomes" (Bandura, 1977). For this study, the health self-efficacy is applied as elder peoples' confident in their handling blood glucose. Commonly, this construct contains proper diet, regular blood checkups, and seeking more information related diabetes via the media. Such defiant nature may motivate to use smartphone application in order to manage better with its features. Perceived benefits will be related to three endogenous variables of TAM. The hypotheses for this construct are as follows:

H5-1 – *Health Self-efficacy is positively related to perceived ease of use of smart blood glucose system.*

H5-2 – *Health Self-efficacy is positively related to perceived usefulness to smart blood glucose system.*

H5-3 – *Health Self-efficacy is positively related to intention to use smart blood glucose system.*

Subjective Norm (SN)

Subjective norm is one of the influential constructs in TAM. It refers "one's perception that most people who are important to him/her think he/she should or should not perform the behavior in question" (Fishbein et al., 1975). For this study, it has specified family doctors and nurses as the important people other than family

members or friends. Because, it is believed that advices of these healthcare professionals are reliable than anyone else do. In this term, we assume that peoples' advice or opinion make elder people to accept smartphone application. The hypothesis for this construct is as follows:

H6-1 – *Subjective norm is positively related to perceived usefulness.*

Results Demonstrability (RD)

Results demonstrability is another antecedent of perceived usefulness in TAM3, refers to "one believes that the results of using a system are tangible, observable, and communicable" (Moore et al., 1991). For this study, it is perception degree of ability of explaining about results after using the smartphone based blood glucose to others. It might be difficult to imagine results without using the smartphone application for elder people, thus, in order to reduce the trial and error we let them watch a short video while collecting surveys. The hypothesis for this construct is as follows:

H6-2 – *Results demonstrability is positively related to perceived usefulness.*

Technology Self-Efficacy (TSE)

The computer self-efficacy is an antecedent of perceived ease of use in TAM, refers "one believes that he/she has the ability to perform a specific task/job using the computer" (Compeau & Higgins, 1995). However, for this study, we modify this construct as technology self-efficacy because of no computer usage applied. It could be defined elder peoples' beliefs or confident in utilizing smartphone application for their blood care. The hypothesis for this construct is as follows:

H7-1 – *Technology self-efficacy is positively related to perceived ease of use.*

Perception of External Control (PEC)

The perception of external control construct refers "one believes that organizational and technical resources exist to support the use of the system" (Venkatesh et al., 2003). External controls include environment, knowledge, opportunity, and system compatibility and make easy to accept new technology such as smartphone application. The hypothesis for this construct is as follows:

H7-2 – *Perceptions of external control is positively related to perceived ease of use.*

Anxiety (ANX)

The computer anxiety construct refers "one's apprehension, or even fear, when he/she is faced with the possibility of using computers" (Venkatesh, 2000). There is also a little modification for this study smartphone replaced of computer. And, this anxiety construct is expected as significant effective variable, because elder people are not likely to be familiar with new technology such as smartphone applications. The hypothesis for this construct is as follows:

H7-3 – *Anxiety is negatively related to perceived ease of use.*

Perceived Enjoyment (ENJ)

Perceived enjoyment construct refers "the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use" (Venkatesh V. , 2000). Since diabetes patients have to check their blood using blood glucose meter or visiting hospitals in daily life. The features of smartphone blood glucose system support more pleasant services such as graphic function, real-time feedback from doctor and it probably enhance motivation of the patients to manage their blood sugar. The hypothesis for this construct is as follows:

H7-4 – *Perceived enjoyment is positively related to perceived ease of use.*

Perceived Usefulness (PU)

Perceived usefulness is mediating variable in TAM and equally important with perceived ease of use in TAM. It refers to "one believes that using a particular system would enhance his or her job performance" (Davis F. , 1989). But, the construct is modified according to a goal of the study, "health performance" instead job performance. When a patient believes using the smartphone blood glucose system is rather useful than using prior devices, visiting hospitals or doing nothing, it might be accepted to him or her. The hypothesis for this construct is as follows:

H8 – *Perceived usefulness is positively related to intention to use.*

Perceived Ease of Use (PEOU)

Perceived ease of use construct is one of the most important two variables in, refers

"one believes that using a particular system will be free of effort" (Davis F. , 1989). This is the quite simple psychology of human being that ease to use or understanding is always welcomed and pleasured by people. Particularly, it is highly crucial factor for elder people who have lack of learning and performing new behavior. The hypotheses for this construct are as follows:

H9 – *Perceived ease of use is positively related to intention to use smart blood glucose system.*

H10 – *Perceived ease of use smart blood glucose system is positively related to perceived usefulness.*

The research model representing the constructs and their relationships are shown in Figure 3.1.

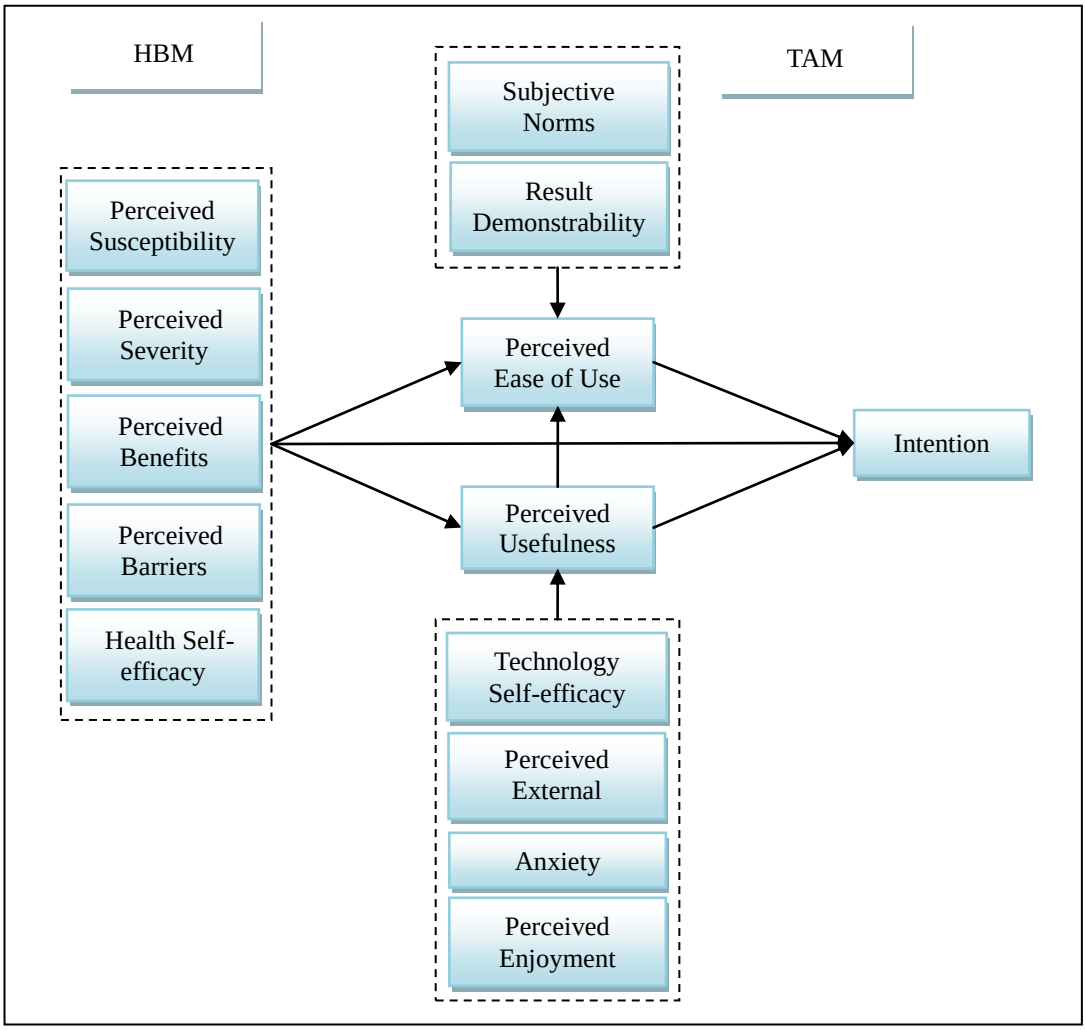

Figure 3.1. Research Model

CHAPTER IV

RESEARCH METHODS AND PROCEDURES

This chapter describes the research methods and procedures which have implemented to test the model and associated hypotheses presented in the previous chapter. This research used a non-experimental design utilizing a paper-based survey to assess the proposed model and research hypotheses. This chapter presents the population under study, survey development, operationalization of constructs, and pretest results. This chapter also presents the data collection method.

4.1. Population

There is a contradiction deciding the population for the study. Because generally smartphone users are young people but they don't have interest on diabetes. And, elder people sometimes have no clue about smartphones or recent technologies, but they are likely to have blood conditions. Thus, we decided the population as normal people (no age range limit) who were smartphone users and elder people who are suffering blood glucose at current.

4.2. Operationalization of the Constructs

Demographics Variables

The demographic variables including gender, age, education, occupation, whether a diabetes patient, if using a blood glucose meter, and monthly income are assessed using categorical response options. Operationalization of the demographic variables can be found in Table 4.1.

Variable	Question	Response option
Gender	Are you male or female?	Male Female
Age	What is your age group?	Teenager 20s 30s 40s 50s Above 60s
Education	What is the highest level of education you have completed?	Less than middle school High school or equivalent 4 or 2 year college Graduate school
Occupation	What is your occupation?	College or graduate student Health related professional Government employee Specialized job Office clerk Independent businessman Other options
Diabetes patient	Are you currently suffering diabetes or blood glucose problem?	Yes or No
Length of diabetes	How long have you been suffered diabetes and blood glucose problem?	Less than 1 year to above 10 years
Blood glucose monitoring meter	In current, do you use a blood glucose monitoring meter?(included who answered yes in prior question only)	Yes or No
Income	What is your income a monthly average?	Less than 1.5 million won 1.5 to 3 million won 3 to 4.5 million won 4.5 to 6 million won More than 6 million won

Table 4.1. Demographic variables

Perceived Susceptibility

There are various measurement items for perceived susceptibility, but we select two items Champion (1984) and two items taken from Gutierrez and Long (2011) that is considered the suitable for the study purpose. Perceived susceptibility is measured on a 5-point Likert scale from highly disagree to highly agree. The

susceptibility scenarios can be seen in Table 4.2.

No	Item	Resources
1	My abnormal lifestyle makes it more likely that I will get diabetes.	Champion (1984)
2	My physical health makes it more likely that I will get diabetes.	
3	How likely will you be to develop the complications of diabetes or have complications worsened?	Gutierrez and Long (2011)
4	How likely are you to have a shortened life expectancy?	

Table 4.2. Perceived Susceptibility

Perceived Severity

Perceived severity refers to a user's perceived seriousness of an occurrence of diabetes. As this construct measurement, we select two items taken from Moss-Morris et al. (2002) and other two from Gutierrez and Long (2011). Perceived severity is measured on a 5-point Likert scale from highly disagree to highly agree. The severity scenarios can be seen in Table 4.3.

No	Item	Resources
1	To what extent do you consider diabetes to be a severe health problem?	Gutierrez and Long (2011)
2	To what extent do you consider complications arising from diabetes to be severe health problems?	
3	My diabetes has major consequences on my life.	Moss-Morris et al., (2002)
4	My diabetes has serious financial consequences.	

Table 4.3. Perceived Severity

Perceived Barriers

Perceived barriers refer to a user’s assessment of the influences that facilitate or discourage adoption of the blood glucose management system. This variable questions are taken from Gutierrez & Long (2011) and measured with a 5-point likert

scale highly disagree to highly agree. The Barriers questions can be seen in Table 4.4.

No	Item	Resources
1	I have trouble remembering to get the smart blood glucose system.	Gutierrez and Long (2011)
2	Family problems make it difficult for me to get the smart blood glucose system regularly.	
3	I would have to change too many habits to get the smart blood glucose system.	
4	Taking my medication through the smart blood glucose system interferes with my normal daily activities.	
5	I do not feel motivated to use the blood glucose system regularly.	

Table 4.4. Perceived Barriers

Perceived Benefits

Perceived benefits refer to an individual's assessment of the positive consequences of adopting the behavior (smart blood glucose management system). This variable questions are taken from Gutierrez and Long (2011) and measured with a 5-point likert scale from highly disagree to highly agree. The Benefits questions can be seen in Table 4.5.

No	Item	Resources
1	Using the smart blood glucose system can help to prevent diabetes complications.	Gutierrez and Long (2011)
2	Sticking the smart blood glucose system will help me control my diabetes.	
3	Using the smart blood glucose system will help me feel better.	
4	Sticking the smart blood glucose system will help me live longer.	

Table 4.5. Perceived Benefits

Health Self-efficacy

Health self-efficacy is a user's belief about capability of performing health related behaviors in order to attain health performance. This variable questions are taken

from Gutierrez and Long (2011) and measured with a 5-point likert scale from highly disagree to highly agree. The Health Self-efficacy questions can be seen in Table 4.6.

No	Item	Resources
1	I have confident in my ability to manage my diabetes.	Gutierrez and Long (2011)
2	I feel capable of handling my diabetes now.	
3	I am able to do my own routine diabetes care now.	
4	I am able to meet the challenges of controlling my diabetes.	

Table 4.6. Health Self-efficacy

Subjective Norm

Subjective Norm refers that one's perception that most people who are important to him think he should or should not perform the behavior. Items of this variable are taken from Venkatesh (2000) and measured with a 5-point likert scale highly disagree to highly agree. The Subjective norm questions can be seen in Table 4.7.

No	Item	Resources
1	According to my family, it is very important for me to use the smart blood glucose system.	Ventakesh (2000)
2	According to my doctor, it is very important for me to use the smart blood glucose system.	
3	According to my friends, it is very important for me to use the smart blood glucose system.	
4	According to my nurse, it is very important for me to use the smart blood glucose system.	
5	According to most important people of mine, it is very important for me to use the smart blood glucose system.	

Table 4.7. Subjective Norm

Results Demonstrability

Results Demonstrability is tangibility of the results of using the innovation, including their observability and communicability. Items of this variable are taken from Ventakesh (2000) and measured with a 5-point likert scale highly disagree to

highly agree. The Results demonstrability questions can be seen in Table 4.8.

No	Item	Resources
1	I have no difficulty telling others about the results of using the smart blood glucose system.	Ventakesh (2000)
2	I believe I could communicate to others the consequences of using the smart blood glucose system.	
3	The results of using the smart blood glucose system are apparent to me.	
4	I would have no difficulty explaining why using the smart blood glucose system may or may not be beneficial.	

Table 4.8. Results Demonstrability

Technology Self-Efficacy

Technology Self-efficacy is the degree to which an individual beliefs the he or she has the ability to perform specific task using IT. Items of this variable are taken from Ventakesh (2000) and measured with a 5-point likert scale highly disagree to highly agree. The Results demonstrability questions can be seen in Table 4.9.

No	Item	Resources
1	I could use the smart blood glucose system if I had never used a system like it before.	Ventakesh (2000)
2	I could use the smart blood glucose system if I had only the system manuals for reference.	
3	I could use the smart blood glucose system if I had a lot of time to get understand how the system works.	
4	I could use the smart blood glucose system if someone showed me how to do it first.	
5	I could use the smart blood glucose system if I had used similar systems before this one to do the same job.	

Table 4.9. Technology Self-Efficacy

Perceptions of External Control

Perceptions of External Control refer the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.

Items of this variable are taken from Ventakesh (2000) and measured with a 5-point likert scale highly disagree to highly agree. The perceptions of external control questions can be seen in Table 4.10.

No	Item	Resources
1	I have control over using the smart blood glucose system.	Ventakesh (2000)
2	I have the resources necessary to use the smart blood glucose system.	
3	I have the knowledge necessary to use the smart blood glucose system.	
4	Given the resources, opportunities and knowledge it takes to use the system, it would be easy for me to use the smart blood glucose system.	
5	The smart blood glucose system is not compatible with other systems I use.	

Table 4.10. Perceptions of External Control

Anxiety

Anxiety is evoking anxious or emotional reactions when it comes to performing a behavior. This variable questions are measured with a 5-point likert scale highly disagree to highly agree. The Anxiety questions can be seen in Table 4.11.

No	Item	Resources
1	Working with the smart blood glucose system makes me nervous.	Ventakesh (2000)
2	The smart blood glucose system makes me feel uncomfortable.	
3	The smart blood glucose system scares me.	
4	I get a sinking feeling when I think of trying to use the smart blood glucose system.	
5	The smart blood glucose system makes me feel uneasy.	

Table 4.11. Anxiety

Perceived Enjoyment

Perceived Enjoyment refers the extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use. This variable questions are measured with a

5-point likert scale highly disagree to highly agree. The perceived enjoyment questions can be seen in Table 4.12.

No	Item	Resources
1	I find using the smart blood glucose system to be enjoyable.	Ventakesh (2000)
2	The process of using the smart blood glucose system is pleasant.	
3	I have fun using the smart blood glucose system.	
4	I feel at pleasant in trying to use the smart blood glucose system.	

Table 4.12. Perceived Enjoyment

Perceived Ease of Use

Perceived Ease of Use is the degree of ease associated with the use of the smart blood glucose management system. This variable questions are measured with a 5-point likert scale highly disagree to highly agree. The Perceived Ease of Use questions can be seen in Table 4.13.

No	Item	Resources
1	I find that using the smart blood glucose system is simple.	Ventakesh (2000)
2	I find that the smart blood glucose system is easy to learn.	
3	I find that the smart blood glucose system saves my effort for preventing and managing the diabetes.	
4	I can use the smart blood glucose system in anywhere and anytime.	
5	Overall, I find that using the smart blood glucose system is convenient.	

Table 4.13. Perceived Ease of Use

Perceived Usefulness

Perceived Usefulness is the degree to which an individual believes that using the smart blood glucose system will help of him or her to attain gains in health performance. First two items are developed by author and other three items are taken

from Huang (2011). Perceived usefulness is measured on a 5-point likert scale from highly disagree to highly agree. The Usefulness questions can be seen in Table 4.14.

No	Item	Resources
1	The smart blood glucose system helps to detect blood sugar problem early.	Self-developed
2	The smart blood glucose system helps to decrease diabetes related mortality.	
3	Having the smart blood glucose system makes me safer in my daily life.	
4	The smart blood glucose system can enhance the quality of my life.	Huang (2011)
5	Overall, I find that the smart blood glucose system is highly useful.	

Table 4.14. Perceived Usefulness

Intention to Use

Intention to Use is the degree to which a user has formulated conscious plans to use or not use the smart blood glucose system in future. Perceived usefulness is measured on a 5-point likert scale from highly disagree to highly agree. The Intention to Use questions can be seen in Table 4.15.

No	Item	Resources
1	It is a good idea using the smart blood glucose system.	Ventakesh (2000)
2	I intent to use the smart blood glucose system.	
3	I will try to use the smart blood glucose system.	
4	I will recommend the smart blood glucose system to others.	

Table 4.15. Intention to Use

4.3. Pretest

After construction of the survey items, pretests were administered twice. It was collected from students in Jeju National University during the Fall Semester 2012. The pretest obtained a total of 64 responses, of which all were usable in order to identify weaknesses in question wording and analyze the reliability of the scales used. Based on relevant comments by those that took the survey, some items were reworded to enhance understanding by respondents with non-technical backgrounds.

Respondent Demographics

Demographic information for the first pretest respondents is presented in Appendix 1. The demographics were consistent with an undergraduate class. It has expected that for the main data collection there will be more diversity in responses and we should see that gender would be approximately equal, more education levels would be represented, and more variation would exist in the age of respondents. The second data is presented with original data.

Reliability and Validity

Cronbach's alpha measures the internal consistency of the items in the factor. The lower limit for an acceptable Cronbach's alpha is 0.7, though 0.6 may be acceptable for newly defined scales (Hair et al., 1998). A reliability analysis of the constructs revealed that the target of Cronbach's alpha of 0.7 was attained for all theorized constructs. Indicating, that proceeding with the main data collection using the items in the pretest is acceptable (see Appendix 2).

Output quality and attitude variables were included in initial model for TAM. But results of factory analysis showed that output quality and result demonstrability, attitude and intention variables were mixed, so we decided to select one of each. Besides, other all variables showed good validity in each constructs.

4.4. Data Collection

Since the objective of the study is determining key drivers on using smartphone application for blood glucose control and diabetes care purpose. The target population has defined as two groups which are young group, fluent of using smartphones. Another group belong unhealthy group (elder people) who has been controlling their blood glucose and suffering diabetes at current. Thus, data was collected twice in different places. First data was collected randomly from regular people. Total 500 numbers of surveys distributed and collected back 451. However, 387 only were used for final analysis due to unreliable information. It took place in Jeju international airport for diversity of respondents from November 2012 to January 2013. There was relatively convenient taking survey on account of well understanding of questionnaires. And second data set took place from August to September of 2013. The target group was diabetes patients. Data conducted at three different places including diabetes clinic "Dong il", general hospital "Halla hospital", and "Jeju National University Hospital". We used short video of iBstar meter[2] while taking survey in order to assist understanding of smartphone blood glucose system for elder people. It took nearly 35 to 40 minutes each respondents taking single survey. A total of 300 surveys were distributed and 253 were collected back.

[2] iBGStar iPhone system by Sanofa Diabetes
http://www.bgstar.com/web/ibgstar/training_tutorials/training_tutorials

CHAPTER V

DATA ANALYSIS

This chapter presents the characteristics of the study sample, its analysis and the results of statistical analysis. The study data set is collected using a survey distributed in person. The sample set as collected contains both 253 and 387 responses. Some of the data such as missing data and unreliable are excluded from final data which used in analysis. The chapter concludes with an analysis of the hypotheses presented in Chapter III.

5.1. Preliminary analysis

In order to apply partial least square - structural equation model (PLS-SEM) analysis technique, some preliminary analysis should be done. In the following parts the data checked for suitability for further analysis.

Handling Missing Data

Missing data means any blank parts in the data set and should be handled, since missing data can affect analysis and cause problems (Field, 2005). In the literature there are several steps that could be done to handle missing data analysis. As also noted by Hair et al. (1998) handling the missing data begins with deciding if the missing cases are enough to be ignored or not. The dataset checked for missing data and seen that four cases had missing values in continuous variables in first dataset. And, these four cases having missing part were excluded from dataset. But there was no missing data in second dataset.

Testing Normality

The normal means symmetry in statistics that is normal is expressed as a symmetric, (like a bell) curve with highest frequency of scores in the central point and minor frequencies at the edges (Gravetter, 2000). Figure 5.1 shows the graphical

representation of normality. Normality can be seen checking Kolmogorov-Smirnov statistics and skewness and kurtosis values (Tabachnick et al., 2007). Skewness and kurtosis values are categorized as positive and negative. Positive skewness tells that values are gathered at the left and negative means the opposite that is scores are clustered to the right. Figure 5.2 shows positive and negative skewness. Moreover positive kurtosis tells the spiky allocation and negative kurtosis tells smooth allocation (Tabachnick et al., 2007) Figure 5.3 shows positive and negative kurtosis. When a distribution is normal it means that the skewness and kurtosis values are equal to zero. According to this interval as it is given in Appendix 3; the values of skewness and kurtosis for each item in the dataset fits for the normality.

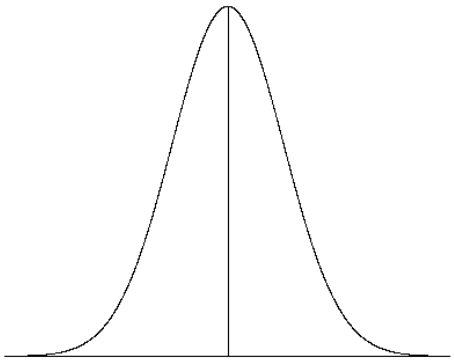

Figure 5.1. Normal Distributed Dataset

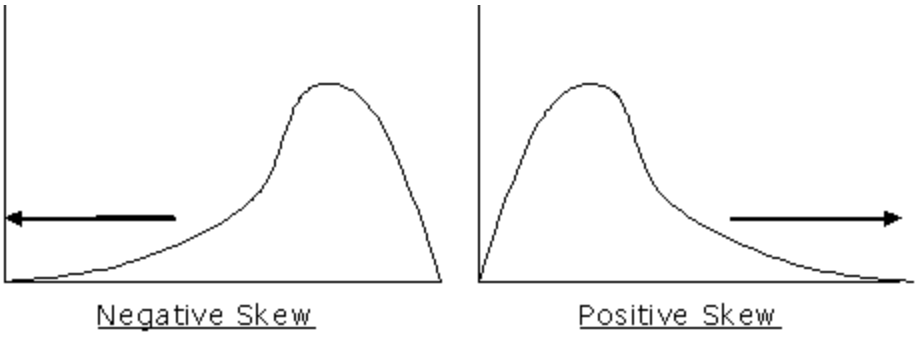

Figure 5.2. Negative and Positive Skewness

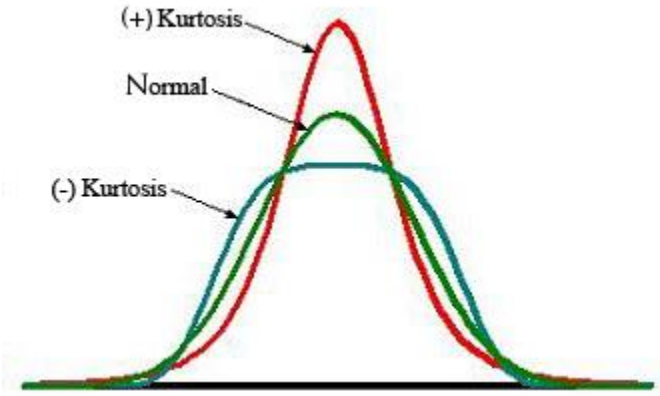

Figure 5.3. Negative and Positive Kurtosis

5.2. Sample Characteristics

The ending of the survey contained demographic variables pertinent to the research model (gender, age, education, and occupation etc.,) which only used for description of the respondents. Table 5.1 shows the demographic information of gender, age, and education etc. The table contains the information of two datasets (left side is first data, right is second).

Male respondents accounted for a slightly larger portion of the respondents in both sets (53%; 54.2%). The largest number of respondents report that their education level is “elementary school or no education” (34.8%). In the age case, above 50 was 63.2%. The majority of respondents report that their occupations are others. Obviously, in whether diabetes patient question entire respondents report that yes answer. Finally, the income of 3-4.5million won has the highest portion of the respondents (35.2%).

According to the target population, there are several changes on survey question. Fifth question “whether someone have blood glucose problem in family” takes place in the first set only because the target is normal/healthy people. Seventh question “length of suffering diabetes” is only in second set, because the target is diabetes patients.

	Question	Frequency		Percent (%)	
		1st set	2nd set	1st set	2nd set
1	Gender				
	Male	205	137	53.0	54.2
	Female	179	116	46.3	45.8
	No response	3	-	0.7	
2	Age				
	20-29	111	1	28.7	0.4
	30-39	125	12	32.3	4.7
	40-49	101	80	26.1	31.6
	50-59	43	84	11.1	33.2
	60 or over	7	76	1.8	30.0
3	Education				
	Less than middle school/no edu	10	88	2.6	34.8
	High school or equivalent	56	80	14.5	31.6
	4 or 2 year college	214	81	55.3	32.0
	Graduate school	18	4	4.7	1.6
	No response	89	-	23.0	
4	Occupation				
	College or graduate student	55	2	14.2	0.8
	Health related professional	7	12	1.8	4.7
	Government employee	34	4	8.8	1.6
	Specialized job	52	7	13.5	2.8
	Office clerk	84	37	21.7	14.6
	Independent businessman	54	55	14.0	21.7
	Other options	89	136	22.0	53.8
	No response	12	-	3.1	
5	Diabetes patient in family				
	Yes	78		20.9	
	No	309		79.8	
6	Diabetes patient				100
	Yes	0	253	4.9	
	No	387		95.1	
7	Length of diabetes occurrence				
	Less than 1 year		49		19.4
	1 to 4 years		72		28.5
	4 to 7 years		47		18.6
	7 to 10 years		31		12.3
	Above 10 years		54		21.3
8	Blood glucose monitoring meter				
	Yes	0	128	2.9	50.6
	No	387	125	97.1	49.4
9	Income				
	Less than 1.5 million won	29	51	7.5	20.2
	1.5 to 3 million won	112	76	28.9	30.0
	3 to 4.5 million won	159	89	41.1	35.2
	4.5 to 6 million won	67	27	17.3	10.7
	More than 6 million won	20	10	5.2	4.0
	Total	**387**	**253**	**100**	**100**

Table 5.1. Sample Characteristics

5.3. Reflective measurement model

This section discusses the results of the analysis to determine the adequacy of questions used to formulate the constructs found in the model. According to PLS-SEM, it is slightly different from covariance based structural equation model (CB-SEM). SmartPLS software provides both constructs validity and reliability analysis. Firstly, for estimating the relationships between reflective latent variables and their indicator, it is needed to check all outer loadings of the reflective constructs. A threshold value of the outer loading is above 0.708 (Hair et al., 2013). In order to avoid complexity of two data, it is presented each results of reflective measurement model.

Sample size – 387

The outer loadings of the reflective constructs are shown in Table 5.2-1 and 5.2-2. As the result of the outer loadings, the items such as BAR3, HSE1, TSE1, PEC2, 3, and ANX3, 4, 5 are not able to meet threshold (>0.708) and are excluded from data set.

Sample size – 253

The outer loadings of the reflective constructs are shown in Table 5.3-1 and 5.3-2. As the result of the outer loadings, all items of anxiety construct do not meet threshold (>0.708) and are excluded from the final analysis. There are some more items such as BAR1, 2, and 3, PEOU1, 3, SUS4, and PEC4 excluded because of threshold issues.

Factors (Sample - 387)							
	SUS	SEV	BEN	BAR	HSE	SN	RD
SUS1	0.849						
SUS2	0.868						
SUS3	0.802						
SUS4	0.836						
SUS5	0.835						
SEV1		0.854					
SEV2		0.876					
SEV3		0.843					
SEV4		0.840					
BEN1			0.890				
BEN2			0.917				
BAR1				0.732			
BAR2				0.709			
BAR4				0.787			
BAR5				0.759			
HSE2					0.862		
HSE3					0.822		
HES4					0.748		
HSE5					0.743		
SN1						0.756	
SN2						0.861	
SN3						0.865	
SN4						0.896	
SN5						0.806	
RD1							0.801
RD2							0.867
RD3							0.862
RD4							0.833

Table 5.2-1. Outer loadings of first data set (continue)

Factors (Sample - 387)							
	TSE	PEC	ANX	ENJ	PEOU	PU	IU
TSE2	0.834						
TSE3	0.890						
TSE4	0.874						
PEC1		0.831					
PEC4		0.777					
PEC5		0.788					
ANX1			0.993				
ANX2			0.842				
ENJ1				0.867			
ENJ2				0.891			
ENJ3				0.900			
ENJ4				0.902			
PEOU1					0.828		
PEOU2					0.827		
PEOU3					0.772		
PU1						0.841	
PU2						0.851	
PU3						0.813	
IU1							0.786
IU2							0.894
IU3							0.916
IU4							0.887

Table 5.2-2. Outer loadings of first data set

Factors (Sample - 253)							
	SUS	SEV	BEN	BAR	HSE	SN	RD
SUS1	0.892						
SUS2	0.904						
SUS3	0.788						
SEV1		0.909					
SEV2		0.895					
SEV3		0.848					
SEV4		0.726					
BEN1			0.874				
BEN2			0.812				
BEN3			0.802				
BEN4			0.874				
BAR2				0.752			
BAR5				0.946			
HSE2					0.826		
HSE4					0.979		
SN1						0.866	
SN2						0.891	
SN3						0.898	
SN4						0.883	
SN5						0.862	
RD1							0.814
RD2							0.912
RD3							0.840
RD4							0.884

Table 5.3-1. Outer loadings of reflective constructs second data set (continue)

Factors(Sample - 253)						
	TSE	PEC	ENJ	PEOU	PU	IU
TSE1	0.714					
TSE2	0.845					
TSE3	0.898					
TSE4	0.887					
TSE5	0.810					
PEC1		0.873				
PEC2		0.817				
PEC3		0.854				
PEC5		0.773				
ENJ1			0.892			
ENJ2			0.920			
ENJ3			0.947			
ENJ4			0.937			
PEOU1				0.754		
PEOU2				0.913		
PEOU3				0.915		
PU1					0.812	
PU2					0.805	
PU3					0.880	
PU4					0.825	
PU5					0.814	
IU1						0.902
IU2						0.917
IU3						0.949
IU4						0.925

Table 5.3-2. Outer loadings of reflective constructs second data set

Composite reliability and convergent validity

In order to validate the measurement model convergent and discriminant validity were taken into consideration in the following parts. For convergent validity Composite Reliability (CR) and Average Variance Extracted (AVE) scores were checked. CR shows the internal consistency that indicates all the items represents the same latent construct. CR value should be equal or greater than 0.7.

Sample size – 387

CR values range from 0.834 and 0.938. AVE shows that whether constructs were powerfully linked to their items or not. AVE values must be 0.5 or bigger to present sufficient validity of convergence. In first data set, AVE scores range from 0.558 and 0.847, there is no variable lower than threshold value of 0.5. Details of the AVE and CR values for each construct are given in Table 5.4.

Sample size – 253

As the result, CR values range from 0.843 and 0.959. And AVE scores are between 0.685 and 0.854, which means all of them are acceptable. Details of the AVE and CR values for each construct are given in Table 5.5. In order to show that all of the constructs in the data set were different from each other Discriminant Validity scores were calculated. Discriminant Validity scores are the square root of AVE values (Bove et al., 2009). Square root AVE values for each constructs should be higher than correlation values of constructs.

Latent variable	Composite Reliability>0.7	AVE>0.5	Discriminant validity
Susceptibility	0.922	0.703	Yes
Severity	0.914	0.728	Yes
Benefits	0.899	0.817	Yes
Barriers	0.834	0.558	Yes
H.Self-efficacy	0.873	0.633	Yes
S.Norm	0.922	0.703	Yes
R.Demonstrability	0.906	0.708	Yes
T.Self-efficacy	0.900	0.751	Yes
Control	0.847	0.639	Yes
Anxiety	0.917	0.847	Yes
Enjoyment	0.938	0.793	Yes
Eese of use	0.851	0.656	Yes
Usefulness	0.874	0.698	Yes
Intention	0.927	0.761	Yes

Table 5.4. Composite reliability and convergent validity (Sample - 387)

Latent variable	Composite Reliability>0.7	AVE>0.5	Discriminant validity
Susceptibility	0.897	0.745	Yes
Severity	0.910	0.719	Yes
Benefits	0.906	0.707	Yes
Barriers	0.843	0.731	Yes
H.Self-efficacy	0.900	0.820	Yes
S.Norm	0.945	0.775	Yes
R.Demonstrability	0.921	0.745	Yes
T.Self-efficacy	0.918	0.695	Yes
Control	0.902	0.707	Yes
Enjoyment	0.959	0.854	Yes
Eese of use	0.897	0.685	Yes
Usefulness	0.916	0.685	Yes
Intention	0.958	0.853	Yes

Table 5.5. Composite reliability and convergent validity (Sample - 253)

Collinearity

Before assessing hypothesis testing analysis, it is needed to examine the structural model for collinearity. The reason is that the estimation of path coefficient in the structural models is based on OLS regressions of each endogenous latent variable on its corresponding predecessor constructs (Hair et al., 2013). Just as in a regular multiple regression, the path coefficients might be biased if the estimation involves significant levels of collinearity among the predictor constructs. Hair et al. (2013) notes that "he considers tolerance levels below 0.20 (VIF above 5.00) in the predictor constructs as indicative of collinearity". In the result, all constructs in both data sets don't have collinearity issue. Collinearity of constructs is shown in Table 5.6 and 5.7.

First set			Second set		
	Tolerance	VIF		Tolerance	VIF
HBM	0.590	2.242	HBM	0.338	2.781
SN	0.546	2.143	PEC	0.357	2.587
DR	0.337	1.961	ENJ	0.332	2.214
			TSE	0.426	2.425
Third set			Forth set		
	Tolerance	VIF		Tolerance	VIF
HBM	0.395	2.566	PU	0.480	2.576
PU	0.412	3.206	PEOU	0.512	1.281
PEOU	0.547	1.861			

Table 5.6. Collinearity of constructs (Sample – 387)

First set			Second set		
	Tolerance	VIF		Tolerance	VIF
HBM	0.490	2.042	HBM	0.438	2.281
SN	0.446	2.243	PEC	0.387	2.587
DR	0.537	1.861	ENJ	0.432	2.314
			TSE	0.416	2.405
Third set			Forth set		
	Tolerance	VIF		Tolerance	VIF
HBM	0.390	2.566	PU	0.380	2.366
PU	0.312	3.206	PEOU	0.312	1.761
PEOU	0.537	1.861			

Table 5.7. Collinearity of constructs (Sample – 253)

5.4. Hypothesis Testing

SmartPLS 2.0 provided the squared multiple correlations (R^2) for each construct in the model and the path coefficients (β) with other constructs also given. The R^2 indicates the percentage of a construct's variance in the model, while the path coefficient indicates the strength of relationship between constructs (Chin, 1998; Ringle et al., 2005). Unlike other CB-SEM such as LISREL, SmartPLS 2.0 does not generate a single goodness-of-fit metric for the entire model. Both the β and the R^2 are sufficient for analysis, and β values between 0.20 and 0.30 yield meaningful

interpretations (Chin, 1998). The SmartPLS 2.0 results for the βs, t-values, and the p values are shown in Figure 5.8 and 5.9. Given convergent and discriminant validity proves that the measurement model was validated. Furthermore PLS Bootstrapping (BT) was used to find out t-values to identify the relations between latent variables.

Sample – 387

In case of first data set 15 paths such as SUS → PU, SUS → PEOU, SEV → PEOU, BEN → PU, BEN → PEOU, BEN → INT, BAR → PU, BAR → INT, HSE → PEOU, SN → PU TSE→ PEOU, ENJ → PEOU, PU → INT, PEOU → INT, and PEOU → PU are shown as significant relationships.

Sample – 253

In second data set, 17 paths such as SUS → PU, SUS → PEOU, SEV → PU, SEV → INT, BEN → PU, BEN → PEOU, BEN → INT, BAR → PU, BAR → PEOU, BAR → INT, RD → PU, TSE→ PEOU, ENJ → PEOU, PEC → PEOU, PU → INT, PEOU → INT, and PEOU → PU are shown statistically significant.

Paths	Path coefficients	t-values	Significance level	p values
SUS → PU	0.143	2.033	**	0.05
SUS → PEOU	0.137	1.887	*	0.01
SUS → INT	0.019	0.487	NS	-
SEV → PU	-0.016	0.244	NS	-
SEV → PEOU	-0.188	2.765	***	0.00
SEV → INT	0.020	0.615	NS	-
BEN → PU	0.197	4.230	***	0.00
BEN → PEOU	0.129	3.165	***	0.00
BEN → INT	0.116	5.052	***	0.00
BAR → PU	0.192	3.155	***	0.00
BAR → PEOU	0.020	0.290	NS	-
BAR → INT	0.367	9.528	***	0.00
HSE → PU	-0.016	0.259	NS	-
HSE → PEOU	0.222	4.426	***	0.00
HSE → INT	0.017	0.553	NS	-
SN → PU	0.398	4.278	***	0.00
RD → PU	0.036	0.484	NS	-
TSE→ PEOU	0.227	4.125	***	0.00
ANX → PEOU	0.030	0.814	NS	-
ENJ → PEOU	0.197	3.300	***	0.00
PEC → PEOU	0.073	1.590	NS	-
PU → INT	0.063	2.202	*	0.05
PEOU → INT	0.183	4.573	***	0.00
PEOU → PU	0.140	3.193	***	0.00

Table 5.8. Significance of structural model path coefficients (Sample – 387)

Paths	Path coefficients	t-values	Significance level	p values
SUS → PU	-0.083	1.893	*	0.05
SUS → PEOU	0.188	3.669	***	0.00
SUS → INT	0.045	0.850	NS	-
SEV → PU	-0.084	1.832	*	0.05
SEV → PEOU	0.016	0.321	NS	-
SEV → INT	0.131	2.648	***	0.001
BEN → PU	0.619	11.756	***	0.00
BEN → PEOU	0.209	3.306	***	0.00
BEN → INT	0.350	5.142	***	0.00
BAR → PU	-0.169	3.228	***	0.00
BAR → PEOU	0.147	2.607	***	0.001
BAR → INT	-0.160	2.950	***	0.001
HSE→ PU	-0.053	1.335	NS	-
HSE → PEOU	-0.007	0.178	NS	-
HSE → INT	-0.023	0.562	NS	-
SN → PU	-0.081	1.291	NS	-
RD → PU	-0.125	2.229	*	0.05
TSE→ PEOU	0.296	4.540	***	0.00
ANX → PEOU		Not measured		
ENJ → PEOU	0.139	2.393	**	0.01
PEC → PEOU	0.320	4.493	***	0.00
PU → INT	0.249	3.599	***	0.00
PEOU → INT	0.169	2.445	**	0.005
PEOU → PU	0.398	7.775	***	0.00

Table 5.9. Significance of the structural model path coefficients (Sample – 253)

The most common measurement of evaluation of a structural model is the coefficient of determination (R^2 value). This coefficient is a measure of the model's predictive accuracy and is calculated as the squared correlation between a specific endogenous construct's actual and predicted values. The R^2 value ranges from 0 to 1 with higher levels indicating higher levels of predictive accuracy. R^2 values of 0.75, 0.50, or 0.25 for endogenous latent variables can, as a rough rule of thumb, be respectively described as substantial, moderate, and weak (Hair et al., 2011; Henseler et al., 2009). In addition to evaluating the R^2 values of all endogenous constructs, the change in the R^2 value what specified exogenous construct is omitted from the model can be used to evaluate whether the omitted construct has a substantive impact on the endogenous constructs. This measure is referred to as the f^2 effect size. Guidelines for assessing f^2 are that values of 0.02, 0.15, and 0.35, respectively small, medium, and large effects (Cohen, 1988) of exogenous latent variable. R^2, Q^2, f^2, and q^2 values are shown in Table of 5.10, 5.11, 5.12, and 5.13.

Variable	R^2 Value	Q^2 Value
PU	0.308	0.204
PEOU	0.246	0.148
INT	0.425	0.321

Table 5.10. R^2 and Q^2 values (Sample – 387)

Variable	R^2 Value	Q^2 Value
PU	0.651	0.476
PEOU	0.461	0.435
INT	0.569	0.484

Table 5.11. R^2 and Q^2 values (Sample – 253)

	PU		PEOU		INT	
	f^2 Effect size	q^2 Effect size	f^2 Effect size	q^2 Effect size	f^2 Effect size	q^2 Effect size
SUS	0.010	0.007	0.010	0.004	NO	NO
SEV	NO	NO	0.023	0.015	NO	NO
BEN	0.050	0.040	0.027	0.014	0.055	0.042
BAR	0.018	0.012	NO	NO	0.222	0.145
HEF	NO	NO	0.043	0.025	NO	NO
SN	0.041	0.028	-	-	-	-
RD	NO	NO	-	-	-	-
TEF	-	-	0.045	0.024	-	
ENJ	-	-	0.025	0.016	-	
PEC	-	-	NO	NO	-	
ANX	-	-	NO	NO	-	
PU	-	-	-	-	0.031	0.020
PEOU	0.031	0.008	-	-	0.053	0.038

Table 5.12. f^2 and q^2 values (Sample – 387)

	PU		PEOU		INT	
	f^2 Effect size	q^2 Effect size	f^2 Effect size	q^2 Effect size	f^2 Effect size	q^2 Effect size
SUS	0.013	0.019	0.048	0.023	NO	NO
SEV	0.013	0.013	NO	NO	0.023	0.017
BEN	0.624	0.255	0.053	-0.021	0.114	0.079
BAR	0.060	0.047	0.131	-0.021	-0.038	0.036
HSE	NO	NO	NO	NO	NO	NO
SN	NO	NO	-	-	-	-
RD	0.023	0.015	-	-	-	-
TSE	-	-	0.100	0.049	-	-
ENJ	-	-	0.023	0.010	-	-
PEC	-	-	0.110	0.001	-	-
PU	-	-	-	-	0.035	0.003
PEOU	0.241	0.091	-	-	0.040	0.001

Table 5.13. f^2 and q^2 values (Sample – 253)

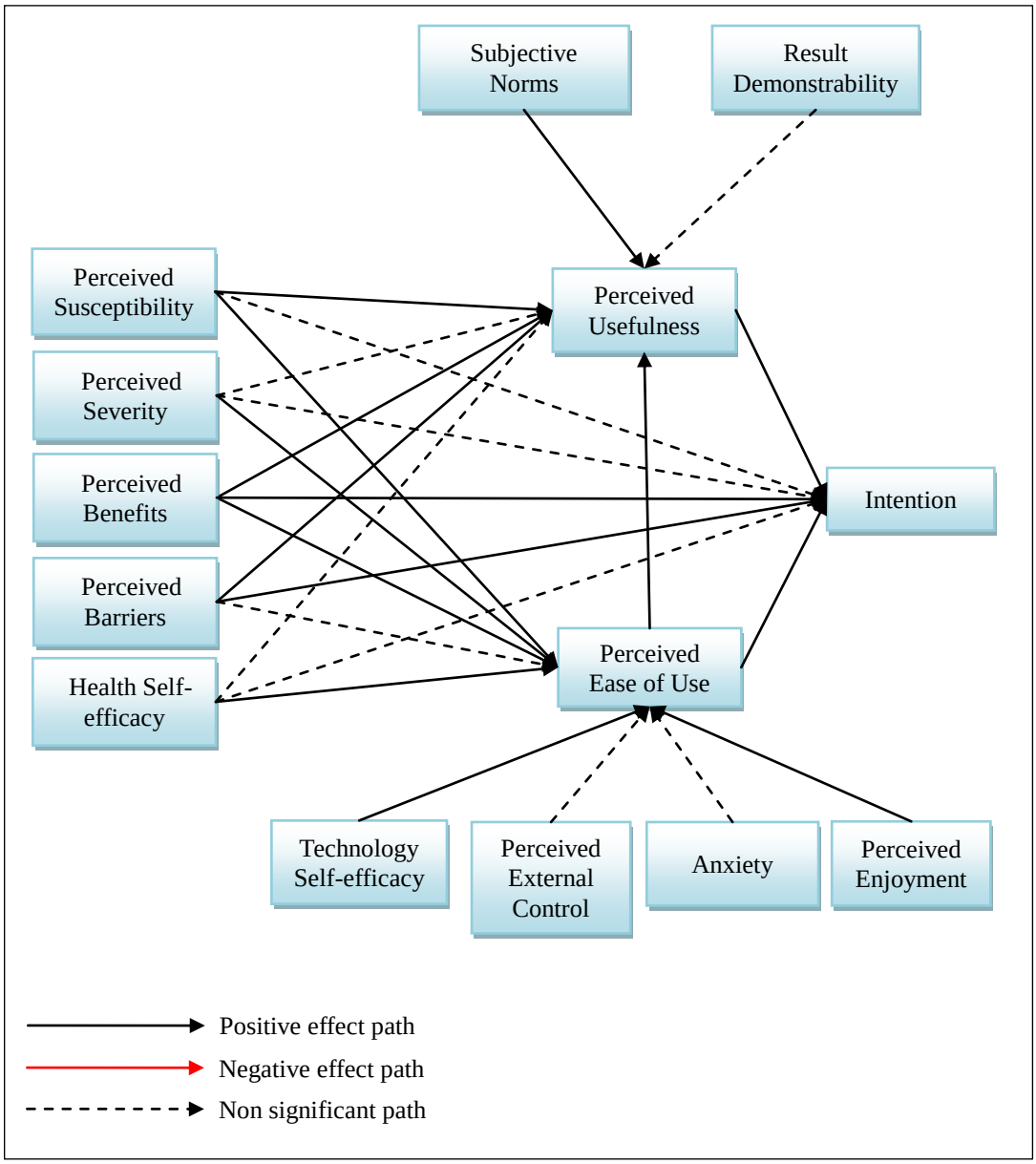

Figure 5.4. Result of the structural model (Sample – 387)

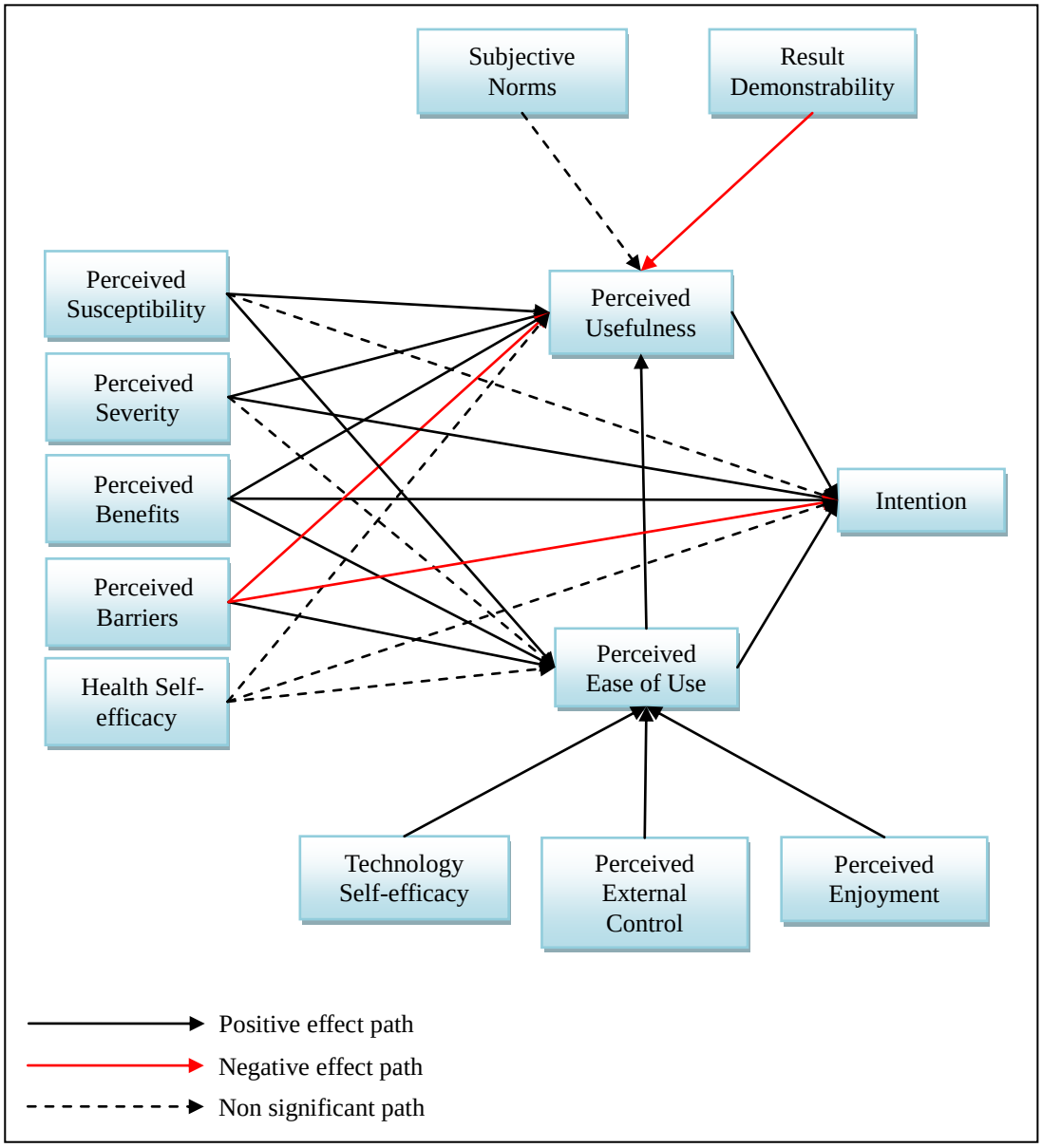

Figure 5.5 Result of the structural model (Sample – 253)

Relations	Hypotheses	Results
SUS → PU	H1-1	Supported
SUS → PEOU	H1-2	Supported
SUS → INT	H1-3	Not supported
SEV → PU	H2-1	Not supported
SEV → PEOU	H2-2	Supported
SEV → INT	H2-3	Not supported
BEN → PU	H3-1	Supported
BEN → PEOU	H3-2	Supported
BEN → INT	H3-3	Supported
BAR → PU	H4-1	Supported
BAR → PEOU	H4-2	Not supported
BAR → INT	H4-3	Supported
HSE → PU	H5-1	Not supported
HSE → PEOU	H5-2	Supported
HSE → INT	H5-3	Not supported
SN → PU	H6-1	Supported
RD → PU	H6-2	Not supported
TSE → PEOU	H7-1	Supported
PEC → PEOU	H7-2	Not supported
ANX → PEOU	H7-3	Not supported
ENJ → PEOU	H7-4	Supported
PU → INT	H8	Supported
PEOU → INT	H9	Supported
PEOU → PU	H10	Supported

Table 5.14. Relations and tested hypotheses (Sample – 387)

Relations	Hypotheses	Results
SUS → PU	H1-1	Supported
SUS → PEOU	H1-2	Not supported
SUS → INT	H1-3	Not supported
SEV → PU	H2-1	Supported
SEV → PEOU	H2-2	Supported
SEV → INT	H2-3	Supported
BEN → PU	H3-1	Supported
BEN → PEOU	H3-2	Supported
BEN → INT	H3-3	Supported
BAR → PU	H4-1	Supported
BAR → PEOU	H4-2	Supported
BAR → INT	H4-3	Supported
HEF → PU	H5-1	Not supported
HEF → PEOU	H5-2	Not supported
HEF → INT	H5-3	Not supported
SN → PU	H6-1	Not supported
RD → PU	H6-2	Supported
TSE → PEOU	H7-1	Supported
PEC → PEOU	H7-2	Supported
ANX → PEOU	H7-3	Not measured
ENJ → PEOU	H7-4	Supported
PU → INT	H8	Supported
PEOU → INT	H9	Supported
PEOU → PU	H10	Supported

Table 5.15. Relations and tested hypotheses (Sample – 253)

In this sense, we propose a new model that could explain users' smartphone based healthcare adoption. This model (Figure 5.6) is general model not specific targets like healthy or unhealthy people. As the result of the study, we conclude that HBM is not well suited model for predicting users' acceptance of smartphone based healthcare applications. Because its main constructs such as susceptibility, severity, and health self-efficacy are not affected on TAM's endogenous variables. It presents that low explanation power and only two construct benefits and barriers are determined as key drivers from HBM. Finally, we are able to design a model with key drivers including benefits, barriers, subjective norm, technology self-efficacy,

external control, enjoyment, usefulness, ease of use, and intention to use.

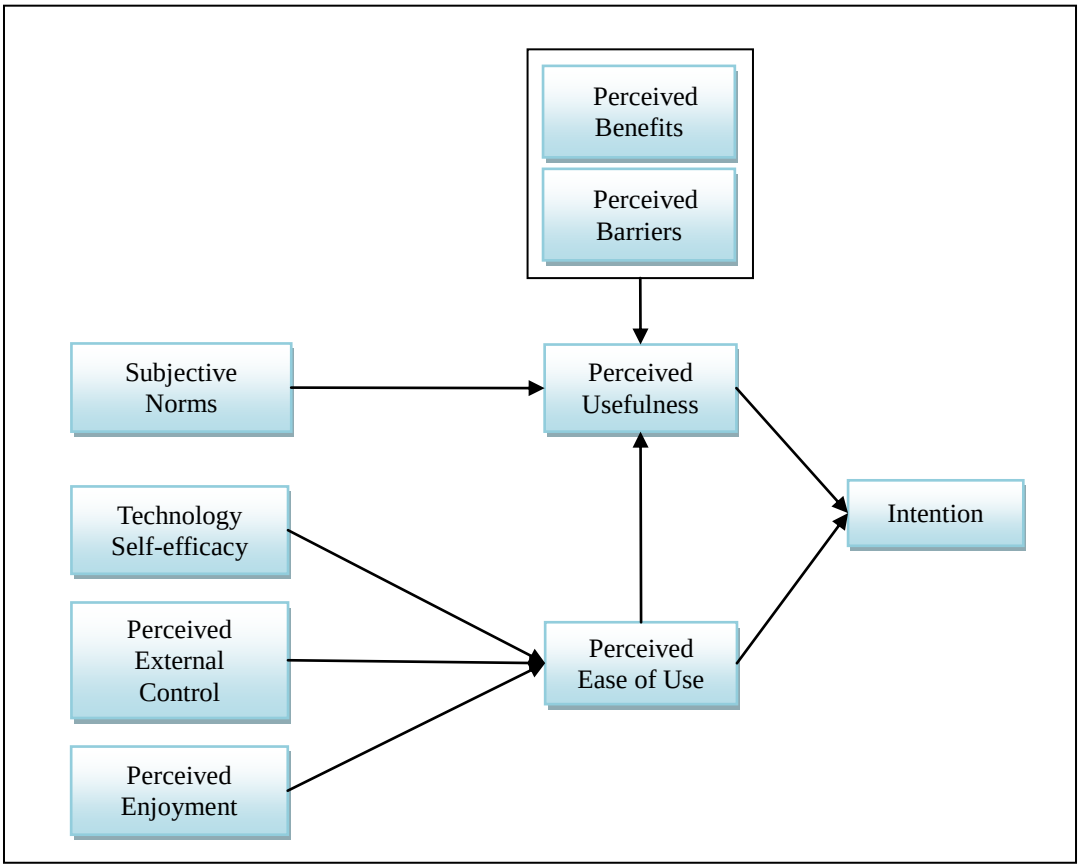

Figure 5.6. A proposed model

CHAPTER VI

CONCLUSION

This chapter examines the findings of this study in relationship to the initial objectives. This chapter contains three main sections; implications to the body of research, limitations, and concludes with possible directions for future research in this area.

6.1. Summary of the Study

The primary purpose of this research is to examine the adoption process of smartphone blood glucose system targeted for both diabetes patients and normal (healthy) people. There are previous researches about the tele-blood glucose managing systems that have high effect on managing with good condition of diabetes (Farmer et al., 2005; Vespasiani et al., 2006). Therefore, it makes sure that the blood glucose managing systems provides efficiency of telecare for diabetes patients who need monitoring and caring of blood glucose all the time. Even though, these systems are efficient enough, it is question about how patients adopt them. When research conduct in the hospitals, it shows highly effective. But, more important thing is that these systems could contribute to prevent from the diabetes occurrence and managing. There are a very few research related with adoption on using smartphone blood glucose systems. In this term, our study gets start to be conducted and examine the determinants in accepting blood glucose systems using smartphone. The research model of the study is contained constructs from HBM, rather recognizable model among health behavior theories, and TAM, highly cited model in IS literatures. The study utilizes a paper-based survey to test the theoretical model. Based on the literature review, a questionnaire is developed and administrated self-report. The data collection is accomplished for two different targets; i) individuals who are users of smartphone, ii) patients who are suffering blood glucose and controlling it. The

former sample size is 387 and the latter one is 253.

The research model contains a total of 24 hypothetical relationships that are tested using smartPLS analysis techniques and explains 42.2% of the variance in intention to use smartphone glucose system. Two samples of the results are summarized as follows;

i) Sample size - 387

Perceived Susceptibility; this construct has significant effect on perceived usefulness and ease of use but no effect on intention to use. Even though the t values show significant, the effect sizes of them are considerably low (f^2=0.01). Thus, it is hard to accept as key driver in the model.

Perceived Severity; this construct has significant relationship with only perceived ease of use but size effect (f^2=0.02) is low. And, it is difficult to identify it as a key factor, but rather considerable as precedent of perceived ease of use.

Perceived Benefits; the result shows high significant relations with perceived usefulness and ease of use, and intention to use. As expected, if one perceives any advantages of the system such as preventive or managing effect of blood glucose and tends to raise intention to use it. Unless it is required more cost and time than its benefits, this theory works for most of cases.

Perceived Barriers; this variable is supposed to have negative effect on the perceived usefulness and ease of use, and intention to use. Surprisingly, there are positive effects on usefulness and intention and no effect on ease of use. It should be considered carefully.

Health Self-Efficacy; this variable has significant effect on perceived ease of use only. But effect size (f^2=0.02) is rather low, it means confidence of managing health condition does not considerable factor for healthy or people. Because accessing smartphone application is not required consideration of health.

Subjective Norm, Technology Self-Efficacy, and Perceived Enjoyment constructs are significantly and positively related with perceived usefulness and ease of use. While Result Demonstrability, Anxiety, and Perceived External Control constructs have no significant effect on perceived usefulness and ease of use.

As key factors in TAM as well as IS research, both of them have effects on intentions to use. Contrast of high effect of perceived ease of use, perceived

usefulness has less effective ($p<0.05$, $\beta=0.098$). Final hypothesis H9, perceived ease of use significantly influence on perceived usefulness as earlier researches.

ii) Sample size – 253

Perceived Susceptibility; this construct has same as young group significant effect on perceived usefulness and ease of use but no effect on intention to use. While the effect size ($f^2=0.01$) on perceived usefulness is slightly low, its effect size ($f^2=0.05$) on ease of use is medium.

Perceived Severity; this construct has significant relationship with perceived usefulness and intention. But its effect size of both path ($f^2=0.01$, 0.02) is low. And, it is not considered as a key factor.

Perceived Benefits; this construct is the only construct that is highly effected on all three endogenous variables perceived usefulness and ease of use, and intention to use. It can be explained same as young group that one perceives any advantages of the system such as preventive or managing effect of blood glucose and tends to raise intention to use it. Unless it is required more cost and time than its benefits, this theory works for most of cases. This construct is definitely indentified as one of the key factors.

Perceived Barriers; this construct has negative effect on perceived usefulness and intention, but unexpectedly positive effect on perceived ease of use. It means the obstacles in accepting the smartphone blood glucose system do not influence on perceptions of its convenience. Due to effect size of it we consider it as key driver.

Health Self-Efficacy; this construct has no significant effect on all three endogenous variables such as perceived usefulness, ease of use only, and intention.

Subjective Norm has no effect and Result demonstrability shows negative effect on perceived usefulness. Elder people might not understand well about the system function and not sure to explain about this to others. Anxiety construct is excluded because of low validity. Other three constructs including Technology Self-Efficacy, Perceived External Control, and Perceived Enjoyment constructs are significantly and positively related with perceived ease of use.

6.3. Limitations

It is hard to find a study without limitations of some sort. In our case we have three major limitations as follow;

1. Population; The research population is limited by one city, Jeju, not covered whole Korea. And also it is important to include both groups health risky(diabetes patients) and healthy as smartphone blood glucose system is eligible to prevent and treatment.
2. New system; the system introduced in the study is not yet commercialized in Korea. Even though, included brief explanations and short video in survey, still there is no chance to find out probability of respondents' insight.
3. Constructs; there are still greater determinants except of the constructs used in the study for intention to use. For respondents' convenience, it is usually impossible to include all possible variables for a single study.

6.4. Future

For improvement of this study, including more population such as diverse of residential address would be better research. And this systems which is not widely introduced yet, are needed more detail explanations even using visual aids, expected to help decreasing errors. It would be interesting to test more detail about perceived barriers, as one of contributors of this study, it may help to explore different level of real barriers when accept healthcare services through smart phone. Finally, we except the model found in the study is useful not only in blood glucose care but also in other u-Health or s-Health services.

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APPENDICES

Appendix 1

Characteristics	Frequency	Percent (%)
Gender		
Male	38	59.4
Female	26	40.6
Age		
Less or 19	-	-
20-29	58	90.6
30-39	3	4.7
40-49	1	1.6
50-59	2	3.1
60 or over	-	-
Occupation		
College or graduate student	55	85.9
Health related professional	3	4.7
Government employee	2	3.1
Specialized job	-	-
Office clerk	1	1.6
Independent businessman	3	4.7
Other options	-	-
Diabetes patient in family		
Yes	14	21.9
No	50	78.1
Diabetes patient		
Yes	3	4.7
No	62	95.3
Blood glucose monitoring meter		
Yes	2	3.1
No	62	96.9
Income		
Less than 1.5 million won	10	15.6
1.5 to 3 million won	25	39.1
3 to 4.5 million won	20	31.3
4.5 to 6 million won	8	12.5
More than 6 million won	1	1.6

Table A1. Pretest demographic information

Appendix 2

Construct	Number of Items	Cronbach's alpha
Perceived Susceptibility	5	0.704
Perceived Severity	4	0.879
Perceived Barriers	5	0.740
Perceived Benefits	3	0.780
Health Self-efficacy	5	0.881
Subjective Norm	5	0.907
Results Demonstrability	4	0.829
Technology Self-Efficacy	5	0.874
Perception of External Control	5	0.865
Anxiety	5	0.798
Perceived Enjoyment	4	0.863
Perceived Ease of Use	4	0.932
Perceived Usefulness	5	0.823
Intention to Use	3	0.886

Table A2. Pretest reliability test

Appendix 3

Variables	Min	Max	Mean	St.Dev	Skew	St.Err	Kurtosis	St.Err
SEV	1	5	4.005	0.814	-0.816	0.153	0.535	0.305
BEN	1	5	3.658	0.813	-0.253	0.153	0.082	0.305
BAR	1	5	2.873	0.716	-0.191	0.153	0.278	0.305
HSE	1.75	5	3.489	0.795	0.052	0.153	-0.531	0.305
SN	1	5	3.464	0.870	-0.106	0.153	-0.261	0.305
TSE	1	5	2.981	0.948	0.006	0.153	-0.750	0.305
ANX	1	5	3.142	1.110	-0.034	0.153	-0.944	0.305
ENJ	1	5	3.014	0.783	0.145	0.153	0.083	0.305
PEOU	1	5	2.869	0.955	0.068	0.153	0.028	0.305
PU	1	5	3.706	0.771	-0.524	0.153	0.730	0.305
IU	1	5	3.681	1.002	-0.462	0.153	-0.396	0.305

Table A3. Normality of data

설문지

안녕하십니까?

바쁘신 가운데 설문에 응답해 주셔서 감사드립니다. 본 설문지는 제주대학교 대학원 박사학위 연구의 자료 수집을 위한 것이며, 질문은 정답이 없고 귀하께서 평소에 생각하시고 느끼신 대로 안내 문구에 따라 한 문항도 빠짐없이 답해주시면 감사하겠습니다. 귀하께서 성실하게 응답해 주신 소중한 의견은 본 연구의 귀중한 자료가 될 것이며, 수집된 자료는 학문적 연구의 용도로만 활용될 것이므로 개별적으로는 절대 공개되지 않습니다.

귀한 시간을 내주셔서 진심으로 감사합니다.

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Hp: 010-3434-1920

보기카드

당뇨 환자에게 필수적인 미래형 “스마트 혈당관리 시스템”이 개발된다면 당신도 사용하시겠습니까?

- 스마트폰이 귀하의 혈당조절을 관리해 드립니다.
- 간편한 혈당체크로 전문의료진의 적합한 진단과 처방을 받을 수 있습니다.
  - **무방문** : 직접 방문을 찾는 번거로움이 없습니다. (Anywhere)
  - **실시간 진단 및 처방** : 전문의료진의 정확한 진단 및 처방이 실시간으로 전송됩니다. (Anytime)
  - **콘텐츠 제공** : 운동요법, 식단조절, 혈당에 관한 기본 콘텐츠를 제공합니다.
- 이상과 같이 스마트폰을 활용한 미래형 혈당관리 시스템이 개발 중입니다.
- 이러한 시스템에 대한 귀하의 의견을 시스템 수용에 관한 연구에 사용하고자 하오니 솔직한 심정으로 응답해주시기 바랍니다.

분당서울병원”u-헬스서비스”를 근거로 함.

▣ 다음은 당뇨병에 대한 지각된 민감성(Susceptibility)과 심각성(Seriousness), 건강 자기효능감(Self-efficacy)에 대한 질문입니다. 해당되는 번호에 체크(✔)하여 주십시오.

No	내용	전혀 아니다		보통	매우 그렇다	
1.	귀하의 부적절한 생활습관(음주, 흡연, 식습관, 운동부족)은 당뇨병을 악화시킨다고 생각하십니까?	①	②	③	④	⑤
2.	귀하의 건강상태(비만, 고혈압)는 당뇨병을 악화시킬 확률을 높인다고 생각하십니까?	①	②	③	④	⑤
3.	귀하는 당뇨병 합병증이 발생하거나 악화될 확률이 높다고 생각하십니까?	①	②	③	④	⑤
4.	귀하는 본인의 생명단축 예상 가능성이 어느 정도 있을 것이라고 생각하십니까?	①	②	③	④	⑤
5.	귀하는 당뇨병을 심각한 건강 문제로 생각하십니까?	①	②	③	④	⑤
6.	귀하는 당뇨병으로부터 발생한 합병증을 심각한 건강 문제로 생각하십니까?	①	②	③	④	⑤
7.	당뇨병은 귀하의 삶에 영향이 있을 것이라고 생각하십니까?	①	②	③	④	⑤
8.	당뇨병으로 인해 경제적으로 문제가 생길 것이라고 생각하십니까?	①	②	③	④	⑤
9.	귀하는 당뇨를 잘 관리할 수 있다고 생각하십니까?	①	②	③	④	⑤
10.	귀하는 당뇨를 관리할 수 있는 능력이 있다고 생각하십니까?	①	②	③	④	⑤
11.	귀하는 현재 일상생활에서 당뇨관리 습관을 잘 터득했다고 생각하십니까?	①	②	③	④	⑤
12.	귀하는 당뇨를 관리하는데에 있어 다양한 도전을 할 수 있다고 생각하십니까?	①	②	③	④	⑤

다음 질문들은 귀하가 본인의 스마트폰을 통해 혈당관리를 할 수 있다면이라는 가정하에 묻는 질문입니다.

▣ 다음은 주관적 규범(Subjective norm)에 관련된 질문입니다.

No	내용	전혀 아니다		보통	매우 그렇다	
1.	가족이 스마트폰 혈당관리시스템을 제안한다면 사용할 것이다.	①	②	③	④	⑤
2.	주치의가 스마트폰 혈당관리시스템을 제안한다면 사용할 것이다.	①	②	③	④	⑤
3.	친구가 스마트폰 혈당관리시스템을 제안한다면 사용할 것이다.	①	②	③	④	⑤
4.	간호사가 스마트폰 혈당관리시스템을 제안한다면 사용할 것이다.	①	②	③	④	⑤
5.	나한테 중요한 사람들이 이 시스템을 제안한다면 사용할 것이다.	①	②	③	④	⑤

▣ 다음은 기술에 대한 자기효능감(Self-efficacy)과 결과 논증가능성(Result demonstrability)에 관련된 질문입니다.

No	내용	전혀 아니다		보통		매우 그렇다
1.	사전경험이 없어도 스마트폰 혈당관리시스템을 사용할 수 있을 것 같다.	①	②	③	④	⑤
2.	사용설명서만 있으면 스마트폰 혈당관리시스템을 사용할 수 있을 것 같다.	①	②	③	④	⑤
3.	시간을 충분히 들이면 스마트폰 혈당관리시스템 사용법을 이해하는데 문제가 없을 것 같다.	①	②	③	④	⑤
4.	사용법을 알려주면 스마트폰 혈당관리시스템을 사용할 수 있을 것 같다.	①	②	③	④	⑤
5.	예전에 비슷한 시스템을 사용해본 경험이 있다면 스마트폰 혈당관리시스템을 사용할 수 있을 것 같다.	①	②	③	④	⑤
6.	스마트폰 혈당관리시스템을 사용한다면 그 결과에 대해서 남들한테 쉽게 이야기할 수 있을 것 같다.	①	②	③	④	⑤
7.	스마트폰 혈당관리시스템에 대해서 다른 사람들과 의논할 수 있을 것 같다.	①	②	③	④	⑤
8.	스마트폰 혈당관리시스템을 사용한다면 그 효과를 분명히 볼 수 있을 것 같다.	①	②	③	④	⑤
9.	스마트폰 혈당관리시스템을 왜 사용하는지에 대해 남들한테 설명해 줄 수 있을 것 같다.	①	②	③	④	⑤

▣ 다음은 유익성(Benefits) 및 장애성(Barriers)에 대한 질문입니다.

No	내용	전혀 아니다		보통		매우 그렇다
1.	스마트폰 혈당관리시스템을 사용하는 것이 당뇨관련 질병(합병증 등) 예방을 하는데 도움이 될 것 같다.	①	②	③	④	⑤
2.	스마트폰 혈당관리시스템은 내 당뇨를 관리하는데 도움이 될 것 같다.	①	②	③	④	⑤
3.	스마트폰 혈당관리시스템을 사용한다면 내 기분도 좋아질 것 같다.	①	②	③	④	⑤
4.	스마트폰 혈당관리시스템은 나를 오래 살게 해줄 수 있을 것 같다.	①	②	③	④	⑤
5.	스마트폰 혈당관리시스템의 정기적인 사용을 기억하지 못한다.	①	②	③	④	⑤
6.	가족 문제 때문에 규칙적인 스마트폰 혈당관리시스템을 사용하는데 어려움이 있을 것 같다.	①	②	③	④	⑤
7.	스마트폰 혈당관리시스템을 규칙적으로 사용하려면 일상생활에서 많은 습관을 바꿔야 할 것 같다.	①	②	③	④	⑤
8.	스마트폰 혈당관리시스템 사용은 내 일과에 방해가 될 것 같다.	①	②	③	④	⑤
9.	스마트폰 혈당관리시스템을 사용할 동기를 잘 느끼지 못한다.	①	②	③	④	⑤

▣ 다음은 외부통제(External control)와 불안감(Anxiety), 유희성(Enjoyment)에 관련된 질문입니다.

No	내용	전혀 아니다		보통		매우 그렇다
1.	나는 스마트폰 혈당관리시스템을 제어할 수 있을 것이라고 생각한다.	①	②	③	④	⑤
2.	나는 스마트폰 혈당관리시스템을 사용하는데 있어 필요한 주변환경이 갖춰져 있다.	①	②	③	④	⑤
3.	나는 스마트폰 혈당관리시스템을 사용함에 있어 필요한 지식을 갖고 있다.	①	②	③	④	⑤
4.	이 시스템을 사용하는데 있어 필요한 주변환경과 기회, 지식 등은 이 시스템 사용을 용이하게 해준다.	①	②	③	④	⑤
5.	이 시스템은 내가 쓰는 다른 시스템 및 소프트웨어와 호환이 잘될 것 같다.	①	②	③	④	⑤
6.	스마트폰 혈당관리시스템을 사용한다면 조금 긴장할 것 같다.	①	②	③	④	⑤
7.	스마트폰 혈당관리시스템을 사용한다면 조금 불안할 것 같다.	①	②	③	④	⑤
8.	스마트폰 혈당관리시스템을 사용한다면 조금 불편할 것 같다.	①	②	③	④	⑤
9.	스마트폰 혈당관리시스템을 사용한다고 생각하면 왠지 걱정이 된다.	①	②	③	④	⑤
10.	스마트폰 혈당관리시스템 사용법은 쉽지 않을 것 같다.	①	②	③	④	⑤
11.	스마트폰 혈당관리시스템 사용은 재미있을 것 같다.	①	②	③	④	⑤
12.	스마트폰 혈당관리시스템을 사용하면 기분이 좋아질 것 같다.	①	②	③	④	⑤
13.	스마트폰 혈당관리시스템을 사용하면 흥미진진할 것 같다.	①	②	③	④	⑤
14.	스마트폰 혈당관리시스템을 사용하면 즐거울 것 같다.	①	②	③	④	⑤

▣ 다음은 유용성(Usefulness)과 용이성(Ease of use)에 관련된 질문입니다.

No	내용	전혀 아니다		보통		매우 그렇다
1.	스마트폰 혈당관리시스템은 당뇨를 초기에 발견하는데 도움이 된다.	①	②	③	④	⑤
2.	스마트폰 혈당관리시스템은 당뇨로 인한 사망을 줄이는데 도움이 된다.	①	②	③	④	⑤
3.	스마트폰 혈당관리시스템은 내 하루하루를 안심시켜줄 것 같은 느낌이 든다.	①	②	③	④	⑤
4.	스마트폰 혈당관리시스템은 나의 삶의 질을 높여주는 느낌이 든다.	①	②	③	④	⑤
5.	나는 전반적으로 스마트폰 혈당관리시스템을 유용하다고 생각한다.	①	②	③	④	⑤
6.	스마트폰 혈당관리시스템 사용법은 간단하다.	①	②	③	④	⑤
7.	스마트폰 혈당관리시스템 사용법을 쉽게 배울 수 있다.	①	②	③	④	⑤

8. 스마트폰 혈당관리시스템은 당뇨 예방이나 관리에 대한 노력을 줄인다.	①	②	③	④	⑤
9. 스마트폰 혈당관리시스템을 언제 어디서나 사용할 수 있다.	①	②	③	④	⑤
10. 나는 전반적으로 스마트폰 혈당관리시스템은 사용이 편리하다고 생각한다.	①	②	③	④	⑤

▣ 다음은 사용 의도(Intention)에 관련된 질문입니다.

No	내용	전혀 아니다		보통		매우 그렇다
1.	스마트폰 혈당관리시스템을 사용하는 것이 좋은 생각인 것 같다.	①	②	③	④	⑤
2.	스마트폰 혈당관리시스템을 사용할 의향이 있다.	①	②	③	④	⑤
3.	스마트폰 혈당관리시스템을 사용하려고 노력할 것이다.	①	②	③	④	⑤
4.	스마트폰 혈당관리시스템을 다른 사람들에게 추천할 것이다.	①	②	③	④	⑤

▣ 다음은 기본적인 질문사항입니다. 해당 번호에 체크(✔)하여 주십시오.

1. 성별 ① 남 ② 여

2. 나이 ① 19세 이하 ② 20대 ③ 30대 ④ 40대 ⑤ 50대 ⑥ 60세 이상

3. 학력 ① 중학교 졸업 ② 고등학교 졸업 ③ 대학교재학/대졸 ④ 대학원재학/원졸

4. 직업 ① 학생/대학원생 ② 의료관계자 ③ 공무원 ④ 교사직
⑤ 전문직(의료직 제외) ⑥ 일반사무직 ⑦ 자영업 ⑧ 기타

5. 귀하는 현재 당뇨관리를 하고 계십니까?
① 네 ② 아니오

6. 귀하는 당뇨관리를 하신지 얼마나 되셨습니까?
① 1년 미만 ② 1~4년 미만 ③ 4~7년 미만 ④ 7~10년 미만 ⑤ 10년 이상

7. 귀하는 현재 혈당측정기를 사용하고 계십니까?
① 네 ② 아니오

8. 귀댁의 월평균 소득(가구 전체 소득)은 얼마나 되십니까?
① 150만원 미만 ② 150~300만원 미만 ③ 300~450만원 미만 ④ 450~600만원 미만
⑤ 600만원 이상

- 설문에 응답해주셔서 감사합니다. -