The use of mobile health applications and health improvements

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The authors declare that they are the sole authors of this thesis and that they have not used any sources other than those listed in the bibliography and identified as references. They further declare that they have not submitted this thesis at any other institution to obtain a degree.

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ABSTRACT

Background: This thesis aims to investigate if the use of mobile health (mHealth) applications have positive effects on health.

Objectives: This research are to provide an insight of how people are using mHealth applications but also provide an insight of the target group. Additionally, the thesis will provide an analysis of the proposed Structural Equation Model (SEM) to understand the influencing factors (constructs) for health improvement.

Method: In this research a Structural Equation Model (SEM) approach was used in which a questionnaire with closed ended questions related to each construct were provided to collect the data. The data were analyzed by the computer program IBM SPSS 25 and the SEM was made by the IBM SPSS AMOS 25.

Results: The proposed theoretical SEM model showed validity and the proposed hypotheses 1 and 2 were significant for this model. The corresponding contributed construct to improve health, were “Healthcare Service” and “mHealth App Behavior”. “New Technology” did not contribute to improvement of health directly, but it correlated strongly to “Healthcare Service” but also to “mHealth App Behavior”.

Conclusions: The target group was defined as a group of early adopters who used mobile health applications and more specifically, they used fitness apps to enhance health. People in the target group were high educated and had occupations which corresponded well with their education. Additionally, this group used their knowledge by reading and understanding health information when they needed healthcare service to improve health.

Keywords: Adoption, Health, mHealth, New Technology
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1 INTRODUCTION

World Health Organization (WHO) have reported that in 2016, more than 1.9 billion adults were overweight and 41 million children under the age of 5 were overweight or obese (statista, 2018). The consequences of overweight and obesity is an increased risk of cardiovascular diseases, e.g. heart disease and stroke, which in 2012 were the leading cause of death. High weight also increases the risk for diabetes, musculoskeletal disorders, and different forms of cancers. It is therefore obvious that each effort to help a patient has not only a direct effect on the individual himself, but also a great impact on the healthcare system for a country, but of cause also an enormous impact on the global life quality for human kind.

1.1 Problem discussion

One major reason why patients’ health continuous dwindling is due to peoples’ lifestyle. With the fast-paced life people live in recent times, reliance on processed food is inevitable. Additionally, smoking habits in many countries seem to be on the increase (Wellington, 2012). This, together with environmental pollution has also added to the increase of chronic diseases globally (Fred, 2011).

With an increased aging population, combined with the increased trend of lifestyle diseases, a country’s healthcare systems are put on high pressure.

Modern healthcare systems need to find new ways to meet the new challenges that come with increased pressure on healthcare. One way to do this, is to adopt to new technologies; globally, locally and individually. By adopting to new technology and use developed products for this purpose, it will help both patients and healthcare professionals (HCP) to enhance better health for the individual patient but also decrease the pressure in the healthcare system. This can be done by adopting to new technology, and by using mHealth apps specifically.

1.2 Problem formation and purpose

The purpose with this thesis was to investigate if peoples’ health have been improved by adoption to new technology. And more specifically, in this research the focus has been on a specific new technology, the mHealth apps.

A mHealth app can be used for medication purpose, prescribed by doctors but today most people use mHealth apps from other product segments, such as fitness apps.

The border line between a healthy person and a patient is also getting more transparent as we are all patients but in different stages from time to time during our lives. For example, when we exercise and eat healthy food it is one kind of preventive care to ourselves. We can get sick or having an injury which needs acute care at hospital. Additionally, we might need rehabilitation care after an injury or a disease. For all these situations, the use of mHealth apps could be one way to enhance health for the patient, for the person, for you. With this focus in mind that all of us are patients, combined with the patient-centered approach needed to meet challenges in healthcare (Porter and Lee, 2013), I wanted to investigate healthcare service together with mHealth technology and how this impact health.

A mHealth technology acceptance model (M-TAM) was used for one of the identified constructs (mHealth app behavior) which was used in the Structural Equation Model (SEM). Additional factors to investigate health improvement in the SEM model were “New Technology” and “Healthcare Service”.

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According to Shupei et al. (2015) the impact of health and fitness apps has recently started to be acknowledged. However, most studies done on mobile apps have had a focus on the content and features of health mobile apps, instead of the customer perspective. To make an empirical study on how customers are adopting mHealth apps is one way to see if companies have started to embrace strategies which are focusing on the customer and by this, the patient-centered perspective.

In this study, a survey was implemented using a structured questionnaire to collect data. The data were analyzed by using Confirmatory Factor Analysis (CFA) and Structural Equations Modeling (SEM). The intention of the empirical study combined with literature research was to investigate the following research questions (RQ).

RQ1: What factors are influencing people’s health improvement?
RQ2: What are the relationship between the factors influencing health improvement?

The objectives of this study are to:

(1) Providing an insight of how people are using mHealth apps.
(2) Analyze the proposed SEM model to understand influencing factors for health improvements.
(3) Providing implications for healthcare professionals (HCP).

1.3 Delimitations

The thesis will include the theory of different models of acceptance of use to new technology because the use of mHealth applications were investigated in this thesis. But, because the time is limited only the most relevant theories were chosen. Also, the scope of the thesis needed to exclude many factors (constructs) to make the data reasonable to handle.

1.4 Thesis structure

The thesis structure will hereafter include these parts:

Chapter 2. Theory
In this part, relevant theory has been investigated. The focus has been on what drives mobile health applications, current challenges in healthcare and what are the important values for mobile health. Additionally, different new technology theoretical models will be introduced.

Chapter 3. Method
In this chapter the chosen method will be introduced. Furthermore, the questionnaire which was used to collect data will be presented together with the summary of the target group.

Chapter 4. Results
In this part, the empirical results are presented, but the chapter involves also the selecting of data process.

Chapter 5. Discussion and conclusions
This chapter will discuss the outcome of the result and analyze this. Additionally, this chapter will give conclusions.

Chapter 6. Future research
This part will provide suggestions for further research.
2 THEORY

2.1 What is mobile health—mHealth?

In 2011, the definition of mobile health (mHealth) was set by World Health Organization (WHO) and stood for a component of eHealth supported by mobile devices, such as mobile phones, personal digital assistants (PDAs), patient monitoring devices and other wireless devices (WHO, 2011).

Mobile health (mHealth) can be defined as the healthcare-related technology providing mobile information communication and network systems together with services (Adibi, 2015). With this, mHealth comprises mobile devices used by healthcare providers, patients and also customers in order to gather, store and analyze data (Sezgin and Özkan-Yıldırım, 2014). mHealth is also described as the use of information and communication technologies (ICT) for health (WHO, 2016). mHealth can be considered as a subcategory of “eHealth”, which is a broader term when using electronic technologies such as computers in medicine and public health (Dicianno, 2015). The simplest forms of mHealth are voice communication and text messaging.

WHO has made a survey of the use of new technology (WHO, 2011) and it summarizes the report with “The use of mobile and wireless technologies (mHealth) to support the achievement of health objectives has the potential to transform the face of health service delivery across the globe”.

2.2 What drives mHealth?

2.2.1 Values of Healthcare

Around the world, healthcare systems are confronted with challenges such as aging population and increased budget pressure. mHealth could be one tool to handle these challenges by contribute to more patient-focused healthcare and at the same time, supporting the shift towards prevention and at the same time improving system efficiency (EC, 2014).

mHealth apps can contribute to a more efficient way of healthcare by better planning and by reducing unnecessary consultant times with over 30% of their time. Additionally, patients will feel more empowered by participating and having more responsible of their own health through sensors that detect and report vital signs and mHealth apps that encourage to adhere to diet and medication (EC, 2014).

In 2025, Sweden shall be the leading country worldwide in eHealth. This is a goal the government in Sweden has set. If this is done the right way, over 180 billion SKR would been saved per year (Cederberg, 2016). Most savings are estimated to come from unnecessary meetings and wrong medications which leads to wrong treatments. The technology is already here, it has just to be implemented the right way with its full potential.

At the moment, mHealth is considered a field in the health industry that improves patient’s lives and their health and facilitates the communication between doctor and patients due to a more advanced communication and computing capabilities of tablet devices and smartphones (Zapata et al., 2015).

In 2010, Porter published an article where he defined value as a division of the total health outcomes achieved per dollar spent (Porter, 2010). He meant that if value improves, everyone can benefit from that; patients, payers, providers and suppliers. This at the same time while the economic healthcare system increases. Porter argues that value should be defining the framework for performance improvement in healthcare. Furthermore, he describes that value should be measured by “the
multidimensional outcomes achieved and not the volumes of services delivered or the particular process improvement leading the way". The costs should include the total costs of the cycle of care and not only the cost for individual services (Porter, 2010).

2.2.2  Costs in Healthcare

Costs in healthcare are an important factor since aging of population and development of new treatments have become a trend across countries and these facts are associated with costs. There is a lack of knowledge of how much it costs to deliver patient care and how these costs are compared with the outcomes achieved (Kaplan and Porter, 2011). According to the authors, the costs simply needs a new way to measure the costs and compare them with outcomes. Better outcomes are often related with lower total care cycle costs. By spending more on early detection and better diagnosis of diseases, this generally leads to less complex and less expensive care later. But this is challenging to measure costs accurate in healthcare. Healthcare involves many steps and types of resources when a patient is treated such as personnel, space, equipment and suppliers, each with different capabilities and costs. The authors argue that an accurate costing system must see to the total costs of all resources needed used by the patient (Kaplan and Porter, 2011).

The authors proposed a cost measure system “time-driven-activity-based” costing or “TDABC”. The framework contained seven steps, but the main variables were two; cost of each of the resources in the process and the quantity of time the patient spends with each resource. The main conclusion when using this framework in practice when optimize over the full cycle of care was to eliminate clinical processes that waste resources and created delays and unnecessary administrative processes.

2.3  Current challenges in Healthcare

A report made by Deloitte (2014) showed that the population globally, would expect to triple for people at 60 years old and above by 2025. This, together with trends such as increase of chronic diseases in an aging population, combined with costs and quality challenges, puts the world healthcare in a demanding situation. The advances the adoption of new digital health information technologies such as mHealth application expects to enhance, the restructuring care delivery models. These will give a more efficient use of resources between physicians, payers, patients and stakeholders.

2.4  Healthcare strategy in the future

2.4.1  Patient-centered Healthcare

Michael E. Porter and Thomas H. Lee proposed a value-agenda model in how healthcare was organized, measured and reimbursed consisting of six strategic components. They identified that healthcare worldwide is struggling with rising costs but also unsatisfying quality. The authors noticed that no easy solutions or quick fixes were identified, instead it had resulted in physicians were receiving lower incomes, healthcare service got more limited and patients were paying more. To be able to improve healthcare for patients, a shift had to be implemented from a supply-driven approach to a patient-centered healthcare approach (Porter and Lee, 2013).

The value-agenda model contain the following areas:

1. Organize into integrated practice units (IPUs).
2. Measure outcomes and costs for every patient.
3. Move to bundled payments for care cycles.
4. Integrate care delivery across separate facilities.
Expand excellent services across geography.
Build an enabling information technology platform.

In Sweden, the community-based and regional parties have a vision that in 2035, the individual will need to share their personal health condition data with their healthcare system. Example of this could be blood sugar and weight. To use digitalization as a tool for prevention of injuries and diseases is something which saves much money and is a driving factor for the Swedish healthcare system (Karlsson, 2016).

2.4.2 Patient-centered Service

In an article presented by Swan (2009) the individual will take control of the healthcare for himself. The person is the focus and will interact with peers and professionals when the person finds it necessary. To enable this patient-centered service, there are suggestions of different interactions between platforms and forums, in which exchange of information can be made. The main purpose of this idea is that the individual act and interact to understand when healthcare is needed and to what extent. Another publisher (Sarker, 2003) also confirms this view of having a platform to be a promising technology field in a future healthcare service.

![Diagram of health and healthcare](image)

Figure 2.1. Model of health and healthcare. Source: Swan, 2009.

2.4.3 Predictions for Healthcare


*Healthcare consumers*

Healthcare organizations will interact with patients via social media. Clinicians will be more tech-savvy and monitoring their patients in real life and advanced analytics will, with help of wearable devices, be a common practice.

Online patient communities are predicted to grow to become a source of crowd-sourced data. The patient will become more responsible for their own health, having control over electronic health record and decide whom to share it with. Business and government will need to work with committees of patients. Additionally, hospital and payers need to identify best practices and cost-effective solutions (Deloitte, 2015).
Healthcare delivery system
While patients receive ownership of their own data, this will start a shift to a more patient-centered and outcome-based delivery model which will eliminate the silos between the hospital and community care. Furthermore, traveling and waiting times will decrease. This new type of healthcare system will be possible due to telemedicine – enabled clinical e-visits, robotics, 3D printing of medical devices and organs and web-integrated wireless monitoring of devices (Deloitte, 2015).

Wearables and mHealth application
Biosensing and wearables devices will enhance the quality of life for many patients due to the continuous monitoring for a broad range of physiologies. This will be included in the medical prescriptions. With this, wearables will be cheaper than the ones today and will be more interoperable, integrated, engaging plus outcome focused. Patients will provide reviews, rate and evaluate new mHealth apps and technologies. However, the privacy and security issues are a concern which requires further regulations (Deloitte, 2015).

Big data
Due to big data, focus shift to data and outcomes from research and development pharmaceutical companies will need new data management and analytic capabilities which will create new partnerships with payers and hospital systems. With this, general public and governments will recognize the benefit when using personal health data and turn this into a measure of national economic development (Deloitte, 2015). European Commission (2014) recognized that thanks to big data, it is a way to provide healthcare authorities with an accurate and holistic view of patients’ illnesses and behaviors.

Regulatory compliance and patient safety
The previous scenarios for 2020, will not be possible if not new regulations are developed. US Food and Drug Administration (FDA) and the European Medical Agency (EMA) are expected to establish a regulatory framework for the use of big data, wearables and social media in the medical field. With this, not only an increase in patient safety will come as a result, but also a faster approach process of drugs and monitoring apps and devices. (Deloitte, 2015).

2.5 Values of mHealth apps
Statistics show that only in Sweden, 8.4 million mobile phones are available and over 47, 000 iOS healthcare apps were available during quarter 3 in 2017 (statista, 2018). Healthcare providers and doctors are “prescribing” more and more apps. They mean that the help that smart devices gives to manage their patient’s health, have put the smartphones to the newest important tool for disease management (Drell, 2014).

Mobile applications have become disruptive innovations in healthcare. They improve quality of care, patient satisfaction and safety while moving to a value-based delivery model when reducing costs (Williams, 2012).

Williams (2012) argues that there are three key areas when hospital shall improve value with the help of mobile apps and new technologies; Firstly, focus on tools that help the patient to judge whether a visit at the clinic really is needed. Secondly, the financial professional should play a supporting role instead of a leading role. Finally, keep all new apps simple so professional and patients interacts seamlessly.

2.5.1 mHealth apps segments
mHealth apps can be categorized in six different segments (Medium, 2018);
1. **Chronic care management apps** – These types of apps include mHealth apps for managing blood pressure, diabetes, cancer, mental health and more.

2. **Medical Apps** – Different diagnostic apps. These types of apps generate awareness to the patients. They create alerts, could serve as a medical reference for the patients and physicians.

3. **Healthcare and Fitness apps** – This segment includes different nutrition apps, health-tracking, fitness and weight loss apps.

4. **Women’s Health apps** – These types of apps involve pregnancy, fertility, breastfeeding and after birth exercising.

5. **Medication management apps** – To this segment, all mHealth apps that keep track of medication to improve adherence among patients fits into this category.

6. **Personal Health Record apps** – These apps allow patients to store medical conditions data for example, such as allergies, and can share this with their doctor.

### 2.6 New Technology

Today, the adoption rate of apps for health and fitness apps is rather low (19%), compared to adoption of gaming (60%) or social networking (47%) (Firenze, 2018). Therefore, it is even more important for the ones who deliver the health apps (e.g. developers, health educators, researchers or business partners) to understand how individuals perceive and their intention to continue to use these apps in the future (Shupei et al., 2015). For mHealth apps, this will have a big impact on how patient will enhance the new technology and additionally, this will have a great impact of healthcare service and cost for the society.

The essence of this chapter is to consider some models and theories that are related to the research work. The major topics of this literature review include theories of different acceptance models for new technologies.

#### 2.6.1 Adopters Theory

Three major theories play out in the adoption of apps, the theory of rational expectations and adaptive learning and the theory of information transmission and the rational expectations theory of technology adoption. These theories focus on how firms and people are able to adapt to new technologies and immediately put them to use. They discuss the outcomes likely to be encountered when technologies are introduced.

Adoption, as defined by Rogers and Shoemaker (1971), is the resolution to accept and utilize an innovation considering it a new idea, creation or service and in a more precise case acceptance and continual usage of health apps. Rogers classified the adopters into five kinds as (1) Innovators (2) Early adopters (3) Early majority (4) Late majority and (5) Laggards (Rogers, 1962)

1. **Innovators**

   The first set of adopters is called “Innovators” and is usually about 2.5%. These are people who like taking a risk and would want to take on new things and want to be known as the first to get to know of new methods of carrying out things and are always looking out for new innovations. Innovators are adventurous and well-educated. They have multiple information sources and show greater penchant to risks their funds. They value technology and are willing to bear initial challenges. They are not known to follow the status quo, they believe change is the only thing that is constant.

Innovators are risk takers, youngest in age, have the maximum social class, possess good financial freedom and very social.
2. Early Adopters
The next group of adopters is the “Early Adopters”. 13.5% of adopters fall into this category. People in this class are also well-educated, well esteemed in the society and usually are some kind of opinion authorities in their locality and they tend to be part the first groups of people to purchase of new innovations or ideas. These persons have the highest degree of authority among the other adopter categories.

3. Early Majority
The “Early Majority” form 34% of adopters. These set of adopters focus on the innovators and early adopters to have technical know-how of a product before they purchase it. Most times, they decide based on approvals from users that have already used the product or service and consciously consider it a while before making a final conclusion to adopt it.

4. Late Majority
The next set of adopters is “Late Majority” and they are 34% of them, who are more cynical about a new invention, conventional and of lower social-class status. They tend to go for products when the average people are done. They are known to adopt a product when it becomes very trendy and there is mass usage.

They are price-conscious. They are forced to buy technology just to keep up with the rivalry and often seek the assistance of a single, trustworthy advice-giver to help them use technology effectively.

5. Laggards
The last set of adopters, “Laggards”, are 16% and they consist of people who lag for a long-time before adopting a technology. In this group, people who never adopt the technology are inclusive. They are more unadventurous and are skeptics of change agents and new inventions. Laggards are innovation critics who only want to retain the status quo. They really do not believe that technology can augment efficiency and are probable to stop new innovation acquisition.

2.6.2 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) is a popular model in the social psychology sphere. TRA, propounded by Fishbein and Ajzen (1975), is a well-studied intention model which has been verified successfully in forecasting and elucidating behavior across a wide assortment of domains—the study of technology acceptance inclusive. It was deduced from past research which started out as the theory of attitude, which eventually progressed to the study of attitude and behavior. The features of TRA are of three broad constructs: Behavioral Intention (BI), Attitude (A), and Subjective Norm (SN). In other words, an individual’s performance of a particular behavior is based on his or her behavioral intention to act the behavior, and behavior is mutually based on the individual’s attitude and subjective norms relating to the behavior in question, (Algahtani and King, 1999). The explanation shows that an individual's voluntary behavior is foretold by his position towards that behavior and how he feels others would accept them if they performed the behavior. Attitude has to do with a belief system and the resultant effect of carrying out the behavior multiplied by his assessment of these consequences. Subjective norm is considered to be a combination of perceived outcomes from relevant persons or groups along with intentions to conform to these outcomes.

2.6.3 Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) is a theory about the connection between attitudes and behavior. It was propounded by Ajzen (1985) as an expansion of the Theory of Reasoned Action (TRA). It is one of the most analytical persuasion theories, which has been applicable to studies of the connections among beliefs, attitudes, and behavioral intentions. The Theory of Planned Behavior’s intent is to explain in detail why people carry out certain actions. They do so because they form an
intention to carry out the action. The stronger the intention to carry out a particular behavior, the more likely the individual is to carry out that behavior. Intentions are influenced by the person’s belief system, the societal influence to agree to the wishes of others, and their perceived ability to carry out the action. These are known as beliefs, outstanding referents and perceived behavioral control. According to Ajzen (1985), the intention is an immediate predictor of behavior. This intention is loaded by Subjective Norm (SN) (i.e., perceived societal pressure), PBC (the beliefs about the ability to be in charge of the behavior) and one’s attitude towards a behavior.

**Attitude towards Behavior:** Attitude toward a behavior is the level to which performance of the behavior is positively or negatively valued. It is defined as a person’s positive or negative mindset about performing the behavior. It is usually determined through an evaluation of one’s beliefs towards the consequences coming from a behavior and an evaluation of the appeal of these consequences. Formally, attitude can be evaluated as the sum total of the individual consequence multiplied by appeal evaluation for all expected consequences of the behavior.

**Behavioral Control:** Perceived behavioral control implies the people’s opinion of their capacity to carry out a given behavior. It can be defined as one’s perception of the complexity of performing a behavior. TPB takes the control that people have over their behavior as lying on a continuum from behaviors that are easily carried out to those that need considerable effort, resources, etc.

### 2.6.4 Mobile-Theory of Acceptance (M-TAM)

To understand a user’s adoption of a new technology a theoretical framework named Mobile-Technology Acceptance Model (M-TAM) (Sezgin and Özkan-Yıldırım, 2018) was used for the “mHealth app behavior”-construct for this study but was slightly modified. The M-TAM model was also adapted from the originally developed model (TAM), which has been empirically tested in many different technological areas (Gefen and Straub, 1997; Hu et al., 1999; Pai and Huang, 2011).

The reception of new technologies is usually low from the beginning until some awareness is created. (Davis and Bagozzi, 1989). Also, people in an industry usually consider the threat a new product possess to their profession before choosing to accept it or not. According to Technology Acceptance Model (TAM), users come to accept and use technology. This model explains why people accept or reject new technologies. (Davis, 1989; Bagozzi and Warshaw, 1989).

The M-TAM model consists of nine exogenous constructs which are; Social Influence (SI), Compatibility (CO), Technical support and Training (TT), Perceived Service Availability (PS), Result Demonstrability (RD), Personal Innovativeness (PI), Mobile Anxiety (MA), Mobile Self-efficacy (MS) and Habit (HA). For the exogenous constructs Performance Expectancy (PE) and Effort Expectance (EE) were identified leading to the last exogenous construct, Behavioral Intention (BI). All M-TAM-constructs except for the Technical Support and Training (TT), were used for the “mHealth app behavior”- construct together with the “New Technology”-construct in this research and related questions were added to the questionnaire (Q1-Q36). The “mHealth app”-construct aims to relate to the user’s behavior when the “New Technology” aims to focus on the more technical parts.
Figure 2.2. M-TAM model framework

**Behavioral intention (BI)** is defined as “the degree to which a person has formulated conscious plans to perform or not perform some specified future behavior”.

**Effort expectancy (EE)** is defined as “the degree of ease associated with the use of the system”. Performance expectancy (PE) is defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance.”

**Performance expectancy (PF)** is defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance.”

**Social influence (SI)** is defined as “the degree to which an individual perceives that important others believe he or she should use the new system”.

**Habit (HB)** is defined as “constitutes the level of routinization of behavior, i.e. the frequency of its occurrence”.

**Personal innovativeness in the domain of IT (PI)** is defined as “the willingness of an individual to try out any new IT, plays an important role in determining the outcomes of user acceptance of technology”.

**Result demonstrability (RD)** is defined as “the extent to which the tangible results of using an innovation can be observable and communicable”.

**Compatibility (CO)** is defined as “the degree to which an innovation is perceived as being consistent with the existing practices, values, needs and experiences of the Healthcare professional”.

**Computer self-efficacy (CS)** is defined as “the degree to which an individual believes that he or she has the ability to perform specific task/job using computer”.

**Computer anxiety (CA)** is defined as “the degree of an individual’s apprehension, or even fear, when she/he is faced with the possibility of using computers”.

10
Technical support and training (TT) is defined as “the technical support and the amount of training provided by individuals with knowledge”.

Perceived service availability (PS) is defined as “the degree to which an innovation is perceived as being able to support pervasive and timely usage”.
3  Method

In this chapter, the chosen method which is used in this research will be presented. The method is a Structural Equations Modeling (SEM) and involves constructs which in this study are five different constructs and each construct correlates to specific questions. These questions were 48 closed-ended questions, provided in a questionnaire. The collected data were later analyzed in a data analyze program called SPSS and then later in a program named AMOS for further analysis of how the phenomenon of how the construct interact and give impact to the construct “Health Improvement”.

3.1 Chosen method

I have chosen to use Structural Equations Modeling (SEM) to analyze the data for this research. SEM is a multivariate technique combining aspects of factor analysis and multiple regression that enables the researcher to simultaneously examine a series of interrelated dependence relationship among the measured variables and latent constructs (vaiates) as well as between several latent constructs.

The reason why SEM has become a popular multivariate approach is because that researchers see the advantages in how SEM can express a theory in terms of relationships among measured variables and latent constructs (vaiates). SEM shows how well the theory fits reality as it is represented by data (Hair, 2010).

Structural Equations Modeling (SEM) can be described in the six-step decision process.

1. Defining individual constructs.
2. Developing the overall measurement model
3. Designing a study to produce empirical results
4. Assessing the measurement model validity
5. Specifying the structural model
6. Assessing the structural model validity

The first three steps are related to method and will be described in this section. Step four, five and six are related to the result and will then be further described in the result section.

3.2 Step 1 – Defining individual constructs.

In literature (Hair, 2010) it is described that a good measurement theory is necessary to obtain useful results from SEM. Therefore, the researcher needs to invest much effort in the beginning of the research process to ensure that the measurement quality will enable valid conclusions. To do this, the researcher needs to define a good theoretical definition of the constructs. After defining the constructs, the researcher operationalizes the constructs by selecting its measurement scale items and scale type. Furthermore, it is common to use previous research studies to defined constructs and how they operationalize these. To replicate in this way is a proven way to ensure quality since it has for these reasons already been proven to have a good model fit. To ensure high quality of the questions in the questionnaire, replicates could be taken from previous studies for the same reason.

For this research, I wanted to investigate if usage of health applications would improve health. I chose one construct which involved usage of mHealth apps (mHealth). From the literature I involved many of the areas which normally is involved in behavior intention of use of apps (Sezgin and Özkan-Yildirim, 2018). Additionally, I wanted to add new technology as a construct which would represent the technology focus when using an application from a mobile phone (Jessup et al., 2017). Also, I was curious to see if healthcare service (HCS) could be giving a positive effect on health. Many studied
have been made in the new technology field used by healthcare professionals and I have chosen my questions from published articles (Jessup et al., 2017; Howell et al., 2017; Stavor, 2017) and adopted to my purpose.

Additionally, I decided to have a construct named “Health Status” which would catch the status of the participant’s health and lastly the second endogogenous construct called “Health Improvement” which involve if the person has improved health.

A questionnaire was made involving these five constructs with their corresponding questions, in total 48 questions. The “mHealth App Behavior” (mHAB) involved 17 questions, “New Technology” (NT) involved 19 questions, “Healthcare Service” (HCS) involved 6 questions, and construct “Health Status” (HST) involved 3 questions and “Health Improvement” (HIM) 3 questions. Additionally, questions regarding demographic data were also made (gender, age, education, occupation and type of mHealth app).

![Figure 3.1. Identified constructs.](image-url)

### 3.3 Questionnaire

Data were collected with the help of a questionnaire with the technique of a structured interview with closed questions, which aimed to produce quantitative data. The entire questionnaire will be found in appendix 1. For the measurement scale and scale type for this research I have chosen a five-stage Likert scale to be able to collect scalable responses and to reduce bias (Allen and Scaman, 2007; Krosnick and Presser, 2010). The scale was designed as; “1: Strongly disagree”, “2: Disagree”, “3: Neutral”, “4: Agree” and “5: Strongly agree”.

The questionnaire was divided into three parts. In the first part, the participant was introduced to this study’s purpose and scope and the confidentiality of the data. The second part included 48 closed-ended questions. The third part involved the demographic data which included age, gender, education level and occupation.

But firstly, the inclusion criteria to be able to be involved in this study a question was asked to the person if the person had used any health app the last 12 months. The type of app could be used for exercises, relaxing, diet, weight control, blood sugar levels, smoking habits and so on. If the person was using several apps, then the app with the most impact on health would be asked to be considered.

The supervisor reviewed the questions for the questionnaire before proceeding with the interviews.
3.4 Collecting the data

Once the questions were reviewed and approved by the supervisor one hundred fifty questionnaires were collected between 24th of March to 3rd of May 2018. The inclusion criteria for being able to participate in this research study was to have an application in the mobile phone which involved health. Additionally, the person was also asked if this app had been used the last 12 months. If the answer was no, the person was not considered to participate in this study. These responses were not registered since this was considered out of scope for this research. However, if the person said yes, the person would then be asked to join the study. Some of the interviews were held and led by myself by telephone, where I was describing the case and read the questions and wrote down the notes on the paper. Some of the questionnaires were filled in by the participant himself but with me being next to the person or close nearby if any questions were raised. Also, I would then have the opportunity to find any missing data and could directly confront the person. The target samples were randomly selected people, in different areas in Mölndal and Gothenburg but also people I know who would use some kind of mHealth app the last 12 months. The areas where I was confronted people and received high participating rate were at some of the gym centers and by my working place in the big meeting and coffee room environment. Once all 150 questionnaires were collected, the data was interpreted into IBM SPSS 25 software. The papers were saved and stored so they could be used if any clarification or double checks were needed when analyzing the data.

3.4.1 Demographic data of the target group

Before the 48 questions were correlated and analyses, a demographic data table of the participants were summarized in table 3.1.

<table>
<thead>
<tr>
<th>Categories:</th>
<th>Number of responses</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>73</td>
<td>49%</td>
</tr>
<tr>
<td>Female</td>
<td>77</td>
<td>51%</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-29</td>
<td>9</td>
<td>6%</td>
</tr>
<tr>
<td>30-39</td>
<td>42</td>
<td>28%</td>
</tr>
<tr>
<td>40-49</td>
<td>76</td>
<td>51%</td>
</tr>
<tr>
<td>50-59</td>
<td>17</td>
<td>11%</td>
</tr>
<tr>
<td>60-</td>
<td>6</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school</td>
<td>12</td>
<td>8%</td>
</tr>
<tr>
<td>Uni. 3 years</td>
<td>40</td>
<td>27%</td>
</tr>
<tr>
<td>Uni. 4 years</td>
<td>52</td>
<td>35%</td>
</tr>
<tr>
<td>PhD</td>
<td>39</td>
<td>26%</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthcare Professionell (HCP)</td>
<td>8</td>
<td>5%</td>
</tr>
<tr>
<td>Education</td>
<td>3</td>
<td>2%</td>
</tr>
<tr>
<td>Service related</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>Scientist</td>
<td>69</td>
<td>46%</td>
</tr>
<tr>
<td>Engineer</td>
<td>39</td>
<td>26%</td>
</tr>
<tr>
<td>Other</td>
<td>31</td>
<td>21%</td>
</tr>
<tr>
<td><strong>Type of app</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise</td>
<td>107</td>
<td>72%</td>
</tr>
<tr>
<td>Meditation/Relaxing</td>
<td>15</td>
<td>10%</td>
</tr>
<tr>
<td>Food/Weight</td>
<td>23</td>
<td>15%</td>
</tr>
<tr>
<td>Blood sugar</td>
<td>5</td>
<td>3%</td>
</tr>
<tr>
<td>Smoking</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Table 3.1 Demographic data
The table present that close to 50% were male and female in this research. Just over 50% of the participants were in the age of 40-49 and 90% were between 30-59 years old. The education level was rather high, with about 25% with a PhD. Over 70% were scientist or engineers and over 70% of the participants were using their mHealth app for exercise.

This target group shows middle age people with rather high education and with jobs that probably fits well with their education. They want to stay healthy and use the mHealth app for exercise. A majority of the target population were working at AstraZeneca. By looking at the education level, age and occupation, this could raise questions if it is possible bias, when the target group is very tight and maybe not representing the people population. That is probably true. However, the inclusion criteria to be able to join this study was that you had to have used a health app during the last 12 months. This means that not only the target group needs to have used any health app the last 12 months, it also means that the target group itself have already adopted to new technology and would probably be included in the category of people named early adopters. The demographic data show that the target group is likely early adopters using the mHealth product segment “fitness apps” to enhance health.

So, for this reason, I believe that the outcome could be rather similar if the majority was people passing by on the street. The target group I ideally wanted to investigate were was the one who used professional mHealth apps which had been prescribed by doctors. This kind of target group was the group I first started to have in mind when I was in the beginning of this research. But, for legal reasons and due to time limitation for this study, I decided to change the scope related to the target group and try to investigate a wider perspective of mHealth apps.

3.5 Step 2 – Developing and specifying the measurement model

In this step, the latent constructs are identified in the model and the measured indicator variables (items) will be assigned to the latent constructs, which normally is presented with a diagram.

There are three types of relationships: measurement relationship between indicators/items and constructs, structural relationship between constructs, and the correlational relationship between constructs. Also, there are two types of error terms; one is related to individual indicators and the other to endogenous constructs (Health Status and Health Improvement in this case).

![Diagram of identified constructs and their relationship.](image)

Figure 3.2. Identified constructs and their relationship.

When specifying the model, some issues need to be investigated further:
1 - Will the validity and unidimensionality of the constructs be empirically supported?

2 - How many indicators should be used for each construct and what is the minimum number of indicators per construct?

3 - Should measures be considered as portraying the constructs, meaning they are describing the constructs or seen as explaining the constructs?

In my research, the constructs have the minimum three indicators.

3.6 Step 3 - Designing a study to produce empirical results

When designing a study, issues could obtain due to research design and model estimation. Regarding research design, areas such as the type of data to be analyzed (covariances or correlation), impact and remedies for missing data and the impact of sample size needs to be addressed. Regarding the model estimation, areas such as the model structure, the various estimation technique available and the computer software need to be looked into.

SEM requires careful consideration of factors affecting the research design to receive a promising SEM analysis. SEM can be estimated with covariances or correlations data. In this study, I have chosen Pearson correlation which then became the base of further analysis.

Regarding the impact of missing data, this needs to be taken care of to minimize any problems with the estimation. There are several approaches depending on what kind of data, and how much data are missing. In my case I chose to have control over the replies in my survey for two reasons; one because I did not want to end up with any missing data, and secondly, I wanted to have a communication with my participant, so any misunderstanding around the questions could be addressed to me in person. Therefore, I did not have any missing data which means all data that were collected were able to be analyzed.

When it comes to sample size, this is a critical question when using SEM to be able to produce trustworthy results. Five areas are affecting sample size when using SEM; multivariate normality of the data, estimation technique, model complexity, amount of missing data and lastly, the average error variance among the reflective indicators. For example, simpler models could have smaller sample sizes, but the more construct, the larger sample size. A larger sample size is also required if a construct is having less than three indicator variables or a multigroup analysis. In literature (Hair, 2010) it is recommended a minimum sample size of 100 when a model containing five or fewer constructs, with three or more items (observed variables). In my case, I have five constructs and three or more indicators per each construct. But, when starting to interpret my data I wanted to have an ability to better values. Therefore, I decided to choose 150 participants to my research.
4 RESULTS

In this section SEM step four, five and six will be explained and presented. These areas involve the demographic data and the Pearson correlation matrix of the results. The confirmatory factor analysis (CFA), the proposed path diagram and SEM model will be presented.

4.1 Step 4 – Assessing measurement model validity.

4.1.1 Selection of questions.

To start with, a Pearson correlation, see figure 4.1 below (a larger figure will be found in appendix 2) with all questions involved were calculated. From this matrix, data were selected, some to be included and some to be removed in next step of analyses. The aim of this correlation was to see which indicator correlates with other indicators and hopefully they were in the same construct. I have chosen to keep all indicators with values above 0.5 so see if this could give good model fit in the upcoming confirmatory factor analysis (CFA) but one additional question was selected (Q38) with a correlation at 0.272 because I wanted to have at least three indicators per construct.

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
Q1-Q17 represent the mHealth app behavior (mHAB)
Q18-Q36 represent New Technology (NT)
Q37-Q42 represent Healthcare Service (HCS)
Q43-Q45 represent Health Status (HST)
Q46-Q48 represent Health Improvement (HIM)

Figure 4.1. Table of Pearson correlation, all N=150

After the selecting process, 26 questions remained in total. A summary of these questions and their constructs are found in appendix 3. From the beginning, many of the questions were related to the "mHealth App Behavior" (mHAB) construct. Of this reason, it did not impact anything at the moment to take away five questions when still thirteen questions were left. For the construct "New Technology" twelve questions were removed, and seven questions were remaining. The construct "Healthcare Service" kept three questions.
However, for the “Health Status” (HST) and “Health Improvement” (HIM) only one respectively two questions were remaining. So, since “Health Status” and “Health Improvement” is basically the same thing when it comes to health, I decided to merge them into the same construct and change the new name to “Health Status and Improvement” (HSTIM). In appendix 3 all the remaining questions and its construct name will be found.

4.1.2 Testing the validity of the CFA model

The CFA model will test the factors which have been selected and to see if they are relevant to the constructs, which the CFA model consists of. From now on the model will consist only of four constructs.

In CFA five items need to be defined; latent constructs, measured variables, the loading per each construct, the relationship between the constructs and lastly, the error terms per each indicator.

The measurement model’s validity depends on both having accepted level of goodness-of-fit (GOF) for the model and finding evidence of construct validity. GOF indicates how well the model reproduces the observed covariance matrix among the indicators items.

Model fit compares the theory to reality by assessing the similarity of the estimated covariances matrix (theory) to reality (the observed covariance matrix) (Hair, 2010). If the theory were perfect, the estimated covariances matrices would match.

Other values related to GOF, is chi-square, degrees of freedom (df), and adjusted goodness-of-fit (AGFI). How to interpret and use the model fit should be used as a guide for usage and not as rules that guarantee a correct model. But, to use several guidelines can help determine acceptability of fit for the model. It is recommended to report at least one incremental index (CFI or TLI) and one absolute index (GFI, RMSEA, SRMR), but also GOF, df and chi-square.
Figure 4.2. The measurement CFA model

The reason why to use a CFA model with the questions and their correlated constructs, is to see if the results of the questionnaire will give some reliable measures of the result. If a reliable relation between the construct occur, it will allow the model to reach next step, the SEM step. The arrows in the CFA model will go from a “correlational relationship” shown by arrows in both directions and bended to a “dependence relationship” in the SEM model shown by arrows now in one direction. The estimation of the CFA model is summarized in table 4.1.

<table>
<thead>
<tr>
<th>Name of Test</th>
<th>Results</th>
<th>Expected value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted (AGFI)</td>
<td>0.808</td>
<td>&gt;0.80</td>
</tr>
<tr>
<td>Chi-square ($\chi^2$)</td>
<td>273,672</td>
<td>Depending on model, no limit. Theory is supported if $P&lt;0.05$</td>
</tr>
<tr>
<td>Comparative Fit Index (CFI)</td>
<td>0.935</td>
<td>&gt;0.90</td>
</tr>
<tr>
<td>Construct Reliability (CR)</td>
<td>Under 5</td>
<td>under 5</td>
</tr>
<tr>
<td>Degrees of Freedom (df)</td>
<td>166</td>
<td>Depending on model no limit</td>
</tr>
<tr>
<td>Goodness-Of-Fit (GFI)</td>
<td>0.862</td>
<td>&gt;0.90</td>
</tr>
<tr>
<td>Loading factors within constructs (convergent validity)</td>
<td>0.47≤$\leq$0.93</td>
<td>0.5≤$\leq$0.95</td>
</tr>
<tr>
<td>Root Mean Square Error of approximation (RMSEA)</td>
<td>0.066</td>
<td>&lt;0.095</td>
</tr>
<tr>
<td>Skewness/Kurtosis</td>
<td>Within limits</td>
<td>±1.5</td>
</tr>
</tbody>
</table>

Table 4.1. Estimation of the CFA model.
The factor loadings within the constructs should not be too small (<0.5) but not too high (>0.95), but be balanced (Bagozzi and Yi, 1988). My loadings within the constructs were in all cases except for question nr.48 (with loading 0.47) between 0.52 to 0.93. Furthermore, the loadings between the constructs (discriminant validity) should not be too high. In this CFA model, the loadings were between 0.12 to 0.50. The only values that didn’t reach the desired levels were GFI and one loading factor just under 0.5. However, as mentioned earlier, it is recommended to report at least one incremental index (CFI) and one absolute index (GFI and RMSEA) and GOF, df and chi-square. In my results I have reported RMSEA so GFI could be considered as optional. Additionally, the use of the model fit should be used as a guide and not as a strict rule to follow and since all the other values showed good results, I considered my model to have good validity.

4.2 Step 5 – Specifying the structural model

In this step not only the indicator variables are finalized to the constructs, which was accomplished in step 2, but also the structural model will assign the relationship from one construct to another based on the proposed theoretical model. This is done by using the dependence relationship between constructs and turn this to a structural hypothesis of the proposed theoretical model by the researcher. While specifying the measurement model in step 2, it is time to specify the structural model here in step 5. This is done by adding single-headed directional arrows which will represent the structural hypotheses in the model.

It is time to select the key factors which influence the endogenous constructs which in my research would be “Health Status and Improvement” construct. Based on this theory the following structural relationship was proposed:

![Path diagram](image)

Figure 4.3. Path diagram, showing hypothesized structural relationship and measurement specification.

Due to the objectives in this study, I wanted to investigate them by testing some hypotheses in this direction. This path diagram shows the hypotheses for this model which are expressed as followed:
Hypothesis 1: “Healthcare Service” construct has a positive relationship to “Health Status and Improvement” construct.

Hypothesis 2: “mHealth App behavior” construct has a positive relationship to “Health Status and Improvement” construct.

4.3 Step 6 – Assessing the structural model validity

This final step in the SEM process involves testing the validity of the structural model but also its corresponding hypothesized theoretical relationship (H1-H2). When testing the fit of a structural model relative to a measurement model, two key differences needs to be addressed; first, even if an acceptable overall model fit is established, for the proposed model, alternative models are encouraged to be tested. Secondly, focus is on the estimated parameters for the structural relationship because they provide the direct empirical evidence related to the hypothesized relationships shown in the structural model.

The structural model’s validity will be estimated also this time by observed data which still are represented by observed covariance matrix as in step 4. But, now additional SEM estimated covariance matrix is computed and differ from the measurement model due to the relationship in the model. Since in the measurement model all constructs are correlated with each other (correlational relationship), but in a structural model some relationships between constructs are assumed to be zero. Of this reason, most likely SEM models will show less values compared to the values in the measurement model. But, overall fit can be assessed by using the same criteria as for the measurement model.

However, good model fit alone is not enough to support the proposed theory. The theoretical model is considered valid if it is statistically significant and in the predicted direction, which means greater than zero for a positive relationship, and less than zero for a negative relationship.

Figure 4.4. SEM model, scenario 1.
The estimation of the validity for the SEM model gave the results shown in table 4.2. Additionally, assessment of normality was tested and analyzed by looking at skewness, kurtosis and construct reliability (C.R.). The factor loadings within the constructs were in all cases except for question nr.48 (with loading 0.47) within recommended levels (Bagozzi and Yi, 1988) between 0.55 to 0.93. The results show that GFI is still a bit lower than recommended. But since another absolute index (RMSEA) is already reported and the other values are within limits, the model should be considered to be valid.

<table>
<thead>
<tr>
<th>Name of Test</th>
<th>Result: Scenario 1. (H1, H2)</th>
<th>Expected value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted (AGFI)</td>
<td>0.832</td>
<td>&gt;0.80</td>
</tr>
<tr>
<td>Chi-square (χ2)</td>
<td>154.834</td>
<td>Depending on model, no limit. Theory is supported if P&lt;0.05</td>
</tr>
<tr>
<td>Comparative Fit Index (CFI)</td>
<td>0.927</td>
<td>&gt;0.90</td>
</tr>
<tr>
<td>Construct Reliability (CR)</td>
<td>Under 5</td>
<td>under 5</td>
</tr>
<tr>
<td>Degrees of Freedom (df)</td>
<td>81</td>
<td>Depending on model, no limit</td>
</tr>
<tr>
<td>Goodness-Of-Fit (GFI)</td>
<td>0.887</td>
<td>&gt;0.90</td>
</tr>
<tr>
<td>Loading factors within constructs</td>
<td>0.475 &gt;0.93</td>
<td>0.5≤χ²≤0.95</td>
</tr>
<tr>
<td>(convergent validity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root Mean Square Error of</td>
<td>0.079</td>
<td>&lt;0.095</td>
</tr>
<tr>
<td>approximation (RMSEA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skewness/Kurtosis</td>
<td>Within limits</td>
<td>±1.5</td>
</tr>
</tbody>
</table>

Table 4.2. Summary of results from SEM model.

Question no. 1, 2, 4, 5, 13 and 15 were taken away from the model to improve model fit. The actual question corresponded to the question number will be found in appendix 3.

The SEM model showed statistical significance and the estimated loading per hypothesis 1 (H1) was +0.42 and for hypothesis 2 (H2) the loading was +0.34.

The structural model showed validity and all hypotheses were statistical significant and were predicted greater than zero (having a positive relationship) in their predicted direction. The theoretical model is considered valid.

As stated before, even if a model has overall acceptable model fit, it is encouraged to test other alternative models to see if any of these will improve model fit but also to test if any other hypotheses will be found. Four additional scenarios have been tested, scenario 2-5. The figures of the SEM models with scenario 2, 3, 4 and 5 will be found in appendix 4 and 5 with corresponding results. The summary of scenario 2, 3, 4 and 5 are that none of the proposed competitive SEM models had better model fit compared to the chosen SEM model in scenario 1.
5 Discussion and Conclusion

Did this research answer the research questions asked and did the objectives being investigated?

The objectives of this study are to:

1. Providing an insight of how people are using mHealth apps.
2. Analyze the proposed SEM model to understand influencing factors for health improvements.
3. Providing implications for healthcare professionals (HCP).

5.1 Providing an insight of how people are using mHealth apps.

With this research I wanted to get an insight of how people are using mHealth apps. Additionally, it is also important to understand who the target group is, and how we can learn from this.

To understand how people are using mHealth apps, I first needed to get access to my target group, the people who were using one kind of mHealth app. As mentioned in the beginning of the thesis, there are different product segments also for mHealth apps, but the factor that connects all of them are health. Some people use it to become healthier (e.g. exercise), but some people use mHealth apps to keep the health stable (e.g. measuring blood sugar). But, even if you have a disease to manage or if you want to use the mHealth app to lose weight, become stronger or faster, all people who are using a mHealth app use it to receive a positive impact on health. This was the reason why I included all product segments of mHealth apps in my research because I wanted to investigate if the use of a mHealth app would improve health. However, one way to access people using mHealth apps was to find people using any kind of fitness apps. This was also the outcome of the results shown in table 3.1. that most people in the target group (72%) used the mHealth app for exercising purpose.

When I asked my inclusion criteria question for this research to people, - “Have you used any health app the last 12 months?”, many people answered they did not use any mHealth app. This information was not further investigated since this information was out of scope for this research. However, many people were telling me, they were exercising or being health conscious but did not want to use any technology to track this. Obviously, people take an active decision not to use an app when exercising even if it could be beneficial. This is an interesting area to look more into when new technology is not used even if it is easily assessable and ready to use. Probably this group of people are more resistant to use new technology and would therefore be included into the groups defined as “late majority” or “laggards” (Rogers, 1962).

The people who answered “yes” on the inclusion criteria question, could use any type of health app which made the person feel good or healthy in a way that suited the person. This was very individual if it was an app for meditation, exercise, food or weight control or if the person used it for any medical controls. However, the majority of the participants were using the app for exercise purpose. One reason for this was of cause because I had identified this target group from the start, to be able to get access to people using any kind of mHealth apps, in which fitness apps are one of them. Of the people who did participate in this research, the main target group were in the age range of 40-49. I tried to reach both younger but also older people. It seemed like younger people were not using any apps for health intention, and the older generation who maybe should benefit from using a mHealth app, are not using this technology, yet. Therefore the target group were in this age-range. Additionally, this target group are users of new technology, which includes them to the group of “early adopters” (Rogers, 1962).

Furthermore, I chose to ask people close to their working place (AstraZeneca in Malmö) and at fitness places to get access to the target group using mHealth apps. For this reason, people not working
out or people not having a job to go to were excluded. So, for example, people over the age of 80 years old might not work out at a fitness place or go to work anymore.

In summary, the answer to the question “who” is the target group, the answer would be; middle age people who are well educated and having an occupation which fits well with the person’s education. The target group use mostly a mHealth app from the product segment “fitness apps” and use it to feel healthy and are interested in being healthy. This target group will be defined as “early adopters” since they are using fitness apps as a mHealth app, which is still a new generation of technology (Firenze, 2018).

5.2 The analyze of the proposed SEM model to understand influencing factors for health improvements.

The path diagram with proposed hypotheses seen in picture 4.3, was confirmed to be valid and received positive values in desired directions. The construct “Health Status and Improvement” (which was the new and combined name for the “Health Status” and “Health Improvement” constructs) became the endogenous construct in the theoretical model and path diagram. To understand how the phenomenon of how the construct interact and give impact to this construct “Health Status and Improvement” we need to look at the path diagram and see which factors are giving positive values in this direction. The stronger loading (value), the better and more impact that construct provide the “Health Status and Improvement”-construct.

The results showed that the influencing factors for “Health Status and Improvement”-construct were both “Healthcare Service” (H1) and “mHealth App Behavior” (H2).

5.2.1 Healthcare Service

The first construct contributed positive to “Health Status and Improvement” construct was “Healthcare Service” (H1). This construct was represented by both performance and knowledge abilities (Stavor et al., 2017) with three questions in total from the questionnaire (Q38, Q40 and Q41). The question correlated to performance was (Q38); “I have the ability to find good health information”. What that means is that the respondent can search and find health information. It could for example be looking up symptoms on internet or know when to call 1177 (healthcare information service) or 112.

The other ability “Knowledge” involved the two questions “I have sufficient information to take care of my health”, and “I can read and understand health information enough to know what to do”. The target group were middle age, well educated people using fitness app to stay healthy. They can use the knowledge they have enhanced by experience or by following news to be updated in aspects around health.

Recently, an article in the daily newspaper (G.P., 2018) published results from a clinical study showing that it took stroke patients with lower education and lower income 25 minutes longer time from the SOS call to the actual treatment in hospital compared to the other patient group which was high educated with higher income. The researchers behind the study argued that one aspect in why it differs so much could be due to if you have lower education it might also be harder to read and communicate with healthcare professionals. This patient group might not follow news in the way a higher education patient group do and are less good in understand information related to disease, symptoms and health. This is exactly what the “Healthcare Service”-construct in this thesis also shows. As confirmed earlier, this target group were also high educated people with assumed relative high income due to the occupation they have.
5.2.2 mHealth App Behavior

The second construct which contributed positive to construct “Health Status and Improvement” was “mHealth App Behavior” (H2). This construct had six questions correlated with this construct. The performance expectancy (PE) – related question: “My mHealth app helps me to conduct and achieve clear health goal”. Additionally, all three questions related to habit (HA) were contributing to the use of the health app. The questions were (Q12, Q13, Q14): “I frequently use the mHealth app”, “I have strong intention to use the mHealth app” and lastly; “I have integrated this mHealth app as a routine in my life”. Furthermore, the last two questions contributing to the “mHealth App Behavior” construct were (Q16, Q17) compatibility (CO) with “Using the mHealth app helps me achieve life objectives” and “Using mHealth applications enhance my life style”.

The M-TAM model showed in figure 2.2. aim to describe the user’s adoption of mobile technology. In this research performance expectancy (PE), habit (HA) and compatibility (CO) contributed to the user’s adoption of mobile technology, which in this particular case was the mobile health app.

“PE” aim to describe “the degree to which an individual believes that using the system will help him or her to attain gains in job performance”. PE investigate the users’ attitudes to identify the actual relationship between “job performance” and “using the technology”. In this research “job performance” means “health improvement” and the use of technology is the mHealth app. This means the relationship between improvement of health by using mHealth apps. This could be achieved by having a health app in the mobile phone which helps the person to reach the goal the person has for training, to stay healthy or improve health in some way. For example, using a fitness app like Runkeeper to log the morning run or by starting the yoga program in the mobile phone with relaxing music.

Habit (HA) is defined as “constitutes the level of routinization of behavior, e.g. the frequency of its occurrence”. The target group in this research seems to have adopted a habit since they respond strongly to all the three habit-related questions. By having integrated the health app as a routine in their life, and the intention to use it, together with the frequently use; it is evident that this target group have not only adopted the mobile technology in their life, they use it so frequently, it has become a habit. This habit by using a fitness app enhance the health in a positive way for the persons in the target group.

The third area contributed with two questions (Q16, Q17) was Compatibility (CO). CO is defined as “the degree to which an innovation is perceived as being consistent with the existing practices, values, needs and experiences. The related questions were; “Using the mHealth app helps me achieve life objectives” and “Using mHealth apps, enhance my life style”. What this means is that the person in the target group has started to use the new technology, (mHealth app) in a degree so it is a part of their life, and especially in this research, a part of their healthy life and it has become a lifestyle.

5.2.3 Health Status and Improvement

The construct “Health Status and Improvement” has the two influencing constructs which contribute to “Health Status and Improvement”. Both “Healthcare Service”-construct (H1) and “mHealth App Behavior” (H2). What this means is for example; if you have the knowledge to know how to take care of yourself by reading and understanding healthcare information (H1) you will then also understand when to contact healthcare professionals and how to do this to stay healthy. Furthermore, the “mHealth App Behavior” construct (H2) contributes with new technology which this target group enjoy using to log their exercise. When using mobile technology, they have involved this so much it has become a habit, which itself makes the person use the mHealth app even more. This has a direct positive effect on health.
By looking at the construct “Health Status and Improvement”, the related questions to this construct are (Q44, Q45, Q48); “I am actively managing my health today”, “I monitor my health all the time” and lastly; “I improve my health all the time”. This confirms what the contributing construct already have shown. The persons use their knowledge and performance abilities, so they know how to stay healthy. Additionally, they use mHealth apps so frequently it has become a habit and monitor the exercise by using the mobile technology to improve health.

5.2.4 New Technology

The construct “New Technology” itself, did not contribute directly to the construct “Health Status and Improvement”. But, by looking at the relationship between the endogenous constructs, “New Technology” correlate strongly to “Healthcare Service” but also to “mobile Health App Behavior”. To investigate these relationships further, we can start look at the relationship between “New Technology” and “Healthcare Service”.

In recent years, digitalization and eHealth has started to be embraced also within the healthcare service in Sweden. The Swedish government has a goal to be the leading country in eHealth by 2025 (Cederberg, 2016). When looking at the corresponding questions left in the “New Technology” construct, we can confirm Sweden has started what it takes to improve healthcare to enable a patient-centered approach (Porter and Lee, 2013). The questions were (Q25, Q28 and Q29): “I could complete the task/exercise by using mHealth app even if I have never used a system like this before”, “I would find the mHealth app easily accessible and portable” and “my mHealth app is available to use whenever I need it”. Even if the construct did not contribute to the persons health directly, we can see that the questions relate to what mobile technology can do to improve healthcare service. Since we are only in the beginning of the eHealth evolution in which mHealth apps are only one part of it, it is clear that mobile apps as a part of new technology, can enhance service in healthcare. We have already started to see that people can manage their prescriptions by they own (e.g. mobile applications named “Mitt Apotek”). Additionally, more health apps have been developed in Sweden for interactions between patients and doctors, for example “Min doktor”. I believe that this research shows that Sweden has started to apply patient-centered approach by using new technology in which eHealth and mHealth is a strong part of it.

5.3 Providing implications for Healthcare Professionals (HCP).

With this research, I have provided an insight of how people are using mHealth apps. Today most people use a mHealth app for exercise and these people are in age 40-49. They are healthy and like to use technology to track their record. I have proposed a research model and given an analysis of the outcome of the results to understand influencing factors for health improvements. The conclusion from the hypotheses are that new technology in general, in which mHealth apps are included, are contributing positively to healthcare service. Additionally, people who are familiar with the healthcare service, are actively taken care of their health and improve their health.

Today around the world, healthcare systems are confronted with many challenges due to an aging population and increased budget pressure, Sweden is no exception. By using mHealth technology it would be one way to manage these challenges by contributing to a more patient-centered healthcare. This was one of the recommendations given by Porter and Lee (2013). Additionally, by using mHealth technology, it is one way to support the shift towards prevention of healthcare and at the same time, improving system efficiency (EC, 2014).

There were three key areas in which leaders, government and healthcare professionals should know about to improve values at hospitals (Williams, 2012), focus on tools that help people judge whether a visit at the clinic really is needed. Secondly, the financial professional should play a supporting role
instead of a leading role and finally, the mHealth apps should be simple so professional and patients can interact seamlessly.

To extend these key areas a bit further I would recommend the following areas of improvement if Sweden will be the leading country of using eHealth technology by 2025. Take the advantage of the mobile technology we already have. Develop easy and simple mobile apps for the healthcare service system for people. In this system, the person can login, book and look and have the initial recommendation by a healthcare professional if a visit is necessary or not. If the person is recommended a visit, the app could be the initial start of the communication between the healthcare professionals and the patient. Sarker (2003) argued that healthcare services together with the mobile platform is a promising technology field. I believe this theoretical model has confirmed this. Also, the platform in which the information technology will be managed, will need to be built in a way which drives a patient-centered approach (Porter and Lee, 2013; Swan, 2009).

Finally, with a society that push focus from the organization to the individual, the patient gets more responsibility to take care of himself. This patient-centered focus has many opportunities as mentioned before. However, as confirmed in the clinical stroke study (G.P., 2018) people with lower education and lower income could have a disadvantage compared to individual with higher education and income. It will require much more of the individual himself to stay updated and be able to read and understand healthcare information and understand when to communicate and contact a healthcare professional. To this, add the multi culture and segregated society most cities and countries experience, and imaging how to include the ones with limited education, income and knowledge. This is the area the healthcare service could make a great improvement on health. With the right tools of new technology and mHealth application, we have all chances to succeed and reach out to all individuals to improve health.

5.4 Research questions

The research questions aim to find out which factors were influencing people’s health improvement. Additionally, the research question asked how the relationship between the factors will influence health improvement.

RQ1: What factors are influencing people’s health improvement?

RQ2: What are the relationship between the factors influencing health improvement?

One of the factors which were influencing the new exogenous construct “Health Status and Improvement” was “Healthcare Service” (H1). “Healthcare Service” were also affected positively by “New Technology” construct. The impact “New technology” gave “Healthcare Service” (H1) was interesting to see because this means that we have seen adoption of new technology also within healthcare service. Since it is still early days in this new field of technology, Sweden confirms to be a country consisting of early adopters. To have a healthcare service in which apply and adopt to new technology, and a willingness to use mHealth apps as one example of new technology, would enhance the future of healthcare service in Sweden. The Swedish government’s goal to be the leading country in eHealth by 2025 is looking promising.

“Healthcare Service” contributed also positively to “Health Status and Improvement”. This means to be very logic. If people use and know how to use the healthcare service, the chance of being healthy improves. High educated people knows how to act and interact to take care of themselves. But, as mentioned before, the back side of this is the individuals that are not capable of reading and understanding information to be able to take care of themselves. This would probably be a challenge to capture this target group.
Another factor which were influencing “Health Status and Improvement” construct and contributed to this in the theoretical model, was “mHealth Apps Behavior” (H2). Again, when people are using mHealth apps, they improve their health in one way or another. In this research most people used the mHealth app for exercise. This is only the beginning of what we will see. As said before, Sweden is a country of early adopters. Soon will more people will use mHealth apps and not only for exercise, but from the other products segment for sure. Especially, when the pressure comes from both patient-driven perspective, but also from goals, set by national level to lead the development of eHealth. This puts the spotlight on different kinds of eHealth technology, but a major part of this new generation of technology will be the mHealth technology.
6 FUTURE RESEARCH

This master thesis has identified a target group of early adopters of new technology, who use fitness apps as a mobile health app. For future research, it would be interesting to investigate other mHealth apps from the product segment.

Additionally, a next step to look more into would be the target group which consists of “late majority” or “laggards” since one identified group when collecting data was the group of people taking an active decision not to use an app when exercising even if it could be beneficial. This is an interesting area to look more into when new technology is not used even if it is easily assessable and ready to use.

Furthermore, the older generation which might need different kinds of mHealth apps to manage their health would be very interesting to know more about.
REFERENCES


### APPENDIX 1 – QUESTIONNAIRE

Hi. My name is Anna Öhrn. This questionnaire is part of my research for the Master of Business and Administration (MBA) at BTH. The questionnaire is about the use of mHealth apps in mobile phones and their effect on health improvements.

The health app refers to the apps you have in your mobile phone. It could be used for exercise, weight, food, smoking, blood sugar and so on. (but, not only a pulse clock) If you have several mHealth apps, please consider the one that gives you most health impact. The questionnaire takes about 5-10 minutes to complete. Thanks for your collaboration.

<table>
<thead>
<tr>
<th>Construct (mHealth app behavior [mHAB])</th>
<th>Category</th>
<th>Q</th>
<th>Question</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavior intention (BI)</td>
<td>1</td>
<td></td>
<td>I intend to use the mHealth application</td>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
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<tr>
<td>Performance expectancy (PE)</td>
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<td></td>
<td>I plan to use the mHealth application in the next 6 months</td>
<td>1</td>
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<td>4</td>
<td>5</td>
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<tr>
<td>My mHealth application helps me to conduct and achieve clear health goals</td>
<td>3</td>
<td></td>
<td>1</td>
<td>2</td>
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<tr>
<td>Using the mHealth application enhances my health</td>
<td>4</td>
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<td>5</td>
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<tr>
<td>My mHealth application enables me to accomplish “exercise/health checks” more quickly</td>
<td>5</td>
<td></td>
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<td>3</td>
<td>4</td>
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<tr>
<td>Effect expectancy (EE)</td>
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<td>My user interface with the mHealth application is clear and understandable</td>
<td>1</td>
<td>2</td>
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<tr>
<td>I find the mHealth application easy to use</td>
<td>7</td>
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<tr>
<td>Social influence (SI)</td>
<td>8</td>
<td></td>
<td>People who are important to me think that I should use the mHealth application</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<tr>
<td>Habit (HA)</td>
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<td>I frequently use the mHealth application</td>
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<td>2</td>
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<tr>
<td>I have strong intention to use the mHealth application</td>
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<tr>
<td>I have integrated this mHealth as a routine in my life</td>
<td>11</td>
<td></td>
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<tr>
<td>I have no difficulty telling others about the results of using my mHealth application</td>
<td>12</td>
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<tr>
<td>The results of using the mHealth application are apparent to me</td>
<td>13</td>
<td></td>
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<tr>
<td>I would have difficulty telling others about the results of using the mHealth application</td>
<td>14</td>
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<tr>
<td>Compatibility (CO)</td>
<td>15</td>
<td></td>
<td>Using mHealth applications is compatible with my daily activities</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>5</td>
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<tr>
<td>Using mHealth applications enhance my life style</td>
<td>16</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>New Technology (NT)</td>
<td>17</td>
<td></td>
<td>If I hear about a new information technology, I would look for ways to experiment with it</td>
<td>1</td>
<td>2</td>
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<tr>
<td>Among my peers, I am usually the first to try out new information technologies</td>
<td>18</td>
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<td>2</td>
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<tr>
<td>I like to experiment with new information technologies</td>
<td>19</td>
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<td>Mobile anxiety (MA)</td>
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<td></td>
<td>The mobile applications are somewhat intimidating and wrong to me</td>
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<td>2</td>
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<td>I hesitate to use the mHealth application for fear of making mistakes that I cannot correct</td>
<td>21</td>
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<tr>
<td>I feel apprehensive about using the mHealth application</td>
<td>22</td>
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<tr>
<td>Mobile self-efficacy (MS)</td>
<td>23</td>
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<td>I could complete the “exercise/health checks” using the mHealth application even if there was no one around to tell me what to do as I go</td>
<td>1</td>
<td>2</td>
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<td>I could complete the task/exercise using the mHealth application even if I had never used a similar system before this one</td>
<td>24</td>
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<td>I could complete the “exercise/health checks” using mHealth applications if I had used a similar system before this one</td>
<td>25</td>
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<tr>
<td>Perceived service availability (PS)</td>
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<td>I would be able to use the mHealth application at any time, from anywhere</td>
<td>1</td>
<td>2</td>
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<tr>
<td>My mHealth application is available to use whenever I need it</td>
<td>27</td>
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<td>I would find the mHealth application easily accessible and portable</td>
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<td>New technology (NT)</td>
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<td>I prefer the mHealth application on my phone, integrated with my watch/bracelet</td>
<td>1</td>
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<tr>
<td>I like to monitor the information by my mobile phone instead using computer/iPad</td>
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<td>Security (SE)</td>
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<td>I believe the mHealth application is secure</td>
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<td>I prefer to add my health information myself in the mHealth application</td>
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<td>Barrier (BA)</td>
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<td>I prefer help of someone I trust to add my health information in the mHealth app</td>
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<td>Doctors and nurses are not supportive of this mHealth app</td>
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<td>Amounts of mHealth apps are overwhelming</td>
<td>35</td>
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<td>-------------------</td>
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<td>---------</td>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td>Healthcare Service (HCS)</td>
<td>Performance (PE)</td>
<td>37</td>
<td>Did you use any Healthcare service the last year? (Hospital, local Healthcare, BB, rehab, dentist)</td>
<td>No</td>
<td>1-2</td>
<td>3-5</td>
<td>6-11</td>
<td>12 or more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>38</td>
<td>I have the ability to find good health information</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>39</td>
<td>When I go to Healthcare Service, I feel supported and understood by my local doctor/nurse</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Knowledge (KN)</td>
<td></td>
<td>40</td>
<td>I have sufficient information to take care of my health</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41</td>
<td>I can read and understand health information enough to know what to do</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>42</td>
<td>When I need to go to a doctor, I know how to proceed</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Health Status (HST)</td>
<td>Status (ST)</td>
<td>43</td>
<td>My health status fits well with the way I like to live</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>44</td>
<td>I am actively managing my health today</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>45</td>
<td>I monitor my health all the time</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Health Improvement (HIM)</td>
<td>Improvement (IM)</td>
<td>46</td>
<td>I intend to improve my health in the next 3 months</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>47</td>
<td>I have actively improved my health the last 12 months</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>48</td>
<td>I improve my health all the time</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>My age</td>
<td>70</td>
<td>65</td>
</tr>
<tr>
<td>Education: (2nd high school/3yrs/4yrs/PhD/Other):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation: (Healthcare Service/Education Service/Scientist/other):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of mHealth app: E.g. (Exercise/relax/weight/blood sugar/a smoking/other):</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### APPENDIX 3. THE 26 QUESTIONS SELECTED AFTER THE PEARSON CORRELATION.

<table>
<thead>
<tr>
<th>Question No.</th>
<th>Question:</th>
<th>Construct:</th>
<th>Question later removed in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>I intend to use the mHealth application</td>
<td>mHealth App Behavior (mHAB)</td>
<td>SEM model</td>
</tr>
<tr>
<td>Q2</td>
<td>I plan to use the mHealth application in the next 3 months</td>
<td>mHealth App Behavior (mHAB)</td>
<td>SEM model</td>
</tr>
<tr>
<td>Q3</td>
<td>My mHealth application helps me to conduct and achieve clear health goals</td>
<td>mHealth App Behavior (mHAB)</td>
<td></td>
</tr>
<tr>
<td>Q4</td>
<td>Using the mHealth application enhance my health</td>
<td>mHealth App Behavior (mHAB)</td>
<td>SEM model</td>
</tr>
<tr>
<td>Q5</td>
<td>Using the mHealth application enables me to accomplish &quot;exercise/health checks&quot; more quickly</td>
<td>mHealth App Behavior (mHAB)</td>
<td>SEM model</td>
</tr>
<tr>
<td>Q7</td>
<td>I find the mHealth application easy to use</td>
<td>mHealth App Behavior (mHAB)</td>
<td>CFA model</td>
</tr>
<tr>
<td>Q9</td>
<td>I frequently use the mHealth application</td>
<td>mHealth App Behavior (mHAB)</td>
<td></td>
</tr>
<tr>
<td>Q10</td>
<td>I have strong intention to use the mHealth application</td>
<td>mHealth App Behavior (mHAB)</td>
<td></td>
</tr>
<tr>
<td>Q11</td>
<td>I have integrated this mHealth as a routine in my life</td>
<td>mHealth App Behavior (mHAB)</td>
<td></td>
</tr>
<tr>
<td>Q13</td>
<td>The results of using the mHealth application are apparent to me</td>
<td>mHealth App Behavior (mHAB)</td>
<td>SEM model</td>
</tr>
<tr>
<td>Q15</td>
<td>Using mHealth applications is compatible with my daily activities</td>
<td>mHealth App Behavior (mHAB)</td>
<td>SEM model</td>
</tr>
<tr>
<td>Q16</td>
<td>Using the mHealth application helps me achieve life objectives</td>
<td>mHealth App Behavior (mHAB)</td>
<td></td>
</tr>
<tr>
<td>Q17</td>
<td>Using mHealth applications enhance my life style</td>
<td>mHealth App Behavior (mHAB)</td>
<td></td>
</tr>
<tr>
<td>Q19</td>
<td>Among my peers, I am usually the first to try out new information technologies</td>
<td>New Technology (NT)</td>
<td>CFA model</td>
</tr>
<tr>
<td>Q20</td>
<td>I like to experiment with new information technologies</td>
<td>New Technology (NT)</td>
<td>CFA model</td>
</tr>
<tr>
<td>Q22</td>
<td>I hesitate to use the mHealth application for fear of making mistakes that I cannot correct</td>
<td>New Technology (NT)</td>
<td>CFA model</td>
</tr>
<tr>
<td>Q23</td>
<td>I feel apprehensive about using the mHealth application</td>
<td>New Technology (NT)</td>
<td>CFA model</td>
</tr>
<tr>
<td>Q25</td>
<td>I could complete the task/exercise using the mHealth application even if I had never used a system like it before</td>
<td>New Technology (NT)</td>
<td></td>
</tr>
<tr>
<td>Q28</td>
<td>I would find the mHealth application easily accessible and portable</td>
<td>New Technology (NT)</td>
<td></td>
</tr>
<tr>
<td>Q29</td>
<td>my mHealth application is available to use whenever I need it</td>
<td>New Technology (NT)</td>
<td></td>
</tr>
<tr>
<td>Q38</td>
<td>I have the ability to find good health information</td>
<td>Healthcare Service (HCS)</td>
<td></td>
</tr>
<tr>
<td>Q40</td>
<td>I have sufficient information to take care of my health</td>
<td>Healthcare Service (HCS)</td>
<td></td>
</tr>
<tr>
<td>Q41</td>
<td>I can read and understand health information enough to know what to do</td>
<td>Healthcare Service (HCS)</td>
<td></td>
</tr>
<tr>
<td>Q44</td>
<td>I am actively managing my health today</td>
<td>Health Status and Improvement (HSTIM)</td>
<td></td>
</tr>
<tr>
<td>Q45</td>
<td>I monitor my health all the time</td>
<td>Health Status and Improvement (HSTIM)</td>
<td></td>
</tr>
<tr>
<td>Q48</td>
<td>I improve my health all the time</td>
<td>Health Status and Improvement (HSTIM)</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 4. SEM MODELS; SCENARIO 2, 3 AND 4.

Scenario 2:

Scenario 3:

Scenario 4:
APPENDIX 5. SEM MODELS; SCENARIO 5 + TABLE SUMMARIZING SCENARIOS 1-5.

Scenario 5:

![Diagram of Scenario 5]

Table summarizing result from SEM models scenario 1-5.

<table>
<thead>
<tr>
<th>Name of Test</th>
<th>Scenario 1: (Chosen)</th>
<th>Scenario 2: H1, H2, H3, H4</th>
<th>Scenario 3: H1, H2, H5</th>
<th>Scenario 4: H1, H2, H6, H7</th>
<th>Scenario 5: H1, H2, H5, H7</th>
<th>Expected value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjusted (AGFI)</td>
<td>0.832</td>
<td>0.67</td>
<td>0.675</td>
<td>0.668</td>
<td>0.661</td>
<td>&gt;0.80</td>
</tr>
<tr>
<td>Chi-square ($\chi^2$)</td>
<td>134,834</td>
<td>364,591</td>
<td>555,018</td>
<td>560,888</td>
<td>570,146</td>
<td>Depending on model, no limit.</td>
</tr>
<tr>
<td>Comparative Fit Index (CFI)</td>
<td>0.927</td>
<td>0.709</td>
<td>0.775</td>
<td>0.772</td>
<td>0.762</td>
<td>&gt;0.90</td>
</tr>
<tr>
<td>Construct Reliability (CR)</td>
<td>Under 5</td>
<td>some items out of limit</td>
<td>some items out of limit</td>
<td>some items out of limit</td>
<td>some items out of limit</td>
<td>under 5</td>
</tr>
<tr>
<td>Degrees of Freedom (df)</td>
<td>81</td>
<td>185</td>
<td>183</td>
<td>183</td>
<td>183</td>
<td>Depending on model, no limit</td>
</tr>
<tr>
<td>Goodness-Of-Fit (GFI)</td>
<td>0.887</td>
<td>0.736</td>
<td>0.74</td>
<td>0.734</td>
<td>0.729</td>
<td>&gt;0.90</td>
</tr>
<tr>
<td>Loading factors within constructs (Convergent validity)</td>
<td>0.475&gt;0.93</td>
<td>0.485&gt;0.93</td>
<td>0.475&gt;0.93</td>
<td>0.475&gt;0.93</td>
<td>0.475&gt;0.93</td>
<td>0.559&gt;0.95</td>
</tr>
<tr>
<td>Root Mean Square Error of approximation (RMSEA)</td>
<td>0.079</td>
<td>0.117</td>
<td>0.116</td>
<td>0.117</td>
<td>0.119</td>
<td>&lt;0.095</td>
</tr>
<tr>
<td>Skewness/Kurtosis</td>
<td>Within limits</td>
<td>some items out of limit</td>
<td>some items out of limit</td>
<td>some items out of limit</td>
<td>some items out of limit</td>
<td>=1.5</td>
</tr>
</tbody>
</table>