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Consumer acceptance of biometrics for identity verification in financial transactions

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CONSUMERS' ACCEPTANCE AND USE OF PERSONAL HEALTH RECORD SYSTEMS: A THEORETICAL MODEL

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Abstract

Recently, there has been a growing trend towards consumer-based healthcare in which consumers are increasingly becoming partners in their own care. One way of accomplishing this is to provide consumers with access to their health records through the use of Personal Health Record (PHR) systems. In spite of their potential benefits, recent research has shown that PHRs are not yet popular or well known to consumers. The overall objective of this research is to investigate the influences of various personal, behavioral, and environmental factors on the adoption and use of PHR systems by Canadian consumers. Drawing on both the information systems and behavioral healthcare literatures such a model is developed and presented. The proposed model will be validated using a longitudinal design over a period of 16 months involving patients from two local clinics. The study participants will be introduced to an existing PHR system at those clinics. The system will subsequently be made available for their potential use. Users will be surveyed at various points in time regarding their perceptions about the system utilizing both close-ended and open-ended questions. Collected data will be analyzed using structure equation modeling and qualitative data analysis techniques.

Keywords: e-Health, Personal Health Record system, Technology Adoption, Social Cognitive Theory, Longitudinal Study

1. INTRODUCTION

Two important trends can be observed in the Canadian healthcare system (Urowitz et al. 2008): the advent of e-Health giving rise to a more important role for information technologies in healthcare (Eysenbach 2001; Tan 2005); and a shift towards consumer-based healthcare (Eysenbach and Diepgen 2001; Runy 2000) where patients are considered as partners in their own care process (Urowitz et al. 2008). For example, today's educated and computer literate baby boomers who make up almost one in every three Canadians (Folker 2007) are facing health-related conditions as they age and are increasingly seeking health-related information from various sources including the Internet (Bliemel and Hassanein 2007). Providing access to personal health information through innovative technologies could potentially reduce the cost and complexity of healthcare delivery through efficient use of resources in the healthcare system (Raghupathi and Tan 2002). One such innovative technology is the use of Personal Health Record (PHR) Systems.

A PHR can take various forms including a stand-alone application or an Internet-based system (Endsley et al. 2006). PHRs are created, owned, updated, and controlled by an individual and/or others authorized by her/him. They contain a summary of a consumer's lifelong health information such as allergies, home monitoring data (e.g. blood pressure), medications, laboratory test results, conditions suffered, treatments given, vaccinations, etc (Thomas 2006). Numerous benefits have been suggested for consumers utilizing PHRs. For example, they can access a wide range of reliable and credible health information leveraging this access to increase their understanding of their health condition and to be active participants in their own care (Cimino et al. 2002; Moehr and Grant 2000; Ueckert et al. 2002). PHRs put consumers in control of their own health information by allowing them to update their records either manually or by automated polling of information from visited care facilities (e.g. hospitals, physician offices) (Tang et al. 2006). By leveraging the control and access provided by PHRs, consumers could become empowered to better manage their health (Tang et al. 2006). For example, they could in collaboration with their physicians, detect disease in the early stages by observing trends in their health status (e.g. changes in blood pressure). They can also consult with their physicians on any unusual conditions observed in their health records. Moreover, the system can alert people when their health records show such unusual conditions or exceptions (Tang et al. 2006) (e.g. a conflict between newly prescribed medications and previously or currently used ones). It is important to note that PHR consumers are not necessarily dealing with immediate medical concerns and can be ill or healthy.

PHR systems are also suggested to be beneficial for patients with chronic diseases (Heubusch 2007). Chronic diseases are often characterized by long latency requiring patients to be continuously aware of their condition in an ongoing collaboration with their caregivers (Folker 2007; Heubusch 2007). PHRs can facilitate patient-physician communications in an efficient manner through changing such communications from episodic encounters to continuous interaction (Tang et al. 2006). Furthermore, self-management activities and active patient participation in the care process are major parts of a successful chronic disease management program (Lankton and St. Luis 2005). A PHR system can facilitate such a high level of patient engagement (Tang et al. 2006).

In spite of all the aforementioned potential benefits for PHRs, recent research has shown that they are not yet popular with or well known to consumers (Sittig 2002; Cronin 2006). Very few studies have covered the reasons responsible for the lack of PHRs' popularity. Existing studies have mostly concentrated on overviews to clarify the characteristics and functionalities of PHRs (Abrahamsen 2007; Atkinson et al. 2007; Brown 2007; Cronin 2006; Kim and Johnson 2002; Lafky et al. 2006; Sittig 2002; Tang et al. 2006; Thomas 2006; Yee and Trockman 2006). The few studies performed on the adoption of PHRs were for the most part not empirical in nature (Denton 2001; Iakovidis 1998; Jones 1999; Lafky and Horan 2008; Winkelman et al. 2005). These studies have put forth numerous factors that bring about the lack of PHR popularity. Of particular interest, Tang et al. (2006) suggest

that behavioral factors may impact PHRs' adoption, yet the role of such factors was not empirically tested. Hence there is a need for additional research in this area.

By developing and validating a model that explains the behavioral/social factors influencing consumers' adoption and use of Internet-based PHR systems, this study pursues the following objectives: (i) to identify the behavioral/social factors influencing PHR system adoption and use among the consumers; (ii) to investigate the impact of individual characteristics (perceived health status, age, sex, Internet experience and education) on relationships in the model.

This paper is organized as follows: the proposed research model is presented in section 2 along with theoretical background and hypotheses. Details of the proposed research methodology are presented in section 3. Finally, the potential contributions of this research are discussed in section 4. Throughout this paper the words consumer, individual and patient are used interchangeably unless otherwise specified.

2. THEORETICAL BACKGROUND AND RESEARCH MODEL

Social Cognitive Theory (SCT) (Bandura 1986) will form the basic framework for conceptualizing a research model for this study. SCT explains human behavior as an interaction between behavioral, environmental and personal factors. SCT has been widely employed in the IS literature with demonstrated validity (e.g. Chan and Lu 2004). Specifically, this theory is a widely accepted model for explaining individual behavior in the IS area (e.g. Compeau and Higgins 1995). SCT states that a person takes an action that has personal cognition in a social environment (Bandura 1986). This notion fits well into the context of this study since individuals need to make a decision to adopt a PHR system for managing a healthy life while interacting with the medical environment through the system. The proposed model in this study (Figure 1) builds on the above SCT categories while incorporating related constructs from both the IS and healthcare literatures. The underlying theories for the proposed model are examined below.

Since PHR systems are information systems, IS-related constructs are incorporated in the proposed model. The Unified Theory of Acceptance and Use of Technology (UTAUT) aims to explain user intentions to use a new computer technology and subsequent usage behavior (Venkatesh et al. 2003). This theory was developed through a review and consolidation of the constructs of eight theories that were previously employed in the literature to explain usage behavior regarding a new computer technology. The eight underlying theories include Technology Acceptance Model (TAM) (Davis 1989), Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975), Theory of Planed Behavior (TPB) (Ajzen 1985), Motivational Model (Davis et al. 1992), combined TPB and TAM (Taylor and Todd 1995), model of personal computer utilization (Thompson et al. 1991), innovation diffusion theory (Rogers 1995) and social cognitive theory extended to personal computer usage (Compeau and Higgins 1995). UTAUT holds that three key constructs, namely performance expectancy, effort expectancy, and social influence are direct determinants of usage intention (Venkatesh et. al. 2003). Moreover, gender, age, experience, and voluntariness of use are shown to moderate the effect of the three key constructs on usage intention (Venkatesh et. al. 2003).

Due to the healthcare context of PHRs, there is also a need to consider relevant theories from the healthcare literature. Lee et al. (2007) argue that the design of PHR systems should be informed by the Health Belief Model (Janz and Becker 1984). The Health Belief Model seeks to identify antecedents for an individual's health behaviors which include activities undertaken by the individual for the purpose of preventing or detecting disease (Rosenstock 1966). It asserts that the likelihood of a person taking a preventive healthcare action is the outcome of his/her perceived health threat as well as the benefits/costs associated with engaging in that action. These variables are in turn influenced by demographical, social and psychological cues (Janz and Becker 1984; Jayanti and Burns 1998; Rosenstock 1966). Using PHR systems is similar to such behaviors since such systems are intended to help consumers maintain a healthy life. Hence, it is reasonable to consider using PHRs as a preventive healthcare behavior. Consequently, constructs such as subjective health knowledge and health

consciousness are added to the model from the healthcare literature and hypothesized to have a direct impact on behavioral intention. Additionally, inter-relationships between the aforementioned constructs from both the IS and healthcare literatures are incorporated in the model as appropriate. The relationships between the constructs in the model shown in Figure 1 are explained below in detail.

The main objective of this study is to identify the behavioral/social factors influencing PHR system adoption (intention to use) and usage (actual use) among consumers. Based on Fishbein and Ajzen's (1975) definition, **intention to use**, in this paper, is a measure of the strength of an individual's intention to use a PHR system as a preventive health care behavior. On the other hand, **actual use** is a measure of the frequency and extent of using a PHR system by users (Venkatesh et al. 2003). Prior research has shown a strong correlation between behavioral intention and actual system use (Venkatesh and Davis 2000; Venkatesh et al. 2003). Thus, we hypothesize that:

H1: Stronger consumer intentions to use a PHR system will positively influence her/his future usage of such a system.

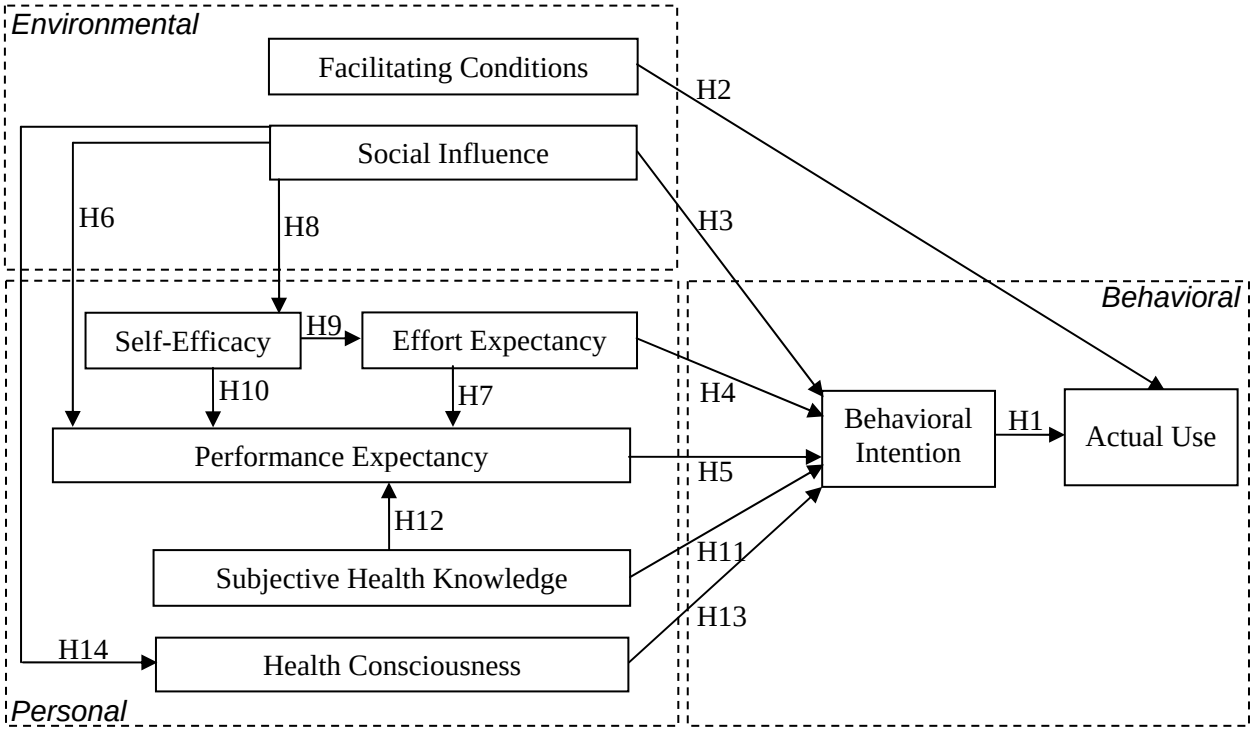

Figure 1. Proposed research model

Facilitating conditions is defined as the degree to which an individual believes that organizational and technical support is provided for using a system, and has been shown to be a direct determinant of system usage (Venkatesh et al. 2003). Within a healthcare setting, caregiver support has been suggested to have a positive impact on consumers using PHRs (Johnson and Singal 2006; Tang et al 2006). Caregiver support is incorporated as part of the facilitating conditions in the proposed model as described in the methodology section. Therefore, the following is hypothesized:

H2: Facilitating conditions will have a positive influence on an individual's actual usage of PHR systems.

Social influence is defined as "the degree to which an individual perceives that important others believe he/she should use the new system", and it has been shown to be a major determinant of behavioral intention to use new technologies (Compeau and Higgins 1995; Ventaktesh et al. 2003). Moreover, Janz and Becker (1984) have shown the positive impact of social influence on intentions to

perform preventive healthcare behavior. Since it has been argued here that using PHR systems is a form of preventive healthcare behavior, the following is hypothesized.

H3: Social influence will have a positive influence on an individual's intentions to use PHR systems.

Effort expectancy is defined as the degree of effort an individual believes is required for using an information system, and has been shown to negatively impact an individual's intention to use new technologies (Thompson et al. 1991; Venkatesh et al. 2003; Wilson and Lankton 2004). In a preventive healthcare context, Janz and Becker (1984) acknowledged the impact of difficulty of taking a preventive healthcare action as a barrier to performing that specific action. Such difficulty is similar to the concept of effort expectancy. Therefore, the following is hypothesized:

H4: A higher effort expectancy associated with using PHR systems will negatively influence an individual's intention to use such systems.

Performance expectancy is defined as the degree to which an individual believes that using an information system will help him/her attain benefits in his/her job (similar to health benefits attained through using a PHR system). Performance expectancy has been shown to be a determinant of behavioral intention to use technology (Davis 1989; Venkatesh et al. 2003). On the other hand, Jayanti and Burns (1998) have acknowledged the positive impact of the degree of ease associated with performing a preventive healthcare behavior on individual's likeliness of performing such behaviors. Moreover, the belief of important others supporting a particular behavior has also been shown to impact an individual's assessment of outcomes associated with that behavior (Compeau and Higgins 1995). Finally, effort expectancy has been shown to be a direct determinant of performance expectancy (Venkatesh 2000). Similarly, Davis (1993) has shown the relationship between perceived ease of use and perceived usefulness of an information system which are similar to effort expectancy and performance expectancy in the proposed model (Venkatesh et al. 2003). Thus, we hypothesize that:

H5: A higher performance expectancy associated with using PHR systems will positively influence an individual's intention to use such systems.

H6: Social influence will have a positive impact on an individual's performance expectancy in using PHR systems.

H7: A higher effort expectancy associated with using PHR systems will negatively influence an individual's performance expectancy associated with using such systems.

Computer **self-efficacy** refers to an individual's belief of having the capability to use computers (Compeau and Higgins 1995). This definition can be extended to the belief of having the capability to use an Internet application such as a PHR system. It has been shown that belief of important others supporting the use of technology, positively impacts an individual's self-efficacy regarding such usage (Compeau and Higgins 1995). Moreover, self-efficacy has been shown to also have an effect on perceived ease of use which is incorporated here as effort expectancy. Individuals with higher levels of self-efficacy will perceive the system as being easier to use (Venkatesh 2000). Finally, self-efficacy was shown to have an impact on performance related outcome expectations regarding the use of a computer system (Compeau and Higgins 1995). This latter construct is incorporated in the proposed model as performance expectancy, thus, we hypothesize the following:

H8: Social influence will have a positive impact on an individual's self-efficacy regarding the use of a PHR system.

H9: A higher level of an individual's self-efficacy regarding the use of PHR systems will negatively influence his/her effort expectancy in using such systems.

H10: A higher level of an individual's self-efficacy regarding the use of PHR systems will positively influence her/his performance expectancy in using such systems.

Subjective health knowledge is defined as an individual's storehouse of healthcare information (Jayanti and Burns 1998), and has been shown to have a positive effect on individuals' likeliness of performing preventive healthcare behavior (Boechner et al. 1990). Subjective measures for health knowledge are well established in the literature, and they cover general health information rather than information about specific symptoms and cures. Moreover, Jayanti and Burns (1998) argue that subjective health knowledge has a positive impact on an individual's assessment of positive outcomes related to performing a preventive healthcare behavior. Therefore, we hypothesize that:

H11: A higher subjective health knowledge level possessed by an individual will positively influence his/her intention to use PHR systems.

H12: A higher subjective health knowledge level possessed by an individual will positively influence her/his performance expectancy associated with using PHR systems.

Health consciousness is defined as "the degree to which health concerns are integrated into a person's daily activities" (Jayanti and Burns 1998). Prior research has shown that individuals who are health conscious are much more likely to engage in a preventive health care activity (Jayanti and Burns 1998; Kraft and Goodell, 1993; Rosenstock, 1966). Since in this research using PHR systems is considered to be a health care behavior, it is expected that individuals who are more health conscious will exhibit higher intentions to use PHR systems. Moreover, Janz and Becker (1984) showed a positive influence of social influence on health consciousness. Therefore, we hypothesize that:

H13: Individuals with a higher level of health consciousness will exhibit a greater level of intention to use PHR systems.

H14: Social influence will have a positive influence on an individual's level of health consciousness.

3. RESEARCH METHODOLOGY

Research setting: The research model presented above will be empirically validated through a longitudinal field study involving patients using an actual Internet-based PHR system. Performing a longitudinal study will allow the investigation of factors as they evolve during the active process of adoption decision-making (Venkatesh et al 2003). The study will be conducted at two local clinics, namely Stonechurch Family Health Centre[1] and the McMaster Family Medicine[2], located in Hamilton, Ontario, Canada with almost 35,000 registered patients. There are currently 27 physicians, 60 residents and 30 nurses, nurse practitioners, and allied health professionals practicing at these clinics. MyOSCAR[3] is an Internet-based PHR system associated with the above clinics which incorporates typical PHR functionalities including communication with healthcare team, requesting copies of records, prescription renewals, appointment requests, access to reliable health information, etc. There are currently 100 users registered with this PHR system which will be used to conduct this research. Prior to testing the hypothesized relationships, and in order to refine/enrich the proposed model, the concerns and experiences of a subset of the current users of the PHR system will be investigated through conducting two focus group sessions with 5-8 participants. Each session will be lead by a facilitator and a recorder will be available in order to capture all the responses (Basch 1987). Collected data will be analyzed in order to identify particular patterns, themes or concerns which are mentioned repeatedly by the respondents (Bender and Ewbank 1994). NVivo will be used as the software tool for analyzing the data (Richards 1999). Mingers (2001) suggests that research results will be richer and more reliable if different research methods from different paradigms are mixed together.

Pilot study: Prior to conducting the actual study, a pilot study involving 30 new users of the PHR system under study will be performed. The pilot will also have a longitudinal design which will be

[1] http://stonechurchclinic.ca/
[2] http://fammedmcmaster.ca/
[3] http://www.myoscar.org

conducted over a period of two weeks. At the beginning, instructions on using various features of the system will be provided to the participants using a short online video. Then, participants will be asked to fill out a survey containing the model measures as well as questions about demographics and perceived health status. Two weeks later, log files of the PHR system will be examined to measure actual usage through objective measures based on frequency and extent of system use. Participants will be encouraged to use the system by asking them to complete specific tasks simulating realistic scenarios encountered by typical users during the pilot study to ensure the collection of enough data to achieve the objectives of the pilot study. Results from the pilot study will be used to: conduct a qualitative analysis based on the open-ended questions and to refine the model; measurement scales for the model constructs will be assessed and refined; and any potential technical issues or problems with procedures will be identified and resolved.

Main study: Prior to starting this research study, a research ethics protocol will be prepared and submitted to the McMaster Research Ethics Board which is the body responsible for reviewing and approving all research studies involving human subjects at McMaster University. This protocol will include a consent form that all participants will be asked to sign prior to joining the research study. The consent form will provide potential participants with information regarding the objectives, nature as well as any potential risks of the study. It will also explain the measures put in place to ensure confidentiality of subjects' collected information and the option to drop out of the study anytime at their will.

Data collection for the actual study will be performed at two points in time over a 16-month period. At the beginning of the study participants will be provided with a short online video tutorial on how to use various features of the PHR system. Then, a survey will be conducted to gather measurement scales for the model factors except for actual use and facilitating conditions which should be measured after users have actually experienced using the system. Individual characteristics (demographics, details of previous computer and Internet use as well as perceived health status) will also be collected at this point. Data collected at this point will be used to validate a model for antecedents of behavioral intention to use PHR systems. Sixteen months later at the end of the study, actual system usage will be measured by analyzing the log files of the system. In addition, subjects will be asked to respond to a survey instrument measuring facilitating conditions. Data collected at this point will be matched to previously collected data and used to validate the full model (including both behavioral intention and actual use). Moreover, perceived health status will be measured again in order to investigate the existence of any meaningful change in this construct before and after using the PHR system. Based on prior research experience in the abovementioned clinics, a 16-month period was chosen to allow for sufficient patient-caregiver encounters thus providing participants with motivation to use the PHR system. The time period between measurement of model constructs and actual use will also allow the establishment of temporal sequencing thus avoiding common method bias (Compeau et al. 1999).

Measurement instruments: In order to ensure content validity, measurement scales for constructs in the proposed model will be selected from extant literature, and will be slightly adapted to reflect the context of this study. Measures that require considerable change will be re-developed following the guidelines suggested by Moore and Benbasat (1991). Intention to use will be measured using the 3-item scale by Venkatesh et al. (2003). Other constructs will be measured as follows: performance expectancy using the 7-item scale by Compeau and Higgins (1995); effort expectancy using the 4-item scale by Moore and Benbasat (1991); self-efficacy using the 10-item scale from Compeau and Higgins (1995); social influence using the 4-item scale from Thompson et al. (1991); health consciousness using the 6-item scale from Jayanti and Burns (1998); subjective health knowledge using the 5-item scale from Jayanti and Burns (1998). Finally, a formative construct will be devised for facilitating conditions to capture both concepts of technical support (Thompson et al. 1991) and caregiver support (Paswan and Young 2002) relying on both IS and healthcare literatures. Measurement scales for this construct will be developed following the three stages of item creation, scale development and instrument testing suggested by Moore and Benbasat (1991) while considering guidelines on specifying formative constructs by Petter et al. (2007). Perceived health status will be measured using

the 2-item scale from Kaplan and Baron-Epel (2003). A subjective measure for health status is employed as an individual's perception of his/her health status is likely to influence his/her adoption and use of a health service like PHR system (Ware et al. 1981).

Qualitative analysis: Participants will also be asked to respond to open-ended questions relating to their concerns and experience with using the PHR at the two points of data collection in this study. Subjects' responses to open-ended questions will be analyzed using NVivo in order to enhance the robustness of results as well as to strengthen the findings through triangulation (Benbasat et al. 1987). Triangulation involves validating the results by combining a range of methods (Tashakkori and Teddlie 1998).

Model validation: Structural Equation Modeling (SEM) will be used to validate the proposed model. SEM allows the analysis and investigation of unobservable variables that are indirectly measured from observable variables (Chin 1998). In particular Partial Least Squares (PLS) will be used as it is applicable to both exploratory and confirmatory research which is appropriate for this study and as it supports having both reflective and formative constructs in the model (Chin et al. 2003; Gefen et al. 2000). Further, PLS gives optimum prediction accuracy because of its prediction orientation (Fornell and Cha 1994). The measurement model in PLS will be assessed in terms of item loadings, internal consistency and discriminant validity (Gefen et al. 2000) using SmartPLS[4] software.

Impact of individual characteristics: In order to investigate the impact of individual characteristics on PHR system usage, various statistical techniques will be employed. First, Chow's (1960) test will be used to investigate whether the validated model varies for individuals with various perceived health statuses. To this end, subjects will be divided into two groups of well and un-well people based on their responses to the perceived health status scale. One PLS model will then be developed for each group and corresponding path coefficients will be compared across the two models using Chow's test to identify any significant variations (Chin 2000). The same approach will be used to compare PLS models for males and females. Second, the impact of age, education level and frequency of Internet use will be examined by creating a series of control models. To this end, for each of the aforementioned variables, one construct will be added to the model and additional paths will be created from the new construct (e.g. age) to all the existing constructs. Then, variance explained for the constructs in the original model and the controlled models will be compared. Finally, we will examine other possible relationships which are not hypothesized, through a saturated model analysis (Chin et al. 2003). In addition, any possible interaction effects between independent variables will be examined using PLS as suggested by Gefen et al. (2000).

Sample: The sample size for validating the model in PLS is determined by the maximum of 10 times the most number of paths leading to a construct and 10 times the number of items for the most complex construct (Chin et al. 2003). Self-efficacy is measured using the most number of items (10) in the proposed model resulting in a minimum required sample size of 100. Performing the Chow test will require twice as many subjects (200) since the models should be tested for the two groups separately (Ghilagaber 2004). To allow for possible spoiled surveys 300 participants will be recruited. Previous research experience in the clinics indicates a 50% initial response rate. Considering the longitudinal nature of the study and the fact that questionnaires will be sent out at two points in time, it is reasonable to expect that part of the subjects might drop out of the study. Assuming a 50% dropout rate, there is a need for initially targeting 1200 adult registered members of the clinics in order to ensure having 300 participants throughout the study. Invitations to participate in the actual study will be sent by regular mail to a randomly selected sample of 1200 adult patients and followed up with reminder phone calls. Approached members of the clinic will be incented to participate through opportunities to win prizes. In order to assess non-response bias, respondents and non-respondents of the both surveys will be compared, based on demographic information (Compeau et al. 1999).

[4] http://www.smartpls.de

4. POTENTIAL CONTRIBUTIONS

Personal health record systems have the potential for helping consumers to take over more of their own care, thus reducing the burden on the healthcare system. But it is essential to improve the adoption rates of such systems if they are to have an impact on patient care. Behavioral issues have been identified as major inhibitors to adoption of PHR systems by consumers. Thus, there is a special need to focus on consumer behavioral factors influencing intention to use health information systems in general and personal health record systems in particular. While there is a plethora of research discussing adoption models for information systems in general, only a few studies have focused on the adoption of information systems in healthcare settings. The proposed study attempts to address this gap by seeking to develop and validate a theoretical model explaining the factors influencing an individual's intention to use personal health record systems as a preventive health care behavior. Although this research is being carried out in a Canadian context, it is highly relevant for other developed countries that have similar demographic and healthcare system characteristics.

From an academic perspective, results of this research will contribute to the IS and e-Health literatures by developing an adoption model specific to PHR systems. It is hoped that this research will attract the attention of researchers to further develop and test constructs and models applicable to consumer intention to use personal health records and other health information systems as a preventive healthcare behavior.

Practitioners will also gain a better understanding of consumer preferences through this work, resulting in practical guidelines for PHR systems' development, promotion and use. Results from this research can help direct attention to the most influencing adoption factors while proposing solutions that mitigate consumer resistance. Such solutions will enhance the PHR benefits for consumers and the healthcare system. Technology providers will benefit by informing the design of their proposed systems based on these results. This, in turn, will lead to higher rates of adoption and success of the Internet-based personal health records. Health care providers will also benefit from the results of this research by being able to deliver a higher quality level of care at a lower cost and complexity by involving patients in their own care through PHR systems. Given the growing importance of consumer-centered healthcare and e-health, adoption studies of this nature are both timely and relevant.

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