The Role of Support and Sustainability Elements in the Adoption of a Self-management Support System for Chronic Illnesses

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TITLE:	The Role of Support and Sustainability Elements in the Adoption of a Self-management Support System for Chronic Illnesses
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Abstract

The Canadian healthcare system, by design, has been historically oriented to delivering acute and symptom-driven care; however, the current cost of treating chronic disease has risen to an average of nearly 45% of direct costs of the national health budget. As a consequence more attention is being directed to the diagnosis and treatment of chronically ill patients who also may suffer from disabilities, illiteracy, impairment in judgment, depression, or multiple co-morbidities. This has also resulted in a new emphasis on health and disease self-management, to help patients to mitigate and manage the impacts of chronic diseases. This approach affects and involves the patient's entire circle of care including the patient, healthcare providers, and the patient's family and friends.

This study discusses how support elements (i.e. decision support, education and training, family and community support) and sustainability elements (i.e. recreation and entertainment, rewards systems, online social networks) combined with online technological support can help to support and provide motivation for chronically ill patients to adopt self-management in a sustainable manner. The PLS (Partial Least Squares) statistical approach was used to validate a proposed SEM (Structural Equation Model) research model with data collected from 198 participants across North America without any prior exposure to our proposed system. The research model hypothesized that support and sustainability constructs have a strong positive influence on the willingness of users to adopt and use the proposed system. The model results in a very good fit for Behavioural Intention to Adopt for patients with no caregiver support (R^2=0.71), and for patients with such support (R^2=0.65). The results clearly validate our proposed model including a high predictive relevance for endogenous variables. This research provides useful theoretical and practical insights and understanding for design, development and promotion of chronic care self-management systems as well as the perceptions of users regarding the adoption and use of such systems.

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Glossary of Terms

A

Adherence	Refers to a specific behaviour of patients who accept and follow special treatment regimens ordered and prescribed by their physicians (Sidel, Ryan, & Nemis-White, 1998).

B

Behavioural Intention	An indication of an individual's readiness to perform a given behaviour. It is assumed to be an immediate antecedent of behaviour (Ajzen & Fishbein, 1977).

C

CCM	Chronic Care Model: A heuristic model that can be used to help understand the complex nature of chronic illnesses in multiple settings (Estes, 2011).
Confirmation	Assessment of the perceived performance of a product or service by users (customers) to determine the extent to which their expectations are satisfied comparing to their original expectations (Bhattacherjee, 2001).

E

Effort Expectancy	The efficacy beliefs that influence the determination of the degree of ease associated with the use of a system (Venkatesh, Morris, Davis, & Davis, 2003).
EMR	An electronic medical record (EMR) is defined as a systematic way of collecting electronic health information of patients in digital format (Archer, Fevrier-Thomas, Lokker, McKibbon, & Straus, 2011).
EHR	An electronic health record (EHR) contains all information ranging from clinical information, radiology, pathology, etc. that has been combined and structured in a digital format and is mostly used by hospitals, clinics, etc. (Archer et al., 2011).

F

Facilitating Conditions	The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system (Venkatesh, Morris, Davis, & Davis, 2003).

H

Habit	Repeated performance of a behaviour can result in well-established attitudes and intentions that can be triggered by attitude objects or cues in the environment. Once activated, attitudes and intentions will automatically guide behaviour without the need for conscious mental activities, such as belief formation or retrieval (Venkatesh, Thong, & Xu, 2012).
Hedonic Motivations	The degree to which an individual is “receptive to new ideas and makes innovation decisions independently” and novelty seeking which is “the tendency of an individual to seek out novel information or stimuli” (Venkatesh et al., 2012).

P

PAD	Peripheral arterial disease (PAD), is a disease that results in obstruction to blood flow in the arteries, exclusive of the intracranial and coronary vessels. It inflicts problems within the upper extremity arteries, extra-cranial carotid and the mesenteric and renal circulation and causes chronic arterial occlusive disease in the arteries to the legs (Ouriel, 2001).

PHR	Personal Health Record (PHR), is a health record where health data and information related to the care of a patient is maintained by the patient (Archer et al., 2011).
Performance Expectancy	The degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh, Morris, Davis, & Davis, 2003).
PDSS	Personal decision support systems (PDSS) are small-scale information systems that are normally developed for one manager, or a small number of managers, for an important decision task (Arnott, 2008).
PEoU	Perceived Ease of Use is the degree to which a person believes that using a particular system would be free from effort (Davis, Bagozzi, & Warshaw, 1989).
PU	Perceived Usefulness is the degree to which a person believes that using a particular system would enhance his or her job performance (Davis et al., 1989).

S

Self-care	An active cognitive process undertaken by a patient to maintain health or manage illness and disease (Carlson, Riegel, & Moser, 2001).

Self-management	the actual participation of the patient in the treatment process, whether it is for the daily management of a chronic disease (e.g. diabetes) or simply for activities (e.g. exercise) to promote good health through life style changes (Lorig & Holman, 2003).
Self-monitoring	Self-monitoring is occurring when an individual measures his/her own blood pressure, for example, at home, in the workplace, or any place other than a clinic (McManus et al., 2009).
Social influence	The degree to which an individual perceives that important others believe he or she should use a proposed system (Venkatesh, Morris, Davis, & Davis, 2003).
Sustainability	The continued implementation of a practice at a level of fidelity that continues to produce intended benefits, becoming a desired goal for successful interventions (Loman, Rodriguez, & Horner, 2010).

T

TAM	Technology Acceptance Model (TAM) is a theory in the information systems area that models how users come to accept and use a new technology (Davis et al., 1989).
TRA	Theory of Reasoned Action (TRA), suggests that an individual's behavioural intention depends on his/her attitude about the specific behaviour and also on relevant subjective norms. TRA states that

	it is likely that an individual carries through with a behaviour, if he/she has the intention to do so (Ajzen & Fishbein, 1977).

U

User Satisfaction	User satisfaction in the Information Systems context is defined as user beliefs about the relative value of the specific system or simply understanding a system and its success. It confirms the notion that satisfaction with a system is a form of evaluative response towards that system (Deng, Turner, Gehling, & Prince, 2010).
UTAUT	Unified Theory of Acceptance and Use of Technology (UTAUT) is a technology acceptance model that aims to explain user intentions to use an information system, and subsequent usage behaviour (Venkatesh, Morris, Davis, & Davis, 2003).
UTAUT2	A revised version of the original unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2012).

Chapter 1. Introduction

1.1 Background Information

The exponential growth of Internet technology during the 1990s gave birth to a new and promising application of digital support for health research and practice, which was called Electronic Health (or eHealth). The new field was expected to revolutionize the healthcare system by reducing costs and errors, while improving the quality of service/care and empowering customers/patients to understand their specific needs for making better/informed decisions. Some of the initiatives undertaken in this field have included Telemedicine, e-Prescribing, Electronic Medical Records (EMRs), Electronic Health Records (EHRs) and electronic Personal Health Records (PHRs) (Raisinghani & Young, 2008).

Among these initiatives, electronic Personal Health Records (PHRs) have recently become prominent, as they help to bring the concepts of patient-centred care and consumerism to the health industry. PHRs are expected to support a new relationship between patients and caregivers, through the sharing of health information. Easy access to PHRs and a strong consumer commitment to using PHRs may help to change the passive behaviour of today's consumers from treatment-receiving to active information seeking and self-management (Raisinghani & Young, 2008). Consumers with this new attitude should be able to work in close partnership with healthcare providers to help prevent, manage, or cure many different health conditions (Raisinghani & Young, 2008), (Decker, Jamoom, & Sisk, 2012), (Heisey-Grove & Danehy, 2014).

Studies have shown that much of the North American population relies on the Internet for information that can be used in making decisions about medications, lifestyle choices, treatments, and healthcare education, either for themselves or for others (Archer et al., 2011). Nevertheless, only 42% of the population keep any health records, and among those, almost 87% of the records are in paper-based format (Archer et al., 2011), which means that even if consumers want to, it is difficult to manage and share their own health records effectively. This has given rise to the development and use of electronic Personal Health Record systems (referred to exclusively in this thesis as PHRs) that can be used by consumers/patients to create, store, access, and manipulate their own healthcare information (Archer et al., 2011). There is a variety of definitions for PHRs, but this definition has been chosen because it's in line with the purpose of this research. According to Jones et al. (2010), more than 91 different PHR systems were available in the market at that time, and more than 70 million users, in the US alone, were estimated to have potential access to their own PHRs (WS Journal, 2006). In contrast, only 7% of all Americans tended to use them to improve their health (Archer et al., 2011), even though many benefits could be realized by using PHR systems, such as higher patient satisfaction, increased efficiency, increased patient empowerment, and improved disease self-management (Kaelber, Jha, Johnston, Middleton, & Bates, 2008), (Heisey-Grove & Danehy, 2014).

In recent years, there has been a significant focus on preventive healthcare (Vodopivec-Jamsek, de Jongh, Atun, & Car, 2012), (Heisey-Grove & Danehy, 2014). There are numerous preventive measures available, through nutrition, exercise, pharmacological therapy, or smoking cessation to reduce the risk of cardiovascular disease (Burke, Dunbar-Jacob, & Hill, 1997). In some instances, preventive measures for chronic diseases depend on the control and continuous monitoring of risk factors (Pauwels, Buist, Calverley, Jenkins, & Hurd, 2014). For example, obesity is now recognized as a considerable risk factor that is directly related to heart disease and diabetes, so that the control of obesity could result in a considerable risk reduction for these diseases (Kenchaiah et al., 2002). As another example, when a patient has already experienced a heart attack (an acute disease) and is in the cardiac rehabilitation stage, continuous monitoring and preventive measures could lower the risk of developing chronic coronary heart disease (Ades, 2001).

At this point, the design of the Canadian healthcare system is mostly based on delivering acute and symptom-driven care, with less attention being paid to the prevention and treatment of chronic diseases (Cohen et al., 2014). In the case of chronic diseases like diabetes (*Standards of medical care in diabetes-2014*, 2014), for example, the daily care needed to deal with the disease is largely in the hands of the patient. Therefore, developing with the patient's care provider a collaborative self-management plan becomes not just promising but essential. The self-management plan must allow patients to set goals that may involve changing their lifestyles, and to make frequent daily decisions that do not undermine their values, while also promoting effective treatment/management of their conditions (Haas et al., 2013). To achieve this goal, education is key to patient self-management, since it promotes better understanding of diseases and hence adherence to treatment regimens (Funnell & Anderson, 2004), (Khunti et al., 2012).

The overall goal of self-management is to improve a patient's health status and health behaviour, and at the same time, to reduce and minimize the inappropriate utilization of resources of the healthcare system (Lorig, Ritter, Laurent, & Plant, 2006), (Schulman-Green et al., 2012). Self-management can be seen to play a major role in both preventive and chronic care, and is a significant way of promoting patient quality of life, with simultaneous cost reductions for the healthcare system (Schulman-Green et al., 2012), (Lorig, Ritter, Ory, & Whitelaw, 2013). Living in a normal home environment, made possible by health self-management support, can also improve a patient's quality of life in comparison to a hospital or clinic setting (Gitlin, Hodgson, Piersol, Hess, & Hauck, 2014). Also, in this environment patients can interact with family members who can assist them with their self-management tasks (Tang, Pang, Chan, Yeung, & Yeung, 2008).

1.2 Motivation and Objectives of the Study

To improve the quality of care for patients with chronic illnesses, many healthcare systems have begun to adopt a heuristic model called the Chronic Care Model (CCM) (Estes, 2011). The CCM helps patients to understand and deal with the complex nature of chronic illnesses and it can be applicable in multiple settings. It is comprised of three different realms: the community, the healthcare system, and the provider organization (Estes, 2011). According to Estes:

> "*The community encompasses the wealth of resources and policies to implement healthcare. The healthcare system is founded within the context of the payment structure to reimburse for healthcare. The provider organization provides the context of the delivery system to supply healthcare. The three realms provide a general structure to understand the embedded elements of managing chronic illness*" (Estes, 2011) page 164.

The provider organization realm, which is the target of this study, consists of four essential elements (Bodenheimer, Wagner, & Grumbach, 2002):

1) Self-management support: This prepares the patients to play a collaborative and active role in their own care processes, by helping them to understand the importance of their role,

2) Delivery system design: ensures follow-up and continuity in changes to meet patient needs by composition and proper functioning of appointment systems, practice teams, and their approaches,

3) Decision support: ensures that caregivers and patients have ready access to preventive knowledge and clinical information, and

4) Clinical information: ensures that care providers can readily access patient health status information (Glasgow, Orleans, & Wagner, 2001).

Among these elements, self-management support empowers patients and families to manage chronic illness through a collaborative care approach, where the patient becomes the principal caregiver and receives support from the patient's family and the healthcare provider organization (Bodenheimer et al., 2002).

One old and one more recent comprehensive study on the effects of computer-based Clinical DSS (CDSS) for physician performance and patient outcomes (Hunt, Haynes, Hanna, & Smith, 1998), (Jaspers, Smeulers, Vermeulen, & Peute, 2011) have both showed that such systems had a great impact on patient and practitioner empowerment by providing useful information to the parties involved, so they can make the best decisions in a given circumstance.

CDSS can: perform complex evaluations; generate, synthesize, and integrate patient-specific information; and provide results and insights to patients/practitioners in a timely fashion. Decision support systems can play a big role in today's healthcare system (Hunt et al., 1998). A strong and direct relationship exists between a person's current health status and the person's awareness, health literacy, and most importantly, the decisions related to their health that are made on a daily basis (Tang, Pang, Chan, Yeung, & Yeung, 2008). This is very important, since a total reliance on the person's family doctor means that there could be a delay between making an office appointment and visiting the doctor to get the doctor's advice, depending on the locations of both parties and the availability of the family doctor (Mitnick, Leffler, & Hood, 2010). Decisions are based on the individual's awareness, and when a patient is more aware of certain complications, the patient will make better health-wise decisions (Tang, Pang, Chan, Yeung, & Yeung, 2008).

This is even more important for patients with chronic diseases (Haas et al., 2013). For example, patients suffering from chronic kidney disease who are more educated and aware of their status and how to manage their disease, will make better decisions (e.g. minor adjustments to medication levels) and be better able to deal with their conditions (Plantinga et al., 2008).

On the other hand, there is a need for a repository for information and data derived from patient experience and regular self-monitoring, which is essential for decision support and other needed functionalities of the CCM. A Personal Health Record (PHR) can satisfy this requirement. According to the Markle Foundation, a PHR is: *“a set of computer-based tools that allow people to access and coordinate their lifelong health information and make appropriate parts of it available to those who need it”* (Markle Foundation, 2003) page 15. There are several different classifications for PHRs (Raisinghani & Young, 2008): 1) Provider-based PHRs that are basically provided by healthcare providers such as doctors or hospitals; 2) Payer-based PHRs that are provided by insurance companies or employers of consumers; and 3) Consumer-based PHRs that are based on the voluntary storage and retrieval of health records and personal information by the consumers themselves. The focus of this study involves the latter of these three classifications.

Consumer-based PHRs can be found in two major categories: web-based and non-web-based. Non-web-based PHRs such as USB memory sticks, smartcards, CDs, etc., are similar to their off-line (paper-based) predecessors except that they are electronic. Their advantage is that consumers have complete control and ownership over them. The disadvantage is that they need to be manually updated with clinical information from other sources such as their healthcare providers (Raisinghani & Young, 2008). A web-based PHR (sometimes referred to as a portal) on the contrary is online and usually connected to one (or more) of the provider-based or payer-based systems and therefore can be updated automatically (Archer et al., 2011) with clinical data. A problem with this model is that consumers don’t have control over the data and often are not allowed to enter their own personal data. In this model, the amount and type of data which is accessible by the patient is decided by the providers/payers (Raisinghani & Young, 2008). The current study involves a modification of the portal PHR model that allows patients to track their own health status as well as to allow their physicians (with patient permission) to access certain portions of the patient-entered data.

The primary objective of this dissertation is to contribute to the information systems (IS) and healthcare literature by shedding light on the factors which directly or indirectly influence an individual’s intention to use a comprehensive health self-management support system; this system addresses the issues of self-management of chronic illnesses and empowers patients to deal with their own healthcare conditions in collaboration with their healthcare providers.

1.3 Research Questions

For ease of wording, the word “system” was used for “Comprehensive Chronic Disease Self-management Support System”. The research questions to be answered by this research are the following:

1) How do individuals’ perceptions regarding the use of the system influence their behavioural intention to use such systems?
2) How do support elements (i.e. care partner support, decision support, family and community support, and education and training) influence individual perceptions in regards to using the system?
3) How do sustainability elements (i.e. online social network, entertainment components and patient reward system) influence individual perceptions in regards to using the system?

4) How do individual characteristics such as age, gender, educational background, etc. and nationality (US vs Canada) affect the dependent variables (i.e. Performance Expectancy (PE), Effort Expectancy (EE), Hedonic Motivation (HM) and Behavioural Intention (BI)) in regards to using the system?

The main hypothesis in this research is that sustainability elements including recreational elements (e.g. games, entertaining videos, etc.), online social networks, and patient reward systems combined with support elements including continuing education & training, family and community support, decision support, and self-monitoring, can provide feedback to patients that help them to self-manage chronic illnesses. These elements can be significant factors in influencing the perceptions of users and their interest in the adoption of a chronic disease self-management system.

Since the theory of self-management systems that has been developed (Ariaeinejad & Archer, 2014b) is capable of covering almost all types of chronic illnesses, the adoption model was tested by an Internet panel of consumers with a variety of serious chronic illnesses. The adoption model will be developed in the next chapters.

1.4 Outline of the Dissertation

In this dissertation, some of the usual problems that patients with chronic illnesses face on a daily basis are described in Chapter 1. How these problems can be addressed is then discussed, by empowering the patients through self-management and self-care, or by introducing the role of a volunteer care partner who might be the patient’s spouse, other close relative, or neighbour. In this context, first a generalized framework covering all identified factors will be developed in Chapter 3. Then, based on that framework, a simplified research model will be introduced. The study will focus on self-management as well as the use of a personal decision support system (PDSS) for patients, to deal with their conditions through better education and more effective decision-making. The proposed system includes several functionalities that are built into patient PHRs, to provide decision support for patients in managing their chronic illnesses. A research model based on UTAUT2 is then introduced and the related theory is described. In Chapter 4 a revised research model based on UTAUT2 but including Support and Sustainability elements is introduced, along with related hypotheses. Chapter 5 outlines the research methodology and data collection from an Internet panel composed of equal numbers of US and Canadian citizens who have serious chronic illnesses. Analysis of the data in the context of a patient self-management model, using structural equation modelling, is described in detail in Chapter 6, along with an examination of participant responses to open-ended questions. The thesis concludes in Chapter 7 with a discussion of the study's conclusions, contributions, and limitations.

Chapter 2. Patient Disease Self-management

Disease self-management is a complex task that has four internal components (Bodenheimer et al., 2002): 1) Self-monitoring, 2) Self-care, 3) Adherence and 4) Decision Support. Each of these components has a vital role in achieving the goals of self-management. Further, there are three external components that help patients in a supportive and sustainable manner, including: 1) Family and community support, 2) Education and training and 3) Sustainability elements (Entertainment, social network, etc.). Figure 1, which I propose as a suitable conceptual model, demonstrates those components and their relationships. In the following sections, patient disease self-management along with its components will be discussed in considerable detail.

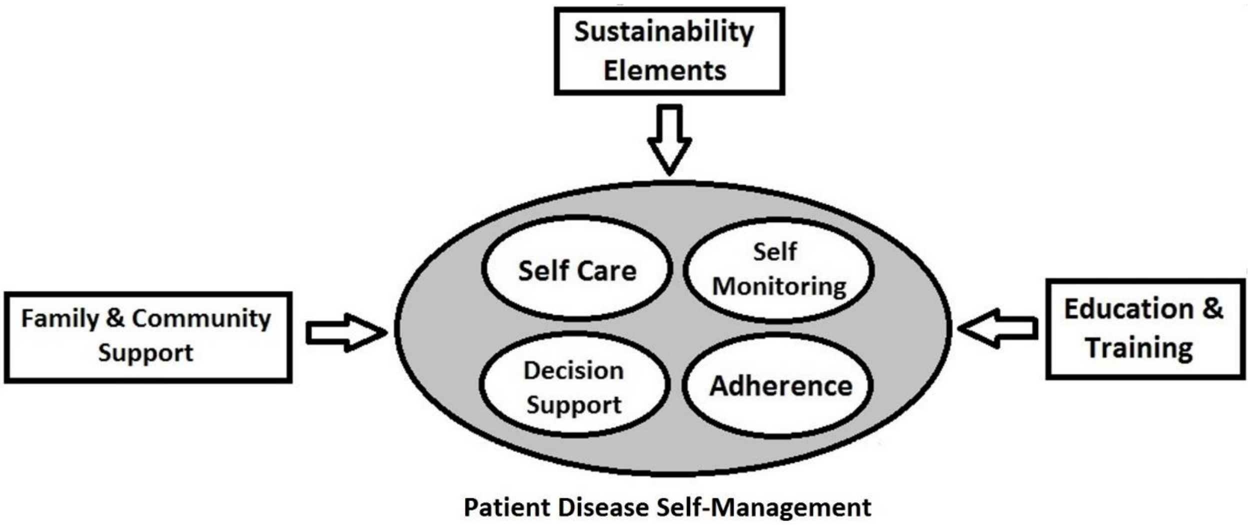

Figure 1. Proposed Patient Disease Self-management Conceptual Model

2.1 Patient Self-Management

Self-management itself (without adherence and decision support) includes three different aspects (self-management, self-monitoring, and self-care), aided by decision support activities, which are discussed below in detail.

2.1.1 Self-Management

Self-management, which is important for both disease prevention and disease management, can be directly supported by functionalities provided through PHRs. These can assist patients who frequently monitor their health and detect any critical situations or health conditions well in advance of a crisis, leading to in-time intervention (Demiris et al., 2008). The process is also cognitive, which requires continuous evaluation and recognition of the significance as well as implications of changes in conditions/symptoms, and implementation of any necessary modifications to treatment (MacIntyre, Thabane, Cranney, Cook, & Papaioannou, 2010). The process rests on patient judgment and decision-making skills, which is supported by relevant education, having suitable access to healthcare professionals, and appropriate adjustments to actions (Pogue, Thabane, Devereaux, & Yusuf, 2010).

The act (task) of self-management is described as the actual participation of the patient in the treatment process, whether it is for the daily management of a chronic disease (e.g. diabetes) or simply for activities (e.g. exercise) to promote good health through life style changes. Some specific tasks belong to the self-management category, such as: 1) medical management, which involves tasks for treating and taking care of a condition (e.g., a special diet or taking medication); 2) behaviour change, which includes adopting or creating new roles or behaviours for improving illness symptoms; and finally, 3) emotional management, which involves tasks dealing with emotions that commonly result for chronically ill patients (e.g., fear, frustration, anger, and depression) (Lorig & Holman, 2003).

Self-management goals and plans can result from close teamwork between patients and their physicians. Patients can use the plans and goals independently to make frequent daily decisions, which do not undermine their values or lifestyles and, at the same time, help to effectively manage their conditions. A systematic review of 71 trials of educational approaches to self-management for patients with chronic disease found small to modest effects in managing diabetes, hypertension, and asthma (Warsi, Wang, LaValley, Avorn, & Solomon, 2004). This suggests that education is a necessary but not a sufficient condition for effective disease self-management.

As the costs of healthcare continue to increase, with over 45% of direct expenditures for treatment of chronic diseases in Canada, self-management has become promoted as a major factor in controlling such diseases (Lorig et al., 2006). Basically, chronic diseases and related conditions must be managed on a daily basis, so that self-management and medical management of certain conditions, including management of negative emotions, are crucial aspects of health. For successful self-management, patients need to have knowledge, self-efficacy, and problem-solving skills (Lorig et al., 2006). They also need to have some means (such as PHRs) of recording data and information related to the conditions or diseases they are managing. The goal of self-management is to improve the individual's health status and health behaviour, while reducing healthcare utilization (Lorig et al., 2006). With newer technologies, like the smartphone and mobile and smart-home technologies, self-care monitoring is becoming more reliable and accessible (Linda, Townsend, & Badley, 2012).

2.1.2 Self-Care

Carlson et al. (2001) defined self-care as “an active cognitive process undertaken by a patient to maintain health or manage illness and disease.” The cognitive process can simply be to comply with a healthy lifestyle by following a recommended diet, proper exercise, and in the case of a specific disease, adhering to a prescribed medication regimen. Self-care also requires a certain amount of perception, thought, astuteness, and effort to accomplish health-oriented goals.

From another perspective (Riegel et al., 2009), self-care is defined as “a naturalistic decision-making process that patients use in the choice of behaviours that maintain physiological stability (symptom monitoring and treatment adherence) and the response to symptoms when they occur.” The authors defined a “naturalistic decision-making process” as a focus on process rather than outcomes and making decisions based on the situation, specific context, and information that is available at the moment. According to Riegel et al. (2009), self-care includes the following inter-related behaviours:

A) Complying with prescribed medication and non-prescribed (e.g. herbal) remedies: This is mainly about taking exact prescribed medication with the right dosage at the exact prescribed time. It also involves using herbal remedies as well as alternative medicine or over-the-counter medications.

B) Symptom monitoring: This involves frequent monitoring of the symptoms (see Section 3.1.3. self-monitoring) as well as taking proper action (seeking care by calling a doctor, going to the hospital, etc.) whenever a change in symptoms occurs.

C) Dietary adherence: This includes following a daily diet as instructed.

D) Alcohol restriction and smoking cessation: Cessation of smoking and alcohol restriction is a traditional factor in self-care for patients with chronic diseases. This is also recommended for preventive care for all individuals.

E) Exercise and weight loss: Having a routine and regular exercise program can help individuals lose excess weight. It effectively improves the body's oxygen delivery process and increases the anaerobic threshold. It strengthens heart muscles and improves heart rate variability. It also improves ventilatory response and blood flow. Even patients suffering from severe heart disease can benefit from special exercise programs that are tailored for their conditions.

F) Preventive behaviour: This includes common sense behaviour, such as routine hand-washing, oral and body hygiene, dental health, good night's sleep, etc.

Self-care involves decision-making, and certain factors can make this difficult for patients. Factors that may complicate decision-making or otherwise interfere with it include, for instance (Riegel et al., 2009):

A) Having multiple conditions: Having two or more diseases at the same time; for example, diabetes and heart failure, or obesity and heart failure, can contribute to complications and difficulties in making decisions concerning symptom monitoring, dietary adherence, and taking medications (Riegel & Carlson, 2002), (Riegel et al., 2009).

B) Anxiety and depression: Both anxiety, and in severe cases, depression can complicate the decision-making process when dealing with a medical condition (Riegel et al., 2009).

C) Age-related issues: Several different types of problems are related to age. For example, young patients (adolescents) might face challenges with their transition to adulthood, due to possible genetic influences or developmental problems, when self-care is a societal expectation. In contrast, older adult patients might have certain issues with self-care, especially if they are at their end of life stage, stemming from a mistaken belief that they are "too old to do this" (Albert, Buchsbaum, & Li, 2007), (Riegel et al., 2009).

D) Impaired cognition: Some chronic diseases (e.g., heart failure) might cause diminished cognition. Patients suffering from cognitive dysfunction may have less knowledge about their condition or have more difficulty caring for their own health, compared to those with intact cognitive function (Archer, Keshavjee, Demers, & Lee, 2014).

E) Sleep disturbance or poor sleep: Several reasons might explain a patient's sleep disturbance or poor sleep, such as old age or a specific disease, etc. In any case, sleep disturbances can contribute to other factors that cause difficulties in self-care or may even be the direct cause (Coltan & Altevogt, 2006), (Riegel et al., 2009).

F) Poor health literacy: According to the *Healthy People 2010* report ("Healthy people 2010 report," 2010), health literacy is defined as "the ability to read and understand appointment cards, health materials, prescription medication instructions, and to process and understand basic health information and services in order to function successfully in the patient role and to make effective health decisions." Therefore, having poor health literacy may influence a patient's ability to perform acceptable self-care.

G) Problems with the healthcare system: Patients who have a problem with one or more components of the healthcare system (e.g., with hospitals, insurers, etc.) or who have not received acceptable self-care education might not be able to perform good self-care (Riegel et al., 2009).

2.1.3 Self-Monitoring

Self-monitoring has a number of different definitions, according to various authors. Van der Meer et al. (2010) described self-monitoring in the context of asthma control as the ongoing assessment and monitoring of symptoms to determine whether or not the goals of therapy are being met. Alternatively, McManus et al. (2009) defined self-monitoring in the context of blood pressure control as occurring “when [individuals] (or care partners) measure their own blood pressure outside the clinic, at home, in the workplace, or elsewhere.”

It is inferred that in general, self-monitoring, in the context of decision support, is the continuous and ongoing assessment and monitoring of the symptoms of a certain condition (problem or disease), as well as other important factors (such as weight, sleep, etc.) at any place other than a clinic (e.g., home, workplace, etc.) by patients or their care partners (possibly family members). The data gathered from self-monitoring can be saved and evaluated (in patient PHRs) to determine whether or not the goals of therapy are being met.

Collected monitoring data can also engage patients with the self-management process by directly demonstrating trends in their health status. PHRs, as individualized repositories, can support the recording and monitoring of a patient’s health status measures, such as blood glucose, blood pressure, activity logs, weight, and stress scales (Archer et al., 2011). Health status measures can be used as input for PHR-based decision support functionalities, to provide warnings and advice to care providers, patients, or even care partners. Finally, such information, along with the treatment regimens provided by care providers, can support self-management decision-making, through daily tasks such as exercise, dieting, or the daily management of chronic disease symptoms

(D. Jones, Shipman, & Plaut, 2010). Additionally, access to clinical records maintained by their physicians can be combined with patient records to provide a more complete picture of patient health history and current status.

2.1.4 Adherence

Adherence refers to a specific behaviour of patients who accept and follow special treatment regimens ordered and prescribed by their physicians. For many chronic illnesses, the level of adherence usually declines from the time when an initial regimen is prescribed. Moreover, it has been found that close to half of all patients will not continue with their prescribed regimens beyond a year (Sidel et al., 1998). According to (Wahl, Gregoire, & Teo, 2005), the probable causes of non-adherence are:

- Complexity of treatment
- Lack of patient self-efficacy
- Lack of social support
- Lack of disease knowledge
- Availability of treatment alternatives
- Costs
- Side-effects
- Disruption of patient lifestyle

According to a 2013 comprehensive study on cardiovascular patients in US (Bitton, Choudhry, Matlin, Swanton, & Shrank, 2013), the annual cost of healthcare for these patients is surprisingly high ($475 billion US dollars). Another study (Chiatti et al., 2012) shows that lack of adherence to treatment plans and medicine, as well as drug wastage due to non-adherence and non-compliance, are estimated to be 10 to 15 billion US dollars. A decline in motivation to continue treatment would probably result in failure to achieve treatment goals (Chiatti et al., 2012). Adherence has been claimed to be one of the most important contributors to treatment success at the individual level (Loman et al., 2010).

Any lack, or decline, of motivation could directly result in a failure to achieve the goals of treatment. This could pertain to disruptions in collecting and entering monitoring data, and the irregular use of the system, but could also result from not following a treatment regimen or (equivalently) not following daily suggestions from the patient's online decision support system which would normally be a functionality supported by his/her PHR. The continuing promotion of successful adherence to self-management must, therefore, be motivated through both education (Funnell & Anderson, 2004) and other support activities.

2.1.5 Decision Support

Health self-management could be assisted by patient support from a decision support system. A decision support system (DSS) assists decision-makers in decision-making activities by compiling useful information based on raw data, treatment guidelines, acceptable ranges for patient vital signs (heart rate, blood pressure, blood sugar, etc.) and other status indicators (body weight, etc.), and by providing knowledge regarding the specific problem or set of related problems, which eventually helps the decision-maker to make a better decision (Berner, 2007).

Clinical decision support systems (CDSS) have been used for some time by physicians to assist in decision-making. A recent systematic review of chronic disease management CDSS concluded that a small majority of 55 trials showed improved care processes and some improved patient health (Roshanov, Misra, Gerstein, Garg, Sebaldt, Mackay, Weise-Kelly, Navarro, Wilczynski, Haynes, et al., 2011). In the following section, a brief review of existing CDSSs is presented, along with measures that might be useful in adapting ideas from CDSS for patient health self-management.

2.1.5.1 Existing Healthcare CDSSs

A comprehensive study of the effects of computer-based clinical decision support systems on physician performance and patient outcomes shows that such systems have an impact on patient and practitioner empowerment by providing rightful information to them and letting them make the best decisions under specific circumstances (Hunt et al., 1998). CDSS can perform complex evaluations, generate, synthesize and integrate patient-specific information, and finally provide the right results to patients/practitioners in a timely fashion, thus playing a role in today's healthcare system (Hunt et al., 1998). According to Hunt et al. (1998) there are four major categories of CDSS in healthcare including: 1) drug dosage recommendation systems, 2) diagnosis systems, 3) predictive and preventive care and recommendation systems, and 4) all other types of DSS.

Many different clinical DSS currently exist. For example, Durieux et al. (2000) developed a computer-based CDSS to provide and present guidelines to practitioners for preventing venous thromboembolism prophylaxis in an orthopedic surgery department, to empower them with appropriate clinical information and therefore aid them in making better decisions. Their results showed a significant change in the behaviour of the physicians and improved compliance with the guidelines (84%). The source of data for this and other studies was actual patients and practitioners. Other relevant studies include (Van Wyk et al., 2008) on screening and treatment of dyslipidemia, (Roy, Durieux, Gillaizeau, & Al, 2009) which assessed the effectiveness of a CDSS in a hand-held device to improve practitioner diagnosis of pulmonary embolism, and (Piazza & Goldhaber, 2009) which used a CDSS to detect a type of cardiovascular disease.

Although there have been multiple studies of CDSS and their effectiveness, these have almost invariably centred on support for healthcare providers, and very few studies of health self-management DSS have appeared. We can certainly learn from all those CDSS studies, including their measures of effectiveness, and then use that knowledge to develop a personal decision support system to help patients in making routine daily decisions. The system should also provide the users (patients) with feedback.

2.1.5.2 CDSS Measures of Effectiveness

According to several reports (Roshanov, Misra, Gerstein, Garg, Sebaldt, Mackay, Weise-Kelly, Navarro, Wilczynski, & Haynes, 2011), (Overby, Tarczy-hornoch, Hoath, Smith, & Devine, 2011), (Cleveringa et al., 2010), (Sittig et al., 2008), several important measures can be used in deciding whether or not a CDSS is effective:

A) Patient outcomes: These may include the system’s effects on biomarkers and clinical exacerbations, such as improvements or changes in blood pressure, blood glucose, etc.

B) Patient satisfaction: Measuring any elevation of the level of health-related quality of life, through validated patient questionnaires.

C) Cost-effectiveness: This is an important factor in determining the helpfulness of a CDSS. The cost/effectiveness ratio (ratio of the costs of the system to the benefits it provides) is an important factor in choosing whether to adopt a system.

D) Improvements in the care process: These refer to any improvement in diagnosis, treatment, and monitoring of disease.

E) Relationships with care provider support: The system must provide a supportive environment to improve and support the relationship between patients and care providers (e.g., physicians).

F) Relationships with caregiver support: The system must also provide a supportive environment to build, improve, and support the relationships between patients and any possible care-givers, including family members, friends, volunteers, etc.

G) Sustainability: A CDSS should have specific standards for accessibility (the degree to which the system is available and easy to access for the patients, often through the use of assistive technology), trust levels, and sponsorship (adoption by major healthcare organizations) to provide support for an appropriate business model and to ensure sustainability. Sustainability is defined in more detail in the sustainability elements section (3.4) in this thesis.

2.2 Family and Community Support

While decision support and CDSSs are important, family and community support is also very important in chronic disease self-management. The large increase in the incidence of chronic disease during the last century has shown the importance that caregivers (and care partners) can provide to patients, even though care-giving can be burdensome, stressful, and expensive (Schulz & Sherwood, 2008). As medical and technological advances have led to early detection of chronic disease, prolonged patient life spans, and reduced mortality rates, they have also resulted in patients living longer with chronic diseases and having a greater need for help from caregivers. During the course of a chronic disease, the patient's family is also affected by the disease, which can have a detrimental or even a beneficial effect, as powerful as the traditional medical risk factors (Hartmann, Bäzner, Wild, Eisler, & Herzog, 2010).

The patient's family can influence the course of a disease in several ways (Hartmann et al., 2010):

a) Family members can be involved with the patient's disease management, and the way in which they respond to the disease can influence the patient's self-care behaviour.

b) The patient's physiological system can be directly affected by the family's emotional climate.

Consequently, interest has been growing on how to improve not only the patient's somatic (physical) health, but also how to reduce the family's mental and emotional problems (which can negatively affect the patient and the family members). Active involvement of at least one family member in the disease management and treatment process can be the key to achieving successful psychosocial intervention (Hartmann et al., 2010).

Furthermore, community support (relatives, friends, etc.) can also be an important factor in providing help and support for chronically ill patients. In a study of 22 quantitative and 7 qualitative journal articles examining the relationship between social community support and the well-being of chronically ill patients, community support seemed to have a positive relationship with chronic illness self-management (Gallant, 2003). Patient dietary behaviours were especially subject to change under the influence of the patient's social network (Gallant, 2003). The general conclusion is that special attention needs to be paid to the social network of chronically ill patients.

Therefore, including the help and support of a family care partner as well as the community (relatives, friends, etc.) will assist in the achievement of the goals of treatment. This could pertain not only to helping patients with their daily routine and the regular use of the system, but could also refer to encouraging the patient to follow a prescribed treatment regimen.

2.3 Education and Training

In the early days of self-management, support was focused mainly on providing information. Subsequently, educational interventions were shown to affect patient knowledge but not self-care behaviour, and education was seen to be necessary but not sufficient for behaviour change. Behaviour, in relation to self-management, was found to be affected by several other elements such as social support, motivation, environmental obstacles, emotional adjustment to diagnosis, self-management skills, self-efficacy, feedback, and patient follow up (Pearson, Mattke, Shaw, & Ridgely, 2007). A direct relationship has been found between a person's current health status and awareness, health literacy, and his/her ongoing and related decision-making. In particular, increased awareness of the complications of a health problem is related to improved decision-making (Tang et al., 2008), especially in cases of chronic disease (Levey & Powe, 2008).

In a study by Wiltshire et al. (Wiltshire, Roberts, Brown, & Sarto, 2009) of almost 20,000 American adults, the impact of socioeconomic status (education and poverty) on the likelihood that patients would seek health information and then actually use it during medical encounters was investigated. The authors found that higher levels of education resulted in an increase in searching online for health information, and discussion of that information during physician encounters. The results of the study emphasize the importance of education in acquiring and using health information, and the importance of education and training in enabling chronic disease self-management.

Although self-management education may lead to small, short-term improvements in patient self-efficacy, self-rated health, cognitive symptom management, and frequency of aerobic exercise, no evidence currently suggests that programs that are limited to education improve longer-term psychological health, symptoms, or health-related quality of life, nor do they significantly alter healthcare use (Effing et al., 2009).

Therefore, it is inferred that self-management education should be combined with on-going training and retraining as well as other types of motivators which keep the patients interested in following the guidelines and adhering to treatment regimens in the long run.

2.4 Sustainability Elements

Chronic diseases are the largest cause of death globally (led by cardiovascular disease) and they cause huge economic and epidemiological impacts on healthcare systems. However, almost all types of chronic diseases (e.g. cancer, heart failure, diabetes, asthma, etc.) share some key risk factors such as unhealthy diets, tobacco and excessive alcohol use, and lack of physical activity. Controlling and reducing these risk factors can result in less pressure on the healthcare system, which in most cases is designed for acute illnesses. Chronic disease prevention would also help a great deal; however, patients who have already developed one or more serious chronic diseases are causing the most pressure on healthcare system resources (Yach et al, 2004).

Different types of care plans and specialized chronic disease treatment programs have been developed to deal with chronic disease (with most successful results being achieved through the Chronic Care Model (CCM)). Moreover, the continuing usage of these care plans and programs is the key to successful coping with chronic illnesses (Yach et al, 2004). The problem is that studies have shown (Daar et al., 2007), (Bailie, Robinson, Kondalsamy-Chennakesavan, Halpin, & Wang,

2006) that patients seemingly lose interest and motivation in continuing adherence to their treatments, due to many different issues.

Unfortunately, the growing burden of chronic diseases threatens the sustainability of health care systems everywhere. Therefore, a new approach to improve the continuous delivery of primary care services for chronic diseases and ensure the sustainability of care is needed (Russell et al., 2009). However, sustainability in delivering long term effective treatment and care for chronic illnesses is widely known to be a major challenge (Wagner et al., 2001). Sustainability, as defined by Loman et al. was: "*the continued implementation of a practice at a level of fidelity that continues to produce intended benefits*," therefore became a desired goal for successful health interventions (Loman et al., 2010) Page 179.

A comprehensive study (Tsai, Morton, Mangione, & Keeler, 2005) shows that sustainability in adhering to treatment plans that have one or more elements of CCM have had beneficial effects on processes of care and clinical outcomes, and the results were consistent across a variety of chronic illnesses. Moreover, another more recent comprehensive study of the chronic care model (Coleman, Austin, Brach, & Wagner, 2009) shows the effectiveness of CCM and its sustainability in delivering chronic care.

Russell et al. (2009) (Russell et al., 2009) emphasized the role of nurse practitioners within primary care teams and validated the contributions of community health centers in sustaining chronic care. Furthermore, a fairly recent study (2010) on the barriers and facilitators of sustainability for both patients and providers (Palinkas, Ell, Hansen, Cabassa, & Wells, 2010) (in the case of a *Multi-faceted Depression and Diabetes Program*) provides eight themes in the form of two categories of barriers and facilitators as well as some recommendations:

- **Barriers:** 1) patient concerns about use of medication, 2) provider concerns about use of psychotherapy, 3) increased workload for clinic staff, 4) delay in receiving outcomes data, and 5) lack of resources to sustain the program.
- **Facilitators**: 1) patient benefits: improved clinical outcomes, quality of care received, access and satisfaction; 2) provider benefits: increased awareness and reduced anxiety, and 3) clinical benefits in the form of reduced costs of care.
- **Recommendations**: 1) changes in communication patterns among providers, 2) specific changes in procedures, 3) changes in resources, and 4) changes in clinic organizational cultures.

In the current study, special attention is paid to the use of CCM, nursing support, community support, family care partner support, educational tools, and programs to ensure adherence and sustainability. The barriers and facilitators of sustainability (discussed above) are also taken into account. Attention is be given to the motivation of patients to continue adherence to their treatment plans. Two new components, social media and recreational games and simulations, will be especially designed for the purpose of increasing the motivation of patients to adopt and to continue using the health self-management system.

There is concrete evidence (discussed in the next three sections) that online social networks, entertainment components, and real financial incentives are three important factors that can result in an increase in user motivation to continue using a system. In this study, a specially-designed web-based social network which connects patients to their care partners, family members, and friends seems promising in providing social support and keeping patients motivated to use the system for disease self-management. This would provide intrinsic motivation as well as extrinsic motivation in the form of certain financial rewards. Rewards could include a range of different things such as permission to watch a funny video, a gift card, etc. The social network could also be used for educational purposes. Moreover, online interactive games can be used for the same purpose.

2.4.1 Online Social Networks

The comprehensive set of Internet-based and online communication tools known as social media (e.g. Facebook) offer a range of cost-effective and easy access to online communications to a large number of people all across the planet. These media have a collaborative and participative nature which can provide different types of services for the users such as two-way mobile messaging, collaborative content development, blogs and wikis, development of communities of interest with others having similar problems, and even Internet-based phones (VoIP). The potential of using social media in health promotion activities has been recognized by healthcare professionals to be effective for health promotion, as well as being able to reach a broader range of audiences (Korda & Itani, 2011).

A recent comprehensive research shows that almost half of the world's population are online and among them 96% of Koreans, 78% of UK citizens and 56% of Americans not only use the Internet but also have access to high speed Internet. Among the applications used, after email and search engines, the most popular online activities for adults were using social media (Kuss, Griffiths, Karila, & Billieux, 2014). Further, many reports show a high level of penetration of social media among Canadians (Hermida, Fletcher, Korell, & Logan, 2012), (Duff, Johnson, & Cherry, 2013). Therefore, using social media as a channel for health promotion seems to be promising. Studies of the effects of social media on health promotion have been limited, although some recent studies have shown that social media can in fact encourage health behaviour change and therefore cause health improvements. Some specific approaches seem to be more effective than others in addressing long-term or short-term goals (Fox & Jones, 2011).

Furthermore, the reason users spend so much time on social media comes from two types of motivations: intrinsic motivation, driven by an intense involvement and interest in the activity itself, providing a personal sense of challenge, enjoyment, curiosity, accomplishment or belonging and peer recognition; and extrinsic motivation, which is driven by the desire to achieve some specific external reward which is apart from the activity itself, such as deadlines, money, directives, expected evaluation, threats, surveillance, competition pressure or job promotion (Kietzmann, Silvestre, Mccarthy, & Pitt, 2012). For instance, a study of patients with diabetes showed that patients used an online social network (i.e. Facebook) to receive disease specific knowledge and emotional support from their peers as well as their friends and family members. It showed that almost 15% of the posts on the online social network concerned receiving information, 30% of the posts were an effort to emotionally support other patients with similar conditions, and almost 27% of posts featured some type of promotional activity, advertising some type of non-medically-approved “natural” products (Greene, Choudhry, Kilabuk, & Shrank, 2011).

2.4.2 Entertainment Components

Online entertainment such as online games, entertaining videos, etc. seems to be effective in raising motivation to continue using a system. For instance, interactive games are fun to play and can often motivate certain players to keep spending time on them. About 60% of all Americans over the age of six play computer games and spend more time playing games than on any other computer related activity at home (Lieberman, 2001). Computer games as well as video games are effective, powerful, and engaging media that can motivate health behaviour change. Games that have interactive capabilities can contribute to experiential learning and can be used to serve as powerful health promotion tools (Lieberman, 2001). The concept of serious games or using games for serious purposes has been introduced almost from the time that interactive games began to be successful in the game market (Lieberman, 2009).

Games and simulations can have positive learning and motivational outcomes in various situations. The knowledge and skills developed by learners in these circumstances include the development of the learner's capacity to refer to concepts, definitions, and theories acquired beforehand and to apply them to concrete situations during simulations. Simulation tends to support the consolidation of knowledge through repetition and variability of actions (Sauvé, Renaud, & Kaufman, 2010). Simulations designed specifically for self-management can support the development of a range of problem-solving skills. These include the ability to collect the necessary information for solving the presented problem, identifying common experiences, analyzing and identifying applicable questions, and making decisions that convert knowledge into practice. Further, reports show that video games are extremely popular in the US as 67% or Americans play video games (Entertainment Softare Association, 2010). Upwards of 40% of American adults and 80% of teenagers play video games and statistics show that adults above 30 years of age who play video games, may continue playing for the rest of their lives (Williams, Yee, & Caplan, 2008), which is most probably true for Canadians as well. Moreover, both quantitative and qualitative data on playing video games show that time loss due to this phenomenon is independent of age and gender (Wood, Griffin, & Parke, 2007).

There are several success stories in the design and implementation of serious games. For instance, Albright et al. (2012) examined the effectiveness of a game, ‘‘Family of Heroes,’’ in increasing family engagement in motivating their veterans in stress and resiliency training, in cases where veterans exhibited signs of suicide ideation, depression, post-traumatic stress disorder and post-deployment stress. Their results showed significant success in using the game as an effective tool to engage families in taking an active role in the treatment process as well as motivating veterans to seek help and deal with their stress better. Another example is Federico's work (2012) (Frederico, 2012). She queried registered dietitians about their recommendations and experience for age, topics and platforms for the development of a nutrition game. Her results show that registered dietitians are open to using nutrition games and education apps. They feel that they could benefit from educating the public about nutrition by using such games.

Lu et al. (2012) were among the first to study and analyze the role of stories in health videogames among children. Their results showed that perceived similarity between the players and videogame characters resulted in an enhanced immersion by the players as well as several positive health outcomes. Interactive health videogames could therefore be important when motivating children to adopt prevention behaviours for improved health. Finally, Ferguson (2012) discussed the process through which a serious game is designed and implemented. He strongly believes that health games have a huge impact on the cost, effectiveness and availability of both preventive and remedial health care and wellbeing of people.

In the case of patient motivation, if game play is self-motivating and successful, it promotes the achievement of specific learning and recreational outcomes. Moreover, it is proposed that a properly designed system encourages patients to develop the habit of accessing the online system to play recreational games and get in contact with friends. In turn, this is expected to promote adherence and long-term sustainability of patient self-management programs (Ariaeinejad, Sayyedi Viand, Demers, & Archer, 2012). Further, it is anticipated that entertaining videos can also have a good motivational influence on patients with chronic conditions to use the system. For example, one study used entertaining videos to motivate students with disabilities to learn how to operate an iPod (Kagohara, 2011). It is anticipated that entertaining material such as videos should have the same motivational effect on patients.

2.4.3 Patient Reward Systems

According to different studies (Dawkins, Powell, Pickering, Powell, & West, 2009), (Mason, Street, & Watts, 2010), (Garavan & Weierstall, 2012) rewards and incentives provide a strong motivation for behaviour change. Therefore, a type of reward system will be incorporated into our proposed system in order to provide real financial incentive for the patients. Patients will collect points by regularly using the system and those points will be transformed to gift cards, movie theatre tickets, etc. when they hit a certain limit.

Chapter 3. Theoretical Framework

The objective of this research is to test and understand user perceptions of a prototype design for a full system that will support chronically ill patients to self-manage their conditions. The system will also help us (the researchers) to understand how patients perceive support in their health self-management and self-care tasks, and whether they would like to keep using the proposed system and thereby elevate their quality of life (Ariaeinejad et al., 2012). In the following sections, first the importance of contextualizing theory in IS research, and how a context-specific theory should be developed will be discussed. Then based on that, the theory for this study will be developed.

3.1 Importance of Contextualizing Theory

In developing a new IS theory, generalizability to different settings is important for both research and practice (Hong, Chan, Thong, Chasalow, & Dhillon, 2014). Generally, parsimonious theories which provide reasonable levels of predictive and explanatory power are much more favoured (Charmaz, 2014). However, the need for more practical relevance and richness in IS research has been the reason for more contextualization of the theories in this field. That's the reason that in theory development, the significance of context has received much attention in recent years (Hong et al., 2014).

According to (Johns, 2006) Page 386, context is defined as "*situational opportunities and constraints that affect the occurrence and meaning of organizational behaviour as well as functional relationships between variables*". Although a variety of contextual features such as user characteristics, task types, technology characteristics, and organizational factors has been examined by different studies, most of them were studied in isolation and not collectively. Hence there is a need for a more systematic approach for contextualization in IS research (Hong et al., 2014).

In this research, in order to contextualize the chosen adoption model to the specific research context, the relevant core constructs of the model need to be captured and more exploration is needed on the assumptions and boundaries of the model by adding more relevant context-specific constructs to the model (Hong et al., 2014). Hong et al. (2014) have suggested the following guidelines in order to contextualize a chosen model to the specific context of the research:

1) The research should be grounded in a general theory (model)
2) The grounded theory should be contextualized and refined to be suitable for the context of the research
3) The theory should be thoroughly evaluated to identify the context-specific factors
4) Any identified context specific factors should be modeled
5) The interplay between technology artefact and other factors should be examined
6) Other alternative context-specific models should be examined

3.2 Theory Development and Contextualization

The *Technology Acceptance Model* (TAM) (Davis et al., 1989) is a well-known theory that models how users come to accept a new technology. TAM suggests that when users are presented with a new technology, the user's perceived view of that technology (i.e. perceived ease of use and perceived usefulness) is an essential determinant to user acceptance. According to Davis et al. (1989), perceived usefulness (PU) is "the degree to which a person believes that using a particular system would enhance his or her job performance", and perceived ease-of-use (PEoU) is "the degree to which a person believes that using a particular system would be free from effort".

TAM has been continuously studied, used, and expanded during the past decades in order to explain the behavioural intension of users for adoption and use of a new technology. Moreover, many modified versions of TAM have been developed, including TAM 2 (Venkatesh & Davis, 2000), the *Unified Theory of Acceptance and Use of Technology* or UTAUT (Venkatesh, Morris, Davis, & Davis, 2003) and TAM 3 (Venkatesh & Bala, 2008) for the same purpose. Each of these models proves the effectiveness of the two major determinants Perceived Ease of Use (PEoU) and Perceived Usefulness (PU) (equivalent to effort expectancy and performance expectancy respectively in UTAUT (Venkatesh & Bala, 2008)) in the acceptance and usage prediction of a new technology. In UTAUT, social influence and facilitating conditions are other influential factors that could influence the adoption and use of a new technology where age, gender and experience of the users are moderators of these influential factors (Venkatesh, Morris, Davis, & Davis, 2003). These theories are perfectly suitable to be used for predicting the adoption of a new system and it is intended in this research to choose the one which is the most relevant to its context.

Following the first two guidelines of Hong et al. (2014) (section 3.1), UTAUT2 has been chosen to guide the development of a context-specific model for this research. After a longitudinal study of the various factors and variables that influence user adoption and use of a new technology, Venkatesh et al. (Venkatesh et al., 2012) introduced the second version of the *Unified Theory of Acceptance and Use of Technology* (UTAUT2) by adding three important constructs (hedonic motivation, price value and habit) to the original UTAUT constructs (performance expectancy, effort expectancy, social influence and facilitating conditions). UTAUT2 also inherited all three moderator variables (age, gender and experience) from the original UTAUT. Figure 2 demonstrates the resulting UTAUT2 model.

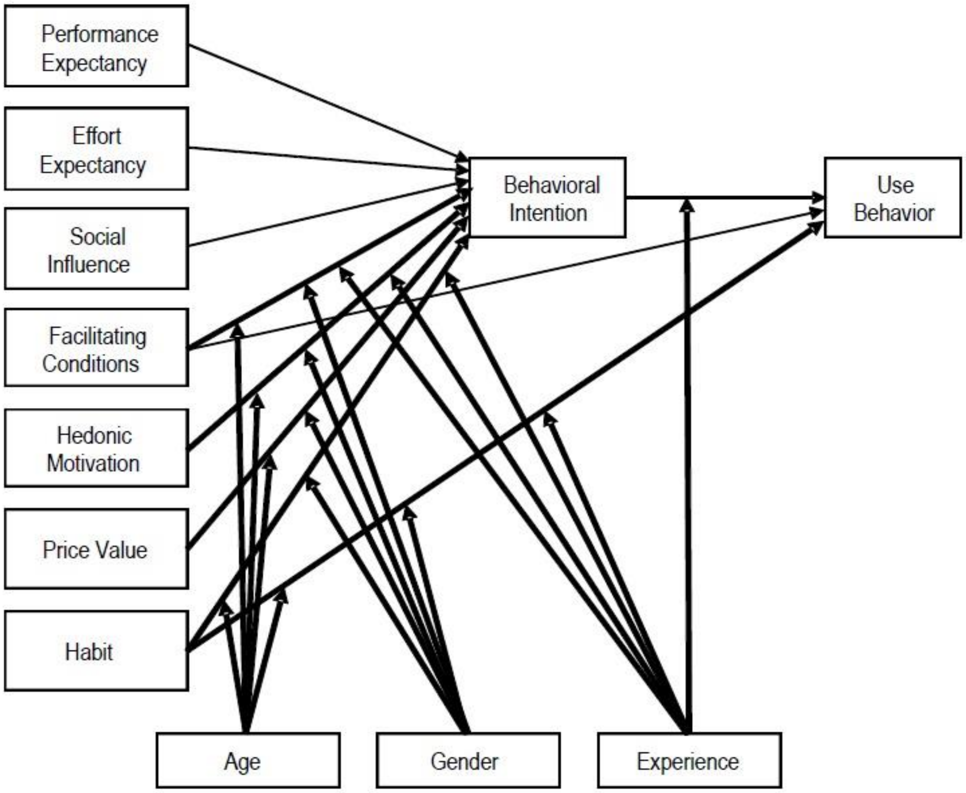

Figure 2. The UTAUT2 Model [adapted from (Venkatesh et al., 2012)]

Venkatesh et al. (2012) Page 161, defined hedonic motivation as "*the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use*". Research has found that such hedonic motivation directly influences technology acceptance and use and is an important determinant in this context. Therefore, it is important that hedonic motivation be considered in this research as a predictor of user intention to use a new technology (Venkatesh et al., 2012). Since sustainability elements in the proposed research have a strong role in stimulating users to adopt and use the system, it seems reasonable to adapt the UTAUT2 model as a basis of adoption for the study. Further, The UTAUT2 model has been tested through a longitudinal empirical study and has been proven to be a robust predictor of information system adoption as well as usage continuance behaviour (Venkatesh et al., 2012). UTAUT and its related predecessors (TAM, etc.) have been applied in a large number of technologies in various settings with successful results (Brown, Dennis, & Venkatesh, 2010). UTAUT2, as an adoption model, explains that what leads to the adoption of a new technology are mainly beliefs about performance of the new technology, the effort that users need to adopt and use the system as well as other factors that influence adoption (e.g. Hedonic motivation, Habit, etc.). However, it is not exactly clear what influences these beliefs themselves (Venkatesh et al., 2012), (Brown et al., 2010). To the best of our knowledge, this model has not been applied in the health self-management context so far, which is one of the contributions of this research.

Brown et al. (2010) have shown that the UTAUT model as a whole could be a mediator between user beliefs and actual use behaviour. They developed a framework that relates some constructs that are believed to influence these beliefs as antecedents of the key constructs (Performance Expectancy, Effort Expectancy, etc.) of the UTAUT model. Their results on various studies using that model show that this approach is reliable and valid (Brown et al., 2010). Since UTAUT2 is not dramatically different from its predecessor (UTAUT), it can be inferred that the above-mentioned approach (Brown et al., 2010) is consistent with the UTAUT2 model too.

Following the third guideline by Hong et al. (2014) (section 3.1), we explore what would influence the user's beliefs to adopt and use the system. In this research, what supposedly influences potential user beliefs is a set of facilitators provided by the proposed system. These facilitators are divided into two categories: Support Elements and Sustainability Elements. The first category, "Support Elements", includes care provider support, decision support, family and community support, and education and training (Ariaeinejad & Archer, 2014a). All of these major factors influence the performance expectancy of the system in some way. They also affect user satisfaction with the system indirectly. Therefore all of them are included in the proposed framework of the system. The second category, "Sustainability Elements", includes online social network and entertainment components (e.g. entertaining videos, games, etc.) and a patient reward system (Ariaeinejad & Archer, 2014a). These factors affect the hedonic motivation of users to adopt and to continue using the system.

Following the fourth and fifth guidelines by Hong et al. (2014) (section 3.1), the direct effect of the support and sustainability factors and the addition of relevant constructs to the theoretical framework are proposed. Thus, there is an opportunity to test a full model along with those facilitators that are believed to influence the users in the sense of performance expectancy as well as hedonic motivation. Figure 3 demonstrates the proposed adoption model. It is important to note in the model that both support and sustainability elements are considered to be different aspects of "Technology Characteristics" in the Brown et al. (2010) model. Finally, following the sixth guideline of Hong et al. (2014), a saturation analysis (in chapter 6) will be performed to see whether any other alternative relations exist.

However, since support and sustainability elements are considered to affect Performance Expectancy, Effort Expectancy and Hedonic Motivation, it will simplify the model even further to contextualize the model and tailor it towards the purpose of this research (Hong et al., 2014) by eliminating Social Influence, Facilitating Conditions, and Habit constructs. The simplified model will be discussed in more detail in the next chapter.

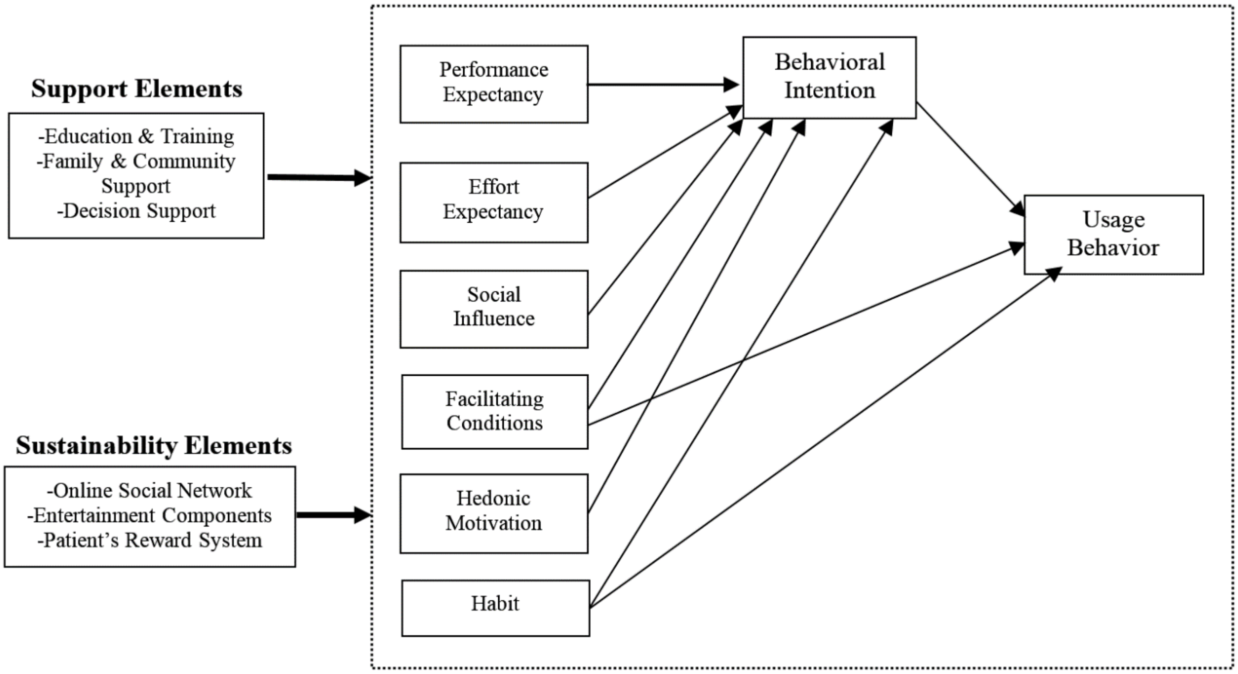

Figure 3. Proposed Framework for System Adoption

Chapter 4. Research Model and Hypotheses

As this research has shown, there is currently a lack of a generally accepted framework that suits the self-management of all types of chronic diseases. In addition, most of the current models are specifically designed for one type of chronic disease. A review of Bourbeau and Nault's work (Bourbeau & Nault, 2007) provides a list of key components of a successful framework for chronic disease self-management. They suggest a patient oriented approach as a means of success for patient self-management. However, employing new technologies such as social networks, online decision support systems, etc. may significantly improve the effects of those components. Table 1 demonstrates the suggested patient empowerment components by Bourbeau and Nault (Bourbeau & Nault, 2007) as well as those proposed by this study.

Table 1. Comparison of (Bourbeau & Nault, 2007) **and The Proposed Study**

Self-Management Support Components	Bourbeau and Nault	Proposed Study
Strong Patient Oriented Approach	X	X
Education and Training (both physicians and patients)	X	X
Individual & Group Action Plans (CCM)	X	X
Care Partner Support		X
Online Decision Support		X
Online Social Network Support		X
Entertainment Components		X
Patient Reward System		X

This study presents a conceptual model of a system for chronic disease self-management, integrated with a simplified personal decision support system, an online social network, and some entertainment components. The assertion is that the combination of continuing educational games and simulations with decision support empowers patients to monitor their status regularly and potentially make appropriate changes in their behaviour. Feedback from the system (Ariaeinejad et al., 2012) can be a significant factor in motivating patients to successfully self-manage chronic diseases, thereby improving long term system sustainability. However, considering the variety of factors that are involved in the proposed model, it is not feasible to test every aspect of the model in a single study. Moreover, it is better to simplify the research model to the specific context of the research (Hong et al., 2014). Therefore, the research model was simplified in order to test it properly in a single study. Figure 4 demonstrates the simplified research model.

As shown in Figure 4, there are three constructs that have been removed from the model: Social Influence, Facilitating Conditions and Habit. Habit and Facilitating Conditions have no relevance to the type of study that has been performed. Social Influence has been removed since this study is focusing on support and sustainability elements and their effect on the model. Even though Social Influence seems to be relevant, since none of the support and sustainability elements have any hypothesized effect on it, it was decided to remove it from the study.

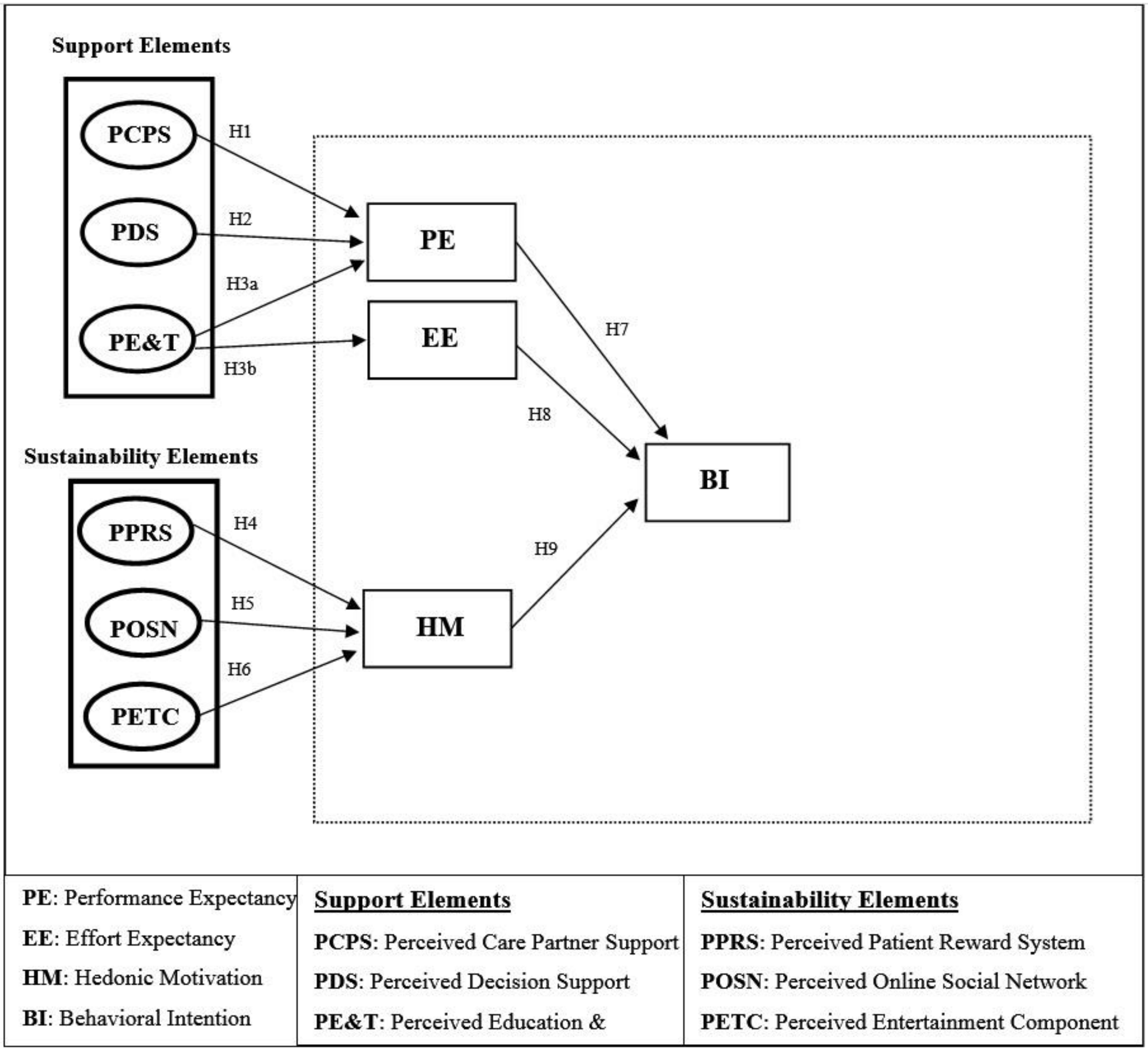

Figure 4. Simplified Research Model

4.1 Support Elements

As demonstrated in Figure 4, there are three support elements: perceived decision support, perceived education & training, and perceived care-partner support. The pre-validated instruments for measuring them are adapted from previous validated studies (Archer et al., 2011) & (Pavlou, 2003).

4.1.1 Perceived Care Partner Support (PCPS)

Several studies support this type of intervention. For instance, (Molloy, Johnston, & Witham, 2005) studied family involvement for patients with heart failure. Their results showed improvements in health and emotions, and a decrease in mortality among patients. Furthermore, (Campbell et al., 2007) studied African American survivors of prostate cancer. The authors developed a telephone-based educational program for coping with the treatment and side-effects of the disease by patients and, more importantly, their intimate partners. Their results showed that the program significantly improved the coping skills of the patients and their partners, confirming the role of a family partner in helping to manage the disease and its treatment.

Moreover, (Hartmann et al., 2010) performed a conclusive meta-analysis study on family involvement in a variety of diseases including stroke, cancer, diabetes, and arthritis. Their results showed that family involvement in the treatment process led to significantly better outcomes, compared to the standard treatment process, both physically and emotionally.

Involvement of a family member as a care partner will help the patient in different ways. For instance, in cases that a patient has cognitive issues, care partners will help patients with their daily system data entry task. In extreme cases, care partners can take over the task of data entry completely. Care partners can also be helpful in motivating patients to adhere to their treatment regimens. Therefore, the inclusion of a care partner can have a positive effect on the success of the system.

In the case of care partner support, family care partners often provide much of the homecare for patients with some chronic diseases (e.g. cancer, dementia, etc.). Usually, the informal costs of care (e.g. emotional costs) provided by the care partner are higher than formal costs (e.g. time, money, etc.) to the healthcare system. Special types of interventions that enable care partners to support patients with chronic diseases may improve the quality of life for care recipients and also reduce the cost of care (Nichols et al., 2008). As discussed, a family care partner has an important role in empowerment of the patient to use the system (hence, the system will be more useful for them) as well as to motivate the patients to use the system by helping them use it. Therefore, it is hypothesized that:

H1: *Perceived usefulness of care partner support has a positive influence on user perceptions of the performance expectancy of the system*.

4.1.2 Perceived Decision Support (PDS)

The degree of deployment of decision support tools is one of the measures of support in decision making (Lai, 1994). As discussed earlier (in section 3.5), decision support is an important factor in patient health self-management. However, the hypotheses that are tested here relate to the impact of decision support on the performance expectancy of the system.

Interpretability and transparency are two desirable features of a decision support system. Research has shown that acceptance of decision support systems is closely related to the usefulness of recommendations made by the system. In the case of medical decision support, where the decisions may have serious impacts and consequences on the user's health, it is crucial that users have confidence in the decision support that they receive. More transparent and interpretable recommendations improve the usefulness of the system considerably and in turn the system becomes more acceptable by the users (Doyle, Cunningham, & Walsh, 2006).

On the other hand, as their strong influence in the technology adoption model (TAM) shows, Performance Expectancy is one of the main considerations of users in adopting a new technology. Understanding the antecedents of performance expectancy is an important key in determining acceptance and use (Venkatesh & Davis, 1996).

Therefore, it is hypothesized that:

H2: *Perceived usefulness of decision support has a positive influence on user perceptions of the performance expectancy of the system*.

4.1.3 Perceived Education and Training (PEAT)

Bandura's social cognitive theory (Bandura, 1986), distinguishes two types of experiential learning conditions: enactive mastery (EM) and vicarious experience (VE). The former refers to "actively performing a specific task during experiential training" while the latter refers to "viewing another person actively performing the task". According to Luse et al. (Luse, Mennecke, & Townsend, 2013) experience can have a substantial impact on the perceptions of users about the necessary effort that should be expended in order to learn and use a product. Luse et al. (2013) explain that effort expectancy in UTAUT model is built upon social cognitive theory (Bandura, 1986) and is related to efficacy beliefs and influences the determination of an outcome expectancy. They also explain that individual motivation as well as expectation from a new technology differs based on the effect of the training context as well as greater influencing perceptions and behaviour related to the training environment, which leads to beneficial outcomes such as system adoption and use behaviour.

Performance expectancy is determined by a match between the person’s needs and the technology’s capabilities (Luse et al., 2013), since it is an outcome belief (Teasdale, 1978). Therefore, educating users about what to expect from the system seems to directly influence those outcome beliefs (performance expectancy). Therefore, it is hypothesized that:

H3a: *Perceived education and training has a positive influence on user perceptions of the performance expectancy of the system*.

Furthermore, according to the *Extended Theory of Planned Behaviour* (Pavlou & Fygenson, 2006), behavioural intention is the most influential factor to predict actual behaviour and *Perceived Behavioural Control* (PBC) has a direct influence on behavioural intention. Perceived behavioural control is a “*set of control beliefs and their perceived power to facilitate or inhibit the performance of a behaviour*” (Pavlou & Fygenson, 2006) Page 117, and is defined as “*person's perception of how easy or difficult it would be to carry out a behaviour*” (Pavlou & Fygenson, 2006) Page 119, which is similar to *Effort Expectancy* (EE) in the UTAUT2 Model (Venkatesh et al., 2012). In this case, those beliefs (EE) are directly influenced by education and training, since users learn what the components and features of the system are, where they are located and how easy it is to use them in an effective manner. Therefore, it is hypothesized that:

H3b: *Perceived education and training has a negative influence on user perceptions of the effort expectancy of the system*.

4.2 Sustainability Elements

Sustainability elements are those which are offered by the system as a package to the patients/users. Online social networks, entertainment components and a patient reward system are all important factors that impact hedonic motivations of the patients to adopt and to continue using the system. Instruments to measure these sub-constructs were also developed based on the construct used by (Venkatesh, Morris, Davis, & Davis, 2003) and (Venkatesh et al., 2012).

4.2.1 Perceived Patient Reward System (PPRS)

In one study (Mason et al., 2010), the relationships between financial incentives and performance of crowds in two different experiments were investigated. Their results confirm that increased financial incentives increase the quantity of work performed by participants. In another study, Garavan et al. studied the neurobiology of reward processes and cognitive control and then addressed the effective role of the reward in behaviour change for the treatment of addiction (Garavan & Weierstall, 2012). Their results also clearly confirm the effectiveness of rewards in a successful recovery from addiction. Therefore, it is hypothesized that:

H4: *Perceived patient rewards system has a positive influence on user hedonic motivation to adopt and use the system*.

4.2.2 Perceived Online Social Networks (POSN)

As explained earlier in section 2.4.1, the reason users spend so much time on social media comes from two types of motivations: intrinsic motivation which provides a personal sense of challenge, enjoyment, curiosity, accomplishment or belonging and peer recognition; and extrinsic motivation, which is expected evaluation, threats, surveillance, competition pressure, etc. (Kietzmann et al., 2012).

Using social media (i.e. an online social network) will help to stimulate and, at the same time, foster both intrinsic and extrinsic motivation. In turn, continuing use of the system will tend to raise the level of patient hedonic motivation by increasing enjoyment of the system. Therefore, it is hypothesized that:

H5: *Perceived online social networking has a positive influence on user hedonic motivations to adopt and use the system*.

4.2.3 Perceived Entertainment Components (PETC)

Venkatesh et al. (Venkatesh et al., 2003) explains that intrinsic and extrinsic motivations are critical factors in behavioural usage intention of users towards a new technology. According to *Motivation Theory*, there are different approaches towards motivation: cognitive, physiological, social and behavioural, which can be divided into two specific types: Intrinsic and Extrinsic Motivation (Cofer & Appley, 1964).

Intrinsic motivation refers to a type of motivation that is driven by an enjoyment or interest within the task itself, rather than relying on any external pressure. It exists within an individual, and is basically an internal stimulant to perform a certain task based on taking pleasure in an activity such as a game rather than working towards an external reward. Extrinsic motivation, on the other hand, refers to performing an activity for the purpose of attaining an outcome, such as a reward. It comes from outside of the individual, and is therefore considered to be an external stimulant. Such rewards could be grades, social status or money, or even threat of punishment (Wigfield, Guthrie, Tonks, Perencevich, & Taylor, 2004).

Moreover, as previously explained in section 2.4.2 of this document, game playing seems to be effective in encouraging users to develop the habit of accessing the system to play recreational games by fostering their intrinsic motivations and in turn, raising their level of hedonic towards the system. Thus it is expected that the resulting higher level of hedonic motivation will promote adherence and long-term sustainability of patient self-management programs. Therefore, it is hypothesized that:

H6: *Perceived entertainment components have a positive influence on user hedonic motivations to adopt and use the system.*

4.3 Dependent Variables of the Model

4.3.1 Performance Expectancy (PE)

According to a variety of theories such as TAM (Davis et al., 1989), Performance Expectancy (or Perceived Usefulness) is defined as the degree to which an individual believes that using a certain technology would help him/her perform his/her job better. The performance expectancy (perceived usefulness) construct has been validated through a variety of studies in the past such as (Davis et al., 1989), (Venkatesh et al., 2003), (Lu, Yao, & Yu, 2005), and it has been found to have a positive influence on the intention of users to adopt a new technology.

Furthermore, the performance expectancy (PE) construct has garnered an enormous amount of support from (Agarwal & Prasad, 1998), (Lu et al., 2005) and many more. They consistently reported that perceived usefulness has a significant positive influence on the user's perception of how useful the system is, and therefore it affects the satisfaction users derive from the system's help to perform their job better. PE reinforces the behavioural intent for adoption (Ramayah & Ignatius, 2005). Furthermore, according to a recent healthcare-related study (J. Jones, Cassie, Thompson, Atherton, & Leslie, 2014), cardiac patients' perceptions of usefulness had a direct influence on their decision whether to adopt an Internet-based healthcare information delivery system, which is very much in line with this study. Therefore, it is expected that in our research model, PE will significantly affect the behavioural intention of users which in turn will result in the adoption and acceptance of the system. Thus, it is hypothesized that:

H7: *Performance expectancy will have a positive influence on the behavioural intentions of users to adopt and use the system.*

4.3.2 Effort Expectancy (EE)

According to Davis (Davis, 1989), even though people may find an application useful, they may think that the performance benefits of usage are out-weighed by the effort of using the application. In other words, the application might be very useful, but at the same time, very difficult to use. This indicates that effort expectancy (perceived ease of use) is closely associated with the user friendliness of the system (Ramayah & Ignatius, 2005). If the users find the system difficult to use, they might not decide to use it or at very least they won't continue to use it. Poorly designed user interfaces can potentially harm the effort expectancy of the users and in turn the behavioural use intention of the system.

Furthermore, a number of studies (Venkatesh et al., 2003) have reported the negative influence of ease of use on the behavioural use intention of the users. Moreover, the results of a healthcare-related study (Calvin et al., 2011) show that patients are more likely to accept a new healthcare-related technology and perceive it as useful if they feel that it is easy to use and not much effort is need to get the benefits of the technology. Thus, it is expected that user effort expectancy (perceived ease of use by the users) has negative effects that leads to the behavioural use intention of the user. Therefore, it is hypothesized that:

H8: E*ffort expectancy of the system will have a negative influence on the behavioural intentions of users to adopt and use the system.*

4.3.3 Hedonic Motivation (HM)

Hedonic motivation is defined as "*the fun or pleasure derived from using a technology, and it has been shown to play an important role in determining technology acceptance and use*" (Brown & Venkatesh, 2005). On the other hand, information systems research and consumer behaviour research have both reported that enjoyment of using a system or technology (i.e. hedonic motivation) are a very important factor in the use of that particular system or technology, and integrating such a construct in a research model would complement its strongest predictor which emphasizes utility (Venkatesh et al., 2012). Further, a study of self-management for diabetes patients (Wong, Siu, & Lam, 2013) has revealed that hedonic features are a motivator for the patients to self-manage their own condition. On the other hand, another recent study (Forman & Butryn, 2015) on self-regulation of weight control has shown that hedonic pleasure (e.g. pleasure of having tasty food, etc.) is the most important paralyzer of the patients' efforts to self-regulate their own weight. So it could be inferred that hedonic motivations are very important in success or failure of self-management efforts in healthcare related subjects. Thus, it is hypothesized that:

H9: *Hedonic motivation will have a positive influence on the behavioural intentions of users to adopt and use the system*.

4.3.4 Patient Perception Outcomes or Behavioural Intention (BI)

As discussed before, behavioural intention is the most influential factor in predicting actual behaviour (Pavlou & Fygenson, 2006). The goal of this research is studying the perceptions of patients about using the system (behavioural intention) before they are exposed to the actual system and after they have watched a video about capabilities of the system. This will enable us to study their behavioural intentions towards adoption and therefore, to predict and explain actual system adoption.

The main focus of this study is therefore on observing perceptions of the users before adoption, after watching a video about the capabilities of the proposed system. The reason for choosing to study only the perceptions of the users is that although it been established that Behavioural Intention (BI) is a predictor of actual use and performance expectancy, effort expectancy and hedonic motivation are also known to affect BI (Venkatesh et al., 2012). However, the effect of support and sustainability elements that are products of the proposed system, on the factors that directly affect BI (PE, EE and HM) have not been studied in this context before. Although their usefulness (at least to some extent) has been verified (mostly in isolation) in other studies (Gallant, 2003), (Hartmann et al., 2010), (Wiltshire et al., 2009), they have not been studied together. So it is crucial to study whether having them in the model in relation to other constructs will change user perceptions and motivate patients to adopt the system. One purpose of this study is to verify how having these constructs in the model (in relation to other constructs) will change user perceptions towards adoption and continual use of the system. The focus here is on perceptions that lead to BI.

Chapter 5. Research Methodology

The following sections will describe the research methodology employed to validate the research model presented earlier, including study subjects, research settings and data collection procedures, measurement instruments and data analysis techniques. The questionnaire used in this research appears in Appendices A and B. Appendix A contains the introductory material presented to participants, while Appendix B includes the components of the actual questionnaire. Prior to answering questions about the proposed system, participants were shown an eight minute video clip that described how the system would work. Development of the video clip is described in the following section. The remaining sections of this chapter describe the analysis of data collected from the remaining quantitative and qualitative sections of the questionnaire.

5.1 Introductory Video Clip

This study aimed to target individuals with any type of serious chronic disease. Therefore, an introductory video clip about the various capabilities of the system, with a focus on support and sustainability elements, was produced and used to introduce the health self-management system to participants, to study their perceptions of the system, and to note their decisions on how useful it might be to them in managing their chronic illnesses.

5.1.1 Why a Video Clip?

There were several reasons that a video clip was chosen to educate the participants, compared to direct training on the actual system or other types of educational and training methods. Here are a few of those reasons:

1) Training on the actual system, using text and image based material to guide the participants through the system would have been much more time consuming; a video clip can be as effective and capable of delivering fairly the same amount of information and guidance in less time. In terms of effectiveness of the video clip comparing to text and image based presentation, research has shown that narrated videos are considered to be effective in reducing perceived ambiguity of the introduced task (Lim & Benbasat, 2000). Further, in terms of the length of the video, there are a number of studies that created and used video clips for educational purposes, ranging in length from 8 to 30 minutes (Battersby, Ben-Tovim, & Eden, 1993), (Yi & Davis, 2003), (Hu & Hui, 2012). The shorter videos that could convey the message correctly were considered to be more effective.
2) The researcher has more flexibility in the sense of organizing the information and using a variety of information delivery tools (e.g. pictures, texts, audio, etc.). Some scenarios can also be constructed and introduced in an online social network in order to educate the user how to use it. Using multimedia content (i.e. video clips) instead of still images, or text-based material is believed to be more effective and provides a much better learning experience in a richer format for the audience (Raney, Arpan, Pashupati, & Brill, 2003). Further, the number of commercial and non-commercial websites that employ video clips to demonstrate their features has been constantly increasing (Zhenhui & Benbasat, 2007). The reason behind this increase is that video presentation provides the audience with ongoing sound effects and visual stimuli and therefore is far more effective than still images or text-based material (Coyle & Thorson, 2001). Finally, experimental study has shown that narrated videos used for the introduction of an online product's features (e.g.

websites) provide a greater breadth of recall compared to text-based and still images (Li, Tan, Teo, & Wei, 2012).

3) The completed system is supposed to be an online system that is not bounded by demographics. Therefore, a video clip seems to be more reasonable since it can reach a wider audience regardless of their geographical location, demographics, or schedule. Further, it provides identical learning experiences for all participants and therefore improves the quality of the study results in terms of representation of the whole population.
4) There are other studies that have suggested the use of a video clip instead of live training, (Davis, 1989). They suggest that a video clip can be used to "*create realistic facades of what the system consists of*", and they (video clip and live training) are shown to be equivalent for the audience, in that specific sense (Davis, 1989).

5.1.2 Video Clip Content

The video clip is divided into three main sections: 1) explanation of the system or concept (what), 2) benefits of the system for the user (why) and 3) demonstration of the features and functionalities of the system (how) which is consistent with other prior studies pursuing the same goals, e.g. (Mun & Davis, 2003), etc. The content material that has been used to produce the video clip includes narrated text, related pictures to demonstrate concepts, and related animations which would help to shape and explain attitudes, beliefs and intentions towards the information system.

In the first and second section, through narrated text, related pictures and animation, the patient understands and gets familiarized with what the system is and why the patient should start using the system. In the third section, the patient learns about different features and functionalities of the system and how to actually use them. The video is kept as short, simple and informative as possible so it is easy to understand and follow. The video clip targets a wide range of demographics.

5.1.3 Video Clip Development Process

The video clip was produced and refined based on a variety of sources including doctoral dissertations, published research papers, expert opinions, and also a comprehensive research on videos that were created for the same purpose. The development of the video clip has three stages: 1) scenario & script development, 2) audio & voice over recording, 3) screen video recording, and finally 4) final video production. Each stage is explained here:

- **Stage 1*: Scenario & script development***

In the first stage, a scenario that potentially covers all aspects of the system was developed. In the scenario, the "*what the system is*", "*why should it be used*" and "*how can someone use it*" were explained. Then the detailed script of the scenario was prepared and sent to the PhD supervisor for consultation and refinement. It took twelve (12) versions for the script to be finalized.

- **Stage 2: *Audio and voiceover recording***

In the second stage, the audio (voiceover) of the video clip was recorded using a volunteer student's[1] voice. Audacity[2], free open source software, was used to record the audio for our video clip. Further, five (5) audio recording sessions were recorded before finalizing the audio.

- **Stage 3: *Screen video recording***

In this stage, CamStudio[3], another free open source software, was used to capture and record the screen, while playing the written scenario in the system, in order to show the appearance as well as functionalities of the system to the audience.

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[1] A fulltime student at McMaster University consented to help us in this project.
[2] http://audacity.sourceforge.net/
[3] http://camstudio.org/

- **<u>Stage 4</u>**: ***Full video production***

In this stage, Microsoft PowerPoint was used in order to tie everything together and produce the full video including the voiceover (audio), plain text, pictures, and the recorded video of the system.

5.1.4 Video Clip Pilot

After the video clip was made to the satisfaction of the author, and in order to make sure that the content of the video was a good and reliable tool that could aid data collection, it was uploaded on YouTube[4] (a video sharing website) and its link was sent to a number of experts for their consultation on different aspects of the video (e.g. text, voiceover, pictures, video, etc.).

The experts included three information systems faculty members at the Degroote School of Business, with extensive research experience in eHealth, technology adoption and information systems. After that, the video was also shown to sixteen (16) PhD students in different fields of business such as marketing, information systems and management science, and one eHealth MSc student at the DeGroote School of Business, and their feedback was collected. The reason the graduate student feedback was used was that each of them had looked at the system from their own point of expertise and also at that point most of the required feedback were about the look and feel of the system. Subsequently, the video clip was revised, based on the feedback received from all of these experts.

5.1.5 Technical Considerations

Following are the technical matters that needed to be taken into consideration:

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[4] http://www.youtube.com

- About 29 versions of the video clip were made until it evolved to an optimal level. The initial version of the video clip was 9 minutes and 13 seconds long which was considered to be too long according to the received feedback. The final version was 6 minutes and 4 seconds long.
- The video presented a focus on “any type of chronic disease”.
- YouTube was used as a vessel for video clip watching and testing for all versions.
- All the video playback control buttons were disabled to ensure participants did not skip any part of the video while watching it.
- The video dimensions were set to automatically fit the screen size of the viewer (i.e., the maximum possible size for each viewer).
- The quality and specifications of the video were tested on several different types of computers and hand-held devices, with various screen sizes, screen resolutions, operating systems, and web browsers.

The final script used for the video is shown in Appendix C.

5.2 Data Collection

The focus of this research was on the “pre-usage” stage, so study participants would have had no prior exposure to the proposed system, and probably no other disease self-management support system.

5.2.1 Sample Size Requirement

For the purpose of this research, a group of 204 patients, including males and females, who suffer from a serious chronic disease (e.g. heart failure, rheumatoid arthritis, diabetes, etc.) participated in a study to determine whether watching a video clip about features and functionalities of a system for chronic disease self-management in their home environment would be effective in motivating them to adopt the system. It was anticipated that patients with serious chronic disease would be more suitable for this study since they had to deal with symptoms and effects of their illness on a routine daily basis.

The commercial provider firm (ResearchNow) that provided the database of potential participants has a process in place for screening purposes. It has a database of members (potential participants) that has been collected continuously for years. Upon enrolment, members complete an extensive membership profile survey. This identifies the specific attributes of an individual – sort of like a person's DNA – and the company continuously monitors these data points for any changes. Therefore, the company is aware of the specific chronic diseases that its members (potential participants) have and contact them on that basis.

In addition to provider firm screening, we also screened potential participants in our study using three mandatory questions at the beginning of the questionnaire:

- I am 18 years of age or older ☐ Yes / ☐ No
- I have been diagnosed by a physician to have a serious chronic illness ☐ Yes / ☐ No
- Chronic illnesses can rarely be cured ☐ Yes / ☐ No

A “No” answer to any of these questions would result in a message to participants that they could not continue participating in the study since they were not eligible. Finally, upon completion of the survey, each participant received fair market compensation based on their membership agreement with the company. Due to company policy, no compensation was provided for participants who did not finish the questionnaire.

PLS-SEM (partial least squares – structural equation modelling) was used to analyze the data. PLS was chosen due to its strong capabilities in model evaluation, reporting and minimum data requirements (Joseph F. Hair, Sarstedt, Pieper, & Ringle, 2012). The minimum sample size required to validate the proposed model using PLS was ten times the highest number of predictors, i.e., ten times the larger of the following two numbers (Chin, Marcolin, & Newsted, 2003):

1) Number of predictors in the measurement block (i.e., variable) with the highest number of predictors.
2) The largest number of paths leading to a single dependent variable.

Based on the number of predictors and the largest number of paths leading to a single variable, in the simplified model of Figure 4, a sample size of 90 or higher is suitable. However, having about 200 data points ensures better validity and reliability of the study. Further, according to rules for sample size (Gefen, Straub, & Boudreah, 2000), a sample size of about 200 is suitable for almost all types of statistical analysis such as measuring group differences (e.g., t-test, ANOVA), relationships (e.g., correlations, regression), and Chi-Square. To check for the presence of cultural differences, half of the participants chosen were from Canada and half were from the United States.

5.2.2 Outliers & Anomalies

Since all of the questions related to the proposed model were mandatory, participants who did not want to answer one or more of the questions had to stop. Such partial responses were eliminated. The remaining 204 survey results were therefore virtually complete. These data were searched in order to find specific cases of either anomalies or outliers (Meyers & Gamst, 2006).

5.2.3 Research Ethics

Prior to performing any type of research or collecting any data, an ethics application was submitted to McMaster University Research Ethics Board for the Internet panel survey, and another one to the University of Toronto Research Ethics Board for the St. Michael's Hospital survey. Both applications were approved.

5.2.4 Survey

A cross-sectional survey method was employed to collect data and test the hypotheses postulated in Chapter 4. It is believed that administering a survey after participants had watched the video in order to test the proposed research model was appropriate, since surveys are accepted as one of the most effective tools in information systems research (Sivo, Saunders, Chang, & Jiang, 2006). Moreover, using surveys, according to Webster and Trevino (Webster & Trevino, 1995), is a typical approach to validate adoption models. In the following, the Internet panel survey will be the focus of the study.

5.3 Measurement Instrument

The measurement instrument was composed of: demographics questions to acquire knowledge about individual characteristics of the participants; closed-ended quantitative statements related to the constructs in the proposed research model (Figure 4); and open-ended qualitative questions regarding the perceptions of study participants. To ensure validity of the study contents, measurement scales were selected from pre-validated constructs with some slight changes to adapt to the context of this research.

Since the usability perceptions of users (using a video) were being studied, a scale that measures those perceptions had to be adopted. The perceived usability scale (Pavlou, 2003) and performance expectancy scale (Venkatesh et al., 2012) were chosen since with minor changes they were suitable for measuring usability perceptions. For example, the PCPS construct was operationalized using a PU scale, since user perceptions of the usability of care partner support from the patient's side were collected, and the pre-validated PU scale was capable of serving this purpose. The adapted questions as well as related demographics and qualitative questions are shown in Tables 2, 3, 4, and 5. It should be noted that due to the length of the questionnaire as well as a recommendation from our research partner, Dr. Tony Moloney (Cardiovascular Surgeon & PAD Specialist), the length of the questionnaire was reduced by eliminating items from some constructs. This practice has also been reported in some other published studies (Wu, Larrabee, & Putman, 2006), (Petersen et al., 2006). The criteria used was to cut out more general items from the constructs. For instance, the item: "In general, I think that the system would be useful in performing my regular health self-management tasks" was cut.

Table 2. Demographic Questions

Questions	Items
How old are you?	1. 29 or younger 2. 30 - 49 3. 50 - 69 4. 70 or older
Your gender?	1. Female 2. Male
What is your educational background?	1. Less than high school diploma 2. High school diploma 3. Some college 4. Bachelor's degree 5. Master's degree or higher

Do you have access to the Internet?	------- Yes -------- No
If yes, how much do you use Internet on a weekly basis?	1. I don’t use the Internet at all 2. Up to one hour 3. From 1 to 3 hours 4. More than 3 hours
Do you have and use a Smartphone/Tablet?	------- Yes -------- No
If yes, what is the type of your Smartphone/Tablet?	-------------------------------------
If no, does someone close to you have a Smartphone/Tablet?	------- Yes -------- No
Please indicate your serious chronic illness:	-------------------------------------

Table 3. Quantitative Measurement Scales

Questions	Items
PU - Care Partner Support (Pavlou, 2003) **<u>Adaptation</u>**: the name of "*the system*" was changed to "*the help and support from my care partner*"; the purpose of the system was changed to "*performing my regular self-management tasks*", and since participants were supposed to give their opinion about whether they would use the system in the future, all of the sentences were changed to future tense. Further, one question from the survey has been cut in order to shorten the length of the survey.	1. I think that the support and help from my care partner would be **<u>useful</u>** in performing my regular health self-management tasks. 2. I think that the support and help from my care partner would help me perform my regular health self-management tasks **<u>more effectively</u>**. 3. I think that the support and help from my care partner would help me perform my regular health self-management tasks **<u>more efficiently</u>**.
PU - Decision Support (Pavlou, 2003) **<u>Adaptation</u>**: the name of "*the system*" was changed to "*the help and support from the system*"; the purpose of the system was changed to "*making my regular decisions*", and since participants were supposed to give their opinion about whether they use the system in the future, all of the sentences were changed to future tense. Further, one question from the survey has been cut in order to shorten the length of the survey.	1. I think that the support and help from the system would be **<u>useful</u>** in my regular decision making tasks. 2. I think that the support and help from the system would make my regular decisions **<u>more effectively</u>**. 3. I think that that the support and help from the system would be valuable in making my regular decisions **<u>more efficiently</u>**.
Perceived Education and Training (Venkatesh et al., 2012) **<u>Adaptation</u>**: the name of "*the system*" was changed to "*the education and training about my illness that would be provided by the proposed system*"; Further, two question from the survey have been cut in order to shorten the length of the survey.	1. The education and training about my illness that would be provided by the proposed system would be helpful to me in managing my illness more effectively. 2. The education and training about my illness that would be provided by the proposed system would help me to understand my illness better.
Perceived Online Social Network	

(Venkatesh et al., 2012) **Adaptation**: the name of "*the system*" was changed to "*the online social network that is built into the system*"; the purpose of the system was dropped, and since participants were supposed to give their opinion about whether they are going to use the system and its components in the future, the terms "*if available to me"* and *"if it is made available to me*" were added. Further, two question from the survey have been cut in order to shorten the length of the survey.	1. If available to me, I **predict** I will use the online social network that is built into the system. 2. I **plan** to use the online social network that is built into the system, if it is made available to me.
Perceived Entertainment (Venkatesh et al., 2012) **Adaptation**: the name of "*the system*" was changed to "*the entertainment components that is built in the system*"; the purpose of the system was dropped, and since participants were supposed to give their opinion about whether they are going to use the system and its components in the future, the terms "*if available to me"* and *"if they are made available to me*" were added. Further, two question from the survey have been cut in order to shorten the length of the survey.	1. If available to me, I **predict** I would use the entertainment components that are built into the system. 2. I **plan** to use the entertainment components that are built into the system, if they are made available to me.
Perceived Patient Reward System (Venkatesh et al., 2012) **Adaptation**: the name of "*the system*" was changed to "*the patient reward system that is built in the system*"; the purpose of the system was dropped, and since participants were supposed to give their opinion about whether they are going to use the system and its components in the future, the terms "*if available to me"* and *"if it is made available to me*" were added. Further, two question from the survey have been cut in order to shorten the length of the survey.	1. If available to me, I **predict** I would use the patient reward system that is built into the system. 2. I **plan** to use the patient reward system that is built into the system, if it is made available to me.
Performance Expectancy	

(Venkatesh et al., 2012) **Adaptation**: the name of "*the system*" was changed to "*the proposed system*"; Further, two question from the survey have been cut in order to shorten the length of the survey.	1. Using the proposed system would be helpful in improving my health 2. Using the proposed system would help me to manage my healthcare more effectively
Effort Expectancy (Venkatesh et al., 2012) **Adaptation**: the name of "*the system*" was changed to "*the proposed system*"; Further, we have cut the last question from the survey to shorten the length of the survey. Further, two question from the survey have been cut in order to shorten the length of the survey.	1. My interaction with the proposed system would be clear and understandable 2. I believe the proposed system would be easy to use
Hedonic Motivation (Venkatesh et al., 2012) **Adaptation**: the name of "*the system*" was changed to "*the proposed system*"	1. I believe the proposed system would be interesting to use 2. I believe the proposed system would be enjoyable to use 3. I believe the proposed system would be entertaining to use
Behavioural Intention (Venkatesh et al., 2012) **Adaptation**: the purpose of the system was changed to "*help me perform my regular self-management tasks*", and since participants were supposed to give their opinion about whether they going to use the system and its components in the future, the terms "*if available to me"* and *"if it is made available to me*" were added. Further, one question from the survey has been cut in order to shorten the length of the survey.	1. If available to me, I **predict** I would use the system to help me perform my regular health self-management tasks. 2. I **plan** to use the system to help me perform my regular health self-management tasks, if it is made available to me.

Table 4. Primary Qualitative Questions

Questions	Items
Do you think you would be interested in starting to use the system that was demonstrated to you?	------- Yes -------- No
If no, please tell us why. This will help us improve the system for you and other potential users.	
Do you have any suggestions for making the system more interesting, more useful, easier to understand, or easier to use?	

Table 5. Secondary Qualitative Questions

This measurement scale is used only if the user **<u>is going to</u>** use the system.	
Questions	**Items**
Do you think you would be able to find time to access the system at least once a day on a regular basis?	------- Yes -------- No
Please explain how you might use the system to help you with managing your chronic illness.	
Do you think you would be interested in using the system over a long period of time?	------- Yes -------- No
Please explain your decision. This will help us to improve the system for you and other potential users.	

5.4 Data Collection Procedure

Data collection for the Internet survey was performed by ResearchNow[5], from a large pre-existing North American database of consumers that volunteer for these and other types of studies, for points accumulated towards rewards for participation. Table 6 demonstrates the steps in the data collection procedure performed by ResearchNow. The detailed questionnaire used for this study is given in Appendix B.

Table 6. Data Collection Steps

Steps	Explanation
1) Invitation to participate in the study	Potential participants (chronically ill consumers) were invited to participate in the study by email. That was the only criterion. However, in order to answer to our survey, participants had to have a basic level of internet literacy to be able to participate.
2) Participation consent	The research is explained to participants in simple terms. Continuing on to complete the survey implies participant consent.
3) Qualifying questions	Participants were asked to answer the following questions in order to check whether they are qualified to participate in the study: • I am 18 years of age or older ☐ Yes ☐ No Please read this and then answer the question that follows:

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[5] ResearchNow (http://www.researchnow.com/) is a company contracted to collect the data. The company has a large database of consumers, including many who are chronically ill.

	"*A chronic illness is defined as an illness that tends to continue or re-occur over the course of at least six months. If a chronic illness is serious, assistance is needed to manage the illness, and medications are necessary; caution and/or special attention and assistance are needed to manage diet, and it may cause major limitations on physical or mental activities; frequent interactions may be required with healthcare providers, and occasional emergency room visits or hospital admissions may be necessary*." • I have been diagnosed by a physician to have a <u>serious</u> chronic illness ☐ Yes ☐ No • Chronic illnesses can rarely be cured ☐ Yes ☐ No
4) Demographic questions	Patients were asked to answer demographic questions.
5) Watching the video	An introductory video including a discussion integrating all the components of the system (support and sustainability components as well as other features of the system) were shown to participants to educate them about what the system is and how it works.
6) Response to the main survey questions	After watching the video, participants were asked to complete the main survey questionnaire.
7) Completion of the qualitative questions	Finally, participants were asked to respond to the qualitative survey questions

5.5 Instrument Pre-test & Pilot

Before starting the final data collection procedure, a pilot study was conducted by the contractor (ResearchNow) with an initial 20 participants. The results were analyzed carefully to determine whether any changes to either the online survey or the data collection procedure were needed. The analysis did not suggest any changes in either the measurement instrument or data collection procedures before completing the full survey. Therefore, data from the pilot study were included in the final dataset for analysis.

5.6 Statistical Data Analysis

The intention of this section is to provide an overview of data analysis techniques and procedures that were employed and used in this study. More details are provided in the next section, along with the results of the study.

5.6.1 Common Methods Bias

Common Methods Bias (CMB) is a technique that instead of focusing on the variance of hypothesized relationships among items and their related latent variables, refers to the common method variance (CMV) related to the measurement method (Straub, Boudrea, & Gefen, 2004). However, a systematic and comprehensive analysis of the past IS research provides strong arguments that CMV makes no significant difference in IS-specific context research. Its findings reveal that contrary to the concerns of some skeptics, CMV-adjusted structural relationships are not statistically differentiable from uncorrected estimates (Malhotra, Kim, & Patil, 2006). Therefore, CMV and CMB were intentionally ignored in this research.

5.6.2 Research Model Validation

The original model that was used is the pre-validated UTAUT2 (Venkatesh et al., 2012) model. Structural equation modelling (SEM) was used as the statistical model for the purpose of this study and PLS (partial least squares) software was employed to do the statistical analysis. In this study, SEM was chosen because it provides a good capability for investigation and analysis of unobservable variables that are indirectly measured from observable variables, especially when the sample size is small (Chin & Newsted, 1999). According to Chin & Newsted (1999), the PLS method should be employed to validate the research model when the theoretical model is relatively new and in early stages of development, which is exactly the case in this study. It also gives optimum prediction accuracy because of its prediction orientation nature (Fornell & Cha, 1994), (Chin et al., 2003), (Joe F. Hair, Ringle, & Sarstedt, 2011). All constructs in this study including PE, EE, HM and BI as well as Support & Sustainability (PCPS, PDS, PEAT, PPRS, POSN and PETC) were modelled as reflective constructs in the research model (Chin et al., 2003). Table 7 demonstrates the reflective constructs used. Reflective constructs used were all pre-validated constructs adapted for this study from previously published works.

Table 7. Constructs in the Study

Construct	Type	Source	Original Items	Used Items
BI	Reflective	(Venkatesh et al., 2012)	**3**	**2**
HM	Reflective	(Venkatesh et al., 2012)	**3**	**3**
PE	Reflective	(Venkatesh et al., 2012)	**4**	**2**
EE	Reflective	(Venkatesh et al., 2012)	**4**	**2**
PU - CPS	Reflective	(Pavlou, 2003)	**4**	**3**
PU - DS	Reflective	(Pavlou, 2003)	**4**	**3**
PEAT	Reflective	(Venkatesh et al., 2012)	**4**	**2**
PPRS	Reflective	(Venkatesh et al., 2012)	**4**	**2**
POSN	Reflective	(Venkatesh et al., 2012)	**4**	**2**
PETC	Reflective	(Venkatesh et al., 2012)	**4**	**2**

SmartPLS[6] software was used for the actual PLS analysis. SmartPLS was chosen for this purpose because it is capable of executing almost all of the required analysis and procedures, and

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[6] SmartPLS; Version: 2.0.M3; http://www.smartpls.de.
All default settings were used:

- Path Weighing Scheme: Mean 0 Var 1, Max Iterations 300, Abort Criterion 1.0E-5, Initial Weights 1
- Bootstrapping: No sign changes
- Blindfolding: Omission Distance = 7

it is most appropriate to use. In reporting the PLS analysis results, the quality of the measurement model was assessed in terms of both validity and reliability of the constructs and then the validity of the proposed theoretical model was evaluated. The methods and techniques used for this purpose were suggested by (Chin, 2010a), and will be discussed in the following sections (Assadi, 2013).

5.6.2.1 Individual Item Reliability Tests

- **Corrected Item-Total Correlation**: This is the coefficient of the correlation between the item and a total score for the remaining items of the construct to which the item belongs (Cohen & Cohen, 1975). Although there is no specific criterion, a rule of thumb suggests that any items with correlation values below 0.4 need to be eliminated before any analysis on the factors (Kerlinger, 1978), (Doll & Torkzadeh, 1988), (Torkzadeh & Lee, 2003). The value of 0.5 was chosen as a more conservative criterion which should lead to more robust results from PLS analysis.
- **Item Loading**: Most of the related references suggest removing very weak indicators and keep the items with loadings above 0.5 (Gefen, Struab, & Boudrea, 2000), (Roldan & Sanchez-Franco, 2012).

5.6.2.2 Construct Reliability Tests

- **Cronbach's Alpha (α)**: This is a measure of internal consistency of a construct (Cronbach, 1951). Although the measure of 0.7 is considered the minimum required for internal consistency, values equal to or above 0.8 are often considered to be the minimum (Nunnally & Bernstein, 1994).
- **Composite Reliability (CR)**: CR is a measure of internal consistency and reliability of a construct when it is combined with other constructs in the model

(Werts, Linn, & Joreskog, 1974). Although 0.7 is considered the minimum required for internal consistency and reliability, values equal to or above 0.8 are often considered to be the minimum (Nunnally & Bernstein, 1994).

- **Average Variance Extracted (AVE):** This is the amount of variance captured by the construct, in relation to the amount of variance due to measurement error, and values greater than **0.5** are considered to be acceptable (Fornell & Larcker, 1981).

5.6.3 Structural Model Evaluation

The following techniques and criteria were used for evaluation and validation of the structural model (Assadi, 2013).

- **R-squared (R^2):** R^2 is the proportion of variance explained by the antecedents of a dependent variable (Rao, 1973). It is a measure of the success for predicting the dependent variable from its independent antecedents (Chin, 2010b). It must be at least above 0.1 and also high enough to have explanatory power (Urbach & Ahlemann, 2010). The R^2 value is generated by SmartPLS software.
- **PLS Path Estimates (β):** The coefficient (β), its sign and significance is generated by SmartPLS software. The bootstrapping technique is used to determine the significance of the coefficients, based on the precision and stability of the PLS results (Chin, 2010b). In bootstrapping, usually about 500 resamples with replacement are taken from the original sample to obtain 500 estimates for each parameter in the PLS model. After that, t-tests are calculated for each estimated parameter in the PLS model from these 500 estimates in order to determine the statistical significances of the parameters (Chin, 2010b).

- **Effect Size (f^2):** The effect size shows the magnitude of effect that an independent variable has over its related dependent variable. The values of effect size are viewed in four categories: between [0, 0.02), [0.02, 0.15), [0.15, 0.35), and equal to or above 0.35 The first of these categories is seen as non-significant and rest are an indication of small, medium and large effect sizes respectively (Chin, 2010b). The effect size is calculated from the R^2 result for the dependent variable and formulated as follows:

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}}$$

- **Cross-validated Redundancy (Q^2):** This is a measure of predictive relevance of the model, or how well the model can predict the behaviour of variables (Chin, 2010b). It is calculated by the SmartPLS software. A value if $Q^2<0$ is an indication of no predictive relevance and $Q^2>0$ shows predictive relevance (Chin, 2010b).
- **Goodness of Fit (GoF):** Goodness of fit indicates the level of prediction performance of the PLS model on both structural and measurement levels (Vinzi, Trinchera, & Amato, 2010). The baseline values of 0.1(low fit), 0.25 (medium fit), and 0.36 (high fit) can be used to assess the overall fit of the model (Tenenhaus, Amato, & Vinzi, 2004), (Wetzels, Odekerken, & Oppen, 2009). GoF is calculated using the SmartPLS results as the geometric mean of the average communality index and the average $R^{2,}$ formulated as follows:

$$GOF = \sqrt{\overline{Communality} * \overline{R^2}}$$

5.6.4 Impact of Individual Characteristics and Control Variables

In order to analyze the impact of the individual characteristics of the participants, first each individual characteristic (e.g., age) was examined as well as the changes caused by them in the explained variance of every endogenous construct in the proposed model. After that, PLS path coefficients and their significance for relationships between each individual characteristic and every construct in the model were examined. The results as well as technical details of these two procedures are presented in the next chapter (Chapter 6).

5.6.5 Examination of Open-ended Questions

There were open-ended questions in the survey that asked participants to comment onthe reasons why and why not they would use the system. The purpose of having these open-ended questions is to provide additional insights and thereby enrich the quantitative results. Responses to these questions were studied in terms of demographics and summarized in terms of the reasons provided for using or not using the system. Results of this study are presented in chapter 6.

Chapter 6. Data Analysis and Results of the Study

This chapter describes the analysis of the data. In more specific terms, this chapter describes the administration of the online survey as well and the treatments that were performed with the data prior to analyses. Moreover, the impact of individual characteristics and variables are analyzed and the results presented. Finally, an analysis of the research model from chapter 4 is presented.

6.1 Survey Administration

Participants completed the survey online from September 22 – 30, 2014. The following is the analysis of the survey results. The survey stopped as soon as it reached the pre-defined limit of ~ 200 completed responses. It was decided to collect data from 100 participants from each country (Canada & US). Because data collection was stopped due to this limitation on the number of participants, response rate calculation is not relevant for this study.

6.2 Data Treatments

The raw data consisted of an initial set of 204 completed surveys. The database was reviewed for missing data, as well as any anomalies or possible outliers.

6.2.1 Outliers & Anomalies

There were five cases in which participants stated that they did not have access to the Internet, nor could they use smartphones (which can connect to the Internet), even though they used the Internet to access the survey. The primary reason for dropping them was that they may have not have been attentive to our survey and answered the questions on a random basis just to collect the promised incentive (gaming). This would make their inputs unusable (gaming is explained in the next paragraph). The secondary reason was that even if they weren’t just after the reward and they had answered the survey correctly (e.g. using a computer at hospital to answer the questions, etc.), since having access to the Internet (through either a desktop or laptop computer, or tablet or smartphone) on a permanent basis (daily access) is vital to this study, these five cases were dropped. The dataset was also examined for any patterns of “gaming”. Gaming happens when participants complete the questionnaire without paying any attention to questions (e.g. by choosing the middle choice for all questions, etc.) in order to collect the incentives only (Ruhi, 2010). One specific case was recognized as an outlier. This case left most of the questions unanswered (choosing “I don’t know”). This case was also removed from the dataset.

The exact time taken by each participant to complete the questionnaire was also taken into account, since rapid completion (mostly by choosing the same choice for all questions) is another key to recognizing participants who are gaming the survey (Downs, Holbrook, Sheng, & Cranor, 2010). It was estimated that it would take a minimum of about 8 minutes to complete the questionnaire. It was certainly expected that participants would take more time to complete the survey since they would not be familiar with the questions. There were nine cases that took more than one hour (60 min) to finish the questionnaire and these might be considered outliers. However, participants might take breaks while completing the survey, or they might suffer from some specific chronic disease (e.g. spinal cord injuries, etc.) that would make their completion times longer. Table 8 demonstrates relevant statistics for completion times of the remaining participants.

Table 8. Statistics on Participation Time

Minimum	7.8
Maximum	57.62
Mean	19.29
Standard Deviation	9.26

Based on the previous proposition, anyone who spent less than 8 minutes to finish the study, should be considered for gaming analysis since they might not have paid enough attention to the questions and therefore, their answers were not reliable. However, there was only one case that spent less than 8 minutes (about 7 min) to finish the study. After examination of the answers for this specific case, and based on the best judgment of the author, it was decided not to drop it.

Following (Ruhi, 2010) and (Assadi, 2013), the dataset was also investigated by drawing a box plot for each item in the proposed model. According to the results, there were very few cases (less than 3%) of univariate outliers. Four of these outliers has already been chosen for elimination. Therefore, the remaining two were not classified as outliers and they were included in the accepted dataset (Meyers & Gamst, 2006), since their mean values differed very little from the mean of the dataset. The resulting final dataset included 198 valid cases (N=198).

6.2.2 Missing Data

There were a few cases in which data were missing. This mostly related to using “I don’t know” answers in the questionnaire. First, the missing data were evaluated and searched for any possible patterns. Figure 5 demonstrates the summary and Figure 6 demonstrates the results of the analysis of missing data.

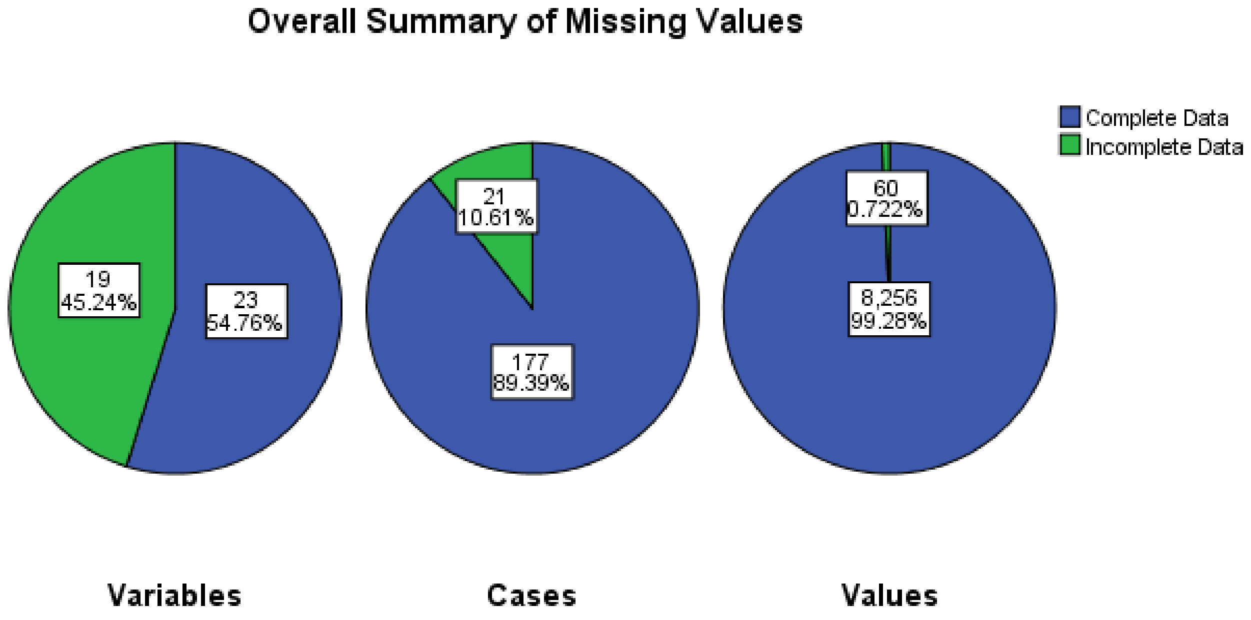

Figure 5. Missing Data Pie Charts

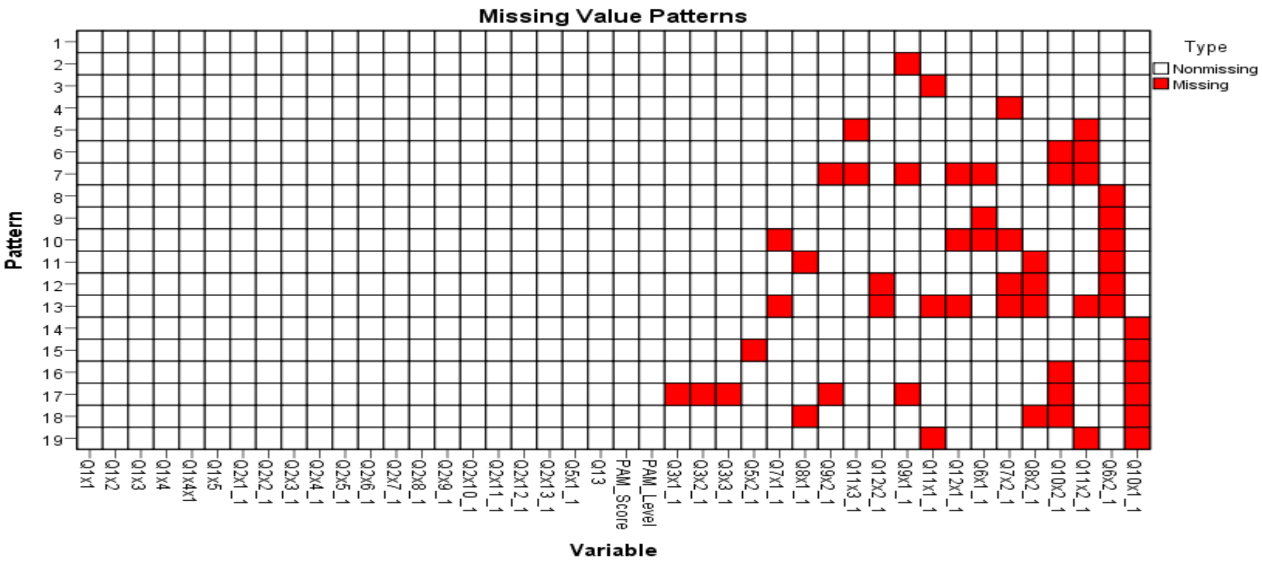

Figure 6. Missing Data Pattern Chart

As shown in Figure 5, 19 items had missing data, and 23 items were complete. Further, there were 21 cases (participants) which had missing data but 177 cases were complete. Only 60 values (about 0.7% of all data) were missing, and there was no specific pattern in the missing data (Meyers & Gamst, 2006). Based on this analysis, the Expectation-Maximization (EM) Imputation technique (Gold & Bentler, 2000) is a reasonable method to use for replacing the missing data. This method is an iterative algorithm/method for finding maximum a posteriori (MAP) or maximum likelihood estimates of parameters in a statistical model, where the model is based on unobserved latent variables and their related observed variables (Gold & Bentler, 2000). After applying EM to the dataset, a complete dataset ready for statistical analysis was available. In figure 6, variable items are listed on the horizontal axis and any possible patterns are shown on the vertical axis. It is clear from figure 6that there is no clear pattern in the missing data.

6.3 Demographics of the Participants

Consistent with guidelines on information systems research presentation of results (Chin et al., 2003), this section presents the characteristics of the study participants.

6.3.1 Location, Gender and Age

Almost half of the participants were from the USA and the other half from Canada. Participant age, gender and location are shown in Tables 9 to 14 below.

Table 9. Canadian Participant Geographical Location

Province	**Frequency**	**Percentage (%)**	**Percentage in the 2011 Canadian Census** ("Canada Census 2011," 2011)
Alberta	7	7.29	10.9
British Columbia	20	20.83	13.1
Manitoba	4	4.16	3.6
New Brunswick	0	0	2.2
Newfoundland and Labrador	1	1.04	1.5
Nova Scotia	2	2.08	2.8
Ontario	46	47.91	38.4
Prince Edward Island	1	1.04	0.4
Quebec	12	12.5	23.6
Saskatchewan	2	2.08	3.1
Northwest Territories and Nunavut	1	1.04	0.2
Yukon Territory	0	0	0.1
Total:	96	100	100

The geographical locations of the Canadian participants are a reasonable match with the Canadian Census population percentage report ("Canada Census 2011," 2011). There is a small over representation from Ontario and British Columbia which is acceptable. Further, since the survey was only offered in English, the participation rate relative to population is low in Quebec and there were no responses from New Brunswick where there are significant French speaking populations.

Table 10. US Participant Geographical Location

State	Frequency	Percentage ~ (%)	Percentage in the 2010 US Census (“US Census 2010,” 2010)
Alabama	0	0	1.53
Alaska	0	0	0.23
Arizona	1	0.98	2.04
Arkansas	1	0.98	0.93
California	9	8.82	11.91
Colorado	2	1.96	1.61
Connecticut	1	0.98	1.14
Delaware	0	0	0.29
District of Columbia	0	0	0.19
Florida	5	4.9	6.01
Georgia	1	0.98	3.10
Hawaii	0	0	0.43
Idaho	0	0	0.51
Illinois	9	8.82	4.10
Indiana	1	0.98	2.07
Iowa	1	0.98	0.97
Kansas	0	0	0.91
Kentucky	0	0	1.39
Louisiana	1	0.98	1.45
Maine	0	0	0.42
Maryland	3	2.94	1.85
Massachusetts	1	0.98	2.09
Michigan	4	3.92	3.16
Minnesota	2	1.96	1.70
Mississippi	0	0	0.95
Missouri	3	2.94	1.91
Montana	0	0	0.32

Nebraska	2	1.96	0.58
Nevada	1	0.98	0.86
New Hampshire	0	0	0.42
New Jersey	2	1.96	2.81
New Mexico	0	0	0.66
New York	6	5.88	6.19
North Carolina	1	0.98	3.05
North Dakota	0	0	0.21
Ohio	9	8.82	3.69
Oklahoma	0	0	1.20
Oregon	0	0	1.22
Pennsylvania	6	5.88	4.06
Rhode Island	0	0	0.34
South Carolina	3	2.94	1.48
South Dakota	0	0	0.26
Tennessee	1	0.98	2.03
Texas	11	10.78	8.04
Utah	0	0	0.88
Vermont	0	0	0.20
Virginia	3	2.94	2.56
Washington	2	1.96	2.15
West Virginia	2	1.96	0.59
Wisconsin	8	7.84	1.82
Wyoming	0	0	0.18
Total:	102	100	100

The geographical locations of the US participants seem to be a reasonable match with the population percentages of the individual states.

Table 11. Gender of Participants

Country	**Gender**	**Frequency**	**Percentage (%)**	**Percentage in Census* (%)**
Canada	Male	50	52.08	49
	Female	46	47.91	51
	Total:	96	100	100
U.S.	Male	54	52.94	49.1
	Female	48	47.05	50.9
	Total:	102	100	100

: ("Canada Census 2011," 2011) , ("US Census 2010," 2010)

The percentage of participants in the study is a reasonable match to the actual population percentage for both genders.

Table 12. Ages of Canadian Participants

Age	**Frequency**	**Percentage (%)**	**Percentage in the 2011 Canadian Census** ("Canada Census 2011," 2011)
18 - 29	0	0	16.9
30 - 49	8	8.33	27.3
50 - 69	75	78.12	26.3
70+	13	13.54	10.5
Total:	96	100	

Table 13. Ages of US Participants

Age	Frequency	Percentage (%)	**Percentage in the 2010 US Census** (“US Census 2010,” 2010)
18 - 29	0	0	16.6
30 - 49	6	5.88	27.2
50 - 69	76	74.5	23
70+	20	19.6	9.1
Total:	102	100	

Table 14. Age of All Participants (both Canada and US)

Age	Frequency	Percentage (%)
18 – 29	0	0
30 - 49	14	7.07
50 - 69	151	76.26
70+	33	16.66
Total:	198	100

Considering that the incidence of serious chronic illness tends to increase with age, these results seem to be appropriate for the populations surveyed.

6.3.2 Educational Background

All participants in the study were asked to specify their level of education. Table 15 shows the results for all participants (Canada and US).

Table 15. Education Level of the Participants

Education Level	Frequency	Percentage (%)
Did not complete high school	3	1.51
High school diploma	21	10.6
Some college	51	25.75
Bachelor’s degree	77	38.88
Master’s degree or higher	46	23.23
Total:	198	100

According to the results in table 15, a high percentage of the participants would be able to understand simple health related material. Since all participants used the Internet to access the survey, it could be inferred that most are Internet literate as well (some would be assisted by care partners). Based on these statistics, it could be inferred that those who answered the questionnaires understood the questions before answering and therefore their answers reflect their beliefs accurately.

6.3.3 Internet Experience and Smartphone Use

All participants in the study were asked to specify whether they had Internet access and confirmed that they have access to the Internet. They were asked to specify how much they use the Internet on a weekly basis. They were also asked whether they use a smartphone or tablet. Tables 16 and 17 show the results for all participants (Canada and US). The weekly Internet use question was included for screening purposes.

Table 16. Participant Weekly Internet Usage

Education Level	Frequency	Percentage (%)
I don't use the Internet at all	0	0
Up to one hour	2	1.01
From 1 to 3 hours	25	12.62
More than 3 hours	171	86.36
Total:	198	100

Table 17. Participant Smartphone Access

Smartphone Use?	Frequency	Percentage (%)
Yes	139	70.2
No	59	29.8
Total:	198	100

According to the results in tables 16 and 17, almost 86% of participants use the Internet more than 3 hours a week and all of them use the Internet at least once a week. This indicates that they could enter data at least once a week, if they choose to do so (a requirement of the online health self-management system if they actually were to sign up to use it). Also, more than 70% of the participants have access to and use smartphones which means they would have easier access to the proposed system depending on their data plan and their intent to use the proposed system.

6.4 Measurement Model Evaluation

In this section, the different steps taken to validate the research model that were proposed in Chapter 5 are explained.

6.4.1 Dropping PCPS from the Model

Perceived Care Partner Support (PCPS) is one of the components of the Support construct in the model. However, almost half of the participants stated that they did not have access to care partner support (almost half from both nationalities). Therefore, it was decided to validate a model that does not include PCPS as Model A (102 had no care partner support) and then perform a similar analysis of those who had care partner support as Model B (96 had access to care partner support). The results from both models are compared in section 6.7.

6.4.2 Reliability Assessment

Model evaluation started by assessing individual item reliability with the specified criteria given in the last chapter (corrected item-total correlations>0.4; loadings>0.5). The results are shown in Table 18.

Table 18. Results of Individual Item Reliability Assessment

Construct	Item	Item Loading	Corrected Item-Total Correlation
BI	BI-1	0.991	0.866
	BI-2	0.992	0.885
HM	HM-1	0.968	0.642
	HM-2	0.962	0.597
	HM-3	0.933	0.861
PE	PE-1	0.971	0.849
	PE-2	0.942	0.823
EE	EE-1	0.993	0.882
	EE-2	0.992	0.870
PDS	PDS-1	0.945	0.811
	PDS-2	0.965	0.817
	PDS-3	0.966	0.836
PEAT	PEAT-1	0.976	0.823
	PEAT-2	0.972	0.787
PPRS	PPRS-1	0.994	0.871
	PPRS-2	0.994	0.873
POSN	POSN-1	0.988	0.768
	POSN-2	0.988	0.785
PETC	PETC-1	0.989	0.801
	PETC-2	0.988	0.787

The reliability of the constructs was also assessed using the criteria explained in the previous chapter (AVE>0.5; CR>0.7; Cronbach's Alpha >0.7). Results are shown in Table 19.

Table 19. Results of Construct Reliability Assessment

Construct	AVE	Composite Reliability (CR)	Cronbach's Alpha
BI: Behavioural Intention	0.985	0.993	0.985
EE: Effort Expectancy	0.931	0.964	0.926
HM: Hedonic Motivation	0.900	0.964	0.945
PDS: Perceived Decision Support	0.919	0.972	0.956
PE: Performance Expectancy	0.983	0.991	0.983
PEAT: Perceived Education & Training	0.949	0.974	0.947
PETC: Perceived Entertainment Component	0.977	0.989	0.977
POSN: Perceived Online Social Network	0.976	0.988	0.976
PPRS: Perceived Patient Reward System	0.987	0.994	0.987

6.4.3 Validity Assessment

In order to test the validity of the model and its evaluated constructs, a confirmatory factor analysis (CFA) was performed in order to generate a matrix of loadings and cross loadings. Then loadings and cross-loading were populated and used to form the following matrix (Table 20) to evaluate the validity of the measurement model. According to the Geffen and Straub (2005) guideline, a measurement item should load on its latent construct at least one order of magnitude more than it's loading on any other latent construct. Finally, items in the matrix were carefully examined and confirmed to load on their corresponding constructs stronger than other constructs as per the guideline provided by Geffen & Straub (2005).

Table 20. Matrix of Loadings and Cross-Loadings for Model A

Item	Construct								
	BI	EE	HM	PDS	PE	PEAT	PETC	POSN	PPRS
BI-1	**0.9926**	0.5448	0.7955	0.7419	0.7845	0.689	0.7188	0.7141	0.8268
BI-2	**0.9925**	0.5384	0.7933	0.7282	0.7674	0.676	0.7097	0.7044	0.8177
EE-1	0.5204	**0.9676**	0.6818	0.5518	0.5858	0.4903	0.4493	0.4154	0.5546
EE-2	0.5331	**0.9618**	0.6629	0.492	0.483	0.3891	0.4168	0.4363	0.5031
HM-1	0.7622	0.6498	**0.9326**	0.7455	0.7858	0.7442	0.6507	0.6235	0.7697
HM-2	0.7638	0.7057	**0.9711**	0.689	0.7151	0.6916	0.6302	0.6702	0.7365
HM-3	0.7518	0.6288	**0.9424**	0.6535	0.6762	0.6669	0.6885	0.6283	0.7436
PDS-1	0.7065	0.5251	0.6949	**0.9452**	0.7728	0.7576	0.6167	0.593	0.6984
PDS-2	0.7078	0.5069	0.6989	**0.9651**	0.8177	0.7543	0.6158	0.6093	0.6855
PDS-3	0.7165	0.5284	0.7175	**0.9661**	0.7981	0.785	0.6343	0.6303	0.7172
PE-1	0.7704	0.5257	0.7475	0.8186	**0.9913**	0.7789	0.6714	0.6695	0.7714
PE-2	0.7797	0.5765	0.7696	0.8284	**0.9915**	0.7888	0.6852	0.6909	0.7686
PEAT-1	0.6816	0.4834	0.7355	0.805	0.789	**0.9765**	0.6675	0.6454	0.6741
PEAT-2	0.6575	0.4057	0.7034	0.7486	0.7504	**0.9722**	0.6482	0.6519	0.657
PETC-1	0.7104	0.4507	0.6954	0.6466	0.6801	0.6819	**0.9890**	0.6732	0.7513
PETC-2	0.7125	0.4379	0.6723	0.6362	0.6727	0.6533	**0.9882**	0.6681	0.7425
POSN-1	0.6907	0.4237	0.6632	0.6292	0.6747	0.6526	0.6592	**0.9879**	0.6611
POSN-2	0.7212	0.4474	0.6711	0.6298	0.681	0.6624	0.6813	**0.9882**	0.6855
PPRS-1	0.8109	0.5378	0.7873	0.7292	0.7729	0.689	0.7508	0.6741	**0.9936**
PPRS-2	0.8354	0.5536	0.7837	0.7217	0.7704	0.6689	0.7507	0.6803	**0.9935**

Furthermore, a discriminant validity test was performed to ensure that constructs in the model are different from each other. According to (Campbel & Fiske, 1959), discriminant validity exists when the correlations between items in any two constructs are lower than the square root of the AVE (average variance extracted) shared by items within a construct. Table 21 demonstrates the construct correlation matrix for the model. As it is obvious in Table 21, the square roots of the AVEs (diagonal elements) do not exceed the inter-construct correlations below and across from them. Thus adequate discriminant validity exists.

Table 21. Construct Correlation Matrix for Model A

Item	**BI**	**EE**	**HM**	**PDS**	**PE**	**PEAT**	**PETC**	**POSN**	**PPRS**
BI	**0.992**								
EE	0.5457	**0.965**							
HM	0.8004	0.6973	**0.949**						
PDS	0.7407	0.5422	0.7339	**0.959**					
PE	0.7818	0.556	0.7652	0.8307	**0.991**				
PEAT	0.6876	0.4579	0.739	0.7984	0.7907	**0.974**			
PETC	0.7196	0.4495	0.6919	0.6489	0.6842	0.6755	**0.988**		
POSN	0.7146	0.4409	0.6753	0.6371	0.6861	0.6655	0.6784	**0.989**	
PPRS	0.8285	0.5492	0.7906	0.7302	0.7767	0.6834	0.7556	0.6815	**0.993**

6.5 Structural Model Evaluation

Results of the PLS analysis of research model A are presented in Figure 7. Further, path coefficients, loadings, t statistics, validation and other useful information are also presented for this model in Table 22.

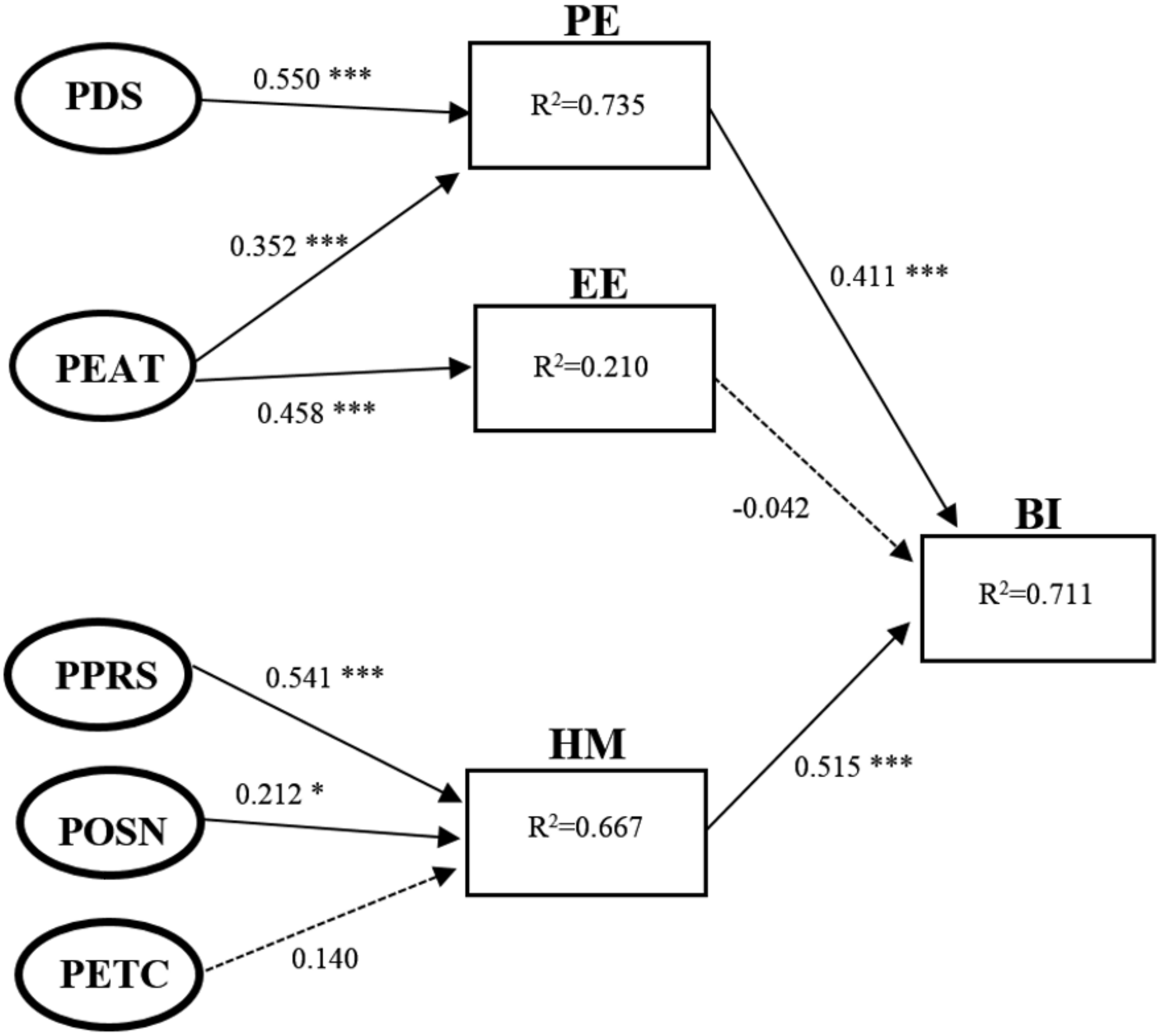

Figure 7. PLS Results[7] from the Proposed Model A

Table 22. Model A Hypothesis Validation Results

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[7] N= 198, *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$, ------: non-significant path

Hypothesis	Path	Path Coefficient	t- Stat	R^2	Validation
H2	**PDS → PE**	0.550	6.024 ***	PE (0.735)	Supported
H3a	**PEAT → PE**	0.352	3.754 ***	EE (0.210)	Supported
H3b	**PEAT → EE**	0.458	5.109 ***	EE (0.210)	Supported
H4	**PPRS → HM**	0.541	5.283 ***	HM (0.667)	Supported
H5	**POSN → HM**	0.212	2.384 *	HM (0.667)	Supported
H6	**PETC → HM**	0.140	1.446	HM (0.667)	**Not-Supported**
H7	**PE → BI**	0.411	4.788 ***	BI (0.711)	Supported
H8	**EE → BI**	-0.042	0.515	BI (0.711)	**Not-Supported**
H9	**HM → BI**	0.515	4.500 ***	BI (0.711)	Supported

***: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$**

According to the statistics presented in the above table and figure, except for the path between (EE) and (BI) and (PETC) and (HM), all other paths are significant and validated.

6.5.1 Effect Size f^2 of the Proposed Model A

The direct effect sizes (f^2) of all pairs of independent and dependent variables are presented in Table 23. Table 24 shows the total effects for the same variables.

Table 23. Direct Effects for Model A

	Dependent Variables			
Independent Variables	**PE**	**EE**	**HM**	**BI**
PDS	0.550			
PEAT	0.352	0.458		
PPRS			0.541	
POSN			0.212	
PETC			0.140	
PE				0.411
EE				-0.042
HM				0.515

Table 24. Effect Size (f^2) for Model A

	Dependent Variables			
Independent Variables	**PE**	**EE**	**HM**	**BI**
PDS	0.415			
PEAT	0.170	0.265		
PPRS			0.330	
POSN			0.063	
PETC			0.021	
PE				0.242
EE				N.S.
HM				0.283

f^2 values of 0.02, 0.15 and 0.35, or above stand for small, medium and large effect sizes respectively (Chin, 2010b). Therefore, based on the values in the above table, it is inferred that the effect size of both (PE) and (HM) on (BI) are large, where for example, the effect size of (EE) on (BI), is non-significant. The independent variable (PPRS) has a close to large effect size where the effects of (POSN) and (PETC) are small.

6.5.2 Model A - Saturated Model Analysis

A saturated model was also created by linking each and every variable in the model in order to explore for any non-hypothesized relationships among the variables of the proposed model. The results of the PLS analysis of these non-hypothesized relations are shown in Table 25 and a schematic of the saturated model is shown in Figure 8.

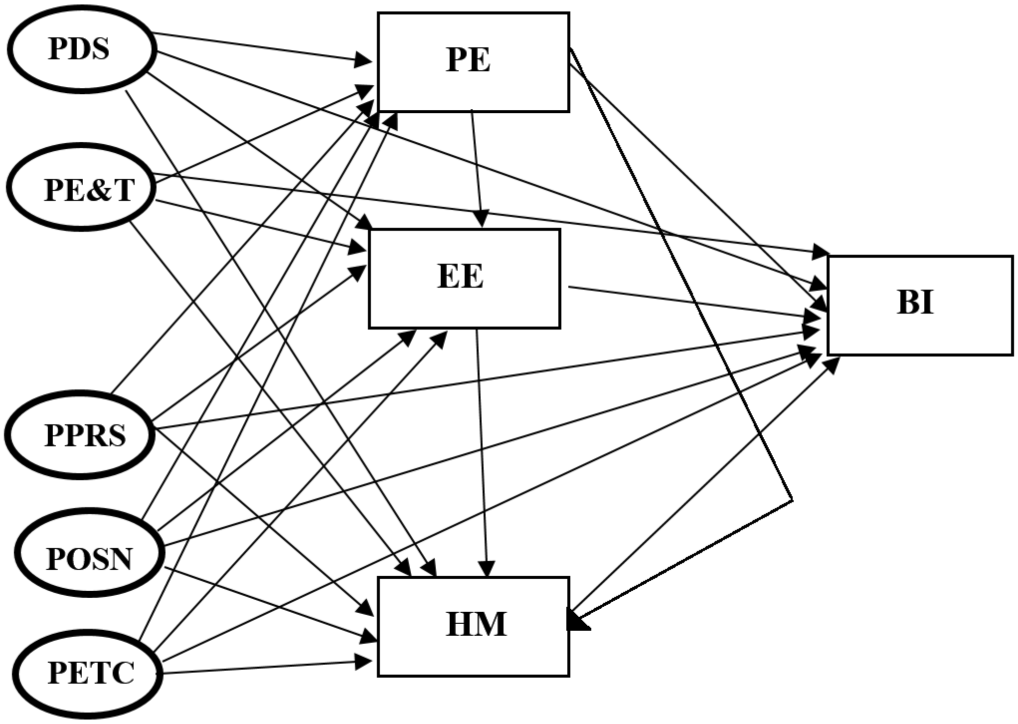

Figure 8. Saturated Model A Analysis

Table 25. PLS Results for Saturated Model A

Path No.	Non-Hypothesized Path	β	t-statistics	R^2	Validation
1	**PDS → EE**	0.228	1.190	EE (0.357)	Not-Supported
2	**PDS → HM**	0.036	0.134	HM (0.786)	Not-Supported
3	**PDS → BI**	0.117	1.089	BI (0.779)	Not-Supported
4	**PEAT → HM**	0.250	2.346 *	HM (0.786)	**Supported**
5	**PEAT → BI**	-0.090	0.839	BI (0.779)	Not-Supported
6	**PPRS → PE**	0.258	2.385 *	PE (0.781)	**Supported**
7	**PPRS → EE**	0.250	1.302	EE (0.357)	Not-Supported
8	**PPRS → BI**	0.326	2.663 ***	BI (0.779)	**Supported**
9	**POSN → PE**	0.103	1.591	PE (0.781)	Not-Supported
10	**POSN → EE**	0.037	0.292	EE (0.357)	Not-Supported
11	**POSN → BI**	0.148	1.971 *	BI (0.779)	**Supported**
12	**PETC → PE**	0.016	0.211	PE (0.781)	Not-Supported
13	**PETC → EE**	0.000	0.003	EE (0.357)	Not-Supported
14	**PETC → BI**	0.075	0.760	BI (0.779)	Not-Supported
15	**PE → EE**	0.223	2.158*	EE (0.357)	**Supported**

16	**PE → HM**	0.067	0.576	HM (0.786)	Not-Supported
17	**EE → HM**	0.324	3.990 ***	HM (0.786)	**Supported**

*: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$

Based on the significance of the relations among the constructs in the saturated model, some of the non-hypothesized links that are highlighted in Table 25 (hypotheses 4, 6, 8, 11, 15 and 17) are significant and valid. A through but unsuccessful literature review was performed in order to find any type of theory to provide support (hypotheses) for those relations. Therefore, it is reasonable to presume that the original theorized research model, including all its hypothesized relationships between constructs is still valid. Ultimately, the new relations found in the saturated model need further investigation in future research.

6.5.4 Predictive Relevance (Q^2) of Model A

Cross validated redundancies (Q^2) for the endogenous variables are presented in Table 26. Predictive relevance of the structural model was examined by calculating Q^2; when it shows a positive value, it is an indicator that the model has predictive relevance, and when it is a negative value, it is an indication that there is lack of predictive relevance in the model (Chin, Johnson, & Schwartz, 2008).

Table 26. Cross-Validated Redundancy for Endogenous Variables in Model A

Endogenous Variables	(Q^2)
PE (Performance Expectancy)	0.718
EE (Effort Expectancy)	0.189
HM (Hedonic Motivation)	0.598
BI (Behavioural Intention)	0. 697

Similar to the case of effect size, values of 0.02, 0.15, and 0.35 or above for Q^2, indicate small, medium, or large predictive relevance for a selected construct respectively. According to Table 26, except for (EE) which has a medium predictive relevance, a large predictive relevance for all other endogenous variables is demonstrated by the model.

6.5.5 Goodness of Fit (GOF) of the Model A

The overall predictability of the model in both measurement and structure is the goodness of fit of the model, defined as (Vinzi et al., 2010):

$$GOF = \sqrt{\overline{Communality} * \overline{R^2}} = \sqrt{(0.9497) * (0.5806)} = 0.7426$$

The baseline values of 0.1 and above (low fit), 0.25 and above (medium fit), and 0.36 and above (high fit) can be used to assess the overall fit of the model (Vinzi et al., 2010). From this result the model shows a high model fit indicating that the model is accurate and useful.

6.6 Analysis of the Impact of Individual Characteristics

Two procedures were used to analyze the impact of individual characteristics of participants on the results of the study. The first approach was to examine the path coefficient (β**)** and t statistics of each individual characteristic (i.e. age, gender, educational background, Internet usage and smartphone access) with each one of the dependent variables. The second approach was to measure the effect size of each individual on the R-squared of each dependent variable. In order to measure the effect size (f^2) and the path coefficient (β) of the individual characteristics on each dependent variable, each was linked to all dependent variables, one at a time. The (f^2) was calculated for each dependent variable using the same formula from previous sections. Results are shown in Tables 27 and 28.

Table 27. Impact of Individual Characteristics on Model A Constructs

Variables	Age		Gender		Education		Int. Use		Smartphone	
Stat.	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**
PE	-0.035	0.636	-0.006	0.126	0.001	0.030	-0.029	0.647	-0.013	0.282
EE	**-0.261**	**3.036**	-0.074	0.889	0.134	1.509	0.059	0.846	-0.104	1.135
HM	-0.017	0.317	0.009	0.189	-0.034	0.714	-0.027	0.605	-0.024	0.485
BI	0.018	0.391	0.035	0.684	-0.022	0.440	0.010	0.219	0.057	1.112

Table 28. Individual Characteristic Effects on R^2 of Model A (f^2)

Variables	PE	EE	HM	BI
Age	0.004	**0.102**	0.004	0.000
Gender	0.000	0.007	0.000	0.004
Educational Background	0.000	0.025	0.004	0.004
Hours of Internet Use	0.004	0.004	0.004	0.000
Smartphone Access	0.000	0.014	0.004	0.012

According to the results in Tables 29 and 30, only Age has a meaningful relation with the Effort Expectancy (EE) dependent variable in the model. One reason could be that only the data of the participants who have at least one serious chronic disease were collected and generally, chronic disease will be more likely to occur at older ages (Aldrich & Benson, 2008).

6.7 Analysis of the Impact of Perceived Care Partner Support (PCPS)

As explained before, in this section an analysis of the impact of care partner support on the perceptions of individuals who had access to such care was undertaken, and whether this encourages or discourages participants to use the system. Table 29 demonstrates the results of model A with the PCPS construct added, now being referred to as model B.

Table 29. PLS Results for Model B

Hypotheses	Path	Path Coefficient	t- Statistics	R^2	Validation
H1	**PCPS → PE**	0.174	1.838	PE(0.706)	**Not- Supported**
H2	**PDS → PE**	0.483	4.266 ***	PE(0.706)	Supported
H3a	**PEAT → PE**	0.281	2.425 **	PE(0.706)	Supported
H3b	**PEAT → EE**	0.344	3.074 ***	EE (0.118)	Supported
H4	**PPRS → HM**	0.339	2.858 ***	HM (0.521)	Supported
H5	**POSN → HM**	0.294	3.208 ***	HM (0.521)	Supported
H6	**PETC → HM**	0.212	2.279 *	HM (0.521)	Supported
H7	**PE → BI**	0.469	5.425 ***	BI (0.695)	Supported
H8	**EE → BI**	-0.071	0.821	BI (0.695)	**Not- Supported**
H9	**HM → BI**	0.436	3.956 ***	BI (0.695)	Supported

***: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$**

As shown in Table 29, all the relationships in the model except for EE→ BI and PCPS → PE are significant and valid. Figure 9 demonstrates model B.

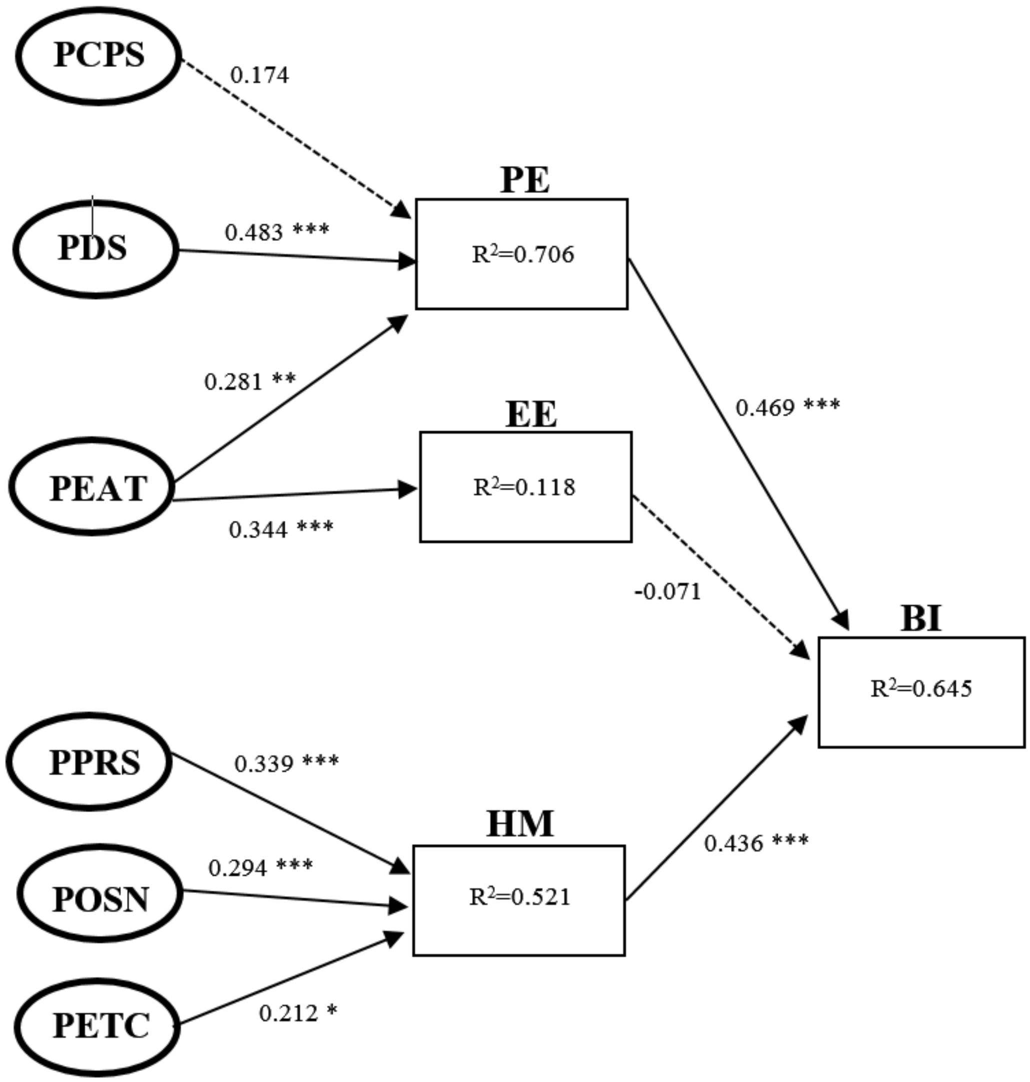

Figure 9. PLS Results[8] for Model B

Similarly to model A, in model B there are two non-significant paths. Surprisingly, PCPS shows a non-significant relation to PE, despite what was hypothesized. However, PETC has now has a significant relation with HM. It seems that participants who already have access to care partner support seem to care about entertainment significantly more than those without such care. However, EE→BI relation is still non-significant which is consistent with model A. At this point, with the (PCPS) construct added to the model (now Model B) a saturation analysis between (PCPS)

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[8] N= 96, *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$, ------: non-significant path

and all the endogenous variables in the model was performed to reveal which of the relations are significant and valid. The results are shown in Table 30.

Table 30. Impact of PCPS on Endogenous Variables of Model B

Endogenous Variables	**PCPS**		
	β	**t**	f^2
PE	0.099	1.104	0.019
EE	0.218	1.725	0.034
HM	-0.001	0.016	0.000
BI	0.150	1.810	0.044

: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$

As shown in Table 30, surprisingly, the (PCPS) construct has no significant relation with any of the endogenous constructs in the model.

6.7.1 Effect Size (f^2) of Model B

The total effect sizes (f^2) of all pairs of independent and dependent variables are presented in Table 31. f^2 values above 0.02, 0.15, and 0.35 are interpreted as small, medium, large effects respectively (Chin, 2010b).

Table 31. Effect Size (f^2) for Model B

	Dependent Variables			
Independent Variables	**PE**	**EE**	**HM**	**BI**
PCPS	N.S.			
PDS	0.319			
PEAT	0.126	0.134		
PPRS			0.125	
POSN			0.106	
PETC			0.051	
PE				0.285
EE				N.S.
HM				0.189

Based on the values in the above table, most notablly the effect size of (HM) on (BI) is weaker than its effect size in model A. Although (PCPS) itself is not present in model A, this could imply that the effect on the usability of a system when a person has care partner support is more than when the person has no such support. Further, the effect of hedonic motivation (HM) on (BI) is less (compared to model A), which means that when an individual has access to care partner support, the person is less likely to be attracted to use the system for hedonic reasons.

6.7.2 Model B - Saturated Model Analysis

A saturated model was also created by linking each and every variable in the model in order to explore for any non-hypothesized relationships among the variables of the proposed model B. The results of the saturation analysis showed no difference (in sense of relations) with the saturated model A.

6.7.3 Predictive Relevance (Q^2) of the Model B

Cross validated redundancies (Q^2) for the endogenous variables of model B are presented in Table 32. Predictive relevance of the structural model was examined by calculating (Q^2) when it shows a positive value.

Table 32. Cross-Validated Redundancy for Endogenous Variables in Model B

Endogenous Variables	**Q^2**
PE (Performance Expectancy)	0.668
EE (Effort Expectancy)	0.104
HM (Hedonic Motivation)	0.458
BI (Behavioural Intention)	0.630

Similar to the situation with effect size, values of 0.02, 0.15, and 0.35 or above for Q^2, indicate small, medium, or large predictive relevance for a selected construct respectively. According to the above table, except for (EE) which has a medium predictive relevance, a large predictive relevance for all other endogenous variables is seen in model B.

6.7.4 Goodness of Fit (GOF) of Model B

The overall predictability of model B in both measurement and structure is the goodness of fit of the model, defined as (Vinzi et al., 2010):

$$GOF = \sqrt{\overline{Communality} * \overline{R^2}} = \sqrt{(0.9403) * (0.4976)} = 0.6840$$

Model B shows a high model fit which makes the model both accurate and useful.

6.7.5 Comparison of R2, Q2 and GOF for Models A and B

The coeficient of determination (R^2), predictive relevance (Q2) and goodness of fit (GOF) of Model B (Figure 9) with the equivalent of Model A (Figure 7) are compared. The outcomes of this comparison are shown in Tables 33 - 35.

Table 33. Comparison of R^2 of Variables in Model B and Model A

Variables	R^2 - B	R^2 – A	Δ R^2
PE	0.706	0.735	0.029
EE	0.118	0.210	0.092
HM	0.521	0.667	0.146
BI	0.695	0.711	0.016

Table 34. Comparison of Q^2 of Variables in Model B and Model A

Variables	Q^2 - B	Q^2 – A	Δ Q^2
PE	0.668	0.718	0.050
EE	0.104	0.189	0.085
HM	0.458	0.598	0.140
BI	0.630	0. 697	0.067

Table 35. Comparison of GOF of Model B and Model A

GOF- B	GOF – A	Δ GOF
0.6840	0.7426	0.0586

Based on the results of this analysis, apparently those who had access to care partner support were less interested in using the proposed system, according to this research. One explanation could be that those who have access to the help and support of a care partner felt more capable of dealing with their conditions on their own. However, those who did not have a care partner and such support, felt more in need of help of a third party (or system). However, this theory certainly needs further investigation, with more specific questions geared towards the theory.

6.7.6 Impact of Individual Characteristics on Model B

Similar to the analysis of model A, two procedures were used to analyze the impact of individual characteristics of participants on the results for model B. The first approach was to examine the path coefficients (β**)** and t statistics of each individual characteristic (i.e. age, gender, educational background, Internet usage and smartphone access) with each one of the dependent variables. The second approach was to measure the effect size of each individual on the R^2 of each dependent variable. In order to measure the effect size (f^2) and the path coefficient (β) of the individual characteristics on each dependent variable, each was linked to all dependent variables, one at a time. The (f^2) was calculated for each dependent variable using the same formula for the previous sections. Results are demonstrated in Tables 36 - 37.

Table 36. Impact of Individual Characteristics on Model B Constructs

Variables	**Age**		**Gender**		**Education**		**Int. Use**		**Smartphone**	
Stat.	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**	**β**	**t**
PE	0.069	1.398	0.005	0.108	-0.050	0.963	0.004	0.075	-0.010	0.187
EE	**-0.327**	**3.660**	-0.018	0.204	0.174	2.109	0.032	0.357	-0.186	1.955
HM	-0.049	0.816	0.065	1.147	-0.086	1.734	-0.021	0.465	-0.030	0.541
BI	0.044	1.113	0.042	0.752	-0.004	0.072	-0.084	1.531	0.040	0.695

Table 37. Individual Characteristic Effects on R^2 of Model B (f^2)

Variables	PE	EE	HM	BI
Age	0.019	**0.158**	0.013	0.007
Gender	0.000	0.000	0.000	0.003
Educational Background	0.011	0.040	0.010	0.000
Hours of Internet Use	0.000	0.001	0.000	0.022
Smartphone Access	0.000	0.015	0.006	0.003

According to the results in the above tables, only Age has a meaningful relation with the Effort Expectancy (EE) dependent variable in the model, which is consistent with the results from model A.

6.8 Examination of Open-Ended Questions

There were three main qualitative open-ended questions as well as two related categorizing questions, in order to collect insights on the mind-set of participants regarding adoption and use of the proposed system. Participant responses were summarized and are presented in this section.

6.8.1 First Open-Ended Question

In the first categorizing question, we tried to understand why people might not be interested in using a system such as the one presented in the video. The participants were asked to say *whether they were interested in using the system* and if their answer was “No”, they were asked to explain why. If the answer was “Yes”, the first open-ended question was ignored and the participant focus was moved to the next (second) question. Here is the first categorizing question as well as its related open-ended question:

First Open-ended Question: “*If no, please tell us why. This will help us improve the proposed system for you and other potential users.*” A summary of the participant responses is in Table 38.

Table 38. Results from the First Open-ended Question

Type of Concern	Number of Answers	Percentage
Too much effort	49	~ 49 %
Lack of need	22	~ 22 %
Security & Privacy	20	~ 20 %
Other concerns	10	~ 10 %

A review of the categorical responses indicates:

1) **Too much effort**: almost 49% of the participants who did not agree that they would use the system, thought that using such system and entering data in a daily or even weekly manner would be too much effort. They were not ready to commit to such time and effort to use the system.

2) **Lack of need**: almost 22% of the respondents who did not agree to use the system thought that there was no need for such a system. They either had access to a similar system or they didn’t think that the proposed system would add any benefit.
3) **Security & Privacy**: almost 20% of the participants who did not agree to use the system had security and privacy issues. They did not trust the system to maintain the privacy of their information online.
4) **Other concerns**: About 10% of the participants who did not agree to use the system, either did not answer why they didn’t want to use it, or they mentioned other reasons or concerns.

6.8.2 Second Open-Ended Question

The second open-ended question asked all participants to provide suggestions for improving the system, as follows:

“Do you have any suggestions for making the proposed system more interesting, more useful, easier to understand, or easier to use?”

Unfortunately, most of the participants said that they did not have any suggestions. A number provided positive feedback such as “good work…”, “it’s awesome…”, “well designed system”, “easy to understand”, etc. while some others just said “No” or “N/A” as a suggestion. However, there were also suggestions that are worth considering. These suggestions were categorized and highlights are provided in Table 39.

Table 39. Highlights of Participant Suggestions for System Improvement

Suggestions
➢ Making it more automated to eliminate data entry, so less effort and time would be needed ➢ Support for more specific conditions ➢ Linking the system to the systems of official healthcare providers ➢ Adding a professional fitness trainer ➢ Patients should be able to see what others with similar condition are doing, rather than just what they choose to post online ➢ Education for the care partner too

6.8.3 Third Open-Ended Question

The third open-ended question and its related categorizing question attempted to understand the participant's perceived effort that would be needed to use the system and whether participants would see themselves using it on a daily basis. After that, participants were asked to tell us how they would use the system. Here is the third categorizing question as well as its related open-ended question:

Third Categorizing question: "*Do you think you would be able to find time to access the proposed system at least once a day on a regular basis?* ☐ *Yes* / ☐ *No* "

Third Open-ended question: "*Please explain how you might use the proposed system to help you with managing your chronic illness.*"

Among the 198 valid responses, 118 participants (~ 60%) answered "Yes", 80 participants (~ 40%) answered "No" to the categorizing question. On the related open-ended question, most of the participants who had already stated that they would not use the system, didn't really make any usable comments, which was certainly understandable. There were also cases where participants indicated that they would want to use the system, but didn't leave any usable comments. The rest of the participants who stated that they were going to use the system, and also left a comment, mostly explained how they would use specific modules. Here are some of the comments, for example:

"Because I have elevated blood pressure I know that I need to lose weight and I know that I need to exercise. I know what to do but I just can't motivate myself to get out there and exercise. If I had to report my exercise on a daily basis and get nagged if I don't then I would exercise. It is like the "gag" that one comedian did. He offered these overweight people a real life conscience to follow them around and nag them about what they were eating. It was all a gag but some people actually took the fellow up on his idea and wanted someone to follow them around and keep them on track. I personally would not like that but I might like to have a reporting system to help me."

"Keep track of exercise and medications. Also keep current health information."

"Monitor my blood daily"

"My illness is managed"

"Put all my info in once a day. Use as an educational tool"

Participants mostly explained their own needs and how they would use the system to cover that need. Although they had a wide variety of different needs and concerns, their ways of using the system were mostly similar but with some differences in the time they were willing to spend using the system.

Chapter 7. Discussion, Conclusions & Future Research

The following sections will discuss the main research questions and whether the results of this study provide a suitable answer for each one of them. Finally, the study's contributions, limitations and possible future research will be discussed.

7.1 Answers to Research Questions

7.1.1 Research Question 1

RQ1: *"How do individual perceptions regarding the use of the system influence their behavioural intention to use such systems?"*

Related Theorized Hypotheses:

H7: "*Performance expectancy will have a positive influence on the behavioural intentions of users to adopt and use the system*".

H8: "*Effort expectancy of the system will have a positive influence on the behavioural intentions of users to adopt and use the system*".

H9: "*Hedonic motivation will have a positive influence on the behavioural intentions of users to adopt and use the system*".

Based on the research findings presented in the previous chapter, it is surprising that even though a pre-validated model (i.e. UTAUT2 (Venkatesh et al., 2012)) was adapted to this study, the results and findings do not align entirely with previous findings. According to a variety of different studies in the context of Information Research (e.g. (Davis, 1989), (Brown & Venkatesh, 2005), (Venkatesh & Bala, 2008), (Venkatesh et al., 2012), etc.) there should be a strong connection between performance expectancy and behavioural intention of users (PE → BI) and also between effort expectancy of the system and behavioural intentions (EE → BI) as well as hedonic motivation and behavioural intention (HM → BI). However, while there was a significant relation between PE→ BI (β=0.411, f^2=0.242) HM→ BI (β=0.515, f^2=0.283), there was no significant relationship between EE → BI. These results were also consistent with the model B results as PE→ BI (β=0.469, f^2=0.285) HM→ BI (β=0.436, f^2=0.189) and there was no significant relationship between EE→ BI.

Comparing the two models (A and B), it is obvious that while the PE→BI and HM→BI relationships are significant and consistent with prior IS research, the introduction of new factors has resulted in a loss of effect size of the EE variable on BI. The new factors are the newly added constructs that are more related to the context of this research (Hong et al., 2014), which appear to influence the perception of participants in their own way. Therefore, it could be inferred that both hypotheses H7 and H9 are still valid and supported by this research for both models (A & B), and consistent with prior IS research.

In the case of hypothesis H8, since the participants were mostly well-educated with only about 10% having a high school diploma or less education, it could be expected that they would have the ability to understand the system and the benefits it could provide. However, examination of responses to the first open-ended question as well as its categorizing question showed that about half of the respondents felt that using such a system requires too much effort (i.e. daily interaction with the system, commitment to daily data entry, etc.). However, even those participants who stated that they did not want to use the system due to the amount of effort needed, had a positive perspective towards the potential benefits for users. This may account for the finding that Effort Expectancy doesn't have a significant effect on Behavioural Intentions of potential users.

Although there is no significant relationship between EE and BI, the saturated model analysis (both models A and B) show that there is a relatively strong relationship between EE and HM (EE → HM). Further, the results suggest that ease of use of the system has a large effect size on hedonic motivation (β=0.339, f^2=0.351) for model A, and (β=0.416, f^2=0.554) for model B. This means that the easier the system is to use, the more motivation users will have to use it, which is very much in line with the results from the first and second open-ended questions.

However, for saturated model B, there is another observation that is certainly worth more investigation. Based on the results of model B (the individuals who have access to care partner support), it seems that individuals with access to care partner support are more motivated to use the system based on the effort they put in to use the system (EE→HM: β=0.416, f^2=0.554) & (HM→BI: β=0.346, f^2=0.197) , compared to the same results for individuals who do not have access to such support (EE→HM: β=0.339, f^2=0.351) & (HM→BI: β=0.315, f^2=0.139) in saturated model A.

7.1.2 Research Question 2

RQ2: *"How do support elements (i.e. decision support, family and community support, and education and training) influence individual perceptions in regards to using the system?"*

Related Theorized Hypotheses:

H1: "*Perceived usefulness of care partner support has an influence on user perceptions of the performance expectancy of the system*".

H2: "*Perceived usefulness of decision support has an influence on user perceptions of the performance expectancy of the system*".

H3a: "*Perceived education and training has a positive influence on user perceptions of the performance expectancy of the system*".

H3b: "*Perceived education and training has a positive influence on user perceptions of the effort expectancy of the system*".

The first hypotheses (H1, H2, H3a, and H3b) were theorized to examine the effect of the support elements (PCPS, PDS, and PEAT) on their relative construct.

According to the results of model A (without care partner support), both PDS and PEAT have a strong and significant relationship with their relative construct (Table 22). Further, according to the results of model B (including care partner support), again those same two constructs (PDS and PEAT) have a significant relationship with their relative constructs, but surprisingly, PCPS shows no significant relation in model B (Table 29). Since in model B, all participants stated that they had access to care partner support, it could be inferred that this construct makes no difference to the results since all are on the same page. They all do have access to care partner support, so their perceptions and therefore, their answers are almost the same.

The second set of hypotheses (H2 and H3a and H3b) were theorized to examine the effect of the support construct on the previously discussed user perceptions of performance and effort expectancy of the system. According to the results of model A, both PDS → PE (β=0.394, f^2=0.205) and PEAT → PE (β=0.266, f^2=0.107) relationships are significant which is in-line with prior IS research. This indicates that the support elements have a considerable effect on the perceptions of users in the sense of perceived usability of the system.

Although it was expected that, in both models A and B, the relationship between PEAT and EE would be strong, surprisingly, it was insignificant. However, in the original model A the relationship was strong with high effect size (PEAT→EE: β=0.458, f^2=0.265) which was in-line with prior IS research (Brown et al., 2010), (Venkatesh et al., 2012). After saturation analysis and finalizing the model (model A), that relationship lost significance and PEAT showed a significant relationship with HM (PEAT→HM: β=0.321, f^2=0.243), which was very interesting. For model B, the results were consistent with model A (PDS→PE: β=0.493, f^2=0.431), (PEAT→PE: β=0.240, f^2=0.102), (PEAT→HM: β=0.378, f^2=0.364), which also reconfirmed the expectation.

7.1.3 Research Question 3

RQ3: *"How do sustainability elements (i.e. online social network, entertainment components, and patient reward system) influence individual perceptions in regards to using the system?"*

Related Theorized Hypothesis:

> **H4:** "*Perceived patient rewards system has an influence on user hedonic motivation to adopt and use the system*".
>
> **H5:** "*Perceived online social networking has an influence on user hedonic motivations to adopt and use the system*".
>
> **H6:** "*Perceived entertainment components have an influence on user hedonic motivations to adopt and use the system*".

Hypotheses (H4, H5, and H6) were theorized to examine the effect of the sustainability elements (PPRS, POSN and PETC) on their relative constructs. Interestingly, model A shows that

PPRS (Perceived Patient Reward System) has a large effect on hedonic motivation (PPRS→HM: β=0.541, f^2=0.330) as was originally theorized and expected, but it also influences both PE and BI as saturated model analysis shows (PPRS→PE: β=0.307, f^2=0.183), (PPRS→BI: β=0.403, f^2=0.218). It clearly shows that reward is a strong driver for participants that not only affects hedonic motivation but also has an influence on usability, directly affecting their decision whether to use the system. Although the result of model B shows less explanatory power for PPRS compared to model A (PPRS→HM: β=0.339, f^2=0.125), and for the saturated model B (PPRS→PE: β=0.261, f^2=0.174), (PPRS→BI: β=0.352, f^2=0.216), it reconfirms the conclusion. This means that, even for patients who have access to care partner support, reward plays a key role in their decision to adopt and use the system.

Further, the results of model A (without care partner support) shows that POSN has a weak relation with HM only (POSN→HM: β=0.212, f^2=0.063). Model B results are also consistent with model A (POSN→HM: β=0.294, f^2=0.106), but the results show a little stronger relation. It could be inferred that participants who have access to care partner support value social relations and social networks more than participants without such support. The results of model B show that participants who have access to care partner support are more likely to want to use the online social network, if they decide to adopt the system.

Perceived Entertainment (PETC) seems to have no meaningful relationship with any of the constructs in model A (based on both model A results and saturated model analysis for model A). However, it has a small effect size relationship with HM in model B (PETC→HM: β=0.212, f^2=0.051), which is very interesting. It could be inferred that participants with access to care partner support are more likely to care about entertainment and would enjoy using the system more than those without such access. However, more research has to be conducted in order to find out “why”.

7.1.4 Research Question 4

RQ4: *“How do individual characteristics such as age, gender, educational background, etc. and nationality (US vs Canada) affect the dependent variables (i.e. PE, EE, HM and BI) in the proposed theoretical model in this dissertation?”*

According to the results of model A presented in the previous chapter (section 6.5.2), it seems that, except for one variable (Age), no other individual characteristics variables (e.g. gender, educational background, etc.) have any influence on the endogenous variables of the model. Age was the only variable that showed a small negative effect ($\beta = -0.261$, $f^2 = 0.102$), but on the Effort Expectancy variable only. Similar results from model B also confirms this ($\beta = -0.327$, $f^2 = 0.158$). The reason could be that data were collected only from participants who have at least one serious chronic disease. Generally, serious chronic disease is more likely to occur at older ages and the older generation have relatively less familiarity with new technology (Aldrich & Benson, 2008).

7.2 Appropriateness of the Proposed Model

The appropriateness of the model is assessed in terms of three important parameters: R^2 (R-squared), Q^2 (predictive relevance) and GOF (goodness of fit) which was explained in the previous chapter. In the case of R^2, a comprehensive study (Venkatesh et al., 2003) examined eight theories of technology or information systems acceptance models by using partial least squares analysis, and compared them with UTAUT theory. It reported that R^2 for BI ranged from 0.30 to 0.38 for these theories, and that the R^2 for UTAUT in the pre-use stage was 0.52. Another study (Venkatesh et al., 2012) compared differences of R^2 for BI (behavioural intention) between UTAUT ($R^2 = 0.56$) and UTAUT2 ($R^2 = 0.74$). The BI in model A in this study achieved an R^2 of 0.711, and model B achieved an R^2 of 0.695, both of which are very good in comparison with some of the most established studies in IS research.

Further, according to the results of model A, the predictive relevance of the endogenous variables in the model are very good. PE, HM and BI have a Q^2 of 0.718, 0.598 and 0.697 respectively which indicates high predictive relevance for all of them. EE's Q^2 of 0.189 indicates a medium predictive relevance which is still acceptable. In model B, the predictive relevance for PE, HM and BI are also 0.668, 0.458 and 0.630 respectively which are also very promising. Just like model A, in model B the predictive relevance for EE is lower (0.104), but it is still acceptable.

Moreover, the goodness of fit for both models A and B are also very good. In model A, the GOF is 0.7426, and in model B it is 0.6840, indicating that both models are appropriate models for predicting the intentions of potential users to adopt and use the system.

7.3 Contributions of This Research

7.3.1 Contributions to Theory

While the contributions of other previous studies in this field have been acknowledged, it seems that most of these studies targeted a specific population (e.g. elderly, children, etc.) or focused on a certain technology (e.g. personal health records) without considering the other factors that might contribute to either acceptance or refusal of a technology (Assadi, 2013). The major theoretical contribution of this research is to introduce a model including new influencing factors (i.e. support and sustainability) for chronic care technology acceptance and use. The new model has been tested and validated with promising results. Compared to the results of other studies, the proposed model has a high predictive relevance (Q^2) and goodness of fit (GOF). The R^2 of behavioural intention (BI) for both model A and model B have also shown high explanatory power (0.711 and 0.695 respectively) which are both higher than most results reported by previous studies using similar models.

Although there is a wide variety of studies that have studied perceptions of users in technology adoption in different fields (e.g. (Davis et al., 1989), (Venkatesh et al., 2003), (Venkatesh & Bala, 2008), (Venkatesh et al., 2012), etc.), there are few studies that have considered the factors that actually impact user perceptions (e.g. (Brown et al., 2010), etc.). It is clear from this research that these newly introduced factors (i.e. support and sustainability), not only affect the perceptions of users regarding the usability and ease of use of the technology (PE and EE), or elevate user motivation and interest in using it (HM), but also directly influence the decisions of users to adopt and continue to use the technology (BI). Including these factors was in line with guidelines for contextualization of the theory of this research (Hong et al., 2014) which have shown a lot of promise. Moreover, there is room for more studies and observations in the future to further explore the capabilities of support and sustainability.

Finally, the roles of individual characteristics such as age, gender, educational background, Internet use, etc. in decisions of users to accept and use technology, has been studied and presented.

7.3.2 Contributions to Practice

This research provides valuable contributions, insights and enlightenment for developers, practitioners, managers and governments. Table 40 summarizes the contributions to practice. According to this research, support elements such as decision support and education enhances user perceptions of usability and ease of use of the technology, as well as elevating their motivation to use it. Sustainability elements such as rewarding patients for continuing to use the system, providing entertainment in the form of games or other amusements, and also letting them network with people with similar conditions would also affect user perceptions of usability. This may result in elevating their motivation and even affecting their decisions to adopt and use the technology.

Table 40. Examples of Practical Implications

Findings	Value Added From This Research	Practical Implications
Support Elements (PDS & PEAT) positively influence Performance Expectancy (PE), Effort Expectancy (EE) and Hedonic Motivation (HM)	Empirical support for this relationship, provided by this research, has not previously been proposed or validated in the context of chronic care systems	• Provide decision support to help patients with routine daily decision making • Train users prior to use and provide on-going education and training during use
Sustainability Elements (PPRS) positively influence Performance Expectancy (PE), Hedonic Motivation (HM) and Behavioural Intention (BI) and Also, (POSN) influences (BI)	Empirical support for this relationship, provided by this research, has not previously been proposed or validated in the context of chronic care systems	• Implement a reward system for users based on the amount of daily and weekly use of the system • Develop a specialized online social network for patients with similar conditions • Entertain users by developing simple but serious games for them, and show entertaining and educational videos to them on a daily basis

7.4 Limitations of the Study

As with any empirical study, there are some limitations to be considered:

1) Generalizability of the findings: the study was conducted in Canada and US where the penetration of Internet and smartphones is high. The findings of this study may therefore not be generalizable to less technologically advanced countries. Further, there are differences in healthcare systems in North America compared to the rest of the world, and this may restrict the applications of the findings of this study outside of North America. Moreover, culture is an important factor which must be taken into consideration, and can potentially limit the generalizability of the findings of this study. Further research is certainly needed to clarify whether these findings are applicable to other countries outside of North America.

2) Behavioural Intention to adopt (BI) was self-reported in this study, which is another limitation. The best way to test USE is to first measure participant intention to use and then give them an actual opportunity to actually use the system, so a comparison between perception and actual use would be possible. However, this is a cross-sectional study and this could not be considered properly. Future research should address comparisons between perception and actual continued use.

3) Another limitation was the target population of this study. Since the data were collected using an online survey, it is possible to argue that participants were biased because they were already Internet users. This limitation needs further investigation through future research.

7.5 Future Research

This research has uncovered some notable issues that certainly need further investigation. As explained in the previous section, there are some important problems that remain to be addressed. One of the most important ones is to compare behavioural intentions of the users and actual adoption and continued use behaviour. Another important issue is to study pre-use and post-use user perceptions of the system. Finally, a study to investigate and understand why patients who have access to care partner support are less likely to be interested in adopting the system is needed. Moreover, more study on the proposed model is needed to further validate the model.

Since a system has been built now for patients with peripheral arterial disease self-management based on these results, it is hoped to find answers to all three of the previously mentioned questions in this application of the system. A longitudinal study, designed so that the same survey in this study is used to collect pre-usage perceptions of the users, will include additional questionnaires at the midpoint and termination of a six month study. This will allow pre-conceptions of users to be compared with their opinions after using the system for several months.

7.6 Conclusions

In this study, the essential elements of a comprehensive and effective self-management support system such as decision support, education and training, networking, recreation and ongoing patient motivation have been reviewed. A theoretical model for the design of a system that fully supports health self-management has also been presented, and suitable revisions to this model have been proposed. The proposed system can be used to support chronically ill patients in their regular self-management tasks and daily decision making. It also can be used by patients for preventive care to maintain their health and mitigate the risks of developing an illness, through education, recreation, monitoring, feedback, decision support, communication, and mutual support for patients and others with similar interests and problems (social network).

Moreover, an online personal DSS would support patient care based on a care plan designed by that patient's physician and/or specialist, and would provide feedback on monitored data regularly. It would also provide advice and support for the patient. This support must also take into consideration that a high percentage of older adults (65+) have at least one type of chronic disease that can cause some levels of activity limitation and/or judgment impairment. This often leads to inability to perform basic activities of daily living routines such as eating, dressing, bathing, and even simply moving around the house (Aldrich & Benson, 2008).

Considering the large and growing proportion of the aging population that suffers from one or more chronic disease, any system for the treatment of chronic conditions should be able to offer a variety of support that takes the needs and limitations of patients suffering from these chronic diseases into account (Aldrich & Benson, 2008). There are also some similarities and differences between symptoms of different chronic diseases. For instance, chronic obstructive pulmonary disease and asthma have some similarities in symptoms as well as some differences that must be considered before treatment (Mauad & Dolhnikoff, 2008).

It is expected that positive results of this nature would be useful to healthcare system policy makers by demonstrating a significant impact on healthcare through improved self-care and management of patient chronic diseases, better communication among the health care team, reduced need for family physician appointments, reduced hospitalization and emergency room visits for patients, as well as improved cost-effectiveness (Ariaeinejad et al., 2012).

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Appendix A. Consent to Participate in a Research Study

Chronic Illness Self-Management Consumer/Patient Survey

Investigator Name and Title	**Contact Information**
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Collaborator: Mr. Muhammad Khan, MSc Web Architect	DeGroote School of Business, McMaster University Hamilton, ON L8S4M4 arfankhan77@yahoo.com

Purpose of the Study

The objective of this study is to gather consumer and patient perspectives on topics related to the potential for the provision and use of an online Chronic Disease Self-management Support

System (CDSSS) by patients with serious chronic illnesses. We believe that the findings from this study will be helpful to consumers and medical practitioners in the ongoing exploration of the need, functionalities and content for supporting chronically ill patients.

What Will Happen During the Study?

First, you will be asked to answer a few demographic questions concerning your age, gender, etc. followed by a short survey concerning your interest in health self-management. Then, after watching a six minute video clip about the features and functionalities of a proposed CDSSS, you will be asked to respond to a short series of statements about your perceptions of the CDSSS. The total time to complete the study will be less than 20 minutes.

Risks

This study is limited to consumers 18 years of age or over. It is unlikely that your participation in this study will cause any discomfort or harm. Some of the questions may cause you to reflect on issues or decisions that may be a source of concern or worry for you. Any responses you provide will be treated confidentially by the researchers named above.

Confidentiality

You will be participating in this study anonymously. Nobody, including the researchers named above, will know that you have participated. All information collected will be stored securely and kept in strict confidence. Only the researchers named above will have access to the data. Participants are anonymous and will not be identified individually in any reports or analyses resulting from this research project.

Withdrawal

Except for a few questions that are critical to the value of the survey, you may skip or answer “do not know” to any questions you do not wish to answer, and you may withdraw from the study at any time. If you withdraw, any data you have provided to that point will be destroyed, and you will not receive any compensation for participation.

Questions about the Study

This study has been reviewed by the McMaster University Research Ethics Board and received ethics clearance. If you have concerns or questions about your rights as a participant or about the way the study is conducted, please contact:

McMaster Research Ethics Secretariat
Telephone: (905) 525-9140 ext. 23142
c/o Research Office for Administrative Development and Support
E-mail: ethicsoffice@mcmaster.ca

Appendix B. Survey Questionnaire

Please answer the following questions:

- I am 18 years of age or older ☐ Yes / ☐ No
- I have been diagnosed by a physician to have a serious chronic illness ☐ Yes / ☐ No
- Chronic illnesses can rarely be cured ☐ Yes / ☐ No

If answers to the above three questions are all Yes, branch to Question 1. (Below) Otherwise Print "Thank you for your interest. Unfortunately, you do not meet the requirements for participation in this survey" => Exit

1. Demographics:

1.1 Your age?

☐ 29 or younger
☐ 30 - 49
☐ 50 - 69
☐ 70 or older

1.2 Your gender?

☐ Female
☐ Male

1.3 Educational background:

☐ Below the high school diploma
☐ High school diploma
☐ Some college
☐ Bachelor's degree
☐ Master's degree or higher

1.4 Do you have access to the Internet?

☐ No

☐ Yes **1.4.1** How much do you use the Internet on a weekly basis?

☐ I don't use the Internet at all

☐ Up to one hour

☐ From 1 to 3 hours

☐ More than 3 hours

1.5 Do you have and use a Smartphone/Tablet?

☐ Yes → **1.5.1** What is the type of your Smartphone/Tablet**:** ______________________

☐ No → **1.5.2** Does someone close to you have a Smartphone/ Tablet that they might help you to use to access online information? ☐ Yes / ☐ No

2. Please check one box only (Patient Activation Measure):

2.1 When all is said and done, I am the person who is responsible for managing my health condition

Disagree Strongly	**Disagree**	**Agree**	**Agree Strongly**	**Not Applicable**
☐	☐	☐	☐	☐

2.2 Taking an active role in my own health care is the most important factor in determining my health and ability to function.

Disagree Strongly	**Disagree**	**Agree**	**Agree Strongly**	**Not Applicable**
☐	☐	☐	☐	☐

2.3 I am confident that I can take actions that will help prevent or minimize some symptoms or problems associated with my health condition

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.4 I know what each of my prescribed medications do

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.5 I am confident that I can tell when I need to go get medical care and when I can handle a health problem myself

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.6 I am confident I can tell my health care provider concerns I have even when he or she does not ask

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.7 I am confident that I can follow through on medical treatments I need to do at home

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.8 I understand the nature and causes of my health condition(s)

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.9 I know the different medical treatment options available for my health condition

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.10 I have been able to maintain the lifestyle changes for my health that I have made

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.11 I know how to prevent further problems with my health condition

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.12 I am confident I can figure out solutions when new situations or problems arise with my health condition

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

2.13 I am confident that I can maintain lifestyle changes like diet and exercise even during times of stress

Disagree Strongly	Disagree	Agree	Agree Strongly	Not Applicable
☐	☐	☐	☐	☐

Please watch the short video clip:

https://www.youtube.com/watch?v=raNgMynG-KM

Kindly respond to the statements below concerning the video presentation you have just seen.

3. Please check the appropriate box (one box only for each statement).

3.1 I think that the support and help from the system would be **useful** in my regular decision making tasks.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

3.2 I think that the support and help from the system will make my regular decisions **more effectively**.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

3.3 I think that that the support and help from the system will be valuable in making my regular decisions **more efficiently**.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

4. Do you have (or intend to have) a care partner to help you with your self-management tasks?

☐ No → Please go directly to question 5.

☐ Yes → Please answer the following questions (4.1 – 4.3):

4.1 I think that the support and help from my care partner will be **<u>useful</u>** in performing my regular self-management tasks.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

4.2 I think that the support and help from my care partner will help me perform my regular self-management tasks **<u>more effectively</u>.**

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

4.3 I think that the support and help from my care partner will help me perform my regular self-management tasks **<u>more efficiently</u>**.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

5. Please check the appropriate box (one box only).

5.1 I think the video I just watched would be **<u>useful</u>** in helping me to use the system.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

5.2 I think the video I just watched would help me use the system **more effectively**.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

5.3 I think the video I just watched would help me use the system **more efficiently.**

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

5.4 I think the video I just watched would help me use the system **more easily**.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

5.5 I consider the video I just watched as a critical element in showing **how to interact with the system.**

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

5.6 I think the video I just watched would help me **understand the system better**.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

6. Please check the appropriate box (one box only).

6.1 If available to me, I <u>**predict**</u> I would use the online social network that is built into the system.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

6.2 I <u>**plan**</u> to use the online social network that is built into the system, if it is made available to me.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

7. Please check the appropriate box (one box only).

7.1 If available to me, I <u>**predict**</u> I would use the entertainment components that are built into the system.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

7.2 I <u>**plan**</u> to use the entertainment components that are built into the system, if they are made available to me.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

8. Please check the appropriate box (one box only).

8.1 If available to me, I **predict** I would use the patient reward system that is built into the system.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

8.2 I **plan** to use the patient reward system that is built into the system, if it is made available to me.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

9. Please check the appropriate box (one box only).

9.1 If available to me, I **predict** I would use the system to help me perform my regular health self-management tasks.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

9.2 I **plan** to use the system to help me perform my regular health self-management tasks, if it is made available to me.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

10. Please check the appropriate box for each statement (one box only).

10.1 Using the proposed system would be helpful in improving my health

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

10.2 Using the proposed system would help me to manage my healthcare more effectively

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

11. Please check the appropriate box for each statement (one box only).

11.1 My interaction with the proposed system would be clear and understandable

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

11.2 I believe the proposed system would be easy to use

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

12. Please check the appropriate box for each statement (one box only).

12.1 I believe the proposed system would be interesting to use

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

12.2 I believe the proposed system would be enjoyable to use.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

12.3 I believe the proposed system would be entertaining to use.

Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree	Do Not Know
☐	☐	☐	☐	☐	☐	☐	☐

13. Do you think you would be interested in starting to use the system that was just demonstrated to you? ☐ Yes / ☐ No

13.1 If no, please tell us why. This will help us improve the system for you and other potential users.

14. Do you have any suggestions for making the system more interesting, more useful, easier to understand, or easier to use?

15. Do you think you would be able to find time to access the system at least once a day on a regular basis? ☐ Yes / ☐ No

15.1 Please explain how you might use the system to help you with managing your chronic illness.

15.2 Do you think you would be interested in using the system over a long period of time? ☐ Yes / ☐ No

15.3 Please explain your decision. This will help us to improve the system for you and other potential users.

This is the end of the questionnaire. If you would like to see a brief summary of the results, you are invited to consult the McMaster eBusiness Research Centre's working paper series at http://merc.mcmaster.ca/working-papers/index.html in early 2015.

Thank you very much for participating in this study and providing us with helpful information!

Appendix C. An Introduction to the Online Self-management Support System

WHAT

- The objective of this video clip is to provide you with introductory information about the online Self-management Support System that is available for patients like yourself to help manage your peripheral arterial disease.
- This video will walk you through the system and show you how you could use it.
- After you have finished viewing the video, you will be asked questions regarding your initial opinions about the system and its features, and whether you might be interested in using it to assist you.
- Please watch the video carefully and in its entirety as this may be very helpful to you.
- This online Self-management Support System is an application that you can securely access through a website.

WHY

- Regardless of your age, gender or location, the system can help you manage your condition, maintain a healthy lifestyle, and improve the quality of your life.
- The system enables you to securely collect, store, view, manage, or share your health information or transactions– when you want, where you want, and with whom you choose.
- If you are not an Internet or smartphone user or do not wish to use the Internet for this purpose, you may have a family member or care partner, who can help you to use it and take advantage of what it has to offer.
- More specifically, the system:
  - ➢ Keeps all your personal records online in one place, and provides 24/7 access
  - ➢ Tracks and helps you to manage your condition(s) and symptoms
  - ➢ Provides specifically tailored advice for a healthy diet and exercise for you, based on your specific condition(s)

- Provides access under your control for your chosen care partner and your physician to your information
- Connects you to the people who have the same or similar condition(s) to help you to discuss information online that is useful to you and others
- Raises your level of knowledge about your condition(s) through various educational methods (videos, articles, etc.)
- Entertains you with recreational materials such as games, entertaining videos, etc.
- While you use the system, you collect points. At the end of the trail period these points are exchangeable for a gift card.

HOW

- To use the system, you need a computer or a Smartphone, an Internet connection and a web browser such as Internet Explorer, Firefox, or Google Chrome.
- Now please watch the following overview of the system's features and functionalities.
- Here users can enter their ID and password to enter the system. A User ID will be given to you by your care provider, and you will set your own password.
- Here, under "Today's Health Articles Section" you can review the most recent articles about your disease and other related conditions.
- For example, you can read about PAD and get yourself familiarized with its symptoms, risk factors, diagnosis and treatments.
- This section is used by your physician to log in to the system and access your information, with your permission.
- There are four main system menus: My SMI Tools, My PHR, Networking and Education. We will explain them later as we get to them.
- Now we log into the system. You can check this box so the system will remember you next time, helping you to access the system more easily.
- Now you are logged in, and your name will be shown here. Let's see how the system works.
- Click on MY SMI Tools. You can see your profile here, including all your measures that you have been tracking, such as blood pressure, blood glucose, and body weight.

- For each measure you are tracking, you can enter your values daily or even more often so you can observe any trends in the measure.
- For instance for blood pressure, you can enter your values (systolic and diastolic for high and low values) at specific time and date.
- Please note that patients involved in this study will be loaned automatic machines that measure blood pressure and heart rate, which can be entered online each time they are measured.
- Here the data entered to date is displayed so trends can be observed. You can set targets so you can watch your progress towards these targets for each measure you are monitoring. You will be assisted in setting your targets as soon as you agree to participate in the study.
- Here, at this section, there are four questions to be answered. These questions measure the level of exercise you have had each day. The answers you give will be combined into one number that appears in your display for exercise. Be sure to watch the trend in this number over time. If it is increasing, that is a sign of good progress.
- At the smoking cessation section, you would report the number of cigarettes you have had each day. You can also add notes if you wish.
- You can add more conditions or measurements to your health toolkit or you can add the names of your caregivers here. You can also enter or change your personal information here.
- Here on the networking section, you can share your opinions and ideas regarding an issue, or ask any questions.
- The posts will be seen and possibly answered by other patients like yourself as well as your care providers.
- Finally, in the education section, you will find helpful information regarding lifestyle changes, how to raise the quality of life, etc.

  You can also post comments or ask question about the videos.
- How to start using your online support system:
  - If you choose to participate in a trial of the online support system, after signing the agreement at the end of the document you have been reading, your doctor or office nurse will create an account for you and you and/or your care partner will be

trained in the use of the system. You will be able to use the functionalities shown in this video.

- The online support system will help you to make informed decisions regarding your health. However, to realize this potential benefit, you must keep your records up-to-date on a regular basis. We recommend that you enter data on each of the measures you are monitoring once each day. At an absolute minimum, you should update your records once a week. If you do not, you will receive an e-mail reminding you to do so.
- Thank you for taking the time to watch this video. Now, please continue by answering the survey questions.

Appendix D. Self-Management Support System

This appendix is a brief outline of the actual self-management support system that was demonstrated to the online panel through the video described in Appendix C, followed up by their completion of the online questionnaire described in Appendix B.

Your health and happiness tools

Better health is only a click away

Patient Portal Plus® offers the best tools to help make you healthier and happier.

Care Provider Login

If you are a registered physician/nurse at Patient Portal Plus® please Click Here to signin.

Today's Smile

When a man died and went to The Judgment, they told him, �Before you meet with God, we should tell you � we�ve looked over your life, and to be honest you really didn�t do anything particularly good or bad. We�re not really sure what to do with you. Can you tell us anything you did that can help us make a decision?� The newly arrived soul thought for a moment and replied, �Yeah, once I was driving along and came upon a person who was being harassed by a group of thugs. So I pulled over, got out a bat, and went up to the leader of the thugs. He was a big, muscular guy with a ring pierced through his lip. Well, I tore the ring out of his lip, and told him he and his gang had better stop bothering this guy or they would have to deal with me!� �Wow that�s impressive. When did this happen?� �About three minutes ago,� came the reply.

Today's Health Articles Section

- PAD Education module from Healthwise
- Smoking Cessation Aid
- Eating Right With Diabetes
- Managing Hypoglycemia - Basic Guidelines
- Cinnamon: The Spice That Cuts Cholesterol and Blood Sugar
- My Blood Pressure
- Healthy Eating

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Figure 10. General View of the System

2) Stakeholders in the System

The stakeholders in the system include the following:

1. **Chronic (PAD) patients**: They will be given access to their PHR (within the system) to input all monitoring data, and status and outcome measures. Also, they will enjoy the outcome of the decision support functionality of the system as well and the sustainability components (For the purpose of testing the system, PAD patients will be the subject of the study. There is a high probability that PAD patients already have or would develop diabetes as well; therefore, consistent monitoring and management of diabetes will also be necessary). The system must support all types of chronic patients.
2. **Care Partner(s)**: These include any voluntary care partners, such as children, spouse, friends, neighbors, or relatives who have accepted the role of care partner. They should be regularly in touch with the patients as well as have access and use the system online.
3. **Primary Care Providers**: They may include specialist(s), primary care physicians, nurses, etc. who are responsible for providing care for the patient.
4. **The System Administrator(s)**: The administrator(s) monitors the system, provides access permissions, updates the functionalities, and troubleshoots any issues that might occur.

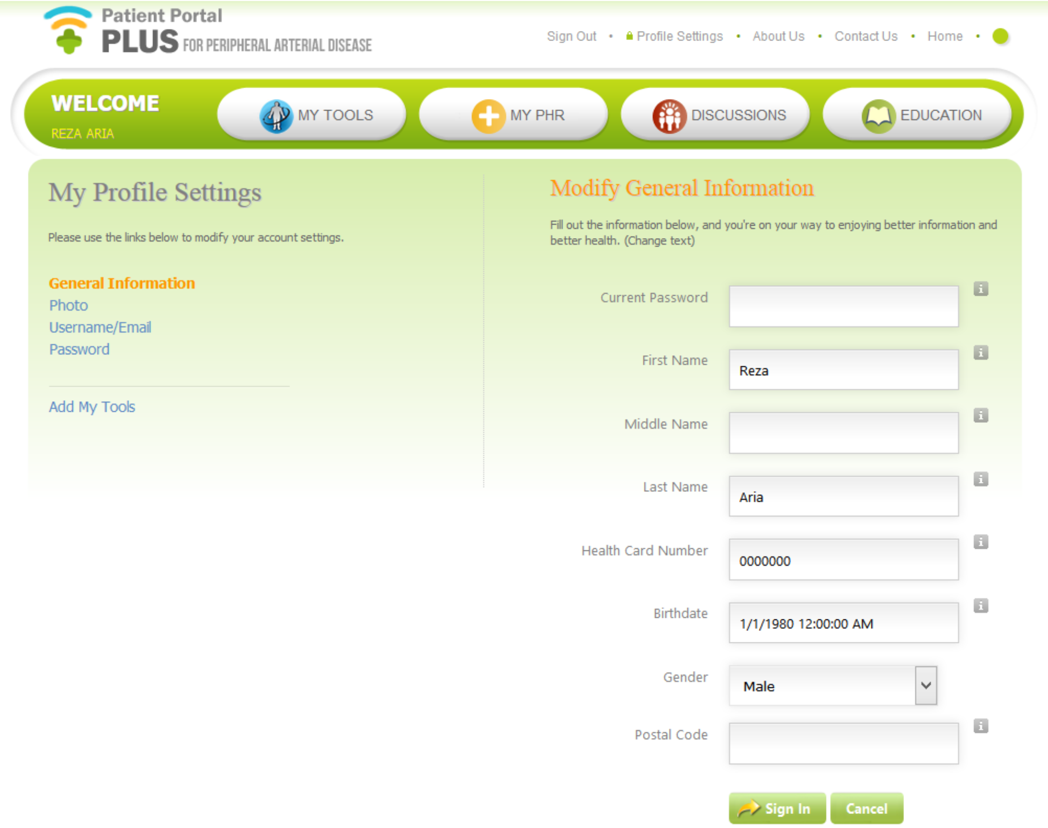
3) System Menus and Functions

Our proposed system has the following menus and functions. All of them should be accessible from the main page, after the patient has signed in. Further, the system will be designed as an online social network. The main page should look like the main page of the most online social networks (e.g. LinkedIn, Facebook, etc.) will possibility of posting interactive material (text, pictures and videos).

I. Patient Profile (My Profile)

Each patient should have a secure profile related to his PHR. Patients may have access to this profile as soon as they signed in the system and from the main page of the website. Patients must be able to change the level of privacy on their profile (meaning who can see what parts of the profile). The profile must have the following sections:

- Personal Page
    - Photograph
    - Basic Information
        - Name
        - Address (work & home)
        - Phone numbers (work, home & cell)
        - Date of birth
        - Gender
        - Insurance info



My Profile Settings

Please use the links below to modify your account settings.

Modify General Information

Fill out the information below, and you're on your way to enjoying better information and better health. (Change text)

Current Password:
First Name: Reza
Middle Name:
Last Name: Aria
Health Card Number: 0000000
Birthdate: 1/1/1980 12:00:00 AM
Gender: Male
Postal Code:

Figure 11. Personal profile

My Account Settings

Please use the links below to modify your profile.

Change your Photo

Please upload your profile photo. Only .JPG, .JPEG, .GIF, and .PNG files can be uploaded with a size not more than 100 Kilobytes.

Browse Photo: No file selected.

Figure 12. Personal Picture Upload

II. Patient Monitoring Data Entry

Patients will actively monitor themselves regularly and enter the collected data into their PHR in the system upon their signup to the system. If patients are unable to do it themselves, their care partners can provide assistance. The data elements will vary depending on their condition. The data elements are among three categories:

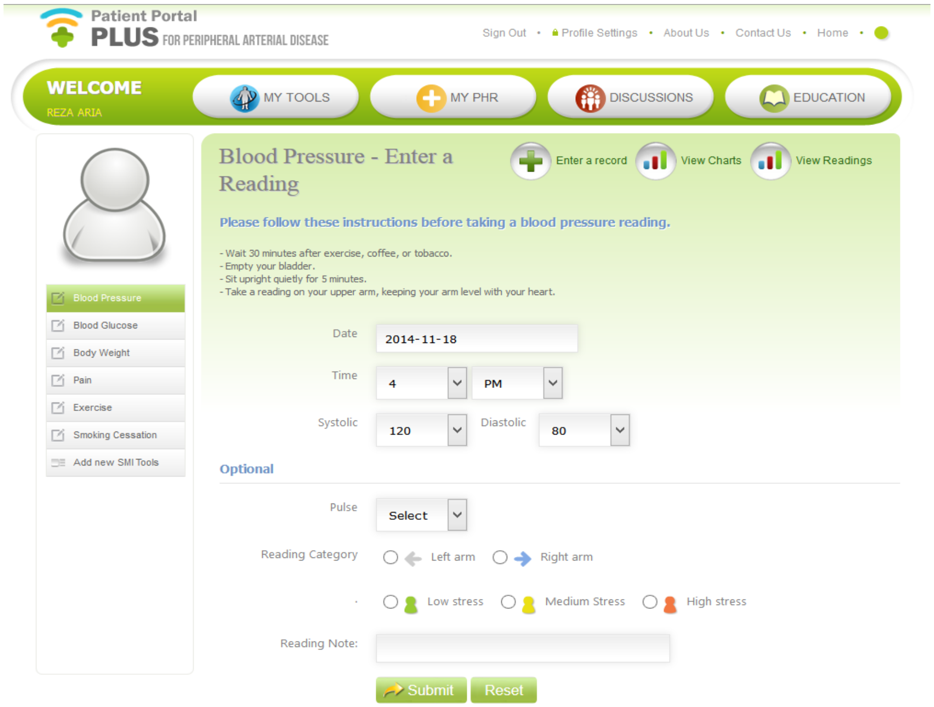
a) General Measures (recorded by everybody):

   a) **Blood Pressure and Heart Rate**: taken daily before breakfast
   b) **Exercise**: recorded each evening, measured in meters walked that day
   c) **Pain Level:** recorded when checked
   d) **Weight**: recorded each morning before breakfast, for patients who are actively controlling their weight

b) Specific Measures (recorded by patients that follow a specific regimen):

   e) **Blood Glucose Level**: recorded when checked (required only for patients who also have diabetes)
   f) **Smoking**: recorded each evening in cigarettes per day (required for smokers)

Need to have target levels and acceptable ranges tailored specifically for each individual patient by the physician. The following tables show the actual look of the system.



Blood Pressure - Enter a Reading

Please follow these instructions before taking a blood pressure reading.

- Wait 30 minutes after exercise, coffee, or tobacco.
- Empty your bladder.
- Sit upright quietly for 5 minutes.
- Take a reading on your upper arm, keeping your arm level with your heart.

Date: 2014-11-18
Time: 4 PM
Systolic: 120 Diastolic: 80

Optional

Pulse: Select
Reading Category: ○ Left arm ○ Right arm
○ Low stress ○ Medium Stress ○ High stress
Reading Note:

Figure 13. Blood Pressure & Heart Rate

Blood Glucose - Enter a Reading

Please follow these instructions before taking a blood pressure reading.

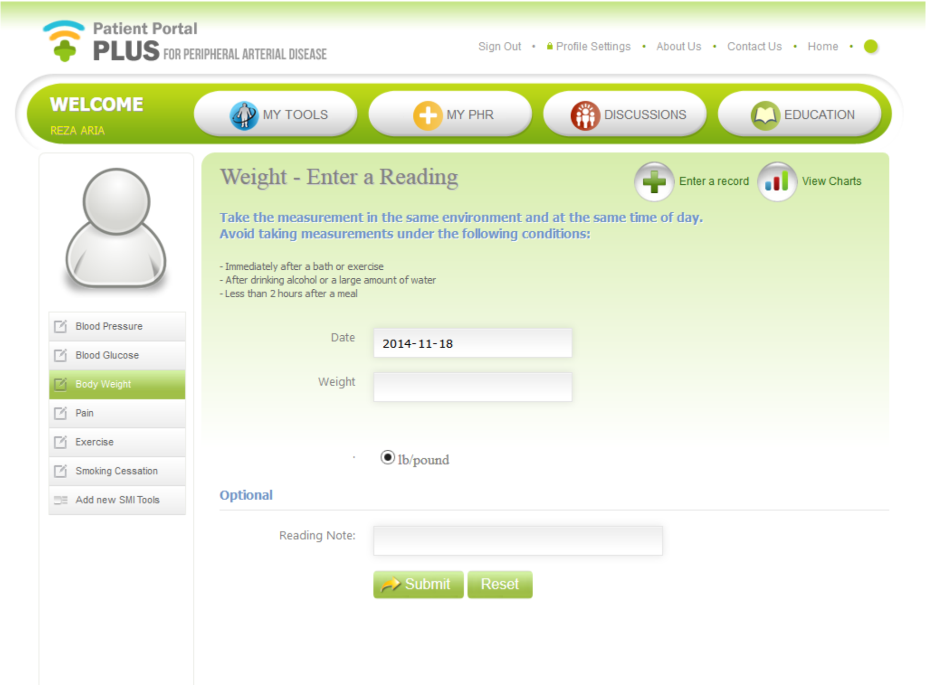
- Wait 30 minutes after exercise, coffee, or tobacco.
- Empty your bladder.
- Sit upright quietly for 5 minutes.
- Take a reading on your upper arm, keeping your arm level with your heart.

Date: 2014-11-18
Time: 5 PM
Glucose: 100 mg/dl
○ Before Meal ○ After Meal ○ Bed Time ● Other

Optional

Reading Note:

Figure 14. Blood Glucose



Weight - Enter a Reading

Take the measurement in the same environment and at the same time of day.
Avoid taking measurements under the following conditions:

- Immediately after a bath or exercise
- After drinking alcohol or a large amount of water
- Less than 2 hours after a meal

Date: 2014-11-18

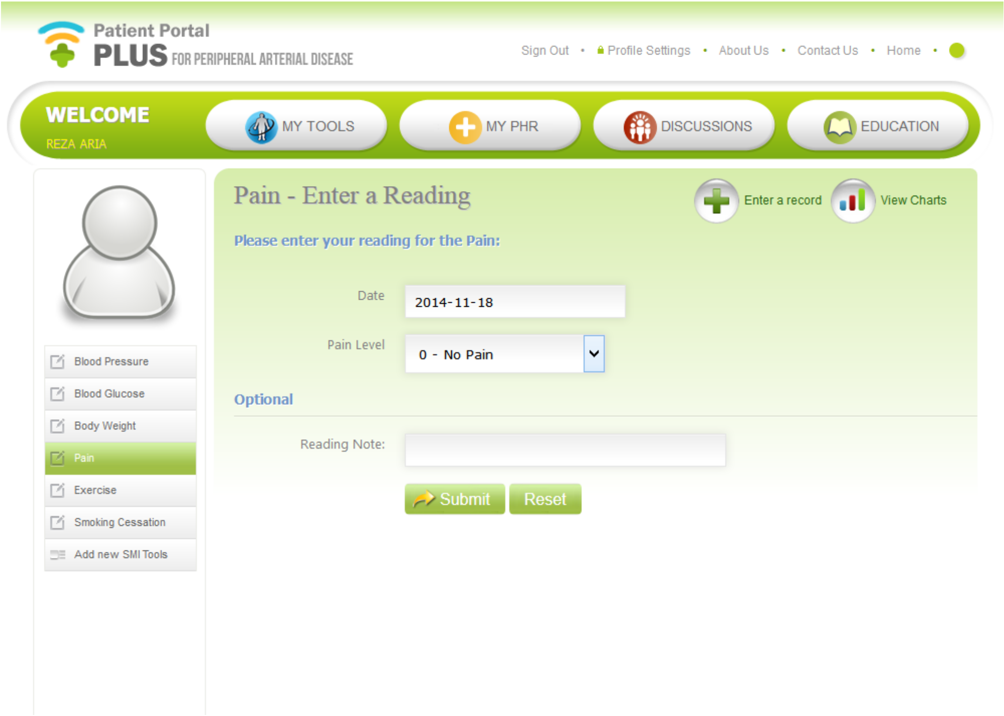
Weight:

● lb/pound

Optional

Reading Note:

Figure 15. Body Weight



Pain - Enter a Reading

Please enter your reading for the Pain:

Date: 2014-11-18

Pain Level: 0 - No Pain

Optional

Reading Note:

Figure 16. Pain Level

Exercise (Estimation of Ambulation Capacity by History) - Enter a Record

Please answer each of the following questions that best describes your situation.

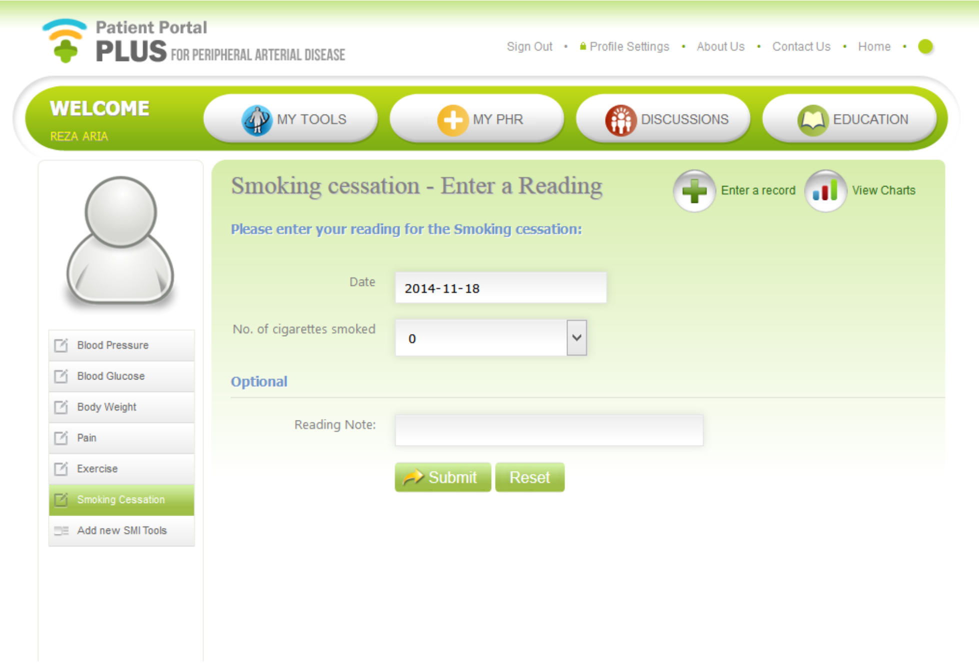
If you never perform an activity, estimate what it would be to perform it.
If you think you would not be able to perform the task of if you cannot physically perform a specified activity without stopping to rest because of symptoms such as leg pain or discomfort, please select the option labelled "Impossible".

Date: 2014-11-18

For each of the following walking speeds, how long can you perform the task easily on level ground without stopping to rest?

	Impossible	30 seconds.	One minute	Three minutes	10 minutes.	30 minutes	One hour	3 hours or more
Walk slowly (slower than usual, or slower than friends, relatives, or persons of your age)?	○	○	○	○	○	○	○	○
Walk at average speed (usual pace, or same pace as friends, relatives, or persons of your age)?	○	○	○	○	○	○	○	○
Walk Quickly (faster than usual, or faster pace than friends, relatives, or persons of your age)?	○	○	○	○	○	○	○	○
Run or Jog?	○	○	○	○	○	○	○	○

Figure 17. Exercise Level



Smoking cessation - Enter a Reading

Please enter your reading for the Smoking cessation:

Date 2014-11-18

No. of cigarettes smoked 0

Optional

Reading Note:

Figure 18. Smoking Cessation

III. Education

Some educational programs will be available for the patients and their care partners (depending on the specific condition) to empower them to deal with their tasks. Short courses will be available in such areas as treatment, medication, symptoms, and managing symptoms. These educational materials will be either developed by our team or may be from external sources too, including blogs, educational videos, or descriptive material by local or international experts Training will also be a type of functionality provided to help patients learn how to use the system. Attempts will be made to use simulations or games where possible to improve patient participation and learning. Examples of the educational materials from third parties are free educational videos on TED that we have downloaded and put on our website.

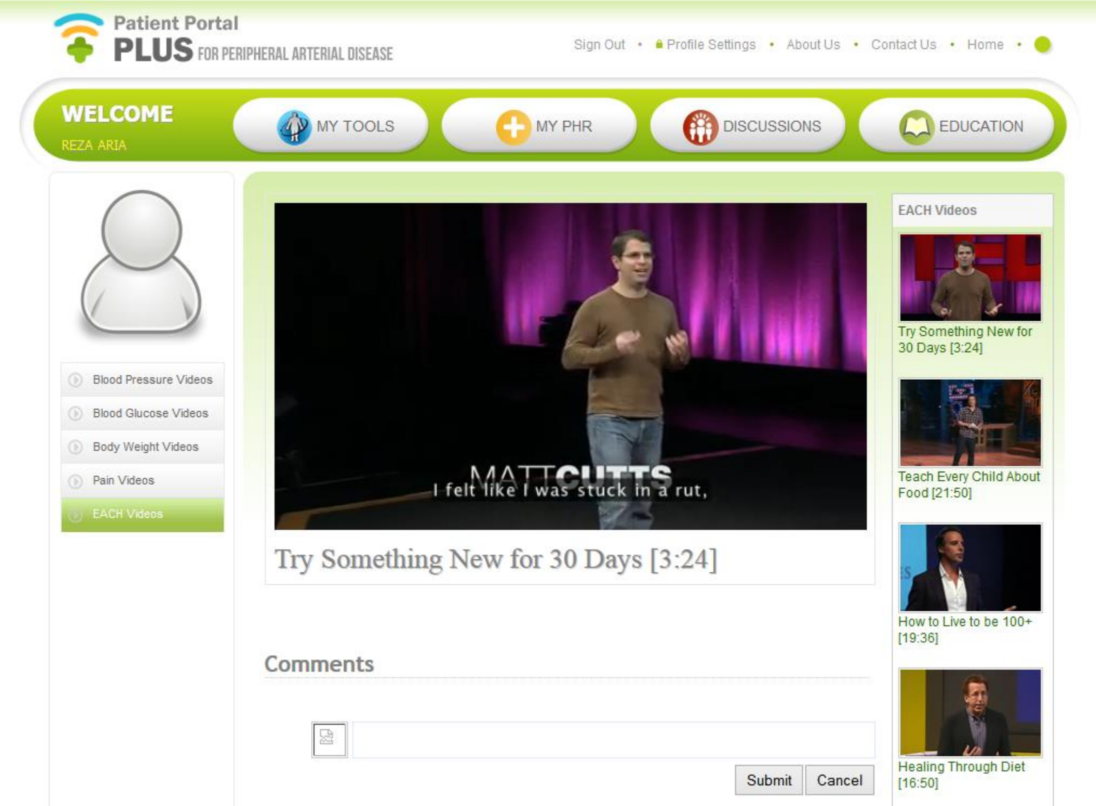
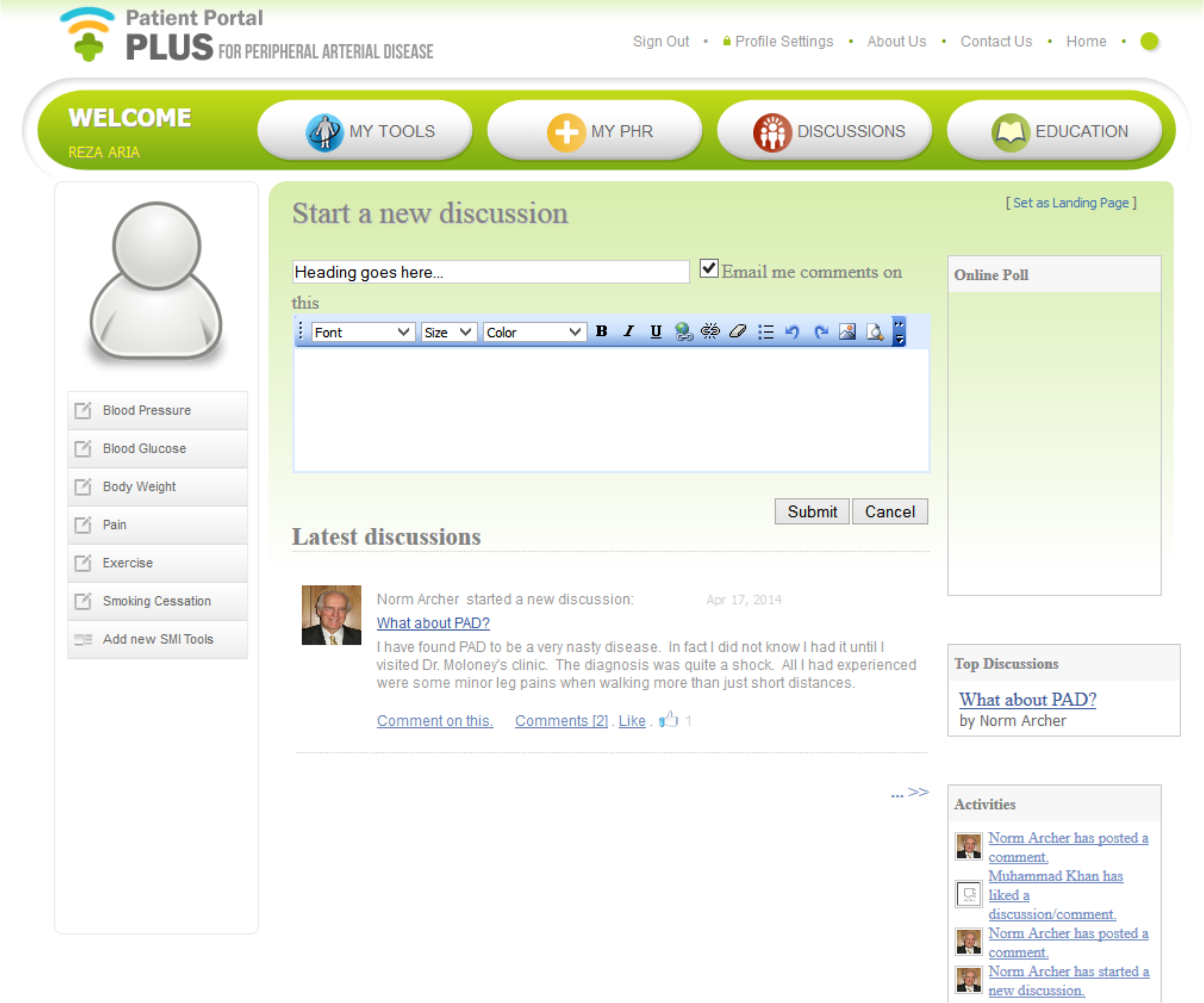


Figure 19. Education Section

IV. Forum

Forum will also be available so that the patients can be in contact with each other to exchange experiences and socialize. Under the menu (Forums and Blogs), should be different forums each related to the topic of a condition or symptom. Also, each patient may have access to his/her own blog (to read and write) and other patients' blogs (to read only).



Heading goes here...

☑ Email me comments on this

Norm Archer started a new discussion: Apr 17, 2014

What about PAD?

I have found PAD to be a very nasty disease. In fact I did not know I had it until I visited Dr. Moloney's clinic. The diagnosis was quite a shock. All I had experienced were some minor leg pains when walking more than just short distances.

Comment on this. Comments [2] . Like . 1

What about PAD?
by Norm Archer

Norm Archer has posted a comment.
Muhammad Khan has liked a discussion/comment.
Norm Archer has posted a comment.
Norm Archer has started a new discussion.

Figure 20. Discussion (Forum) Section

V. Decision Support and Guidance

The DSS, with its guidelines and instructions, will be available 24/7 for patients and their care partners. The DSS will render guidelines and generate plots for the patients and their CPs, using three different color-coding for each situation. White, yellow, and red zones represent acceptable, high risk, and critical conditions, respectively. Each plot will have a set of instructions to help the patient or care partner. Boundaries will be set by the care providers in advance, according to each patient's specific condition.

In cases where a patient does not enter the data into the system on-time, the system will notify the patient, or the care partner, or both by SMS and/or prerecorded voice messages. The system will also notify care providers by email, SMS, or voice messages, depending on the significance of the situation (color codes).

VI. My Charts & Reports

All of the patient reports related to the conditions patient has should appear here. Different types of patient reports will be available upon request. The reports can be either available on-screen or in-print, as needed. Some specific reports will only be available to the care providers (cardiologists, physicians, etc.) and other reports will be available to all parties. The up-to-date process will be in real-time. There is also one survey that asks patients about their perceptions and experience with the online system.

Chart Style: Spline
Target: 120
☐ Show Pulse
Last 7 Days

Figure 21. Charts and Reports

VII. My Symptoms

All of the related symptoms of the chosen condition should appear here. Patient should have ability to choose the appeared symptoms as well as their severity (e.g. None, Mild, Moderate, Severe, etc.)

VIII. Labs, Tests & Hospitalization

A page receives the info about any hospitalization. Also, any type of pre-reported hospitalization may appear here. All tests (related to the chosen condition) should appear here.

IIX. My Conditions

Patients should be able to add conditions here. After adding the condition, it should appear on the page.

IX. Weight & Exercise

Patients should enter their weight here. A little chart may show their weight in the past time fame preset based on the condition (e.g. daily, weekly, monthly, etc.). The exercise that patients are supposed to perform including its related instructions should appear here. Patients may enter how they did the exercise (e.g. full, half, etc.) as well.

4) Functionalities of the System

Modules that support patients include the following functionalities:

A. Patients/caregivers

1) **Regular monitoring of health status measure**s (e.g., blood pressure (systolic, diastolic), blood glucose, etc.). Monitoring of each measure should involve regular collection of data (typically on a daily basis), automated display of results, and triggering levels that should show white (OK), yellow (warning), or red (alarm – automatically sent to specified healthcare provider).
2) **Education and training** support for patients.
3) **Recreational interactions** for patients, using interactive games and/or simulations that patients can play online to maintain their interest. Also, entertaining videos will also be used to keep the patients interested

4) **Online Social Network.** Online social networks provide patients with easy ways of interaction with others who have similar problems. Please find the detailed design in section 5.

5) **Personal Mailbox.** Patients will have access to their own personal mailbox and also would be able to send personal/private messages to each other, to their care partners, and/or caregivers and care providers.

B. Care Providers (Family Physicians, Staff, Visiting Nurses)

1) Ability to browse the presentations and reports for all patients enrolled under their care.
2) Ability to download presentations and reports as needed.

C. System Administrators

1) Ability to change, add, or delete access permissions for all stakeholders/users.
2) Ability to delete or add data files as necessary, according to instructions from patients or care providers.

Figure 22 blocks out the proposed full system with its functionalities and demonstrates the flows of data from and to the participants. In the proposed system, the differences among patient capabilities, abilities and disabilities are considered. For instance, there are differences among the eyesight, mobility, hearing, cognitive ability, etc. of different patients. There are also patients suffering from more than one chronic condition. All of these important factors will be taken into account in the design stage of the system.

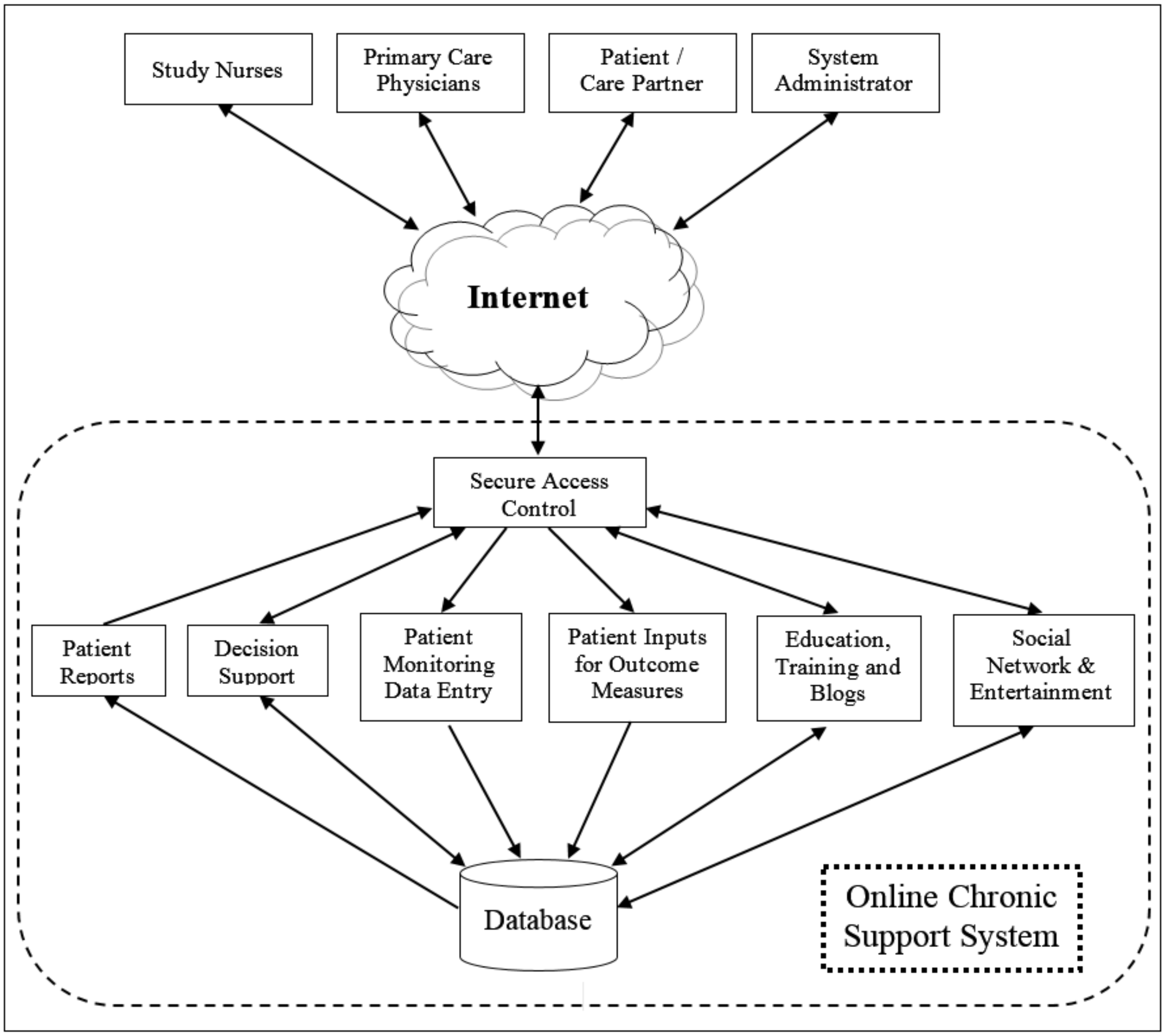


Figure 22. System Layout (Courtesy of Norman P. Archer and Kayvan S. Viand)