Innovative Technology and Change Management: E-health Applications in Canada

By

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Abstract

Background

Focusing on the Canadian healthcare system, this study explores factors influencing the adoption of recent specialized technology in e-health applications due to concerns about the allocation of economic resources and governmental policy formulation. This study focuses on the specific technologies of the Electronic Medical Record (EMR)-based-Personal Health Record (PHR) and their use by physicians and residents of Northern Ontario.

Objectives

The primary objective of this study is to understand the interdisciplinary factors that predict Northern residents' attitude toward EMR-based-PHR innovative technology. Conducting this study also serves to increase awareness of patient-driven e-health in Northern Ontario and provides decision makers with useful quantitative data and strategies to support future initiatives.

Methods/Materials

Using customized data obtained from the National Physician Survey (NPS) in Canada and primary data collected through an adaptation of this survey, a comparative analysis was conducted to understand the electronic patient-physician relationship and explore interdisciplinary factors regarding perception and use of EMR-based-PHR. The data was analyzed using Descriptive Statistics, Z Test for two Population Proportions, ANOVA and Regression Analysis.

Results

The results indicate significant differences between Northern physicians and patients in usage and preference regarding several technological applications. More Northern patients use websites, social media and mobile applications than Northern physicians. In capturing health

information, fewer physicians exclusively prefer to use electronic records than use a combination of paper charts and electronic records, and most Northern patients prefer either a combination of both methods or exclusively paper charts in their healthcare. Interdisciplinary factors related to EMR-based-PHR were significant predictors and explained 69.6% of the variance in the behavioral attitude and 74.5% of the variance in the behavioral intention to adopt this innovative technology.

Conclusions.

Establishing an electronic patient-physician relationship in the Canadian healthcare system requires coordinated and concerted efforts from all stakeholders involved in this process. Significant cost without benefits is evidence of a misallocation of Canadian resources and requires increased attention. New strategies must address current gaps in educational, technical, managerial, and financial supports. Physician support, however, is ultimately the key to increasing the adoption rate of EMR and fostering positive attitudes toward PHR among the Canadian people.

Keywords: Innovative technology; E-health applications; Electronic Medical Records; Personal Health Records; Change management

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Dedication

This thesis is dedicated to my wonderful wife Wejdan and those gifts of God, my beautiful children, Salam, Reem and Amin. This effort might not have been successfully accomplished without their love and motivation, along with their unlimited and unconditional support. Their presence in my life has created a heightened consciousness of what I have to achieve in order to improve their future lives. In addition, I dedicate this effort to my parents, who no longer exist in this life, but exist in my soul. Following their loving guidance was the first milestone in achieving my academic goals and this thesis.

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List of Abbreviations

ADKAR	Awareness, Desire, Knowledge, Ability and Reinforcement
ATU	Attitude Towards Usage
ARPA	Advanced Research Projects Agency
CHIA	Canada's Health Informatics Association
CHICMF	Canada Health Infoway Change Management Framework
CBAM	Concerns-Based Adoption Model
DIST	Department of Industry Science and Tourism
DTPB	Decomposed Theory of Planned Behaviour
EHR	Electronic Health Record
EIU	Economist Intelligence Unit
EMR	Electronic Medical Record
EPHR	Electronic Patient Health Record
HIEs	Health Information Exchanges
HIM	Health Information Management
HIMSS	Healthcare Information and Management Systems Society
HIS	Health Information System
HIT	Health Information Technology
HITECH	Health Information Technology for Economic and Clinical Health
HL7	Health Level 7
ICTs	Information and Communication Technologies
IDT	Innovation Diffusion Theory

OECD	Organization for Economic Co-operation and Development
OMA	Ontario Medical Association
NPS	National Physician Survey
NIST	National Institute of Standards and Technology
PEOU	Perceived Ease of Use
PHI	Patients Health Information
PHR	Personal Health Record
PU	Perceived Usefulness
ROI	Return on Investment
SDLC	System Development Life Cycle
TAM	Technology Acceptance Model
TOE	Technology, Organization, and Environment

Chapter 1 Introduction to the Study

1.1 Background

The Canadian industry services sector continues to be subjected to ever increasing innovative technology needs within a rapidly changing environment. Innovative technology has many applications in most fields of healthcare, education, and so on. Globally in the e-health sector, for example, technology has enhanced the efficiency of healthcare delivery through Health Information Systems (HIS), Electronic Medical Records (EMR), Personal Health Records (PHR), Telemedicine, Physiological Signal Processing and Medical Imaging and Health on the Internet. As well, in the educational technology sector, for example, technology has also enhanced the efficiency of learning delivery through electronic learning management systems and technology tools for teaching such as stream author, course lab, and smart technology. Many informatics experts are optimistic about the prospect of e-health and educational technology, as these technologies are designed to improve sustainability, management, education and decision-making. They also support behavioural changes related to public-health priorities (Piette *et al.*, 2012). In addition, they invest large amounts of time and resources in educational technology, with the goal of enhancing the educational effectiveness of the learning environment (Moseley, 2010). These technologies have enabled scholars to appreciate the interaction between disciplines, innovation and the other areas of the knowledge economy. At one time, I believed that innovative technology was fundamental to a high-performing economy; however, through my reading of different government reports, I am no longer sure about that because Canada has a weak innovation rank among peer countries in many sectors (McGrail *et al.*, 2010; Phillips, 2008; Schoen *et al.*, 2009).

Because of this, the interdisciplinary research process presents the most effective way to better understand this dichotomy. In this research process, I argue that the government spent billions of dollars on e-health innovative technology with limited success, which affects the Canadian economic system as a whole and Northern Ontario in particular. Specifically, this study will concentrate on Electronic Medical Record (EMR)-based-Personal Health Record (PHR), as a one application of the e-health innovative technology from the perspective of the end-users. According to the National Alliance for Health Information Technology, the EMR is "An electronic record of health-related information on an individual that can be created, gathered, managed and consulted by authorized clinicians and staff within one healthcare organization" (p.6). The PHR is "An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be drawn from multiple sources while being managed, shared and controlled by the individual" (p.6).

While several research model approaches for interdisciplinary studies have been presented in recent years, interdisciplinarian scholars (Klein, 2005; Newell, 2007; Repko, 2008; Szostak, 2002) have simplified our thinking in this area, since a weak innovation research problem should be studied in a real context, combined with industrial practices and tuned to fit the context of empirical investigation. Empirical investigation is a common model available for enhancement of the problem-solving skills in the overall interdisciplinary studies. This match with Repko's (2008) research model will be applied to this complex problem, which also proposes that interdisciplines might become the subject of empirical investigation. Focusing on one complex problem that needs empirical investigation, the next section will explore some symptoms of the application of information technology in Canadian service industries.

1.2 Symptoms of the Innovative Technology Problem in Canadian Service Industries

The Council of Canadian Academies report entitled Paradox Lost (2013) has revised the ongoing challenge of Canada's innovative technological development in a series of studies. The report stated that the continuing weakness of Canada's business innovation performance stems from the lack of specialization of Canada in high technology and the lacking degree of importance given by Canadian firms to innovation-focused business strategies (Wolfe, 2014). "With little motivation to change a successful formula, many firms have settled into 'low-innovation equilibrium' that has conditioned Canadian business habits and ambitions. Canadian business behaviour cannot be expected to change unless the conditions that have sustained its profitable, low-innovation equilibrium change first" (Council of Canadian Academies, 2013, p.7). Starting from this point, Canada's overall ranking in innovation and technology has declined over the years, according to the World Economic Forum's Global Competitiveness Index, 2012-13 (Dutta & Bilbao-Osorio, 2012). As reported in a 2009 survey conducted by the International Telecommunications Union on the advanced use of information and communication technologies (ICTs or IT), Canada is ranked 19th out of 154 countries, down from 9th place in 2002 (Carpenter, 2010). In order to address the Canadian innovation challenges, we need to address the overlap between Canadian business habits and business behavior, and between motivation to change and human fears to change. For example, focusing on the Canadian services industry, the following reports reveal that the overlap between human perception, business behavior and motivation have provided the key in the change management process to accept this innovative technology.

In the education industry, Canada has invested in the e-learning infrastructure, but the adoption level of e-learning has been considerably slower than expected in comparison with many other countries (Canadian Council on Learning, 2009). The Economist Intelligence Unit (EIU) report (beyond e-readiness) ranked Canada 11th out of 70 countries in 2010. E-learning provides students with access to qualified and specialized instructors. If instructors could be technologically literate, the rate of student success would not only increase, but would likely reduce the physical existence of some resources, which could alter the academic organizational infrastructure (Sisco, 2010). Some organizations such as the Canadian Federation of Students have expressed concerns that e-learning technologies are simply attempts to replace people with machines (Carpenter, 2010). The key barriers to involving people are the fear of becoming dependent on technology and becoming isolated as learners in the learning process (Carpenter, 2010). These increase resistances among stakeholders in academia.

In the healthcare industry, to date, according to Canada Health Infoway, Canada has invested upwards of $ 2.1 billion to accelerate the e-health implementation process (Canada Health Infoway, 2014-2015). The most part of this investment has been allocated to an integrated EMR and electronic patient records to improve the automation of health service delivery between healthcare stakeholders' (hospitals, physician offices, patients etc.). Nevertheless, recently a Healthcare Information and Management Systems Society (HIMSS) Analytics study looked at data from over 640 hospitals to determine the level of EMR adoption in 2014 (HIMSS, 2014). The scale used in the study rated hospitals from zero, meaning hospitals with an EMR with no functionality installed, to seven, indicating a fully functional paperless system. In 2014, four hospital systems in Canada had attained level six adoption and zero hospital systems had attained level seven adoptions (see Table 1.1).

Table 1.1 *EMR Adoption Statistics by Stage (Data from HIMSS Analytics® Database)*

Canada EMR Adoption Model SM			
Stage	Cumulative Capabilities	2014 Q2	2014 Q3
Stage 7	Complete EMR; CCD transactions to share data; Data warehousing; Data continuity with ED, ambulatory, OP	0.0%	0.0%
Stage 6	Physician documentation (structured templates), full CDSS (variance & compliance), full R-PACS	0.6%	0.6%
Stage 5	Closed loop medication administration	0.5%	0.6%
Stage 4	CPOE, Clinical Decision Support (clinical protocols)	3.6%	3.4%
Stage 3	Nursing/clinical documentation (flow sheets), CDSS (error checking), PACS available outside Radiology	32.5%	32.1%
Stage 2	CDR, Controlled Medical Vocabulary, CDS, may have Document Imaging; HIE capable	28.9%	29.5%
Stage 1	Ancillaries - Lab, Rad, Pharmacy - All Installed	14.5%	14.6%
Stage 0	All Three Ancillaries Not Installed	19.4%	19.1%
Data from HIMSS Analytics® Database ©2014		N = 640	N = 638

A 2013 National Physician Survey found that the use of EMR by Canadian primary care physicians was 53 %, up from 14% in 2000. Not only was it low in 2000 but compared to 97% (from 52%) in New Zealand and 95% (from 25%) in Australia, it was very low (McGrail & Hébert, 2010). After paying these billions and after also 14 years of work on EMR adoption, in 2013, 31.3% of participants who use EMR believe that it did not change the productivity of their medical practice and 13.3% believe that EMR decreased their productivity (National Physician Survey, 2013). In the Commonwealth Fund's 2009 survey of primary care physicians in 11 countries, Canada ranked in the lower half on every measure of the survey; most often, the rank is at or near the bottom (Schoen *et al.*, 2009). As a subsystem of EMR, Canada has also moved forward in applying the innovation in consumer health under a system called PHR, which enables Canadians to manage and communicate their health information with healthcare providers (Canada Health Infoway, n.d.).

In a 2009 survey in Ontario to explore healthcare providers' perceptions of the implementation of PHRs through patient-physician relationship, participants have expressed strong concerns about security and privacy, lack of physician guardianship of medical information, and caution about the quality of the information that is entered by patients (Yau *et al.,* 2011). In addition, the integration of the PHR with EMR will modify the patient-physician relationship in the traditional interpretation of the medical process, which makes patients experience unnecessary anxiety as they attempt to interpret the complex language used in medical records (Yau *et al.,* 2011). However, the low adoption of EMR has a significant barrier to implement and adopt the PHR in Canada, because if the source of PHR falters in the application, then how can the branch succeed. From organizational perspectives, a survey of Chief Executive Officers (CEOs) of Canadian public and acute care hospitals shows that hospital financial resources are the main barrier (86.7%) to providing patients access to their EMR (Urowitz *et al.,* 2008). However, in Canada, "stakeholders have shown interest in the implementation and use of ePHRs, but there is insufficient evidence about their benefits and potential effects on the healthcare system" (Gagnon, 2014, p.1). Results of several studies found that Canadian e-health technologies are slowly moving in the direction of PHR and the Canadian legislative and regulatory entities do not support some of the challenges arising from PHR (Gagnon, 2014; Urowitz *et al.,* 2008; Yau *et al.,* 2011). Therefore, they suggest that before increasing the use and implementation of PHR, the stakeholders should fuel the research to meet their needs; however, this cannot be achieved without considering the end-user (consumer) needs.

1.3 Statement of the Problem

Evidence-based practices have been presented according to the above symptoms of the innovative technology problem in Canadian service industries, so it appears Canada is experiencing some barriers when it comes to computer integration. Focused on Northern Ontario, this study concerns new specialized technology, economic decisions and governmental policy formulation from Canadian perspectives. These took root within the governmental influences in the transition management and implementation of ways to understand the relationship between innovative technology and Northern people. The study proposes that the use and adoption of new technology in the Northern communities alone is not always enough. Instead, other resources must be linked to or integrated within other community factors and infrastructures that can respond to human knowledge challenges (Harris & Bella, 2010). As a result, despite the progress of innovative technology in support of healthcare services, EMR-based-PHR innovative technology has been highlighted in this study to understand this dichotomy. Focusing on the problem of slow progress, it is important that the perspectives of professionals made public across different contexts be considered in order to identify commonalities and/or issues. Therefore, in terms of electronic patient-physician relationship, this study uses a comparative analysis between secondary data based on the healthcare providers' perceptions and perspectives from the Canadian National Survey and primary data based on the Northern regional communities public perception and perspectives, to determine the impact of psychological, managerial, political and economic practices on the use and adoption of EMR-based-PHR innovative technology.

1.4 Statement of Purpose

The main purpose of this study is to explore the reasons for Canada's slow progress in innovative technology in general and EMR-based-PHR innovative technology in particular. The approach to Canada's slow progress in innovative technology is structured under four objectives:

- To explore factors that influence a group of Canadian people's attitude toward EMR-based-PHR innovative technology, through investigating the impact of various individual perceptions and expectations, as well as behavioral and environmental factors on the adoption and use of this technology.
- To act as a proactive approach to raise the awareness of patient-driven e-health (engagement) in preparation of a desired future situation and to continue to support government decisions through adopting practices to successfully implement their plan.
- To quantify EMR-based-PHR innovative technology usage and acceptance from the end-user perspectives within measurable factors in e-health outcomes.
- To align strategies and resources according to Canadians' expectations in order to develop a framework for meaningful use of the EMR-based-PHR innovative technology in a cost-effective and sustainable manner.

In examining these issues, I also explore Northern people's expectations from these technologies. Do these expectations differ as a function of the government decision? Did the Canadian government make the right decision to pay this amount and invest in this technology?

To reach this goal, I took the following steps:

1. A review of the current status of the literature
    1.1 An investigation of history, return on investment, reaction and implementation of innovative technology in service industries.

1.2 An investigation of healthcare industry reaction to e-health adoption and implementation.

1.3 An exploration of the kind of e-health applications to understand the electronic patient-physician relationship in the domain of the EMR-based-PHR innovative technology.

1.4 An exploration of the human models that have been used in the adoption and acceptance of technology to design the research model that will engage and empower patients in the EMR-based-PHR innovative technology.

1.5 A study of whether the adoption of the EMR-based-PHR innovative technology is predicted by interdisciplinary factors such as sociological, psychological, political, technological and so on.

2. The development and testing of a research model that incorporates interdisciplinary factors with data prediction (see Figure 1.1).

2.1 A questionnaire as primary data based on the model was distributed to Northern people to understand their perceptions, expectations and preferences from interdisciplinary factors.

2.2 This was followed by a comparative analysis with the Canadian healthcare provider's national survey as a secondary data to understand the electronic patient-physician relationship and to validate the results.

2.3 An analysis of whether there are differences in the characteristics of people who use EMR-based-PHR innovative technology and those who do not.

2.4 An exploration of the effects of using EMR-based-PHR innovative technology on the quality of patient life and the performance of hospitals.

3. Recommendations and a behavioural model are developed for the health organizations using e-health applications in their practices, along with effective strategies to reduce the barriers associated with using these systems.

1.5 Research Questions

Much of the research concentrates on and has been devoted to EMR-based-PHR innovative technology, which is viewed as a major part of e-health applications that control the patient-physician relationship in the health services industry. A number of questions from generalization to specialization are developed to understand the problem of slow progress which can be summarized by the following:

1. Are there any differences in the technology skills of Northern physicians and patients in using e-health services?
2. Why is Canada's level of compliance so low for innovative technology?
   2.1 Canada is a multicultural country and has a mosaic of personality types. How will this variety affect the success of the innovative technology implementation? Or do sex, age, education and ethnicity have an effect on Northern people's attitude toward EMR-based-PHR innovative technology?
   2.2 Does the interaction of sex, age, education and ethnicity have an effect on determining the behavioural attitude of people in Northern Ontario toward EMR-based-PHR innovative technology?
3. What human barriers impede the adoption of EMR-based-PHR innovative technology in Northern Ontario?
   3.1 Is the perceived usefulness of EMR-based-PHR predicted by the perceived ease of use variable toward adopting EMR-based-PHR?

3.2 Is the perceived usefulness variable of EMR-based-PHR predicted by the external factors for adopting EMR-based-PHR (Governmental Incentives, Physicians Support and Hospital Management Support)?

3.3 Is the perceived ease of use of EMR-based-PHR predicted by the external factors for adopting EMR-based-PHR (Governmental Incentives, Physicians Support and Hospital Management Support)?

3.4 Is the behavioural attitude toward adopting EMR-based-PHR predicted by the technological characteristics of EMR-based-PHR innovative technology?

3.5 Is the behavioural attitude toward adopting EMR-based-PHR predicted by sociological and psychological aspects that relate to human factors?

3.6 Is the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR predicted by a combination of interdisciplinary variables that relate to managerial, technological, sociological, and psychological human factors?

3.7 Is the behavioural intention of the people of Northern Ontario to use EMR-based-PHR predicted by a combination of interdisciplinary variables that relate to managerial, technological, sociological, psychological human factors, their behavioural attitude and perceived behavioural control?

3.8 Is the perceived behavioural control of the people of Northern Ontario to use EMR-based-PHR predicted by psychological human factors?

4. What are the strategies or methods that should be adopted by the decision makers from the perspectives of Canadians to lessen the barriers of the adoption for EMR-based-PHR innovative technology?

1.6 The Importance of the Research

In today's world, many modern health facilities have started using e-health with the aim of managing health service costs and reducing patient waiting time. The use of e-health has enhanced wide area networking, global thinking, and improved healthcare at local, regional, and national levels (Cashen *et al.,* 2004). This means that patients living everywhere but particularly those in regional communities will have easier access to health services (Kwankam, 2004). According to Kwankam, e-health networks can remove time and distance barriers to the flow of health services. EMR as a major part of e-health has the most important reasons that the Canadian healthcare system would benefit from the extensive transition from paper to paperless. Table 1.2 shows the types of missing information and their frequency (Smith *et al.,* 2005).

Table 1.2 *Types and Frequencies of Missing Information*

Information Missing During Patient Visits	% Visits
Lab results	45%
Letters/ dictations	39%
Radiology results	28%
History and physical exams	27%
Pathology results	15%

According to this table, 45% of lab results are re-ordered because of missing information. That means that EMR has excellent benefits such as quality care and patient safety, productivity, financial implications and so on. As a result, increasing the awareness of EMR adoption will also increase the performance of healthcare provider and reduce the hospital costs. As well, these benefits will meet the government's expectations and be a good investment for the national economy.

However, the importance of PHR as a system controlled by patients is mainly the same as the importance of EMR as a system controlled by physicians. A 2006 report of the National Committee on Vital and Health Statistics (NCVHS) has shown several benefits of PHR for patients, healthcare providers, payers and societal/population health benefits. For patients and healthcare provider, these benefits include support for wellness activities, monitoring of illness, improvement of the communication between them, and avoidance of duplication in the medical tests, as well as support of patient home monitoring for chronic diseases etc. (US Department of Health and Human Services, 2006). For payers, PHR will improve the customer service in terms of information transaction, "promote portability of patient information across plan and provide information and education to beneficiaries" (US Department of Health and Human Services, 2006, p.7). The benefits of PHRs to payers may include also lowering chronic-disease management costs, lowering medication costs, and lowering wellness program costs (Tang *et al.*, 2006). As a result, these benefits will reflect back to the population by strengthening health promotion and disease prevention and expanding health education opportunities (US Department of Health and Human Services, 2006). Besides the above benefits, PHR has potential benefits in empowering patients, improving patient-physician relationship, and enhancing patient-physician shared decision making which will consequently improve the quality of care (Tang & Lansky, 2005; Kaelber *et al.*, 2008). A study from the Center for Information Technology Leadership at Partners Healthcare System in Boston examined the cost/benefits "of increasing the adoption of PHRs to 80 percent of the U.S. population, found that it would cost $3.7 billion in start-up costs and $1.9 billion annually in maintenance costs. However, it also found that it would save up to $21 billion annually" (Zieger, 2008). Indeed, the growth in PHRs adoption and use by patients has the same weight of the adoption and use of EMRs by physicians (Archer *et al.*, 2011).

The importance of this research rests on exploring the relationship between sustainability and development of the future in Canadian EMR-based-PHR innovative technology. It has also contributed to the concept of localization and globalization. Another reason that e-health might be more effective is the possibility of personalizing and tailoring messages, and the possibility of reaching people at home (Lustria *et al.,* 2009). If we know the factors and barriers affecting EMR-based-PHR adoption and the relationships between these factors, users will reap the above benefits and maximize the value of their health services.

1.7 Limitations of the Study

The study has some limitations that need to be noted. First, the target population is limited to Northern Ontario physicians and patients, which means that the study results are not automatically generalizable to other areas in Canada. Second, the study concentrates on a developing innovative technology in the healthcare sector, which is available to physicians but not to patients, in most Canadian hospitals. The limitation of the PHR system from the patient side has led to the possibility that Northern patients are still developing their perceptions of the PHR system. This status quo has been utilized to provide quantitative data as a measurement baseline for future development of PHR systems. Third, the study results represent Northern users for one domain of e-health applications; there is limited data on the output of the Canadian health organizational context in the implementation process of the PHR system, particularity in Northern Ontario. Another study limitation is that most Northern people are dealing with paper records and face-to-face communication with their healthcare providers. We believe that it is impossible in a limited environment to explain all aspects of the PHR systems that affect their future usage. Finally, the results of this study are limited to Northern people's opinions, and these opinions may change over the years; therefore, the results should be interpreted carefully as

such opinions cannot be verified. The validity of Northern patients' opinions is limited to the reliability of the survey instrument that has been used in this study. In addition, the validity of Northern physicians' results depends on the Survey instrument used by the National Physicians in Canada.

Chapter 2 Review of the Literature

2.1 Background of Innovative Technology

Like many disciplines, innovative technology and the internet we have reached today started from innovative ideas by the U.S. Government. Specifically, the Advanced Research Projects Agency (ARPA) was established in 1957 to "respond to the perceived scientific and technological advantage the then-Soviet Union displayed in launching the Sputnik satellite" (Congressional Digest, 2007). Some of the ARPA projects are employed to serve military aspects and others were funded and employed to develop technologies, such as computer networking and the internet that serve research, business, and academic institutions. With these projects innovative ideas expanded more and more to communication devices that allowed different computers, from different producers, with different operating systems to communicate with each other (Congressional Digest, 2007). To meet these ideas, ARPA decided to contact different industries for more expansion and development. From these starts the ARPANET was born; it is often believed that the information technology and internet grew as a tree from innovative seeds from the ARPANET network set up in 1969 (Campbell-Kelly & Garcia-Swartz, 2013). Since this time, the innovative technology and internet have moved toward innovative practices for creating a valuable asset for different business industries.

At the historical level, scholars of innovative technology accumulate good knowledge when reasoning about the technology applications at hand and future applications. This has inspired researchers to assess innovative ideas to know more by identifying the driving forces of human beings to adopt these technologies since innovation is a complex process that includes different sets of people, interactions, and the equipment within and across different industries and regions (Antonioli *et al.*, 2014). From the perspective of technology, informatics

involvement is directed by the need and scope of innovation to further understand the cause of business failures (Edquist, 2005). This means that innovation and technology are correlated concepts with equal weight. To understand that and before going into details, we need to define two concepts: “innovation” and “technology”. There are several definitions of "innovation" in the literature and these definitions depend on the discipline, business, and in most cases, on the person generating the idea.

Starting from the root, Joseph Schumpter classified, in 1934, five types of innovation (see OECD, 1997, p.28): a new product or a change in an existing product; process innovation new to an industry; opening a new market; development of new sources of supply for raw materials or other inputs; and changes in industrial organization (Rogers, 1998; Schumpeter, 1934). According to these, the definition of innovation provided by many organizations is linked with Joseph Schumpeter’s classification. For example, the ABS Innovation Survey questionnaire in Australia used a definition that related to the first type “a new product or a change in an existing product” and defined innovation as [..] “any new or substantially improved goods or service which has been commercialized, or any new or substantially improved process used for the commercial production of goods and services”? (Roger, 1998, p.8). In addition, the Department of Industry Science and Tourism (DIST) used a comparatively interdisciplinary definition of innovation that combined Joseph Schumpter’s types with the effect of human ideas and business environment and defined “innovation at the level of an individual firm, might be defined as the application of ideas that are new to the firm, whether the new ideas are embodied in products, processes, services, or in work organization, management or marketing systems” (DIST, 1996, p.2, and credited to Gibbons *et al,* 1994).

On the other hand, in this part the correlation that gives us a common discourse about innovative technology is to investigate the meanings of the term technology. It is often believed that the contemporary application of the technology was created in the Vietnam War by the military. In this direction, McDermott (1997) defined technology from the perceptive of politics as "systems of rationalized control over larger groups of men, events, and machines by small groups of technically skilled men operating through organized hierarchy." According to McDermott, this means that technology has its own politics, which also are different from the perspective of Mesthene (1969, p. 492), who defined the technology as "the organization of knowledge for practical purposes" (Arslan *et al.*, 2014). These perspectives display different definitions of technology. For example, McOmber (1999) in his study classified three meanings of technology. The first one is "technology as instrumentality". In this section, he used Mesthene's (1969) explanation of the relationship between technology and social change as the following:

> The usual sequence is (1) technological advance creates a new opportunity to achieve some desired goal; (2) this requires (except in trivial cases) alterations in social organization if advantage is to be taken of the new opportunity; (3) which means that the function of existing social structures will be interfered with; (4) with the result that other goals which were served by the older structures are now only inadequately achieved. (p. 493)

The second one is "technology as industrialization", according to McOmber (1999), the meaning of technology as industrialization relates a little to the Marxist view of history. Referring to this meaning, "technology is the product of a specific historical time and place". The third one is "technology as novelty," technology refers here to the up-to-date products of

human imagination, innovation and especially to devices not yet widely available or understood (McOmber, 1999).

As a result, technological goods and service innovations can include any of new or improved goods and services whose features differ partly or completely from previous features (Rogers, 1998). According to these definitions, innovation and technology have been placed and correlated with the development of improved or newest products, services, knowledge or materials (Rogers, 1998). As well, this idea matches completely with the first two Schumpeter categories. Because of this, the Oslo Manual, produced by the OECD (1997, 2nd Edition), decided to focus on these categories, which define technological innovation as the adoption of "new or significantly improved production methods, including methods of product delivery" (p.49). From this definition, we can conclude that innovation of technology changes incessantly and generates new concepts; the new is ubiquitous and we need innovative ideas to explore the ubiquitous things and facilitate their adoption.

2.2 Professional Service Industries: Returns on Innovative Technology Investments

Professional service industries are a significant sector to the Canadian economy. This sector is made up of public and private organizations to generate revenues through providing tangible and intangible products and services. Earned revenues result from selling services or products in different sectors such as healthcare, education, agriculture, transportation and so on. From a theoretical background, these sectors invest in many resources to improve their performance and to achieve their final goal through improving their quality. One of these important resources in our contemporary world is an innovative technology. Despite the high cost of this technology in these organizations, they are still investing more and more to satisfy their end-users. The measurement of return on investments (ROI) for innovative technology has

been developed and applied to a variety of sectors, including health technology (Coyle, 2006; Danello *et al.,* 2009; Graves, 2002; Menachemi *et al.,* 2006); educational technology (Krueger, 2013); agricultural technology (Brennan & Martin, 2007) and so on. Figure 2.1 shows how the ROI for technology applications evolved within different sectors, starting from the manufacturing sector to the educational sector (Roulstone & Phillips, 2008, p. 4).

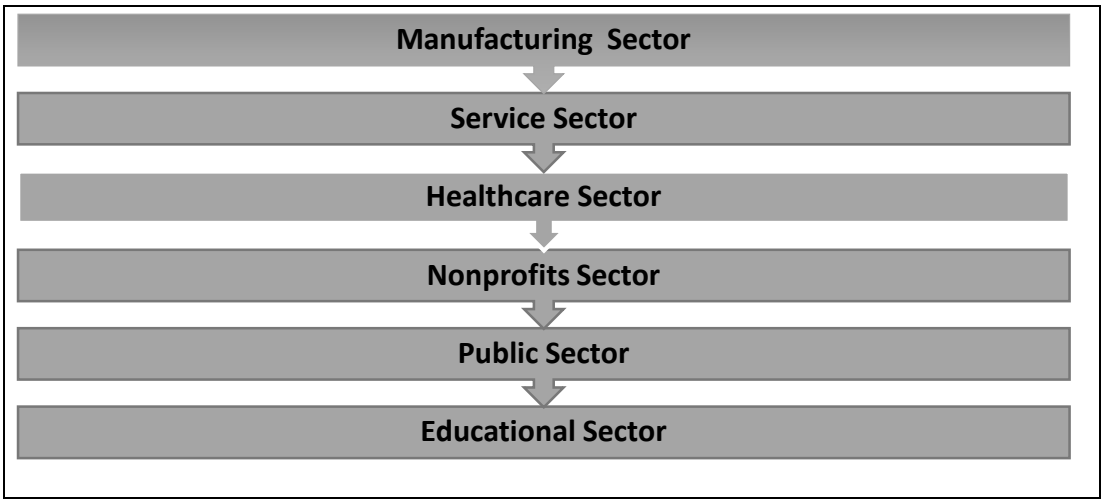

Figure 2.1 Progression of ROI implementation (Movement within the Sectors)

There are several methods to calculate the ROI, but the most frequently used method is reported as a financial analysis ratio and is a measure of an investment's performance. Simply, it is calculated by dividing the net project benefits (or profit) by the total project costs (or assets) invested over the time period. Calculating the ROI has become one of the most challenging issues that service industries must face with regards to the information-technology industry (Andru & Botchkarev, 2012) because most benefits of innovative technology are intangible. They are related to overall performance in the organizations and require many qualitative and quantitative indicators. For example, in 2005 a leading global technology consultancy, called Accenture conducted a study surveying more than 300 organizations using 33 different indicators of high-, average-, and low-performance in managing information technology (Accenture, 2005). Surprisingly, the study's result indicated that "high-performance IT organizations spend

significantly less time maintaining and fixing systems and significantly more time building new systems. High performers, on average, spend 40 percent more time building and integrating systems than low performers"(Accenture, 2005).

This means that with innovative technology investment, there is no financial formula because the value of the gains is difficult to quantify (Contino, 2004). In addition, the benefits created by innovative technology in most cases depend on the long run investments to evaluate the outcomes. Unlike a benefit produced by other investments for which services can be estimated, the use of innovative technology does not produce an additional direct income stream (Menachemi & Brooks, 2006). As a result, ROI is calculated by quantifying costs and benefits in monetary units. But professional service industries are not-for-profit businesses; they cannot measure their operational activity in terms of money. For example, the operational activity in universities is learning, the purpose of educational technology is to improve efficiency, save money and improve the quality of life of learners (Krueger, 2013). According to Krueger, in this case, the focus should not be on measuring the ROI, but on the Value of Investment (VOI), because the investments in technology are focused on educational aspects rather than financial aspects. Healthcare also is a vital sector, which completely depends on caring and providing different health services. Inside this sector, the challenge beyond measuring the ROI is related to the value associated with technology -- mainly that of improved health service and care quality-- and the benefit return to patients or healthcare providers who do not directly pay to receive higher quality services (Menachem & Brooks, 2006). This means that we need to reshape the ROI of innovative technology in service industries.

Mack (2012) adopted three common strategies for rethinking the ROI. The first strategy focuses how the organization increases efficiency: “producing more with fewer resources”. The

second focuses on consistency: “improving quality and emphasizes predictability and repeatability”. The final strategy takes the route of sufficiency, which involves rethinking the approach to building integrated and sustainable industrial systems.

2.3 The Effect of Innovative Technology in Different Industry Types

This section examines the impact of innovative technology on sector performance in different industries. The reality depicted in previous evaluation of the technology projects and the different measurement levels make these highly innovative projects attractive to conventional research sources. On the other hand, in dynamic and sustainable environments, the management of internal and external knowledge is becoming a key factor enabling service industries to gain competitive advantages with foreign providers (Bolívar-Ramos *et al.,* 2013; Camisón & Forés 2010; Currie & Pouloudi, 2000; Lin, 2011). This knowledge translated by technical skills that influence the development of necessary organizational development-- such as thinking creatively, working collaboratively with others, accessing, using, managing and evaluating information, reasoning effectively and using systems thinking-- means that innovative technology is designed to make things easier and integrate a mass of information, decreasing time taken to share knowledge and information within organizations (Pearcy & Giunipero, 2008). As a result, this will achieve a better control of costs, increase productivity and efficiency for both service provider and receiver (Ngai *et al.,* 2011). From a theoretical standpoint, the measurement of technological impact on added value and the improved quality of professional service industries has been adopted in several researches. For example, in the healthcare sector, Jones *et al.,* (2014) explored 236 articles between 1995 and 2013 that related the effect (use) of health information technology (HIT) on quality, safety, and efficiency. Of these, 147 articles evaluated the effect of HIT on 170 quality-related outcomes, 46 articles investigated the effects

of HIT functionalities on patient safety outcomes, and 58 articles assessed the effect of HIT on 62 efficiency-related outcomes (see Table 2.1).

Table 2.1 *Health IT Evaluation Studies Between 1995 and 2013, by Study Outcome Type*.*

Meaningful Use Functionality	Outcome, n			
	Quality	Efficiency	Safety	All
Clinical decision support	257	91	69	417
Computerized provider order entry	63	66	60	189
Multifunctional health IT intervention	146	100	27	273
Patient care reminders	48	8	1	57
e-prescribing	15	18	15	48
Patient access to electronic records	17	3	0	20
Health information exchange	5	10	0	15
Clinical laboratory test results	4	6	1	11
Medication lists	1	1	1	3
Electronic immunization registries	2	1	0	3
Other meaningful use	15	6	1	22
All meaningful use	573	310	175	1057

* (Jones *et al.,* 2014)

Overall, results indicate that there is a positive impact on most effected factors. There were mixed results in some functions and negative impacts in other functions (see Table 2.2).

Table 2.2 *Health IT Evaluation Studies between 2007 and 2013, by Study Outcome Result**

Meaningful Use Functionality	Outcome Result, %				
	Positive	Mixed	Neutral	Negative	Total, n
Clinical decision support	65	17	11	7	142
Computerized provider order entry	63	16	12	9	91
Multifunctional health IT intervention	51	33	8	8	131
Health information exchange	64	30	0	6	33
Patient lists by condition	73	17	3	7	30
e-prescribing	52	28	4	16	25
Patient access to electronic records	60	25	10	5	20
Patient care reminders	60	30	0	10	10
Other meaningful use functionalities	55	36	9	0	11
Total meaningful use	60	24	9	8	493

* (Jones *et al.,* 2014)

That means that, innovative technology has a significant effect on the healthcare service industry that translates into increased productivity, efficiency (reduced cost) and quality of healthcare organizations and service receivers. In another example, innovative technology has

promoted the design and delivery of the e-learning courses for both teachers and students. According to Schooley (2009), the academic industry implementation of e-learning can foster numerous benefits arising from the transformation through the knowledgeable process and advantages, including competency speed, cost reduction, efficiency, flexibility, consistency, and repeatability. Recently, numerous researchers have investigated the impact of technology on the quality of learning, and linked it with perceptions of users in the classroom (Cheng *et al.*, 2014; Kobewka *et al.*, 2014; Venkatesh *et al.*, 2014). Cheng *et al.*, (2014) in Figure 2.2 show examples of 324 articles on workplace e-learning published in each year from 2000 to 2012.

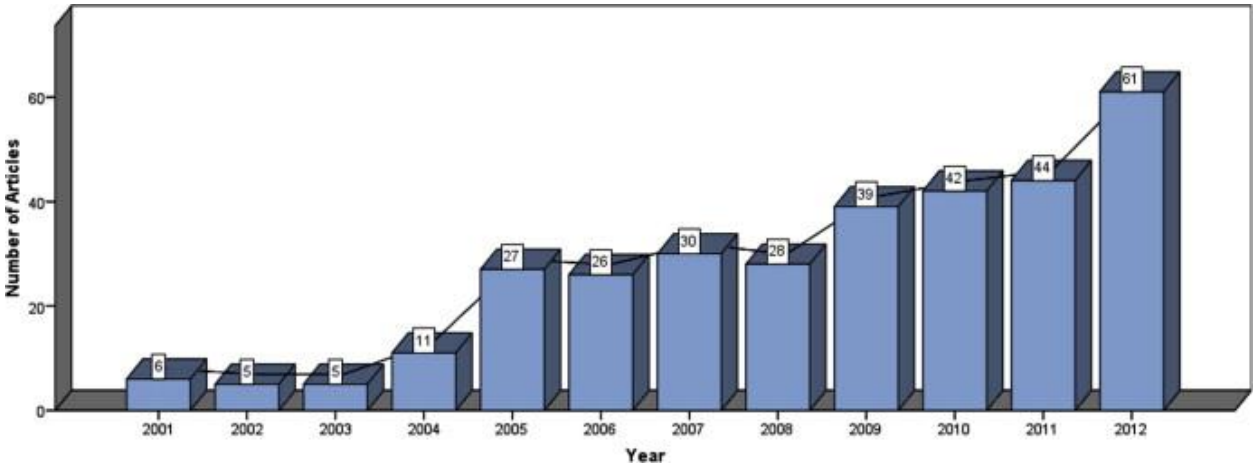

Figure 2.2 Number of Articles on Workplace E-learning from 2000 to 2012.

The graph presents the continuous progress of research related to e-learning in the workplace. The continuous use of e-learning increases the speed of educational service innovation, and productivity and enhances more qualifications. Because of this, Cheng *et al.*, (2014) in their study concluded that e-learning, "by virtue of its anticipated benefits of just-in-time delivery and cost efficiency, has increasingly been adopted in workplace settings and has resulted in the large number of studies on e-learning in the workplace" (p.57).

In their opinion, the most important effect is the efficiency of e-learning, along with the enhancing quality that shrinks costs and enhances the continuous improvement process in

academic organizations. Nevertheless, we cannot dismiss the fact that the implementation of innovative technology has also led to negative effects and technical and human problems (Aryani & Irani, 2014). Some of these effects are related to hardware and software incompatibility or interoperability between systems, and others are related to human acceptance and adoption of these systems. However, we will go through these effects in detail in the next sections, by focusing on one or more technology types of service industries.

2.4 Service Industries Reactions to Innovative Technology Implementation

For a long period of time, many service organizations in different industries have been transforming their reaction toward innovative technology to various strategies from different human–being perspectives and innovation models. These strategies are crafted to enable organizations to implement the new technology smoothly to get human acceptance, to gain competitive advantage, and to increase their performance. Nevertheless, the reactions for organizations that are implementing or updating new innovations like technology are two-fold. The first one is related to cost-benefit analysis for this technology as we discussed in the previous section. They have to analyze the factors that are influencing their decisions in switching from a manual to a technological strategy. The second one is related to a strategy to create a culture of change for management and human acceptance; the execution of this strategy is varied based on industry type and individual adoption and on the models of influencing factors that are vital for every organization. The first and most practical strategy depends on costs and numbers; each organization can conduct their ability and financial assessment to decide on spending. But the second strategy has been a challenge for decades, because it deals with human factors that are the base for the success of the first strategy.

From a historical review, Mumford (1934) concluded that human beings have resisted automated improvements by "smashing the machines or by murdering their inventor" (Carlopio, 1988). According to Mumford, human beings resist automated organization because in a "world of ideas [where] romanticism and utilitarianism go side by side" (p. 284), automation directly makes them "materialistic and rational, and indirectly… hyper-emotional and irrational" (Carlopio, 1988). Historically, Carlopio classified human reactions to technology under two negative headings: first, against exploitation or unsatisfactory working conditions and, second, against job displacement. Until recently, reactions to unsatisfactory working conditions and technology-replacing human–beings create negative consequences related to the implementation of these initiatives dealing with employee stress, technology resistance, technological change and human perceived risks, which result in expensive failures (Lucas *et al.*, 2007; Rizzuto, 2011; Schiavone, 2013 p. 15). Addressing those issues traditionally related with organizational–change management plans by attempting to modify staff and mangers' perceptions, and create interactive environments to better respond to their needs. Because of this, many organizations focus their attention on human acceptance rather than on cost of innovative technology. This will allow the achievement of their goals through improving performance and efficiency and will return the cost of their investment by obtaining the benefits of this technology.

To do that, many researchers elaborated several theoretical models aimed at understanding what factors affect human reactions, behaviors, decisions, and perceptions (Schiavone, 2014). For example, the Technology Acceptance Model (TAM) was developed by Davis (1989) to reflect the human needs, the Innovation Diffusion Theory (IDT) was developed by Rogers (1983) to rate the variables of human adoption of new technology. Another model for change in individuals, the Concerns-Based Adoption Model (CBAM) was developed by the staff

members of the Research and Development Center for Teacher Education at the University of Texas and applied to the changing process by Hall & Hord (1987) to human and organizations experiencing change. The Technology, Organization, and Environment (TOE) framework was developed by Tornatzky and Fleischer (1990), and identifies three contexts that influence the process by which it adopts and implements a technological innovation. These selected models are provided as examples. However, as we mentioned that the reaction of innovative technology on organization is varied by industry type and human beings' abilities. Because of this, in the next section, we will investigate this reaction in detail by taking an example from the professional service industries. This will be selected based on the most vital industries affecting human life in particular and country economics in general. The example is related to innovative technology in the healthcare industry, which will be explored in detail in the next section.

2.5 Healthcare Industry Reactions to Innovative Technology

Like any industry, the Canadian healthcare sector has welcomed technological world change to sustain its development. Although health technology is a critical element of the changing process, its daily updating requirement remains a continuous process improvement. As a global trend, the growing expansion of e-health in many countries such as New Zealand, Australia, and the UK will remain a cause of worries because of Canada's low adoption rates in e-health. The worry increases particularly when the progress of adoption stays slow, as the costs of these projects will exceed the benefits and ultimately the e-health domain in this case will fail. Therefore, public, health organizations and researchers alike are concerned with understanding possible reactions and perceptions of humans in this industry in order to prevent the costly loss of funds and maximize the benefits of e-health. But the relationship between e-health and human reaction and perception is manifold and depends on the real understanding by all parties. To

investigate that, the next section will explore the e-health field as a vital example of innovative technologies.

2.5.1 E-health Background and History

E-health is an innovative assessment and response to the voluminous data available in the healthcare sector. It requires an automated system to make it updateable, reachable, touchable and meaningful. Therefore, e-health is a broad concept about theoretical and technical issues which requires more clarification. A review by Oh *et al.* (2005) found 51 definitions for e-health, suggesting that the term is too general to be useful. While there are several definitions of e-health, the more comprehensive one is observed by Eysenbach (2001) as follows

> E-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networking, global thinking, and improving healthcare locally, regionally, and world-wide by using information and communication technology. (p.1)

Focusing on this definition, e-health is emerging at the intersection of two approaches. Theoretically, e-health is an interdisciplinary approach requiring accumulative knowledge from different disciplines linked with human beings' reactions and perceptions. Technically, e-health has many systems and applications that shape the body of the spirit of information and knowledge in healthcare environments. These systems can include a range of applications or services that are the bridge between the hardware and the software, such as EMRs, telehealth, mobile health, health on the internet, health information systems, clinical decision support systems and others. According to this definition and from a historical background, e-health also

is not new and has been with us for many years because it is defined by using the Internet and related Information Communication Technologies (ICT). This means that the historical development of ICT has a significant role in the growth of the e-health domain, starting with basic ICT (telemedicine1905/1969), followed by the expansion of telemedicine (telehealth 1978), the networking of ICT (e-health 1999), and mobile health (mhealth 2003) (Bashshur *et al.*, 2011) (see Figure 2.3). In general, according to Bashshur *et al.* (2011), the development of the "basic telemedicine concept driven by changes in technology, enabled functionality, and innovative applications" (p. 485).

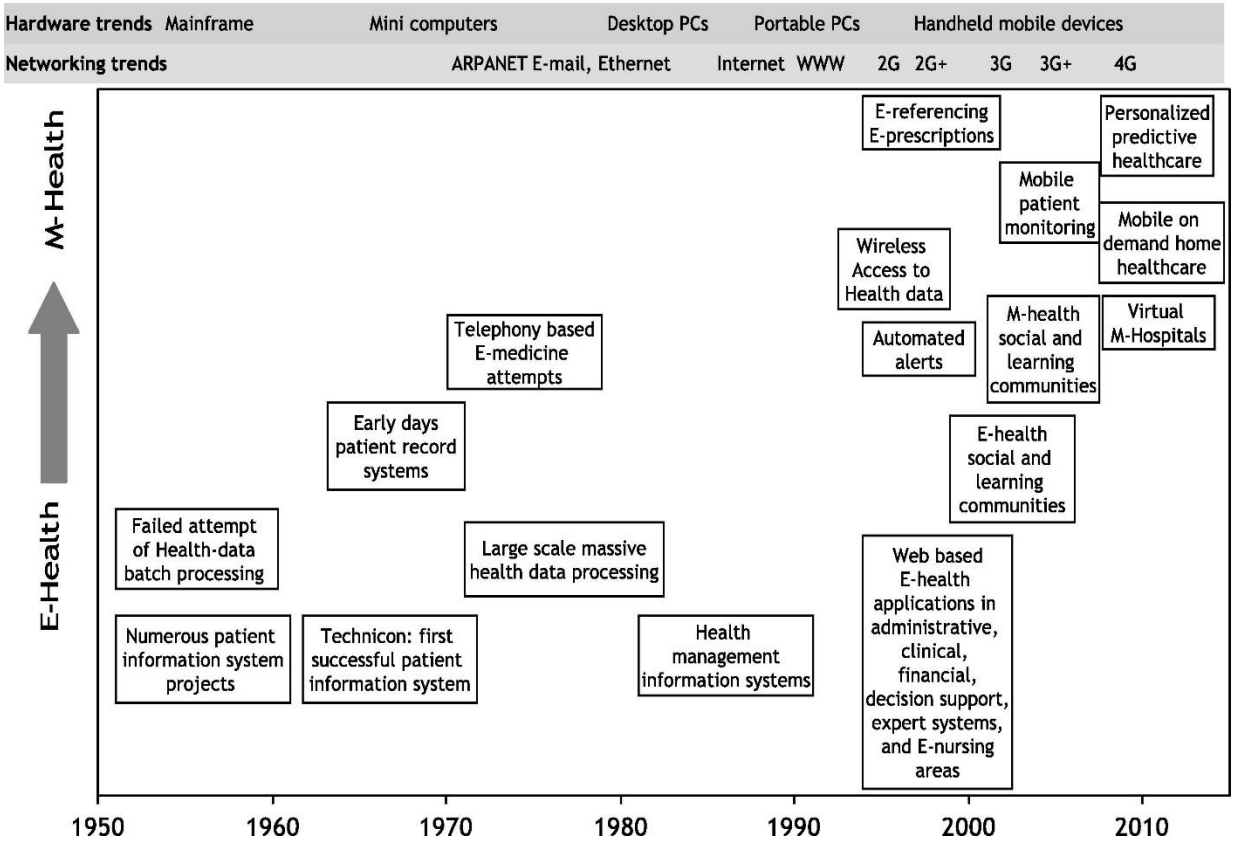

Figure 2.3 Evolution from e-Health to m-Health (Pawar *et al.* 2012).

Another example of e-health systems is the health information system, that has been developed in 1966 using a programming system created by Nell Pappalardo and Curt Marble called MUMP. This language supported the collaboration between the end-user, developers and

system designers in the healthcare sector. EMR as another example has a different history, because it started from the root of health information management (HIM) in 1918 when the American College of Surgeons worked persistently to develop and implement standards of practice (ICTC, 2009). The result led to the creation of a new discipline called "medical records librarian" in 1928 managed by American and Canadian members (ICTC, 2009).

From that time to 1970, the role of HIM expanded to include more diseases interpretations, diseases procedures and codes. As well, parallel with the development of HIM, Schwartz (1970) positively predicted, “clinical computing would be common in the not too distant future”. For the past two decades, e-health has seen significant progress in the capacity of health informatics in different countries and including Canada. As mentioned before that, e-health has been driven and developed with information technology generation. Within this development, in 1991, the Institute of Medicine (IOM) recommended EMR "as a solution for many of the problems facing modern medicine" (Dick *et al.,* 1997). To simplify that and from this division of components, it is clear that these applications are a part of the umbrella of the e-health domain. Each application has a different chronology and a different approach, yet all of these applications utilized the capabilities of information technology. From the above definition, it is clear that e-health is an emerging field, just as any electronic system (e-business, e-government, e-learning and so on) utilize the capacity of ICT for enhancing and delivering health services and information to increase the efficiency of health organizations and the quality of patient life. In this capacity and despite the various definitions and applications of the e-health domain as shown from the literature of the field, in this study, the main goal is that it brings people (professionals and patients) together in a more dynamic interactive information space called Web2 or health on the internet (Cunningham *et al*., 2014 p. 37).

2.5.2 Barriers to E-health Adoption

There are numerous studies exploring barriers and drivers of e-health adoption. The studies and the type of barriers vary from e-health understanding, e-health applications, healthcare organizations and healthcare services providers and receivers. Some of those studies also include barriers classified under broad subjects such as social, ethical, leadership, policy makers and legal issues (Anderson, 2007; Cunningham *et al.,* 2014 p. 147). Other studies were more specific and classified barriers under direct problems such as financial, technological complexity, user age, practitioners' skills, job satisfaction and so on (Conrad *et al.,* 2012; Cresswell & Sheikh, 2013; Jha e*t al.,* 2009; Jimison *et al.,* 2008; Mishuris *et al.,* 2015; Young *et al.,* 2014; Zinszer *et al.,* 2013). However, these barriers also are linked directly with e-health applications, for example, barriers to telemedicine included limited reimbursement, slow clinical acceptance, high cost or the limited availability of high-speed telecommunications, and specifically transmission of video images and other objects (Hoyt & Yoshihashi, 2007 p. 279). In addition, barriers to EMR adoption include: financial barriers, physician resistance, workflow changes, lack of standards, integration with other systems and inadequate proof of benefit (Hoyt & Yoshihashi, 2007 p. 52). Most other e-health applications and systems have common barriers in their adoption; as a result, these barriers are related to technology more than health science information.

Despite the varieties of e-health definitions and applications, most of the literature agrees that the most common barriers are related to users (acceptance, behavioral change, user representation, privacy or security concerns), technological aspects (technological discomfort, complexity, poor access to computers and the Internet, the user unfriendliness of the data input and IT infrastructure), and organizational factors (cost, change in workflow, lack of relative

advantage, financial award and management support) as well as government policy such as legal barriers, national vision and uncoordinated policy (Anderson, 2007; Mishuris *et al.,* 2015; Young *et al.,* 2014). These barriers have permeated and continue to spread in the literature; focusing on recent Canadian literature; some studies went beyond the traditional way of thinking of e-health adoption barriers, particularly when they found that Canada has invested billions to overcome the obstacles and challenges that faced the healthcare sector. They found that existing barriers and challenges to the effective use of e-health relate to governmental policy issues, which are related to the lack of an e-health policy, the lack of a shared national vision and leadership, the lack of coordination between different stakeholders, inadequate involvement of healthcare provider, uncoordinated policy, insufficient investment and poor planning in e-health adoption (Rozenblum *et al.,* 2011; Zinszer *et al.,* 2013). Accordingly, Salzberg *et al.* (2012) summarized the most common barriers from Canadian stakeholder's experiences as follows:

"(1) barriers to alignment of jurisdictional groups with national policies, (2) concerns over the potential staunching of innovation by policies that are too stringent, (3) underestimation of the significance of jurisdictional investments in legacy systems that are being used but do not comply with the new standards, (4) insufficient, incomplete, or miss-timed engagement of stakeholders, and (5) lack of guidance and support in managing changing technology and standards, including when to migrate and how to migrate" (p. 715).

Some of these barriers are manageable, specifically financial and technical issues, because the updating technology sector will create a competitive market that will allow reducing the cost and sustaining the technical development in the future. To overcome human barriers, the government should align the policy strategies with the needs expressed by involved people and prioritize to lessen these barriers.

2.5.3 Users' Characteristics

Regardless of the expansion of this field, the acceptance of e-health by health organizations, physicians and patients still faces many challenges. Generally, end-users (physicians and patients) and health organizational factors are commonly recognized as the main causes of e-health implementation failure (Gagnon *et al.,* 2012; Tour *et al.,* 2012). For that reason, knowing the users' characteristics is one of the most important factors to accelerate the adoption of e-health. For example, Tour *et al.* (2012) summarize this in their explorations and found that the relationship between the health technology and the end-users was not given important consideration from the developer, and "the development and implementation of the technologies were not based on users' needs".

On the other hand, from a technical perspective, the System Development Life Cycle (SDLC) or the e-health development life–cycle has mainly five stages: planning, analysis, design, implementation and maintenance. One of the most important stages in SDLC is system analysis. The main goal of this stage is to engage the end-users in the development process and gather the information from their perspective. That means that there is a gap between e-health and its users because e-health had not been developed based on the end-user's requirements. Therefore, it is important to understand the end-user's characteristics and requirements (service provider and receiver) in the healthcare industry and willingness for technology before introducing any type of e-health in their health organization (Tour *et al.,* 2012). The next section of this paper will explore the characteristics of third-parties in e-health applications (patient, healthcare provider and healthcare organization).

2.5.3.1 Physicians' Characteristics and Competences

Physicians' characteristics are discussed in many studies to evaluate the impact of introducing e-health in hospital-physician-patient interactions during paperless services (Davis *et al.,* 2009; Gagnon *et al.,* 2014; Yi *et al.,* 2006; Walter *et al.,* 2008). The results of these studies have shown that physician characteristics affected e-health capacity as well as its adoption such as gender, age, skills, IT functionality, location, specialty, professional autonomy and professional ideology. According to the NPS, the Canadian physician population also varied according to sex, type of practice license (independent practice v. educational license), medical school from which the physician graduated, and medical specialty. These data indicate significant variety in physician characteristics that are useful in understanding their use and perceptions of e-health technologies.

In addition, a survey of the Commonwealth Fund International Health Policy of Primary Care Physicians in 2006 investigated the spread of information technology systems among primary physicians in seven countries. The use of e-health in this survey has focused on many aspects such as EMR access - other doctors, patient access to records; routine electronic ordering of tests, access to test results, access to hospital records, and computer for patient reminders. The use of this technology from physicians in Canada was 28% (Davis *et al.,* 2009). Physicians in Canada have the lowest rate of access to EMR, for example, the use of health technology to share their patients' electronic information outside of practice or provide patients with easy access to their records was 6% (Davis *et al.,* 2009). In addition, the greater benefit of e-health is in its application within regional and rural communities. In Canada, physicians practicing in small towns and rural locations represented respectively 18% and 9%, which is also a weak representation. From the technical side, only 11% of larger practices have information

technology ability (Davis *et al.,* 2009). Many studies suggest that physicians' characteristics differ from other types of technology user's acceptance; for that reason, the scholars investigated the physicians' characteristics from several angles. Chau & Hu (2002) have characterized this difference in physicians' "specialized training, autonomous practices, and professional work arrangements". However, they are likely to be more pragmatic, focusing more on perceived usefulness than on ease of use (Walter *et al.,* 2008). They prefer to rely on their own skills rather than trust the technology, in spite of its usefulness or ease of use factors (Paul & McDaniel, 2004). They are not willing to support a technology as an intermediate and change their traditional work routines (Chau & Hu, 2002; Walter *et al.,* 2008). They like to be free in their work place, 68% strongly agreed that the freedom is the most essential part in their practices without any constraints (Cooke & Hutchinson, 2001). In the same way, some of them presented resistance to organizational changes, specifically when this change affected their professional autonomy (Spurgeon, 2003). They are likely to embrace their own perspectives and take their workplace in to consideration; usually they take pleasure in keeping a high level of prestige and autonomy within their social network (Yi *et al.,* 2006). Because of this specific profile, the implementation and acceptance of e-health requires highly sensitive response to their expressed resistance in order to persuade them to adopt e-health as a valuable driver for their work.

2.5.3.2 Patients' Characteristics and Competences

Scholars have documented Canadian patients' characteristics in many surveys. Each survey varies according to the groups that have been tested. The surveys are also related to ethno-cultural and demographic characteristics such as traits, values, age, sex, educational level and so on. Some of them document cultural and ethnic differences in Canadian societies; in terms of years of residency in Canada, languages, country of birth and language spoken at home

were sufficiently strong characteristics to guide future research (Mailis-Gagnon *et al.*, 2007). Nevertheless, user's age, educational attainment, trust and level of motivation and degree of engagement are important indicators and seem to affect the acceptance and satisfaction for e-health services (Hardiker & Grant, 2011). In terms of "patients," each Canadian is a patient in his/her location throughout Canada and has a healthcare record number. Therefore, from a broader point of view, patient characteristics are derived from Canadian population characteristics in general. Because of this, this section will highlight some characteristics of Canadian people from government reports and statistics.

The first characteristic is related to the Canadian ethno-cultural classifications, according to Canada's Ethno-cultural Mosaic Report using data from the 2006 Census. Canada has more than 200 different ethnic origins, including aboriginal people, the European groups and immigrants from visible minority groups who came to Canada over the past century. Just in Ontario for example, visible minorities in 2006 represented 54.2% (= 2,745,200), which is more than half of Canada's total visible minorities population. As a result, Canada is a multicultural country; the concept of multiculturalism refers to demographic information defining the people from different ethno-cultural backgrounds in a single society or organization (Dewing & Leman, 2006). This means that particular groups are defined based on their ethno-culture, which reflects the values, beliefs and practices that they have learned and shared, and guides their thinking in a patterned way (Leininger, 1985). As a result, multiculturalism is a very important factor in the adoption of e-health technology, because it is related to different perspectives from different groups, which make the acceptance more challenging. The second characteristic is related to Canadian demographics, which translates into the greatest factor behind the acceptance of e-health. For example, recently according to the Canadian Annual Demographic Estimates report,

one of the main changes occurs in the age and sex structure of Canadian population as a result of population aging. The measure of the baby boomers through the age structure is higher in comparison with thirty years ago: from being young adults in the 18 to 37 range, they now represent the 48 to 67 range. In addition, in 2013, the median age of the Canadian population was 40.2 years; it has risen by 10 years in the past 30 years and is higher for women (41.1 years) than for men (39.4 years).

According to the sex structure, the Canadian people were estimated as 98 males per 100 females and "males outnumbered females in the 0 to 14 and 15 to 39 age ranges, owing to the sex ratio at birth, which averages 105 males per 100 females." The working-age population for the younger segment (aged 15 to 39) is 48.9% and the older segment (aged 40 to 64) is 51.1%. As the population aged 65 and over continues to grow, on July 1, 2013, it became 15.3% of the Canadian population. However, there is no big difference in these ratios among provinces, for example, the median age for Ontario population is 40.3 years, while the ratio of the population aged 65 and over was 15.2%. The third characteristic is related to technical skills. Statistics Canada has conducted a survey of 5,048 of Canadian people who are actively using the information technology through the Internet. They found that those who have higher levels of education and income are more active to use IT and access to the Internet from different places rather than their home. The percentage is also higher in Ontario comparing with other provinces, and this is also the same for those under 55 and men, in comparison to other segments. In addition, the August 2011 report of the EKOS Research Associates Inc. supports these numbers. Younger Canadians are more active with IT and Internet than older Canadians and more knowledgeable about online threats and security. On the other hand, "older Canadians are less active, but more concerned about security," and are always looking for methods to protect

themselves online. We cannot overlook the fact that most Canadian patients are from aging segment which increases the challenge to adopt e-health for this segment of the population (p.7). Another question in this survey is related to Canadians' level of computer literacy: roughly 80 % of "Canadians say they often use computers and other technology in their day-to-day life" (p.21).

Finally, according to the trust and level of motivation characteristic, Statistics Canada shows that Canadian people are very worried about their personal information in their online activities. They need extra steps to protect their personal information online and in home computers, by suggesting a need for concrete information and procedures. However, 76 % of Canadian people say that "it is up to individuals to protect their own personal privacy" (p.38). The level of motivation according to the type of information is also at risk, specifically health information. Of Canadian people, 62% consider health information to be sensitive information and recognize the need for protecting their personal information online. As demonstrated in the section, stakeholders have also very specific profile that needs to be considered when addressing the efficient development and implementation of e-health technologies that can meet all needs efficiently to sustain a successful acceptance. As a conclusion, physicians-patients characteristics led us to the following question: Where is the meeting ground where conflicting interests so physicians and patients can be successfully resolved?

2.5.4 The Relationship between Physician-Patient and E-health

The IOM "Defining Primary Care" 1994 report, as cited in Weiner (2012), presented a model for e-health and patient-physician relationship. In Figure 2.4, they took the patients and physicians who are described in the model and presented them as a centered of sets of massaging loops. The model shows several channels that electronic communications can use to link patients and physicians with various e-health applications. At the top center of the model is the direct

interaction between them and EMRs and, on each side are the interaction for e-health applications: The physician-controlled EMR, the patient-controlled personal health record (PHR), and the web portal is the entry point for patients wanting to access their provider's EMR system (Weiner, 2012). This is the core of the e-health relationship and represents the direct point of responsibility between the physician and patient.

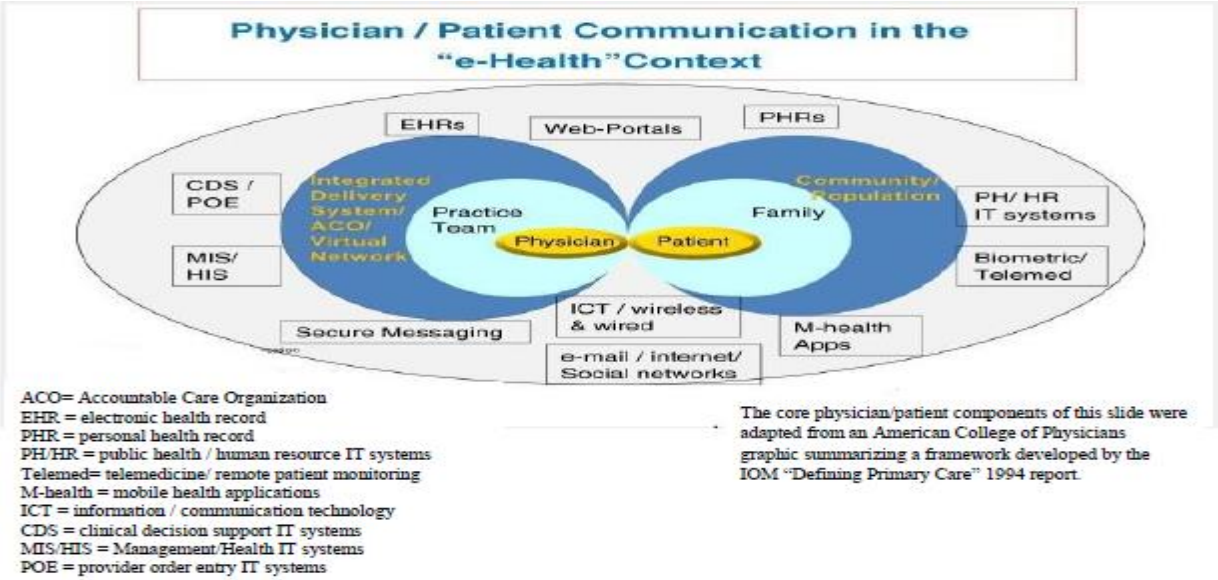

Figure 2.4 Physician-Patient Communication in the "E-health" Context.

Source: Committee on the Future of Health Care Services, Institute of Medicine. Defining Primary Care: An Interim Report. 1994. Washington, DC: National Academy Press.

The next section will present e-health technologies, which are the foundation of the patient-physician relationship, including PHR and patient portals. Well-defined e-health systems with patient-used technologies allow for care synchronization as they confirm that patients and physicians have direct and instant access to accurate health information at home and across hospital settings (Ahern *et al.*, 2011). The care synchronization is a connected domain that links remote patients and healthcare resources such as PHR, and that usually addresses the dynamic interaction with computer- based health information such as patient portals. Cooperatively, PHR

and the patient portal convey patient healthcare information and physician expertise to where they are needed.

2.5.4.1 Personal Health Record (PHR)

To support more patient health informatics, many countries (such as the U.S. and Canada) are trying to increase the awareness of PHRs by encouraging the deployment of patient portals in support of PHRs (Tang *et al.* 2007 p. 792). Recently, PHR applications have been seen by research and governments alike as a means to improve the patient experience and quality by permitting and engaging patients in information gathering, decision-making, and knowledge generation (Tang *et al.,* 2006). Therefore, it is necessary to understand the patient's perception of PHR because this coming phase is being driven by different forces such as government mandates, rising health-care costs and market demands. The National Alliance for Health Information Technology (2008) defines a PHR as "An electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be drawn from multiple sources while being managed, shared and controlled by the individual."

According to this definition, a PHR enables patient's access, management and sharing of their health information in a private, secure, and confidential environment (Markle Foundation, 2006). This means that the PHR is a permanent resource of health information used by patient and healthcare provider alike to make health decisions, whose contents are transferred in through direct input by the patient and sent from the healthcare provider's EMR (Wolter *et al.*, 2012). In addition, through the patient portal, PHR systems enable patients to read and manage their personal health-information 24/7 from any Internet-ready computer. Personal information includes appointment history, health records, lab results, payment reports, their personal

assessments, medications, and they can review the direct comments from their health providers on their results (MTBC, 2011). As well, the concept of electronic patient health record (EPHR) is not new, it was first described in the 1970s (Britain, 1978). In light of the above definition, a PHR is a secure electronic system that serves to incorporate health records in electronic form from multiple sources including EMRs (Pai *et al.*, 2013).

While a PHR provides a comprehensive view, accurate and update of the patients' health information and medical history, it takes time for the physician to review this information which makes the adoption of PHR more challenging (Lewis, 2008). In so far as there is a difference between an EMR which is owned, maintained and accessed by a physician and a PHR which is owned, maintained and accessed by patients, at the end, the data of PHR are extracted from the EMR and presented to the patients. The system allows them to contact the database with new information that the physicians updates in the EMR (Center, 2007). Despite the fact that both PHR and patient portal-communication systems allow the sharing and the exchanging of health information between healthcare provider and patient, there is still a need to clarify the patient portal forming a gateway that includes a PHR and providing patients with a tool to access their own information from different locations. Because of this, the next section will present the web-based PHR or patient portal as a complementary system enabling patients to use and manage their health information from any place.

2.5.4.2 Patient Portal (Web-based PHR)

Early implementation of patient portals originated with the use of the Internet to retrieve and explore general health information. Recently the concept of "*patient portals*" has been used to describe Web-based PHRs. A PHR is a system that is owned, maintained and updated by the patients and a patient portal as a web-based PHR that provides secure access to patient health

information through the internet, is also created and maintained in the EMR facility and showed on the portal for access (Dooling, 2012). This portal is defined as consumer-facing systems tied to EMR, allowing patient views of health information and clinical data in a single institutional EMR and interaction with their physicians and hospitals (Conn & Lubell, 2006). In addition, many patient portals that are available today offer the ability to the patient and provider to dialogue online and go forward into online care-coordination.

While portal technology differs, among many other features, Web-based PHR (patient portals) as cited in Pai *et al.* (2013) and Wolter *et al.* (2012) generally gives patients the ability to:

- Provide and share EMR and input medical data online.
- Facilitate online exchanges between patient and provider as needed (communication or messaging).
- Provide reminders or alerts, along with new patient intake and patient registration.
- Maintain accuracy of the medication lists, allergy lists, problem lists and request refills.
- Provide decision-support tools and access information 24/7.
- View health information (personalized or generalized) and provides patient education materials.
- Network with other Web sites or portals and provide means for navigating the healthcare system.
- Consult care plans, provide questionnaires for patients, and give access to research studies, serve as a repository of personal data.
- Serve as a tool for self-reporting or tracking, compatible with health tracking or monitoring devices.

- Enable social networking related to health information and Facilitate access to support groups and support services.
- Execute billing function allowing patients to pay online.
- Achieve a Near-paperless environment.

According to these features, many organizations have obtained a good result by implementing PHRs and patient portals. For example, as a successful practical story, Anne Dixon, RHIA, manager of Medical Information at Vanderbilt University Medical Center (VUMC), mentioned that VUMC started their patient portal in 2004, with 22,000 user accounts in 2006; in 2012, there were more than 165,000 (Dooling, 2012). As cited in Dooling (2012), Dixon states "a portal is a cooperative effort engaging many departments throughout the facility, and each department plays a role in supporting the program, which includes open feeds between the EHR and portal" (p.34). According to this, health information exchanges within PHR and patient portals are growing, but in reality, engaging and empowering the patient is the focus.

2.5.5 Engaging and Empowering Patients in Patient Portal (Web-based PHR)

Eventually, the patient's engagement is the focus of the progression toward the patient portal and personal health records. Without considering that patient engagement is an essential source that must guide future patient portal acceptance in Canada, Canada will continue to spend increasing amounts of money with little improvement in its ranking for the adoption of EMR-based-PHR innovative technology. The Canadian government is realizing this and can take a more proactive role in its healthcare efforts to engage patients, which then help to control quality and manage cost issues. To illustrate what can be done, the U.S for instance— under the Health Information Technology for Economic and Clinical Health (HITECH) Act, part of the American Recovery and Reinvestment Act of 2009— now focuses mainly on patients' engagement by

"providing patients the ability to view online, download, and transmit their health information..." instead of "providing patients with an electronic copy of their health information." But how can we achieve this objective among advantaged or disadvantaged populations?

Hospitals, healthcare providers and patients must meet the resulting increased demand for health information and provide a full delivery-solution, across technology that is accessible for patients (Wiring for Consumers, 2008). In addition, providing the patients online services requires that we engage them as full partners, as well as considering their perceptions in the design of their health information not just as "checkers" of their health information. Hartwell (2006) offers some insights to engage and empower patients by providing them with a vision of the future, as well as letting them give an input to the health-care plan. Patients can assist in developing goals and challenges, develop measurements to illustrate improvement, ask questions and have developers listen to their feedback and provide encouragement. In this case, they will see the engagement as a mechanism to support their actions in deciding what is best for them, and as a way for them to understand their abilities and conditions (Bechtel & Ness, 2010).

Ultimately, this support will enhance partnerships through increased awareness and self-management through provision of tools and services to manage their abilities and conditions (Bechtel & Ness, 2010). To achieve that, healthcare providers should educate patients about the advantages of patient portals; as well, researchers should also emphasize patients' preferences in terms of increasing their awareness and testing their ability to use this technology, by applying technology-related human models to transfer patients from paper and in-person methods to the Internet. Generally, the literature is rich in these models, which enable researchers to test the patients' preparedness for using the portal and to help the decision-makers to determine patients' preferences in terms of accepted portal design. In light of this, the next section will introduce

some examples of human models that have been used in the adoption of technology. These models will help us find the best factors that can achieve the research goal, and help us design a survey as a tool to test the perception and preparedness of a group of Canadian people and increase awareness.

2.5.5.1 Diffusion of Innovation Theory (DIT)

Diffusion of Innovation Theory (DIT) is presented to clarify the way in which public users address innovations. Hence, IDT, developed by Everett Rogers, comes as a social process to cover many examples and case studies that have been applied in disciplines such as education, health science, and information technology, etc. (Rogers, 1995). Previously, we defined innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1995, p. 11). Diffusion, as a complementary term, is "the process by which an innovation is communicated through certain channels overtime between the members of asocial system" (Rogers, 1995, p. 5). Diffusion of innovations means different things to several scholars, yet most of them agreed with Rogers that it is a body of knowledge built around empirical work that demonstrated patterns of adoption of a new idea overtime by different people in social contexts. Therefore, diffusion of innovation is an emerging concept, which applies three valuable visions within the process of social change related to: "what qualities make an innovation spread", "the importance of peer-peer conversations and peer networks", and the ability to understand the needs of different user segments (Robinson, 2009). Consequently, the IDT mentions that "potential users make decisions to adopt or reject an innovation based on beliefs that they form about the innovation" (Agarwal, 2000, p. 90). As a result, the rate of adoption can be affected by a number of different factors, Rogers through the IDT, recognizes five main factors that determine the success of an innovation:

- Relative advantage is “the degree to which an innovation is perceived as better than the idea it supersedes” (Rogers, 2003, p. 15).
- Compatibility is “the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters” (Rogers, 2003, p. 240).
- Trialability is “the degree to which an innovation maybe experimented with on a limited basis” (Rogers, 2003, p. 16).
- Observability is “the degree to which the results of an innovation are visible to others” (Rogers, 2003, p. 16).
- Complexity is “the degree to which an innovation is perceived as difficult to understand and use” (Rogers, 2003, p. 16).

The process of diffusion differs according to the type of innovation in terms of its user, time and place. As well, the innovation-decision process depends on an individual, a group, society, economy, or country. Rogers defines a sequence of five stages in the Innovation-Decision Process: knowledge of innovation (awareness), formation of attitude toward the innovation (interest), decision to adopt or reject (evaluation), implementation of the new idea (trial), and confirmation of this decision (adoption). In addition, adopters can be categorized into five groups, as shown in Figure 2.5, based on how they can quickly accept and implement an innovation: innovator, early adopter, early majority, late majority and laggard (Rogers, 2003).

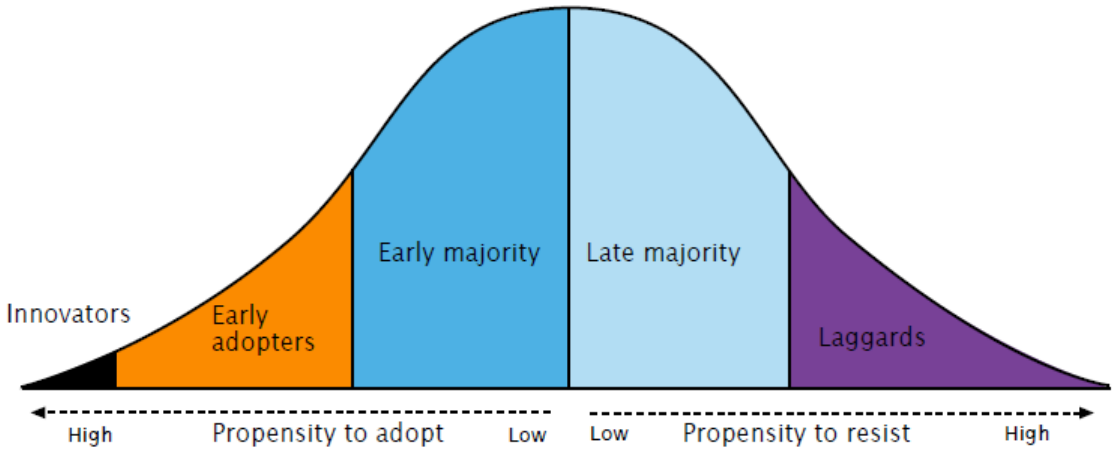

Figure 2.5 Rogers Innovation Adoption Curve (Adopter Categories)

Rogers describes the adopters by different characteristics and by categories. The first group to adopt are the innovators who are adventurous, thrive on adrenaline, like risk, are daring, and have the financial means to sustain loss. Understanding and applying complex knowledge comes naturally to these innovators, and they cope with the high degree of uncertainty when it comes to innovation. The second group are the early adopters. They are known for their social abilities. Though they like to get the upper hand over others, they are more discreet in adoption choices, opting for what will keep them at the center of communication.

The third group are early majority. This group is made up of people who do not seek out leadership but rather deliberate before accepting idea. About one third of adopters fall into this category. The fourth group are the late majority adopters, also representing one third of adopters, approach innovation with a high degree of skepticism. Their social status is below average, have a limited financial liquidity and adopt new ideas after the average persons. The last group of adopters are the laggards. These people are the last to adopt innovations since they typically resist change. They are loyal to tradition, like contact with family and close friends. They are usually among the oldest adopters, have the lowest social status and the lowest financial

liquidity. Certainly, in reality no one is part of an exclusive category. It is impossible to generalize since one can be an early adopter in one instance and a laggard in another instance.

2.5.5.2 Technology Acceptance Model (TAM)

This section discusses the Technology Acceptance Model (TAM) to provide an over view and to bring out the added value of TAM in explaining technology adoption in empirical research. The TAM was developed by Fred Davis (1989) to measure the behavior-relevant components of attitudes. It is derived from the theory of reasoned action (TRA) by Fishben and Alzen (1975) to "provide an explanation of the determinants of computer acceptance that is general, capable of explaining user behavior across abroad range of end-user computing technologies and user populations, while at the same time being both parsimonious and theoretically justified" (Davis *et al.*,1989, p. 985). In other words, TRA tries to explain the psychological factors of attitudes and subsequent acceptance behavior towards technology. As well, TAM is appropriate for exploring perceptions, attitudes, and intentions before/after implementation technology (Vankatesh & Davis, 2000, p.286). As shown in Figure 2.6, the main purpose of TAM is providing an overview of the impact of external variables on internal beliefs, attitudes, and intentions.

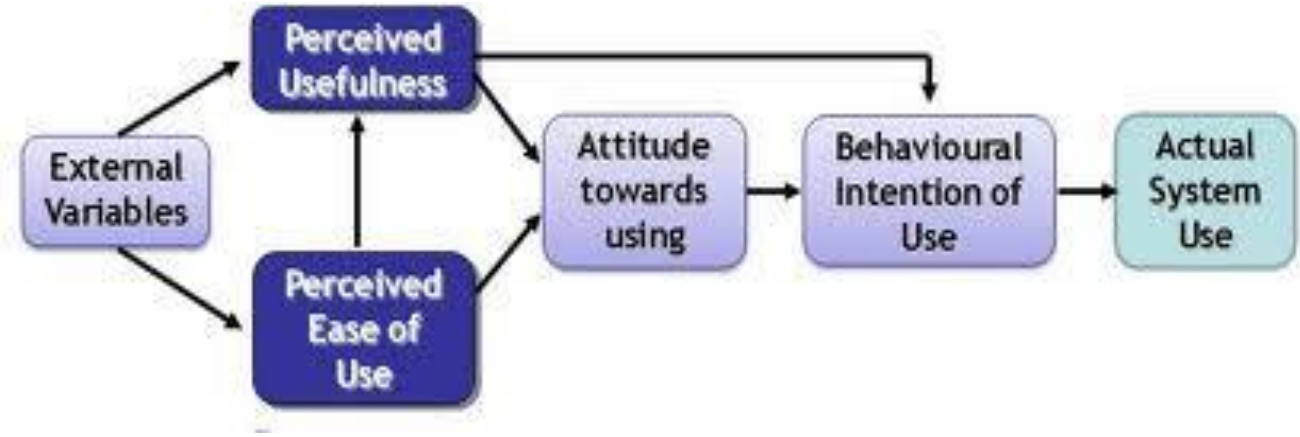

Figure 2.6 Technology Acceptance Model (TAM)

As cited in Shroff *et al.* (2011), the model specifies three major variables which are: perceived usefulness (PU), perceived ease of use (PEOU), and attitude towards usage (ATU). Perceived usefulness (PU) is defined as "the degree to which a person believes that using a particular system would enhance his or her performance" (Davis, 1989). Perceived ease of use (PEOU) refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). PU and PEOU can be reflected as cognitive variables. Attitude towards usage (ATU) is defined as the "the degree to which an individual evaluates and associates the target system with his or her job" (Davis, 1993). This means that ATU works as factor affecting positive or negative user feeling about technology in performing a particular behavior (Ajzen & Fishbein, 2000). TAM has been established as a valuable theoretical model in assisting researchers to understand human behavior in innovative technology implementation, conceptualized usefulness, and ease of use as essential perceptions leading to intentions to adopt new technology (Lee *et al.*, 2003).

2.5.5.3 Concerns-Based Adoption Model (CBAM)

The Concerns-Based Adoption Model (CBAM) was initially developed in the 1970s and 1980s by Hall, Wallace and Dossett; a team of researchers at the Research and Development Center for Teacher Education at the University of Texas at Austin. Initially, it was applied in the academic setting as an adaptation driver for implementing innovations and change within the education industry (SEDL, 2013). Currently, CBAM applies to any one facing change, such as policy makers, teachers, physicians, patients, students and so on (National Academy of Science, 2005). For example, in the e-health domain, the CBAM has been applied to telemedicine (Armer *et al.*, 2004). CBAM has three main diagnostic dimensions (as shown in Figure 2.7) which are clearly explained on the SEDL website (2013).

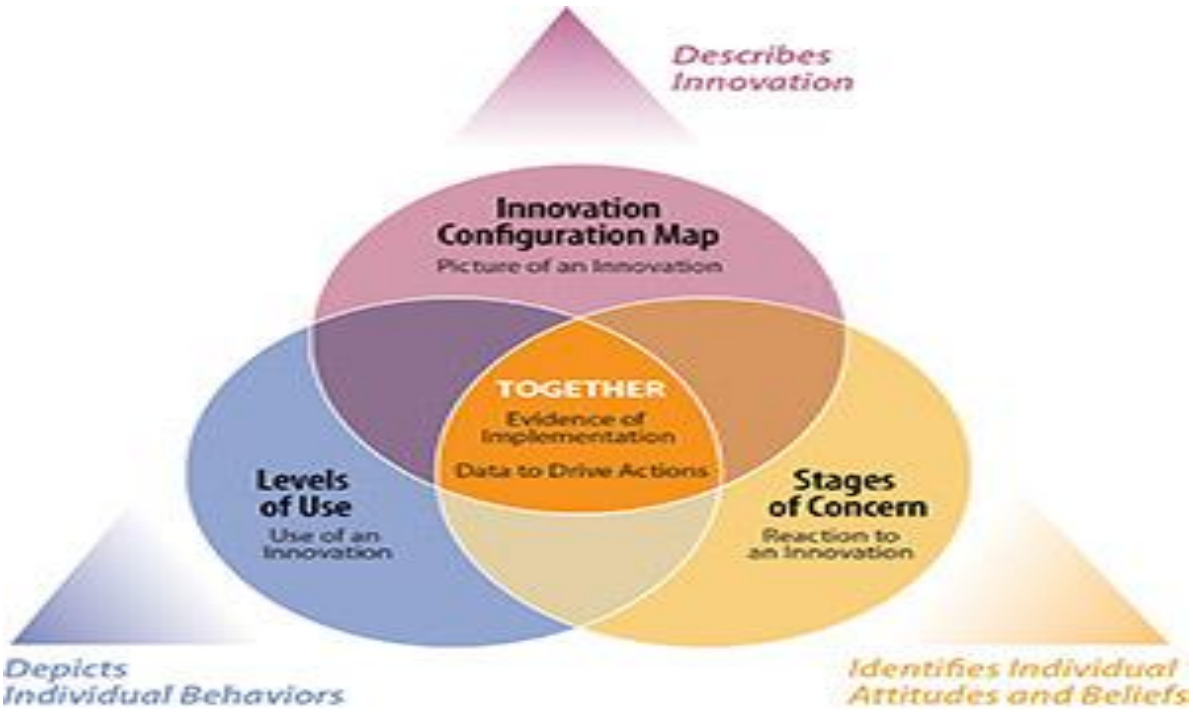

Figure 2.7 the Diagnostic Dimensions of CBAM

The first dimension is an innovation configuration, which “provides a clear picture of what constitutes high-quality implementation and it serves as an exemplar to guide and focus staff efforts” (SEDL, 2013). The second dimension is stages of Concern process, “which includes a questionnaire, interview, and open-ended statements, enables leaders to identify staff members’ attitudes and beliefs toward a new program or initiative." By using the concerns in Table 2.4, which identify and provide ways to assess seven stages of concern, decision makers can take actions to address individuals’ specific adoption problems (SEDL, 2013).

Table 2.3 *Typical Expressions of Concern about an Innovation**

Stage of Concern	Typical Statement
0: Unconcerned	"I think I heard something about it, but I'm too busy right now with other priorities to be concerned about it."
1: Informational	"This seems interesting, and I would like to know more about it."
2: Personal	"I'm concerned about the changes I'll need to make in my routines."
3: Management	"I'm concerned about how much time it takes to get ready to teach with this new approach."
4: Consequence	"How will this new approach affect my students?"
5: Collaboration	"I'm looking forward to sharing some ideas about it with other teachers."
6: Refocusing	"I have some ideas about something that would work even better."

*Source : http://www.nas.edu/rise/backg4a.html

The last dimension is the Levels of Use, in which an "interview tool [that] helps determine how well staff, both individually and collectively, are using a program." (SEDL, 2013). Eight behavioral levels have been defined by the National Academy of Science and range from nonuse to advanced use as shown in Table 2.5 These define a different set of actions and behaviors that individuals engage in when using an innovation or adopting a change in the organizations (SEDL, 2013).

Table 2.4 *Levels of Use of the Innovation: Typical Behaviors**

Level	Typical Statement
Nonuse	"I've heard about it but, honestly, I have too many other things to do right now."
Orientation	"I'm looking at materials pertaining to the innovation and considering using it sometime in the future."
Preparation	"I've attended the workshop and I've set aside time every week for studying the materials."
Mechanical Use	"Most of my time is spent organizing materials and keeping things going as smoothly as possible every day."
Routine Use	"This year it has worked out beautifully. I'm sure there will be a few changes next year, but basically I will use it the same way I did this year."
Refinement	"I recently developed a more detailed assessment instrument to gain more specific information from students to see where I need to change my use of the innovation."
Integration	"Not everyone has all the skills needed to use the program so that it has the greatest impact on student learning. I've been working with another teacher for 2 years, and recently a third teacher began working with us."
Renewal	"I am still interested in the program and using it with modifications. Frankly, I'm reading, talking, and even doing a little research to see whether some other approach might be better for the students."

*Source : http://www.nas.edu/rise/backg4a.html

To date, CBAM continues to be applied in a range of service industries, including academic fields, organizational and research settings. When the researchers combine the above three dimensions, this will help decision makers understand adoption, and guide users as well as staff to successfully adopt and implement an innovation or program.

2.5.5.4 Decomposed Theory of Planned Behaviour (DTPB)

A Decomposed Theory of Planned Behaviour (DTPB) model is one of the behavioral models that adequately target the people who have their own perceptions and beliefs to use technology in the service industries. DTPB as a theoretical framework was developed by Taylor & Todd (1995) to investigate technology acceptance by individuals and professionals. The DTPB is derived from the theory of planned behavior (TPB) developed by Ajzen (1991) to take extra advantage of the ability to recognize specific salient beliefs that may influence technology usage (Ndubisi, 2004). Therefore, Taylor & Todd (1995) explain this advantage by comparing their model with TPB as the following: "In comparing the two versions of TPB, we believe that there is value added as a result of the decomposition, in terms of increased explanatory power and a better, more precise, understanding of the antecedents of behaviour." "Thus in our view, the decomposed TPB is preferable to the pure form of the model" (p. 169). "However, the decomposed TPB provides fuller understanding of usage behaviour and intention and may provide more effective guidance to IT managers and researchers interested in the study of system implementation" (p. 170). This means that DTPB is a good model for scholars who are interested in broader perceptions of intentions, through exploring three factors (see Figure 2.8): the first factor is attitudes (individual's positive or negative feelings) which refer to "the degree to which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question" (Ajzen, 1991).

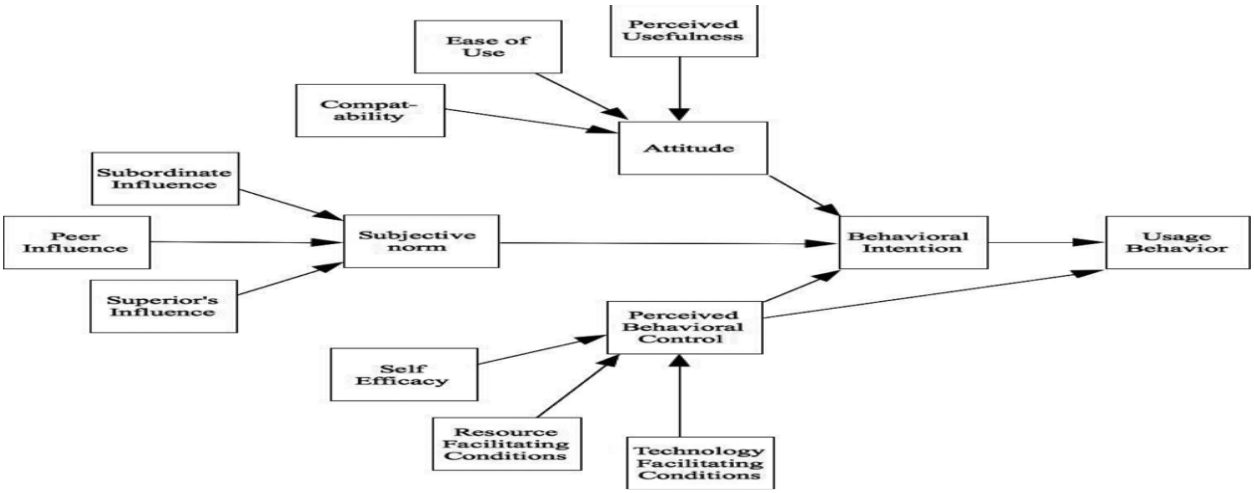

Figure 2.8 Decomposed theory of planned behavior adapted from Taylor & Todd (1995)(Paver *et al.,* 2014).

The second factor is subjective norms which refer to "the perceived social pressure to perform or not to perform the behavior" or an individual's perception that "important others would approve or disapprove of his or her performing a given behavior" (Ajzen 1991). The final factor is the perceived behavior control which states "people's perception of the ease or difficulty of performing the behavior of interest" (Ajzen, 1991) as well as the constraints to technology usage (Taylor & Todd, 1995). DTPB model decomposes these three factors into belief-based measures. For example, perceived usefulness, easy access to technological resources, and compatibility explain attitudes; peer influence, subordinate influence and superior influence explain subjective norms; and self-efficacy (an individual's self-confidence, computer anxiety, training, experiences), resource facilitative conditions and technological facilitative conditions explain perceived behavior control (Ndubisi, 2004; Sadaf *et al.,* 2012).

2.5.5.5 Technology, Organization, and Environment (TOE) Framework

From an organizational psychology perspective, the Technology, Organization, and Environment (TOE) framework recognizes three major factors, which considerably effect technology adoption by service industries organizations. The TOE framework was developed by

Tornatzky and Fleischer (1990) and is also compatible with Rogers' (1995) DOI theory, in terms of "individual characteristics, internal and external characteristics of the organization, as drivers for organizational innovativeness" (Oliveira & Martins, 2011).

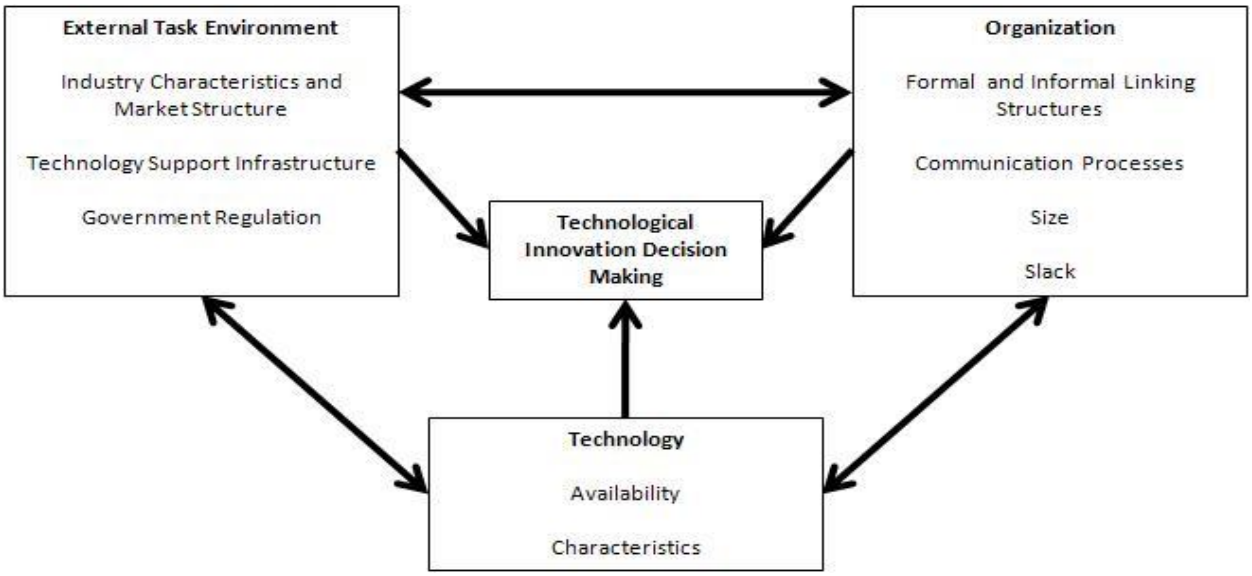

Figure 2.9 Technology, organization, and environment framework (TOE)

Moreover, as Figure 2.9 shows, the TOE framework has been used to adopt and implement a technological innovation decision-making within:

(a) The technology construct that includes both internal and external technologies that are relevant and available to the organization, the perceived benefits of using this technology (relative advantage) and the characteristics (functionality and compatibility) of this technology (Tornatzky & Fleischer, 1990).

(b) The organizational context (organizational readiness) which is achieved within the allocated resources in terms of measures includes managerial aspects, financial aspects, technical aspects and human resources aspects about the organization such as scope, organization size,

communication channels, customer knowledge level, organizational structure and so on (Tornatzky & Fleischer, 1990).

(c) The environmental context is the domain of organization including the stakeholders managing its operational activities and services. The environmental factors include the type of industry, competitors, customers, management support, business partners (peers), as well as applicable government regulations (Tornatzky & Fleischer, 1990).

2.5.6 PHR Boundaries in Adoption and Implementation

The previous models are focused mainly on four perspectives in the adoption and implementation process for any new innovative technology idea: The human perspective, the technological perspective, the organizational perspective, and the governmental perspective. All these are important but not of equal weight, because three of these perspectives depend completely on human acceptance. Nevertheless, the successes of implementing a PHR (patient portal) exist in assembling the joint, harmonized and concerted efforts of the four perspectives. In principle, physician and patient may discuss barriers to PHR as an application of e-health by asking various questions concerning behavioral perspectives. Should both answers lead to the adoption of e-health, a motivating question would be how decision-makers' e-health related human judgments about health policy interact with physician and patient attitudes and practices in relation to each perspective. In the literature that follows, we are trying to explore e-health through the lens of each discipline (sociology, psychology, management, information technology, and economic). This section explains the infrastructure of patient-centric health service delivery and physician's support through patient portal in organizational and governmental environments, and addresses system architecture and functional capabilities.

2.5.6.1 Human Perspective (Psychology and Sociology)

According to the patient and physician characteristics in the previous section, a major problem facing PHR adoption today is the growing challenge of baby boomers in Canada in terms of healthcare needs and their level of computer literacy. As well, the physician group involved in PHR implementation is knowledge-workers in demand with a high level of prestige and autonomy preferring to rely on their own skills. Nevertheless, some Canadian physicians have indicated that there is a good opportunity for the public in PHRs, and they have also a different perspective about older people in the adoption process. For example, Dr. Jay Mercer, from the Central Ottawa Family Medicine Associates is one of the earliest adopters of EMRs and he believes that patient portal as an e-health application is very important for patients because it allows them to access health information without ever leaving home Canada Health Infoway (2014). He says

"I'm not sending an 80-year-old woman out in the middle of winter to potentially break her hip just to come to my office to check her blood pressure. She's doing it at home, feeding it to me online, and we're both getting the same results."

Another early EMR adopter Dr. William Haver, one of 26 physicians in Saskatoon's Lakeside Medical Clinic, also believes that a patient portal based on EMR is a very important tool in patient care. He says

"If we can create a place online where patients can come in and get the information they need at their convenience, and we can simply leave the information there at our convenience, we are improving the care they receive."

According to Nuffield Trust's report, as cited in Pagliari *et al.* (2007), "ePHRs have the potential to improve communication between providers and patients by sharing information, to enhance the quality of records by highlighting inaccuracies, and to reduce the burden of care by engaging patients in managing their own health and illness" (p.5). Unfortunately, for some patients, EMR, PHR and patient portals are new concepts as e-health applications, while for

others, there are still challenges to the adoption process that are making e-health much more problematic.

Several studies have focused on factors facilitating the adoption of the PHR from a patient's perspective (Househ *et al.*, 2014). For example, Day and Gu (2012) have studied the motivating factors that impacted patients to use the PHR such as computer literacy, the effectiveness and efficiency of the system, and an improved patient-physician relationship. Other scholars have investigated the characteristics of patients delivering a health message, assessing their behavioural and emotional feedback (Gibbons *et al.*, 2009). As a result, these scholars have declared that in order to take e-health to the next step, research must focus on the psychological aspects, due to an emphasis on the technical side of e-health in past research (Kaplan, 2001; Berg *et al.*, 2003; Spitzer, 2009). Psychological factors have rarely been applied to the relationship between patients and e-health technologies. Along with that, the implementation of e-health is a complex process that may not necessarily result in the planned outcomes, specifically in regional communities. For example, the introduction of EMR in the UK's National Health Service is four years behind schedule, and each major hospital deployment has encountered significant problems such as strong resistance, lack of use, and staffs' perceived negative computer attitudes (Whittaker *et al.*, 2013). This means that the psychological impacts of limited access to Canadian e-health systems may translate to insufficient access to healthcare systems generally.

Deteriorating health may also translate to psychological stress (due to disease-associated stress, and the psychological consequence of limited medical attention, such as feelings of frustration, helplessness, etc.). However, the challenge is to get insight into the everyday life of healthcare providers and patients so as to integrate these observations into e-health when relevant (Veen *et al.*, 2011). Many studies also favour the use of e-health while ignoring its social or

contextual issues (Kaplan, 2001). Hence, the degree to which e-health influences communication among patients and healthcare providers may bring to light deeper issues with the benefits of e-health integration and use (Aceti, 2010). In addition, as Neuhauser and Kreps (2003) have mentioned, social influence theory suggests that there are two requirements for communication to be persuasive. Firstly, it must involve a transaction between the sender and the receiver, "a spiral of changing feelings and beliefs" (Smith, 1982, P.5). This participatory process is thought to be beneficial in order to effect change in attitudes. Secondly, the recipient drives the communication; that is, the communication should be dependent on the participation of the receiver, not the sender.

On the other hand, Berg *et al.* (2003) recommend that, "information systems require interaction with people and thereby inevitably affect them; understanding information systems requires a focus on the interrelation between technology and its social environment" (p.297). Boddy *et al.* (2009) agree that designing an e-health system must match, rather than challenge, the cultural values of patients, professions or units. This requires identifying the cultural values in the unit concerned, and working with people there to design a system that supports that culture, or alternatively allowing time and resources needed to adapt the culture to the e-health (Wilkowsk *et al.*, 2012). In addition, users from less-developed countries vary in perception, style of thinking, cultural assumptions, and values from those in developed countries and also from those in countries that have recently experienced rapid technological development (Anandarajan *et al.*, 2002). As well, given the expected growth of e-health, patients and healthcare providers are presented with a distinctive opportunity for participating in patient healthcare. E-health may open the window to more preventative rather than reactive healthcare as patients and healthcare providers have the ability to communicate beyond the doctor's office

and in real time (Bacigalupe & Askari, 2013). Finally, this leads to the question of how to analyze patients' and healthcare providers' responses not from the e-health perspective, but based on their personal everyday routines.

As a result, the present study will investigate the acceptance of PHR system in regional communities by understanding affective human factors that will make the implementation of PHRs easier. In order to do that, we have to design a hyper theoretical model starting with the e-health adoption body of knowledge in innovative technology and information system, and based on the applicable human factors that affect patients' intentions to adopt PHRs (Archer & Cocosila, 2014).

2.5.6.2 Technological Perspective and Task Characteristics

A PHR is not just a sub-system connected with an EMR database but is also more than a portal for browsing the patients' health information. PHR is as defined earlier, an "electronic application through which individuals can access, manage, and share their health information, and that of others for whom they are authorized, in a private, secure, and confidential environment" (Markle Foundation, 2003). Behind this definition, there are many efforts from different parties that are working as invisible intermediaries to provide patients with good services. These efforts are started from electronic exchange of information between patients, health organization servers and health providers within a complete and a secure environment. These also guarantee the privacy and security under government regulations and standards with collaboration with health organizational support such as technical supports, staff support and others support services. To understand that, we have to investigate the technological infrastructure that provides an effective EMR-based-PHR system within an e-health domain.

Three types of PHR systems which are the most common will be discussed in more detail shortly including standalone, tethered and integrated PHR systems. Prior to this discussion, however, three technological aspects must be addressed (Househ *et al.,* 2014). The first one is a technological infrastructure, which is built based on the interoperability features to guarantee that health-related information is shared through health organizations according to nationally and globally recognized standards by EMR systems. Interoperability is related to the electronic Health Information Exchanges (HIEs) within the integrated PHR system "through two or more systems and the ability for that information to be used by the recipients of the healthcare data" (Studeny & Coustasse, 2014). Health organizations until today have been working towards interoperability of e-health systems in general, and EMR and PHR in particular. The slow data transmission and the compatibility of e-health system standards for interoperability are the main key barriers to the integration and exchange of structured data among PHRs in healthcare organizations (Detmer *et al.,* 2008). In general, several standards are important for integrated PHRs such as Health Level 7 (HL7), which refers to a set of international standards to exchange data between hospitals. As well as, standards related to consumer terminologies, authentication processes, data integrity processes, security and privacy standards (Detmer *et al.,* 2008).

Therefore, the second technological aspect is related to the security and privacy, which have a significant impact on PHR adoption. The privacy and security differ according to the PHR models or portal types, the holder of data, and security and protection tools (Canada's Health Informatics Association [CHIA], 2012). For example, standalone portals have different security issues compared with integrated portals or tethered portals. Even standalone models differ when dealing with the standalone personal computer with which the patients manage their PHRs, or with the standalone portal that was developed using cloud computing which relays Patients

Health Information (PHI) stored on the Internet (Cavoukian, 2008). However, the health organizations, which offer the standalone portal in Canada, assume that there are no legal responsibilities to protect PHI and ask patients to deal with the posting of their health information voluntarily to avoid the legal issues and ask the patient to accept the risk (CHIA, 2012). In the tethered portal, PHI is stored in a secure place on the health organization server without access from the patient, and the system often provides a secure messaging system for appointments or any feedback (CHIA, 2012). While the patient has a full access on the integrated portal to connect and collaborate with the health providers, this requires more security issues and standards because in many cases the PHI will exchange within multiple systems and several locations such as HL7. In addition, security and privacy involve the identification of patient's health information and the health organization resources such as documentation, policies, standards, procedures and guidelines that guarantee secrecy for the rights and responsibilities for all parties' (CHIA, 2012).

In all PHR portals, the security and privacy process are mainly related to registration procedures, authentication, authorization, messaging encryption over the internet and other processes which are particular to each portal (Cavoukian, 2008). In terms of portal design, generally according to the Information and Privacy Commissioner of Ontario, seven principles of Privacy by Design have been developed and applied to protect user information (see http://www.privacybydesign.ca/index.php/about-pbd/7-foundational-principles). The protection tools have significant impact on the portal type and design such as PHI classification, PHI risk assessment, and PHI risk analysis which provides effective security controls that can be applied to protect PHI.

The third technological aspect is the ease of use aspect as an important factor in usability testing for any technological system. Usability testing is a common tool that has been used to measure human perception and interaction with technology according to socio-demographics issues, sociological issues and so on. As a result, a usable PHR system is not complex and easy of use, simple to browse, and reliable; vice versa if the system is not usable that will cause human errors and user dissatisfaction which ultimately affect user acceptance (Segall *et al.,* 2011). Ease of use and usefulness have also been discussed in the previous section as important factors in the technology acceptance model to determine user attitudes toward using the technology. However, while only health provider can access and maintain EMRs, PHR systems are also accessed and maintained by the patients within their health domain environment (Petrie *et al.,* 2011). As a result, it is concluded that both patient and physician have to deal with data according to specific standards within a secure virtual domain that is user-friendly. This data has been shaped as a PHR which is typically stored in an EMR system which enables patients to access their health information from various sources through patients' portals at any time and from different locations.

2.5.6.2.1 PHR Architectures

The technological process we followed for the design of PHR was chosen to enable different readers from different disciplines to understand the general idea behind the PHR infrastructure and it does not investigate the technical issues deeply. Like other applications of e-health, a PHR contains three primary components (data, software, and hardware). Data includes the electronic health information that flows within the IT infrastructure such as patient history, laboratory tests, imaging results, medication lists, and so on. Software includes all the applications that manage the data flow within the system processing cycle. This cycle involves

entering input and designing adequate processing to achieve the desired output. These applications have been developed through two options, a tailored system based on the user requirement or ready-made applications available on the developer's shelf.

There are a number of PHR readymade systems available in the market such as My HealtheVet, MyChart, My Health Manager, Google Health, Microsoft HealthVault, TELUS health space etc. In many countries such as the United States, the United Kingdom, Canada and Germany, health organizations are using the Microsoft HealthVault for patients. This launched as an integrated PHR system, in October 2007 in the United States (Kostadinovska *et al*., 2015). But in Canada, TELUS offers HealthVault-powered service to launch their own PHR system which is built on Microsoft HealthVault, and is hosted on Canadian servers renamed as "*TELUS health space*". TELUS health space "is a secure online data repository that connects Personal Health Records, Electronic Medical Records (EMRs), portable health devices, healthcare applications and existing information systems through an electronic vault so patients can store personal health information and share it with family and healthcare professionals" (TELUS Health Space, 2014). This software relies on a variety of networks to connect hardware (computers, servers, networking device etc.) to share and manage health information and access the Internet.

Regardless what the system name is, PHR systems mostly are similar in their design, contents, architecture and functions. In terms of PHR architecture, as we mentioned three architectural models of PHR, which are common with all systems that can be distinguished: standalone, integrated, and tethered (Daglish & Archer, 2009). Each one has its own characteristics in terms of interoperability, security and technological components. To simplify comparisons, Steele *et al*. (2012) in Table 2.6 collects the classification of PHR from the existing

research according to connectivity with e-health systems (Tang *et al.*, 2006), mode of data integration and data Location / storage type (Markle Foundation, 2003 & 2006), the types of tools that are available in the market (Pratt *et al.*, 2006), the source of PHR data and its connectivity (Raisinghani &Young, 2008) and the primary source of data (Kaelber & Pan, 2008).

Table 2.5 *Existing Classifications of PHRs**

Category	Classification
Connectivity Type (Tang *et al*., 2006)	Standalone • Individual creation of PHRs, not connected with other systems Interconnected • PHRs connected to various healthcare systems Tethered • Integrated with a healthcare provider's health information systems (e.g. the provider EMR).
Mode of Data Integration (Markle Foundation, 2003)	Patient-centered • Integration of data relies on the patient Intermediary • Data is collected, integrated and stored on a third party's database, connection between the third-party and PHR is provided to facilitate data access Integrated health systems • Data from all components of healthcare are "gathered" such that only one single point of access is provided for data access
Tools Avalable (Pratt *et al.*, 2006)	Web-based interface • Secure Internet access to portions of data maintained and owned by their health-care provider organizations Standalone tools • Patients use to create and maintain their own medical records
Data Location / Storage Type (Markle Foundation, 2006)	Centralized • One database contains all the health related information available on an individual Distributed, Decentralized • Different data stored on different databases, connections to all databases required to retrieve individual health data Peer-to-Peer • Consumer would have to create and manage separate data streams between her PHR and each system that holds her data.
Service provider of PHR and	Provider-based PHR • PHRs offered by the healthcare providers

its connectivity (Raisinghani & Young, 2008)	Payer-based PHR • PHRs offered by the health insurance companies Commercial (virtual bank vault) PHR • PHRs most likely created and maintained by technology companies
PHR Type—as based on its primary source of data (Kaelber & Pan, 2008)	Provider-tethered PHR • PHR tethered to healthcare providers' information systems Payer-tethered PHR • PHR tethered to healthcare payers' information systems Third-party PHR • PHR provided by non-healthcare related organizations (e.g. GoogleHealth, HealthVault) Interoperable PHR • Centralized system with collection, sharing, exchange, and self-management functions

*(Steele *et al.*, 2012).

These models inform ideas behind the connectivity type of PHR, whether offline or online, integrated or separated. The first one is standalone PHR (portal), which is offered via the web by commercial companies. As cited in CHIM, Figure 2.10 shows the functional architecture of a standalone PHR (portal) allowing patients to gather, maintain, store and manage their records and share their PHI with healthcare providers. Other layouts of standalone PHRs also exist, which are called also according to their location when the network connectivity is not required as a "Local PHRs" or "computer-based-record". The standalone model is an individual creation of PHRs and is not sharable with healthcare organizations (Steele *et al.*, 2012). Patients create and maintain their own health records without connection with other systems as well as require manual data entry to populate and update the record (Detmer *et al.*, 2008; Pratt *et al.*, 2006; Steele *et al.*, 2012; Tang *et al.*, 2006). Patients organize, store and access the data anytime and anywhere to share it with practitioners who sometimes may question the accuracy and completeness of the data that has been entered by patients (Detmer *et al.*, 2008). Standalone PHRs enable patients to use and copy data onto personal data storage devices such as PC or a

laptop, USB, mobile device and so on. This means that, the local PHR requires "a specific architectural infrastructure depending on the type of devices utilized" (Steele *et al.*, 2012). For example, a PHR stored in a mobile device has a different architectural infrastructure compared to a PHR stored on a USB, which can effect on how the patients can access, manage or store their data.

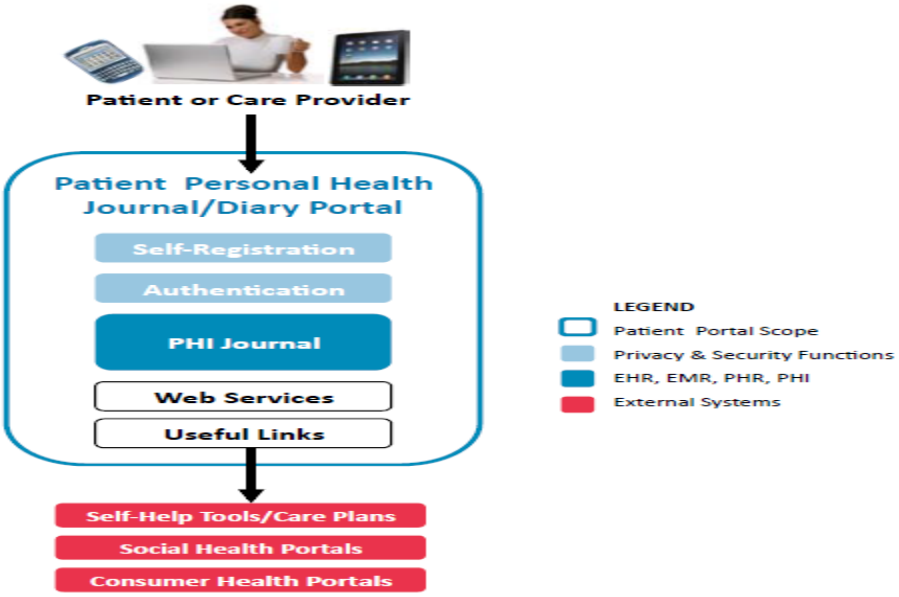

Figure 2.10 Standalone Portal- Functional Architecture

The second model is the tethered one. To be considered a "tethered PHRs", the system should connect to one platform and there is no interoperability to health information exchanges (HIEs) at the national level. In other words, it should connect with "a single provider-based EMR system or other institutional database, offering patients access to parts of their electronic health records via web portals" (Detmer *et al.*, 2008). As shown in Figure 2.11, patients have two separate relations with the provider and the payer; the patient can interact with both by one window to deal with their own PHI. Tethered PHRs in many cases are implemented by a single healthcare organization.

Examples are hospitals, readymade systems such as MyChart system, MyHealtheVet, etc. (Gorp & Comuzzi, 2014). For example, MyChart as a part of TELUS Health Space is a tethered portal for Sunnybrook's hospital in Toronto; it is a for-profit PHR system, which is also built on Microsoft Healthvault (CHIA, 2012).

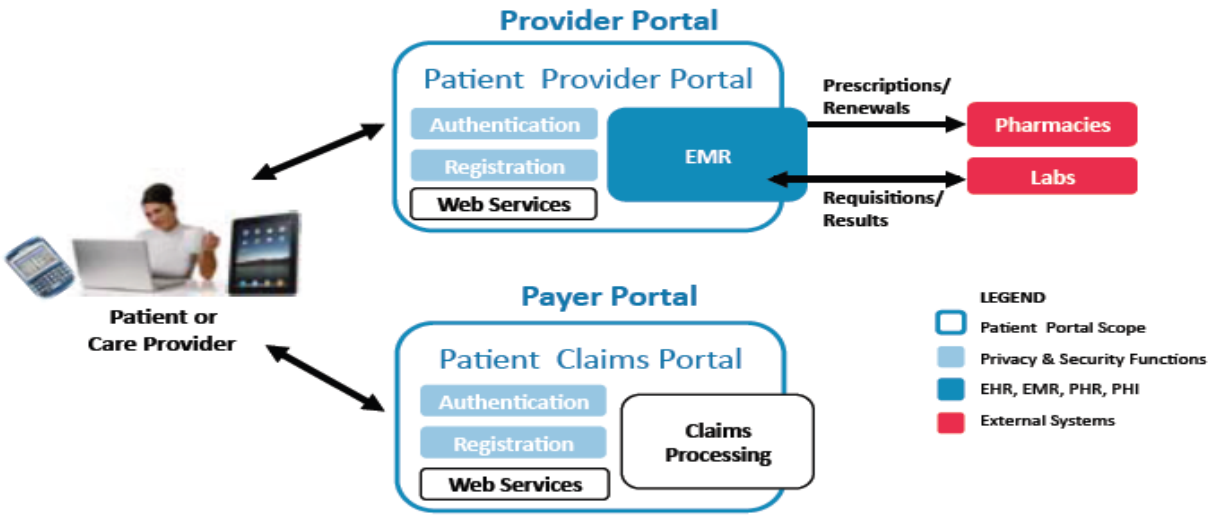

Figure 2.11 Tethered Portal- Functional Architecture

The third model is the Integrated PHRs (portal), it is called also in many papers "interconnected", or a "networked web-based PHRs" (Detmer *et al.*, 2008). As shown in Figure 2.12, PHRs are connected to various healthcare systems from a variety of sources to provide both patients and health providers sharing the health information with a complete picture of the updated entire medical record as stored in the database (Detmer *et al.*, 2008; Tang *et al.*, 2006), including EMRs, health insurance claims, pharmacy data, and any data that has been entered by patient (Van Gorp & Comuzzi, 2014). The integrated PHRs have more interoperability potential by giving patients more options. Nevertheless, integrated PHRs are less successful in terms of adoption when compared to tethered PHRs because patients are required to possess good knowledge of the technology "without being pushed in doing so by a given provider" (Van Gorp & Comuzzi, 2014).

In Canada, TELUS' "health space" PHR originally was a tethered system, but there is no specific platform for the Health Space, which means that it can easily integrate with many other EMR systems (Wilson, 2011), such as: The Ontario EMR (Health screen), Quebec EMR (KinLogix Medical), and Alberta and British Columbia EMRs (Wolf Medical Systems). As well as it can integrate with devices including Smart phones, medical devices and so on.

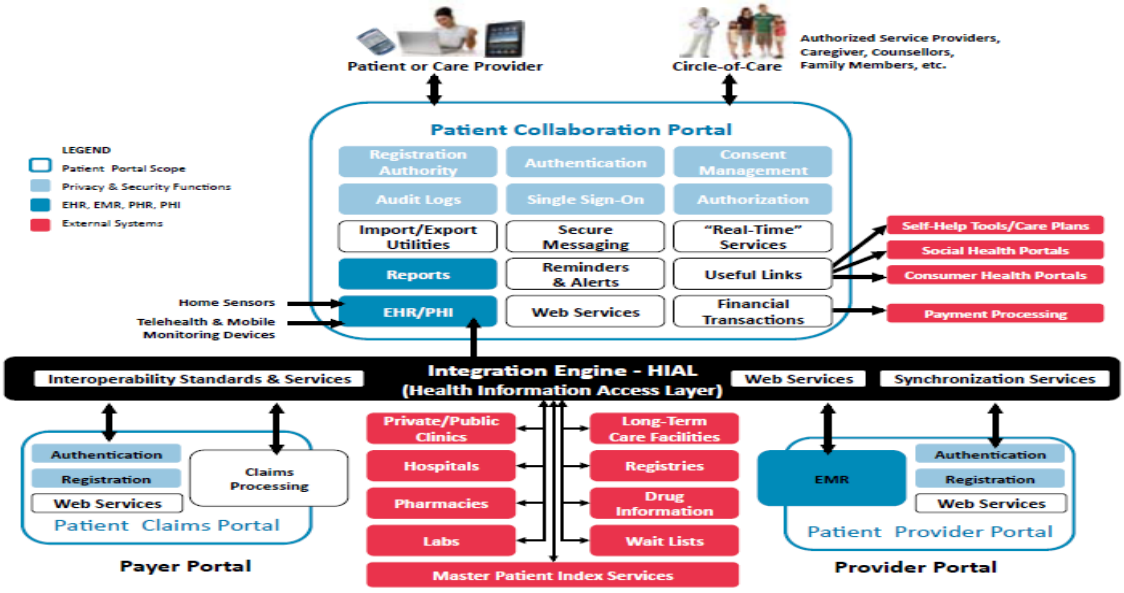

Figure 2.12 Integrated Portal- Functional Architecture

As a result, all portals depend completely on internet connections to enable patients to maintain and access their PHRs. Therefore, there is a need for continuous and reliable connectivity without disruptions between three parties' web servers, providers and patients with more concern about privacy and security (Steele *et al.*, 2012). Due to this, patients can use Web-based PHR to access records that have been managed by a healthcare provider via a reliable internet connection through healthcare organization servers which could be classified as standalone, tethered or integrated PHRs. In terms of PHRs location, patients can use hybrid PHRs as a cross between standalone (local) and remote PHRs (Integrated or tethered PHRs) to utilize the benefits of both types.

2.5.6.2.2 PHR Functional Capabilities

Generally, the functions of PHR can be categorized in three consistent sequences: an information collection, Health Information Exchanges (HIEs) and sharing, and information self-management (Kaelber *et al.,* 2008). These functions are controlled by patient and healthcare provider, HIEs contexts, PHR architecture types, security and privacy, and government standards and regulations. For example, HIEs follow a set of procedures and standards and also vary according to the scale of exchange interoperability, starting from local HIEs, to Regional HIEs, Multi-Regional HIEs and even Nationwide HIEs (Scholl *et al.*, 2010). Consequently, we will discuss the main functions in a simple way to give the reader a brief description for each function. Initially, the information collection starts from the patients accessing process through the PHR portal. Each portal provides a password-protected access to enter PHI and additional identification processes. Kim and Johnson (2002) evaluate the functionality of 11 PHR portals; in general, they have the same functions in allowing patients entering the medical history and medical conditions (nonspecific symptoms, general systemic disorders, and specific etiologic diagnoses). In addition, they allow patients to enter information about laboratory tests, medications, information related to immunizations and diagnostic studies. While it is the patients' responsibility to enter and collect their health information, HIEs are likely to become the important function between healthcare providers, payers, and patients.

To understand the HIEs' function, we will follow Scholl *et al*. (2010) from the National Institute of Standards and Technology (NIST) in their illustrative clinical assessment scenario and apply it to the Canadian Health Space PHR portal. Patients use a Health Space PHR portal to enter medical history and medical conditions, laboratory tests, medications and diagnostic studies. Patients then begin seeing their family doctor or physician, and authorize or allow the

family doctor access to read the PHR. Then the family doctor retrieves patients' PHR from the Health Space PHR portal. To make a complete medical assessment, the family doctor may ask for patients' permission to request additional health information from walk in clinic labs, or the previous family doctor. As a result, the family doctor will use this information to make the health assessment, develop a diagnostic plan and incorporate the new information into patients Health Space PHR. To simplify the scenario, Scholl *et al*. (2010) in Figure 2.13 provides a sequence diagram of the HIEs that occur in this illustrative clinical assessment scenario.

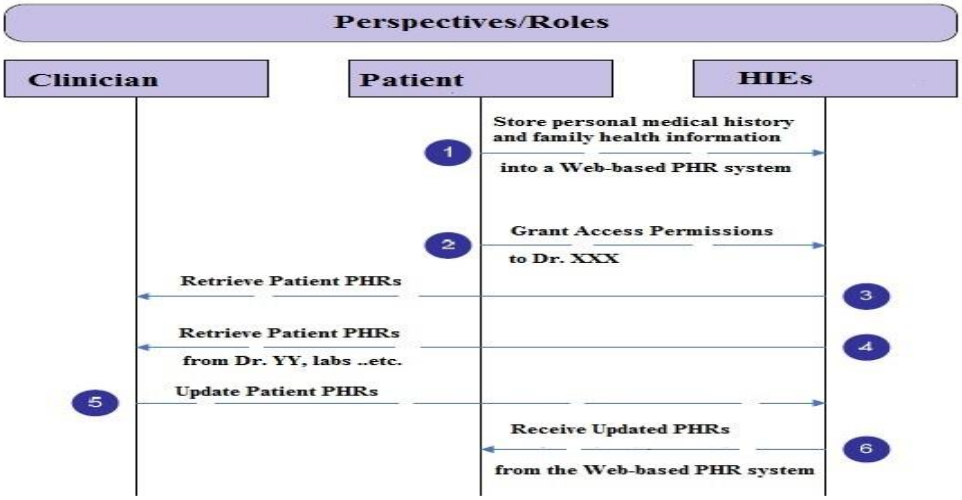

Figure 2.13 Illustrative Clinical Assessment Scenario

Providing a controlled PHI for presentation to healthcare providers required accurate information about the past and current medical conditions, verification of laboratory test results, diagnostic study results and any information about dates and their sequences (Kim & Johnson, 2002). The controlled PHI lead us to the third function of PHRs, which is related to patient health self-management. Because the PHR systems allow the patients to enter, edit, modify and retrieve their health records and information, and this ultimately will enhance patient health self-management (Archer *et al.*, 2011).

As well, the literature of PHR research has been focused on the patient health self-management and HIEs "to improve the patient-provider relationship, enhance patient and shared decision making", and assist the healthcare system to adopt the individualized healthcare management system (Kaelber *et al.*, 2008). But the most important question here is whether all parties in the above functions are ready to adopt the individualized healthcare management system in general and the PHR system in particular.

2.5.6.3 Governmental Perspective (Political and Economic)

This section is an interdisciplinary view of the external factors where we first discuss the general approach to the study of innovative technology adoption, and then study some of the resulting detailed reflections. Among other things, there are three major sides of PHR innovative technology adoption that any interdisciplinary theory must address: governmental support, legal and policy issues and economic cost benefits. Governmental support is an absolute condition to the adoption of PHR systems since it requires specific input and it controls the processing of health information. Through the literature and previous sections, there was a notable growth in health information flows supporting the EMR at all levels of government— local, regional, multi-regional and federal. While EMR has gotten the most attention from the governments over the past years in terms of funding, implementation and adoption, PHR systems on the contrary, as a part of EMR have not received the same level of attention from these governments (Tang *et al.*, 2006). Many governments such as those of Australia, Canada, New Zealand, England, and the United States, have been working on PHRs. Canada's health model and health information infrastructures are considerably ahead when compared with other countries, even though, limited work was done in Canada on PHRs (Detmer & Steen, 2006).

Real innovation in this domain requires the design and implementation of unusual approach, the gathering of observations about daily living of patients to further enhance the different stakeholders ability to focus on key components affecting the delivery of PHR services (Brennan *et al.,* 2010). For example, government policy-makers can conduct several actions on various level to facilities the adoption of PHR. Tang *et al.* (2006) suggest numerous actions that should be adopted by the governments in this direction, such as sponsoring research from relevant federal agencies to assess the health behavior benefits of PHRs. In addition, they suggest a number of legislative actions that also will support the adoption such as a tax deduction for PHR-related expenses, as well as good monetary incentives to providers to implement PHRs. Sometimes, new policies also are necessary to fund special actions targeting special groups, cultures, and minorities to ensure that the improvements in care quality reach everyone (Rudin *et al.,* 2014). In this direction for instance, Yamin *et al.* (2011) in their study found that minority groups are less likely to access and use web-based PHRs than other groups.

At the legal and policy levels, historically, the Canadian healthcare system was created province-by-province until the provincial–federal partnership was put in place by 1971.Under this partnership, the federal government sets national programs, standards, regulations and a healthcare system called “Medicare” which covers the entire population (Rose & Rose, 2014). Medicare also has programs, rules and regulations, but healthcare providers “still have the choice of whether or not to be contracted with these programs” (Bucci, 2014). One of these standards and regulations is the Canadian Health Act of 1984 which requires that provincial healthcare plans must provide the required health services to Canadian population including online services (Rose & Rose, 2014).

In addition, developing standards for protecting the PHI and improving EMR-PHR interoperability is important; examples include the Protection and Electronic Documents Act (PIPEDA), Personal Information Protection Act (PHIPA) and others. Due to this, PHI is considered as one of the most sensitive information sources, and "PHR systems raise a number of interesting issues concerning privacy, security, trust, integration, and interoperability" (Williams & Weber-Jahnke, 2010). Nevertheless, the Personal Health Information Protection Act ("PHIPA") in Ontario leaves some rules about EMRs to be developed in the Regulations. The issue of privacy protection is one that it is in constant evolution and requires diligent monitoring to ensure that all standards are met to the highest level of compliance. Because of this, the inclusion of PHI in PHR systems is expanding the scope of the legal issues, regulations and standards. This attracted scholars from law disciplines to investigate electronic health record regulation in Canada (such as Goodman (2012) and Williams and Weber-Jahnke (2010)).

Economically, reviews of economic returns due to EMR have shown mixed results (Shekelle *et al.,* 2006). Most studies of EMRs, written by different authors, which focused on the economic benefits of use also showed several benefit (Kochevar *et al.,* 2010). The benefits of EMR software include reduction in clerical staff time and costs, and the ability to perform more treatments. One of its most important benefits is reducing waiting time and costs, which is a major issue in the Canadian healthcare system. On the other hand, PHR data usually extracted from multiple information sources and systems including EMR, which benefits the PHR and justifies the funding of these platforms. Yet the real benefit of PHRs does not come in their role in reducing time and costs, but in allowing patient self-management, separating the PHI from multiple information sources and systems, and enabling greater innovation in the e-health applications which can simplify action (Brennan *et al.,* 2010). Because of these benefits,

Canada has established a federally funded non-profit organization called Canada Health Infoway to lead the implementation process of EMR across Canada.

The primary objective for Infoway is to improve the HIEs by deploying EMRs for Canadians, putting the right information in the hands of Canadians and their healthcare providers, which leads to improved quality of life and experience for Canadians (Canada Health Infoway, 2014-2015). This objective was expensive; Canada has invested upwards of $2.1 billion in publicly funded e-health systems as reported in the last reported Canada Health Infoway Corporate Plan for 2014-2015. Despite the fact that Canada Health Infoway has achieved a some success "relatively little in the way of clinical data is being exchanged to date, in part because the adoption rate of electronic health records remains low" (Rudin *et al.,* 2014).

Infoway continues to invest huge amounts to improve the adoption of e-health significantly, but the question remains. "If the adoption of EMR is still low with this amount of investment from the healthcare providers, how much does the government need to invest in the PHR for people most of them seniors, to use PHR?" Surprisingly if the government has also been facing challenges in the adoption of EMR with healthcare providers, who are at the same time educated people and work under the government umbrella. A second question is: "How much does the government need to invest federally to successful implement PHR for people with several demographic characteristics, most of them elderly, from different cultures, without any constraints and incentives. Furthermore, are Canadian people even interested in this technology and are they willing to pay these billions for these systems?

2.5.6.4 Change Management and Organizational Support in Healthcare

Healthcare organizational support is responsible for applying the effective change management plan to transition people from the traditional way to new PHR innovative

technology. The change management plan contains key elements including its definition, how people can understand it, strategies, models, stakeholders, resources and tools, and the collaboration between these elements needed to succeed in the implementation process. The literature review of this dissertation provides sufficient research to understand these elements and the whole process of change management in different industries. For the Canadian perspective on EMR, Pan Canadian Change Management Network [PCCMN] (2011) defines change management as "…a strategic and systematic approach that supports people and their organizations in the successful transition and adoption of electronic health solutions. The outcomes of effective e-health change management activities include solution adoption by users and the realization of benefits" (PCCMN, 2011).

Returning to the context of the adoption of EMR and with only four hospitals achieving HIMSS Stage 6 in Canada, this definition is a good opportunity to understand how healthcare organizations have the main role of change management in achieving the PHR adoption among people. Generally, the definition has been linked to the successful transition of any e-health system with patients, healthcare providers and administrators, each seemingly working under their organization support. The structure and implementation of health technologies are complex processes, much of the change that happens depends completely on the system users, and so running the "people change" at the same time as "technological change" gives a more successful implementation of long-term benefits (PCCMN, 2011).

Due to this, Canada Health Infoway Change Management Framework (CHICMF) offers a general overview of the important elements of an effective change management plan within e-health adoption in the Canadian health organizations. As shown in Figure 2.14, the framework posits six elements to guide the change in Canadian health organizations: governance and

leadership, stakeholder engagement, communications, workflow analysis and integration, training and education, and monitoring and evaluation (Canada Health Infoway, 2013). Each of these will be discussed in turn.

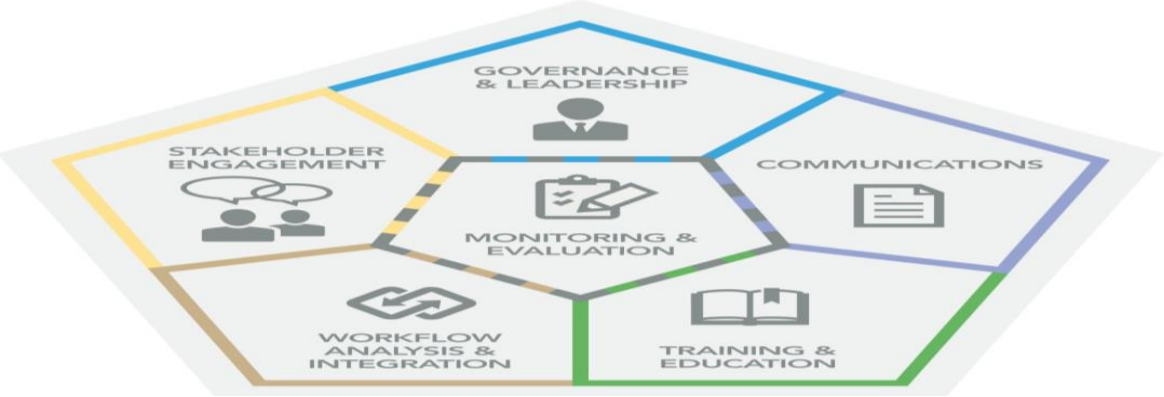

Figure 2.14 Canada Health Infoway Change Management Framework (CHICMF)

2.5.6.4.1 Governance and Leadership

Governance and leadership in health organizations characterizes the mechanisms that lead and standardize the course of an organization (Lukas *et al.*, 2007; Pannoni & Ricketts, 2010). Effective governance and leadership can lead to better decisions and facilitate greater alignment of organizational priorities and more buy-in from stakeholders (Pannoni & Ricketts, 2010). This happens through the governance structure, which identifies the mechanisms by which stakeholders can affect the priorities and progress of any e-health application (Pan-Canadian Change Management Network, 2013). The structure needs to match with the organizational culture and objectives (Lukas *et al.*, 2007) as well as need to engage the end-users/stakeholders to contribute to successful outcomes in e-health system implementation and adoption (Canada Health Infoway, 2013).

Health technology adoption needs more than structuring, designing, or buying EMR or PHR systems. It contains a professional organizational change, which requires strong leadership to solve interpersonal problems, clear strategies and formation of objectives and psychological

support from all stakeholders particularly physicians and patients (Lee *et al.,* 2005). As well, implementing e-health in hospitals is a complex process comparing with other organizations in terms of the complexity of medical data, data entry errors, security and privacy concerns, and a general lack of awareness of the benefits of theses technology from the end-users (Boonstra *et al.,* 2014). Boonstra and Govers (2009) address this complexity for those hospitals that have multiple objectives, highly varied structures and processes and a varied workforce including physicians who possess high levels of expertise, power, and autonomy. This means that the lack of vision, leadership and willingness of the hospitals managers and health authorities to prioritize these objectives in reengineering the health-care will increase the complexities of technological change (Berler *et al.,* 2005).

To be able to move forward in the issues of hospitals complexities in EMR-PHR adoption, which is related to the governance, and leadership in health organizations, Tang *et al.* (2006) concluded that PHR adoption is not limited to technical ones. They found that there are challenges that hinder the progress of EMR-PHR adoption in hospitals and the decision makers have to handle of there. For example, they found that besides the technological issues, there are economic and technological challenges, along with organizational and behavioral issues that can delay PHR adoption. Economically, there are forces in the market that delay PHR and EMR adoption such as the lack of PHR models because the vendors are only offering standalone PHRs, which are not financially successful, and the products and companies are limited which effect on the selection process.

From organizational and behavioral issues, the hospital leaderships need to help physicians and patients change their attitudes and levels of trust based on traditional patient-physician relationship in terms of control, autonomy, and authority. In addition, they must

increase their trust to overcome legal concerns on the part of physicians and the privacy concerns of individuals (Tang *et al.,* 2006). As well, besides organizational support, physicians must involve and learn to encourage and motivate their patients to interact online by using PHR systems. As a result, these involvements require very thoughtful leadership for PHR change management, which is covered under the whole organizational structure to accelerate the adoption and minimize the resistance to the new PHR implementations.

2.5.6.4.2 Stakeholder Engagement

The second CHICMF element is stakeholder's engagement, which "refers to the process of involving people who can affect or who are affected by the achievement of an organization's objectives" (Antwi & Kale, 2014). Lukas *et al.* (2007) cited different engagement strategies for different types of stakeholders in identifying and managing their perceptions and expectations from these systems, such as: informing them on progress and decisions, consulting them in these decisions, involving them in the alternatives of a decision process, and collaborating and empowering the decision implementation process. These strategies will avoid the adoption barriers in terms of misunderstanding, disappointment, and/or resistance. It is also essential that all parties such as physicians, patients and administrators have a common understanding of change and its effects (PCCMN, 2013). Through these strategies, the literature focusing on techno-humanist matter must be taken into account when engaging all stakeholders in general, and physicians and patients in particular.

As mentioned before, issues such as mistrust between different stakeholders, such as those between physicians and nurses, are preventing the effective sharing of information, which decreases engagement (Berler *et al.,* 2005). In addition, the engaging patients with a PHR to perform their tasks need a good knowledge in computer and Internet skills. Accessing a PHR can

be challenging for groups with limited computer and Internet skills, such as many older adults (Taha *et al.,* 2013), and other minorities who lived in rural and regional communities. The scholars found in their samples that a lack of computer skills that causes computer anxiety is a barrier to PHR for the adoption of people of low-income, older adults, and persons with a disability (Gell *et al.,* 2013; Kim *et al.,* 2009).

PHR engagements can also be affected by multiple personnel that influence real and perceived barriers (Archer *et al.,*2001): for instance, the cost, lack of access to computers and the Internet, low health literacy, privacy concerns, and an unwillingness to adopt a new mode of healthcare delivery (Archer *et al.,* 2001). Due to this, Tang *et al.* (2006) suggest that all parties including developers and users of EMRs and PHRs must understand human mental models of healthcare processes, and the related workflows. These authors focused also on cultural issues and trends for PHR adoption as a common goal by increasing the awareness and involving providers, patients, and regulators in the change management process.

2.5.6.4.3 Communications

The above issues will take their places in the communication process as a third element in the change management framework; through the "ability to deliver the right message, to the right person, through the right channel, at the right time" by providing also "an opportunity to solicit feedback, provide information to stakeholders, build trust, and report progress" (Antwi & Kale, 2014). In this domain, PHRs have represented as reducing in-person doctor visits through an enhanced self-management program, and improving the communication process among health providers and patients (Macpherson *et al.,* 2014). There is, however, a technological gap between health-care providers and patients from various level. Physicians are usually reluctant to use technology that they suppose was not designed for them (Berler *et al.,* 2005), and patients may or

may not have a gap in computer and health literacy skills. Focusing on health literacy, which is defined as a "the ability to understand and apply information conveyed with numbers, tables and graphs, probabilities, and statistics to effectively communicate with healthcare providers, take care of one's health, and participate in medical decisions" makes the communication process more complicated (Schapira *et al.,* 2012, p. 2). At this level it means that the communication process is a vague continuum where interests and needs represent one end and knowledge level represents the other.

Focusing on patients for example, the communication process through a PHR is numeric and in most cases is provided in tables and graphs, which means that health numeracy is required to successfully use a PHR to manage the communication with their health providers (Taha *et al.,* 2013). In addition, many activities require computational health numeracy such as finding the date and time of medical appointments, determining whether test results are in the proper range, and resolving how to manage a missed medication dosage (Taha *et al.*, 2013). The application of these PHR activities between physicians (who may or may not have the interest) and patients (who may or may not have the ability) could create a communication problem in understanding and using the health data in the PHR. On the other hand, health information for each patient exists in multiple locations and the integrated PHRs must reach beyond health organizational boundaries to communicate with multiple EMR systems (Tang *et al.,* 2006). The current lack of EMR adoption from the healthcare providers introduces the most communication barriers to patients who want to communicate with the PHR. Therefore, successful communication "will not be realized unless an effort engages large numbers of individuals who believe change is possible and who are willing to actively participate" (Frisse, 2010).

2.5.6.4.4 Workflow Analysis and Integration

The fourth CHICMF element is workflow analysis and integration. This will offer in-depth understanding of existing work processes and opportunities for the continuous improvement in the use of e-health systems (PCCMN, 2013). Analyzing and integrating the existing work processes before the implementation of e-health system will motivate serious analysis on how work is achieved in the current environment, on understanding the ways in which the current processes will improve, and on finding additional opportunities for progress in these systems (PCCMN, 2013). As a result, workflow analysis and integration element look to integrate stakeholders/users, processes, and e-health technology for an effective compatible implementation process. In addition, this element focuses on the gathering of information from users to describe the acceptability and usability of the e-health applications such as PHR.

In general, the gathering information will help to interact with technology user friendliness and usability issues such as data entry and the time to reach these data, the speed of information retrieval with high quality covered under high-security procedures and so on (Berler *et al.,* 2005). For example, the numeracy part of health literacy for adult people and some special needs group may be especially critical to successful use and adoption of a PHR, which should gain attention in the work analysis and integration element to keep it more friendly and usable for all (Taha *et al.,* 2013). However, analyzing the workplace with its stakeholders has a considerable impact on PHR acceptance and subsequent integration factors and invisible factors, which might appear suddenly within the analysis process according to people interaction.

2.5.6.4.5 Education and Training

The fifth CHICMF element is the education and training. Education refers to “a program of instruction in which knowledge or skill is developed or obtained through a learning process”

(PCCMN, 2013). Training is defined as "an organizational activity aimed at imparting information or instructions to improve a recipient's performance or to help him/her attain a required level of knowledge or skill" (PCCMN, 2013). The main objective of this element is to improve the end-users performance, and teach or train them the required level of skills that they need to fulfill the task of e-health system according to their roles (Antwi & Kale, 2014). For the purpose of PHR implementation, education and training to increase user awareness, keeping in mind user specific needs must be given paramount consideration. Using a PHR might be challenging for all users and particularly for older and some special needs users due to the cognitive abilities, which are necessary for the performance of health management tasks (Taha *et al.,* 2013).

Reading a cholesterol panel for example according to Taha *et al.* (2013) required patients to have a sufficient verbal ability to understand the language, executive functioning for retrieving the information from the PHR, and selective attention to find the link to the cholesterol test results among other links. As well, working memory is needed to hold on to the necessary information that has resulted from the search, sufficient processing speed to support working memory, and spatial ability to navigate the PHR. Ultimately, these abilities will affect older patients and some special needs patient in managing their PHI within PHR. In addition, patients with low levels of health literacy are less likely than patients with higher levels of health literacy to successfully view their laboratory results, e-mails communications, and medication refills, and to make medical appointments using a PHR (Sarkar *et al.,* 2010).

Many studies have documented a lack of training and education in computer skills and Internet access, cognitive abilities, health literacy and security concerns as shared barriers to the use of a PHR (Kim *et al.,* 2009; Macpherson *et al.,* 2014; Sarkar *et al.,* 2010; Taha *et al.,* 2013).

As an indicator, one study reported that 80 % of participants required training and support to use the PHR (Kim *et al.,* 2009). To overcome these challenges, Tang *et al.* (2006) suggest identifying educational strategies about health management techniques that should be used early in academic institutions by teaching how the people can manage their health information using simple tools. This is through a new curriculum plan that supports and explains both EMRs and PHRs for health providers to teach their patients about PHRs.

2.5.6.4.6 Monitoring and Evaluation

The final CHICMF element is monitoring and evaluation, which refers to the measuring tools to control and evaluating the impacts of all pervious elements as an initiative on e-health target people (Antwi & Kale, 2014; Lukas *et al.,* 2007). This, as an important element, brings the stakeholders complete feedback on the big picture of the e-health application through the change management initiatives within the health organizations to control the implementation process and to fill the gaps between and within all elements. Patients' feedback on all these elements is also essential, especially for most challenges of technological and behavioral changes in their life. For example, knowing how to use a PHR appropriately, in terms of inputs, outputs, and processing, needs real feedback, follow-up and continuous improvement process. Furthermore, health organizations should formulate a systematic and continuous approach to follow-up in terms of ongoing support, excellent practices and successful stories for patients.

CHICMF should be seen as a benchmark tool for the stakeholders that will lead to PHR adoption in a professional way. Many change management models are shown in the literature with different elements such as Lewin's 3-step model, Kanter *et al.'s* "Big Three" Model of Organizational Change, Lukas et al.'s Organizational Model for Transformational Change in Healthcare Systems, Hinings and Greenwood's Model of Change Dynamics and Pettigrew's

Context/ Content/ Process Model. Table 2.7 as cited in Antwi & Kale (2014) shows a comparative analysis between CHICMF and other established models.

Table 2.6 *Comparison of Canada Health Infoway Change Management Framework*

Canada Health Infoway Change Management Framework Components	Lewin's 3-Step Model	Hinings and Greenwood's Model of Change Dynamics	Kanter*et al.'s* "Big Three" Model of Organizational Change	Pettigrew 's Context/ Content/ Process Model	Lukas *et al.'s* Organizational Model for Transformational Change in Healthcare Systems
Governance and leadership	Yes	Yes	Yes	Yes	Yes
Stakeholder engagement	Yes	Yes	Yes	Yes	Yes
Communications	Yes	Yes	Yes	Yes	Yes
Workflow analysis and integration	Yes	No	No		No
Education and training	No	No	No	No	No
Monitoring and evaluation	Yes	No	No	No	No

According to Antwi & Kale (2014), unlike the above models, the CHICMF "does not present a systematic approach to managing change." As well, it offers core components of managing a change task but without a particular sequence to guide healthcare managers "on what to accomplish first and what to attend to last". In addition, in these models most successful efforts arise when influential control comes from the policy makers in the government and from the healthcare providers' perspectives. For many patients, the issue is not about the system of use or PHR adoption because most of them may be totally unfamiliar with the PHR. Because of this, some change management models focused on awareness. For example, the ADKAR Model of Change Management used five different elements to implement change in organizations, government, and community. Each stockholder can apply these sequential elements to increase

"Awareness" and explain why PHR is necessary. This awareness will foster the "Desire" for each one to share and support the PHR implementation. Desire will involve people in the PHR process, which creates the "knowledge" by asking when, what, where and how we can change. These questions will improve their communication through a systematic training and education program. Then, their "Ability" will increase naturally as their knowledge accumulates about PHR use. As a result of their ability, "Reinforcement" will reward the successful efforts of implementing change (Hiatt, 2006).

Finally, PHR acceptance, organizational support and change management are related to each other, successful health organizations do not implement technology without changes in the perceptions and expectations of the people involved. While the change management models listed above are useable from managerial, organizational, and governmental perspectives, it is not easy to force people to change. People react based on different demographic and cultural factors and they require that PHRs be introduced in different ways to avoid resistance. Extensive research should be pursued focusing on human awareness and perception, and on acceptance of any new innovation because the human being is at the core of the implementation process and without human opinion, the whole process will just be a waste of billions of tax dollars with no any result.

Chapter 3 Methodology and Methods

3.1 Background: Theoretical Perspective of Quantitative Measurements

As mentioned in chapter 2, with innovative technology investment, there is no financial formula to calculate the Return on Investment (ROI) in service industries because the value of the gains is difficult to quantify (Contino, 2004). From a theoretical background, this means that there are different ways to evaluate and measure the ROI for the service industry. Roulstone & Phillips (2008) in their book show the five-level as a complete cycle that has been used to evaluate technology projects (see Table 3.1), and this cycle is not finished until the level 5 is measured (p.32).

Table 3.1 *Technology Projects Evaluation Levels**

Level	Description
1. Reaction and Perceived Value	Measures users' reaction to the technology
2. Learning and Confidence	Measures user's skills, knowledge, or attitude changes related to technology.
3. Application and Implementation	Measures actions on the job with application and implementation of the technology.
4. Impact and Consequences	Measures business impact of technology.
5. Return on Investment (ROI)	Compares the monetary benefits of the impact with the costs for the technology project.

*(Roulstone & Phillips, 2008)

According to this book, the various levels of evaluation are helpful to understand how the service industries calculate their ROI. For example, the first level measures the user reaction toward technology and this usually translates to soft data by using a survey. The second level focuses on the acquired skills and knowledge of this technology and what the attitude of the users is during the transition management of innovative technology in the organizations. Simply, this level is measured by creating tests, group assignments, performance indicators and other evaluation tools for participants.

The third level is a follow-up method to measure the success of technology through demonstrated actions on the job. At this stage, we cannot guarantee that the implementation and application of technology have a positive business impact. Because of this, the fourth level focuses on actual outcomes to measure the quality, cost, time and user satisfaction, which also quantify from soft or hard data to monetary units. The final level measures the ROI, which depends on the costs and benefits. The cost of technology is easy to calculate because it depends on the type of contract (fixed or hyper) with the contractor. But because of the nature of the ROI in service sectors, as mentioned in previous levels, the organizations need to quantify the benefits to monetary units and then calculate the ROI by comparing the monetary benefits of the impact technology with the cost. Some of service industries just conduct surveys to measure the level of satisfaction or user adoption without reaching the final level.

3.2 Research Methods

Every dissertation is based on different research methods to gather information and increase knowledge on the subject chosen for investigation. The methodology that will be used for this thesis is the following:

Quantitative research: The survey strategy is a popular and common strategy in empirical research that is usually associated with a deductive approach (Saunders *et al.,* 2011). Two types of data will be used in this study: secondary data that has been collected by the National Physician Survey (NPS) as an input from Canadian physicians involved in e-health operations and primary data that will be collected by creating and analyzing a survey, taken in Northern regional communities.

Qualitative research: Information from the literature and interviews in newspapers, articles and websites will be gathered. Using this secondary data will provide a deeper

understanding of the subject. In addition, the survey also has five qualitative questions that assess the overall evaluation and expectations of people in Northern Ontario, for the health organizational support, physicians support and the governmental funding policy for e-health applications.

Explanatory research: using the Personal Health Records (PHR) - TELUS Health to test the user interfaces on Northern Ontario people and by browsing also the available PHR system in Northern hospitals to determine their simplicity or complexity.

3.3 Population and Sample of the Study

As mentioned above, the target population for this study was people from Northern Ontario, Canadians who are living in Northern cities as a primary region of the Canadian province of Ontario such as Greater Sudbury area. According to Statistics Canada (2015), the total population of Canadians in 2015 was 35,851.8, therefore, Ontario province represents 38.5 % (= 13,792.1) of the Canadian population, and Northern Ontario represents approximately 5.6% (=775,178) of the Ontario population. A purposive sample has been applied to find the opinions of the target population. This sample has covered subgroups that are more readily accessible in public places to help ensure that the sample represents the entire population base. The convenience sample for this study included Northern people of various ages, genders and ethnic/cultural groups, and such persons were approached in public places. Another consideration in determining the sample size was the number of Northern physicians according to government information. Two categories of e-health users were selected from Northern people. The first one was Northern Ontario Physicians, collected as secondary data, represented by three categories: Family Practice, General Practice and Specialists (see Appendix D). Northern Ontario has approximately 2196 doctors, 323 of whom participated in a 2014 National

Physician Survey in the region. They were from all socioeconomic and demographic levels, male and female within several age groups, from <35 to 65+. Collected as primary data, the second category was represented by a group of Northern citizens. Three hundred and twenty-five participants responded. Several racial and ethnic groups are represented in the survey.

The sample for this study included males and females of varying ages from each of the public places, such as universities, colleges, malls and hospitals. The sample included a diverse group of people with varying levels of experience in the use of e-health innovative technology, ranging from very proficient to not proficient. The respondents answered several questions to examine the relationship between adoptions of EMR-based-PHR innovative technology and the categories of the suggested determining factors as shown in the following section.

3.4 Conceptual Framework

The research model (see Figure 3.1) shows the relationship between adoptions of EMR-based-PHR innovative technology and the categories of the suggested determining factors. It will also examine the effects of adopting EMR-based-PHR on health services performance. Accordingly, adoption of EMR-based-PHR will sometimes be a dependent variable and an independent.

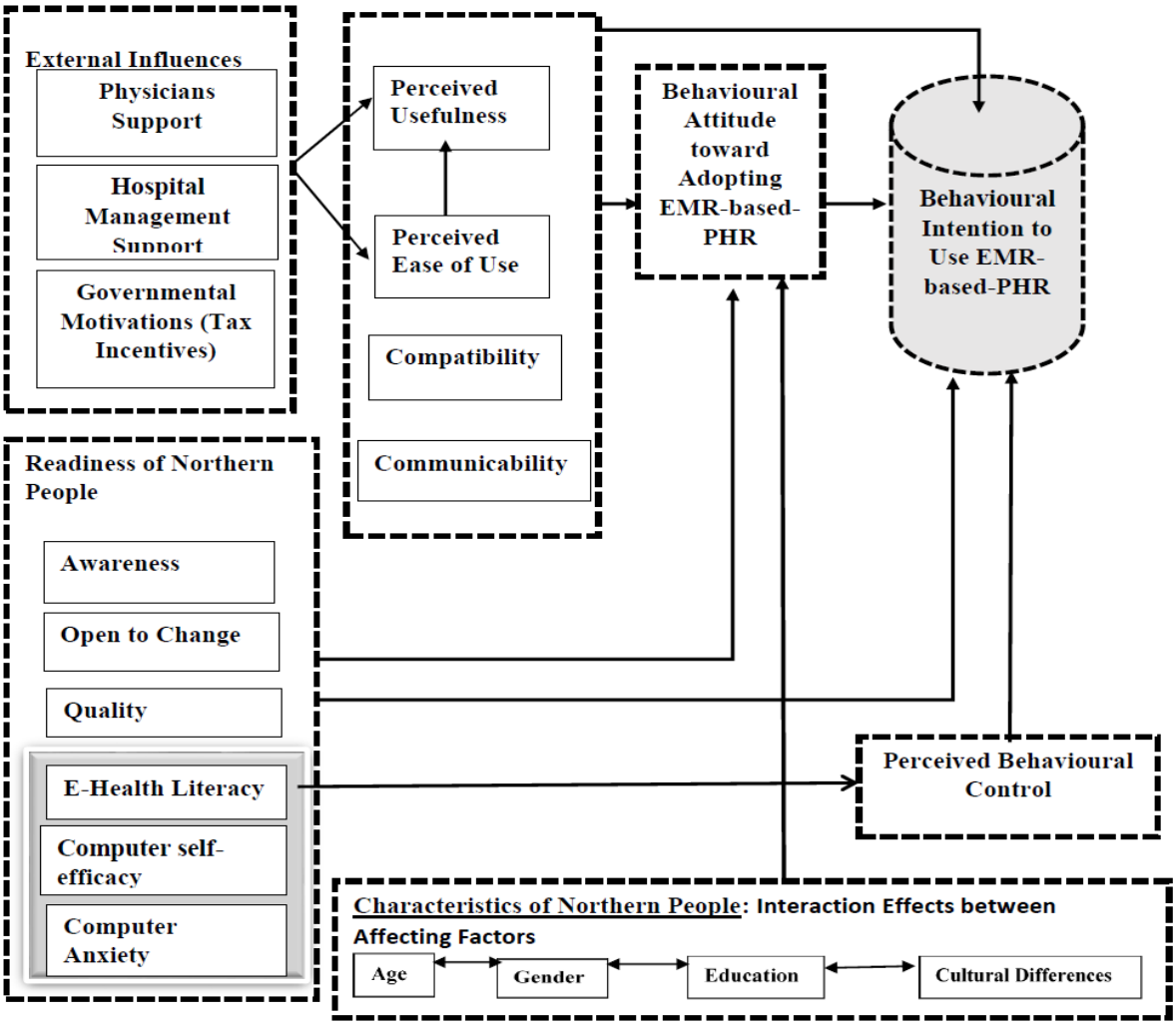

Figure 3.1 Hyper research model of Northern people perception toward EMR-based-PHR

3.5 Research Questions and Hypotheses

1. **Are there any differences in the technology skills of Northern physicians and patients in using e-health services?**

H01: There is no difference between the proportional usage of websites by physicians and patients in Northern Ontario.

H02: There is no difference between the proportional usage of tele health or telemedicine by physicians and patients in Northern Ontario.

H03: There is no difference between the proportional usage of mobile applications (App) by physicians and patients in Northern Ontario.

H04: There is no difference between the two populations in terms of proportions of capturing health information by exclusively using paper charts.

H05: There is no difference between the two populations in terms of proportions of capturing health information by using a combination of paper and electronic charts by physicians and patients in Northern Ontario.

H06: There is no difference between the two populations in terms of proportions of capturing health information by exclusively using electronic records.

H07: There is no difference between the two populations in terms of proportions in the preference to use electronic records in the future.

H08: There is no difference between the two populations in terms of perceptions regarding electronic healthcare self-management in physicians' responses about their patients, and in patients' responses about themselves in Northern Ontario.

H09: There is no difference between the two populations in terms of perceptions of website referrals in physicians' responses about their patients, and in patients' responses about their doctors in Northern Ontario.

H010: There is no difference between the two populations in terms of perceptions about the purpose of website referrals in physician's responses about their patients, and in patients' responses about their doctors in Northern Ontario.

H011: There is no difference between the two populations in terms of proportions regarding the recommendation of mobile applications in physicians' responses about their patients, and in patients' responses about their doctors in Northern Ontario.

H012: There is no difference between the two populations in terms of perceptions regarding the purpose of the mobile applications recommendation in physicians' responses about their patients, and in patients' responses about their doctors in Northern Ontario.

2. Why is Canada's level of compliance so low for innovative technology?

2.1 Canada is a multicultural country and has a mosaic of personality types. How will this variety affect the success of the innovative technology implementation? Do sex, age, education and ethnicity have an effect on Northern people's attitude toward EMR-based-PHR innovative technology?

H01: Age will have no significant effect on attitude toward adopting EMR-based-PHR.

H02: Sex will have no significant effect on attitude toward adopting EMR-based-PHR.

H03: Educational degree will have no significant effect on attitude toward adopting EMR-based-PHR.

H04: Ethnicity will have no significant effect on attitude toward adopting EMR-based-PHR.

2.2 Does the interaction of sex, age, education and ethnicity have an effect on determining the behavioural attitude of people in Northern Ontario toward EMR-based-PHR innovative technology?

H05: The age and sex interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H06: The age and degree interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H07: The age and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H08: The sex and degree interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H09: The sex and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H010: The degree and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H011: The age, sex and degree interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H012: The age, sex and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H013: The age, degree, ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H014: The sex, degree and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

H015: The age, sex, degree and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR.

3. What human barriers impede the adoption of EMR-based-PHR innovative technology in Northern Ontario?

3.1 Is the perceived usefulness of EMR-based-PHR predicted by the perceived ease of use variable toward adopting EMR-based-PHR?

H016: There is no significant prediction between the perceived ease of use variable and the perceived usefulness of EMR-based-PHR.

3.2 Is the perceived usefulness variable of EMR-based-PHR predicted by the external factors for adopting EMR-based-PHR (Governmental Incentives, Physicians Support and Hospital Management Support)?

H017a: The Physicians' Support variable cannot significantly predict the perceived usefulness of EMR-based-PHR.

H017b: The Hospital Management Support variable cannot significantly predict the perceived usefulness of EMR-based-PHR.

H017c: The Governmental Motivations variable cannot significantly predict the perceived usefulness of EMR-based-PHR.

3.3 Is the perceived ease of use of EMR-based-PHR predicted by the external factors for adopting EMR-based-PHR (Governmental Incentives, Physicians Support and Hospital Management Support)?

H018a: The Physicians Support variable cannot significantly predict the perceived ease of use of EMR-based-PHR.

H018b: The Hospital Management Support variable cannot significantly predict the perceived ease of use of EMR-based-PHR.

H018c: The Governmental Motivations variable cannot significantly predict the perceived ease of use of EMR-based-PHR.

3.4 Is the behavioural attitude toward adopting EMR-based-PHR predicted by the technological characteristics of EMR-based-PHR innovative technology?

H019a: The Perceived Usefulness variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

H019b: The Perceived Ease of Use variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

H019c: The Compatibility variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

H019d: The Communicability variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

3.5 Is the behavioural attitude toward adopting EMR-based-PHR predicted by sociological and psychological aspects that relate to human factors?

H020a: The Open to Change variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

H020b: The Awareness toward E-health variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

H020c: The Quality of Healthcare Services variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

H021a: The Computer self-efficacy variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

H021b: The Computer Anxiety variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

H021c: The E-Health Literacy variable cannot significantly predict the attitude toward adopting EMR-based-PHR.

3.6 Is the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR predicted by a combination of interdisciplinary variables that relate to managerial, technological, sociological, and psychological human factors?

H022: There is no significant prediction between the combination of managerial, technological, psychological variables and the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR innovative technology.

3.7 Is the behavioural intention of the people of Northern Ontario to use EMR-based-PHR predicted by a combination of interdisciplinary variables that relate to managerial, technological, sociological, psychological human factors, their behavioural attitude and perceived behavioural control?

H023: There is no significant prediction between the combination of managerial, technological, psychological variables, Northern people behavioural attitude and perceived behavioural control variables and the behavioural intention of the people of Northern Ontario to use EMR-based-PHR.

3.8 Is the perceived behavioural control of the people of Northern Ontario to use EMR-based-PHR predicted by psychological human factors?

H024a: The Computer Self-efficacy variable cannot significantly predict the perceived behavioural control of the people of Northern Ontario.

H024b: The Computer Anxiety variable cannot significantly predict the perceived behavioural control of the people of Northern Ontario.

H024c: The E-Health Literacy variable cannot significantly predict the perceived behavioural control of the people of Northern Ontario

4. What are the strategies or methods that should be adopted by the decision makers from the perspectives of Canadians to lessen the barriers of the adoption for EMR-based-PHR innovative technology?

Questions to be addressed include:

- What does a patient expect from the healthcare provider?
- What does a patient expect from healthcare organizations?
- Do these expectations differ based on the patient's perceptions?
- What suggestions can patients make to help remove the barriers?

3.6 Data Collection and Analysis Procedure

In this quantitative study survey, the data collection method was used. The respondents were intercepted in shopping malls (Mall-intercept personal interview) and other public spaces such as a Tim Horton's branches, New Sudbury Mall and Laurentian University to represent the population in general. Respondents were asked to fill out paper-based survey. These intercepts have been done at various times of the day to tap different strata of the population.

After collecting the entire data, the process of analysis began to summarize and rearrange the data. Several interrelated procedures were performed during the data analysis stage. SPSS version 22 has been used to tabulate and analyze the valid responses. At the beginning, a comprehensive data file was created. Then variables and their labels were defined. A few statistical tools such as measures of central tendency, measures of dispersion, Pearson's Correlation, ANOVA, and Chi Square, were used for the analysis.

3.7 Primary Survey Components

The survey starts with an introduction that briefly states its purpose and includes the instructions for completion before moving on to three sections of questions.

Section 1: This section focuses on general questions about the use of innovative technology in daily life and on patient knowledge of e-health innovative technology. The questions in this section were taken from the 2014 National Physician Survey and adapted

slightly. The purpose of this adaptation was to allow for a comparative analysis between Northern Ontario patients and Northern Ontario physicians answering the same questions.

Section 2: This section focuses on patient interactions, perceptions and attitudes towards the electronic patient-physician relationship (EMR-based-PHR), especially with regard to the use of one's personal health information. The questions vary between technological, psychological, sociological and organizational support factors. Each factor has many items to measure potential attitudes in Northern Ontario. Some items were adopted from three models as mentioned in the literature review: Diffusion of Innovation, the Technology Acceptance Model and the Decomposed Theory of Planned Behaviour. The other items were adopted from previous studies as shown in Table 3.2. The participants chose from a five-point Likert type scale ranging from "very strong" to "not strong at all." Most of these factors have been adapted from previous studies.

Section 3: In this section, the questions ask about background characteristics that may be related to technology use, eliciting the sample's personal and demographic information from people in Northern communities as deemed necessary to achieve the objectives of this study. The entire survey takes approximately 15-20 minutes to complete.

Table 3.2 *Survey Components: Interdisciplinary Factors that Predict Attitude*

Factors	Definition & Factor items
Perceived ease of use (PEU)	"The degree to which a person believes that using a particular system would be free of effort". Adapted from (Davis, 1989). - PEU1- Overall, I believe that browsing or managing my health information through a secure online hospital website is easy for me. - PEU2-I believe that learning to manage my health information through a secure online hospital website is easy for me - PEU3- It is easy for me to become skillful at using a secure online hospital website to manage my health information

Perceived usefulness (PU)	"The degree to which a person believes that using a particular system would enhance his or her performance" Adapted from (Davis, 1989). - PU1- Using a secure online hospital website will be useful to manage my health information - PU2- Using a secure online hospital website will enable me to manage my health tasks more quickly - PU3- I will experience more self-management in my health care by using a secure online hospital website
Compatibility (COMP)	"The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters". Adopted from (Roger, 2003). - COMP1- Using a secure online hospital website to manage my health information is compatible with my personal and work life - COMP1- Using a secure online hospital website to manage my health information is compatible with my learning preferences
Communicability (COM)	"The degree to which aspects of an innovation may be conveyed to others." Adapted from (Rothman, 1974). - COMM1- I feel comfortable communicating online with my family doctor - COMM2-I believe that using a secure online hospital website will promote my communication with my family doctor
e-health Literacy (EHL)	"The ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem." Adapted from (Norman & Skinner, 2006). - EHL1- I know how to find helpful health resources on the Internet - EHL2-I know how to interpret the health information I find on the Internet - EHL3-I feel confident in using information from the Internet to make health decisions
Computer self-efficacy (CSE)	*"*A judgment of human's capability to use a computer" (p. 192). Adapted from (Compeau and Higgins, 1995) - CSE1- I could complete a job using a secure online hospital website even If I had never used similar website like it before. - CSE2-I could complete a job using a secure online hospital website if someone else had helped me get started.

Computer Anxiety (CA)	"The fear of computers when using the computer, or when considering the possibility of computer use". Adapted from (Heinssen *et al.*, 1987). - CA1-I do not think I would be able to learn how to use a computer to exchange health information with my doctor - CA2-I feel insecure about my ability to interpret a computer health information printout - CA3-It scares me to think that I could cause the computer to destroy a large amount of health information by hitting the wrong key
Openness to Change(OTC)	The degree of willingness to support organizational change and positive affect toward change. Adapted from (Miller *et al.*, 1994). - OTC1- I welcome the introduction of new technology in my life - OTC2- I would consider myself open to the changes that are introduced in my work or studies - OTC3- I am willing to learn new skills to take advantage of new technology that is introduced in my work or studies
Healthcare providers Support (HCPS)	The degree of support from healthcare providers in the use of electronic health information. (New scale) - HCPS1- My family doctor has embraced the use of electronic health communication - HCPS 2- My healthcare center supports me in the use of electronic health information
Motivation to Innovate(MOT)	Availability of a motivation system encouraging patients. Benchmarking with Management Support and Performance Based Reward System (Alpkan *et al*., 2010) - MOT1- I could use a secure online hospital website to manage my health information if I receive support from my family doctor - MOT2- I could use a secure online hospital website to manage my health information if I receive training from my healthcare center - MOT3- I could use a secure online hospital website to manage my health information if I will be rewarded from the government
Awareness or Others' Use (AW)	"Reflects the degree to which the system is used by different reference groups". Adapted from (Compeau *et al.*, 2007). - AW1- Many people in my community use a secure online hospital website to manage their health information - AW2- Many people in other communities use a secure online hospital website to manage their health information - AW3- Family doctors in my community use electronic medical records (EMR) - AW4- Within my healthcare center, I am aware of many people using electronic health records

Behavioral attitude (ATT)	"Is the degree to which performance of the behavior is positively or negatively valued" Adapted from (Ajzen, 1991). - ATT1- Using a secure online hospital website to manage my health information is a wise idea - ATT2- I think it would be very good to use electronic records rather than papers record
Perceived behavioral control (PBC)	"Refers to people's perceptions of their ability to perform a given behavior". Adapted from (Ajzen, 1991). - PBC1- I believe that using a secure online hospital website to manage my health information is entirely within my control - PBC2- I have the knowledge and ability to use a secure online hospital website to manage my health information
Behavioral intention (BI)	"An indication of an individual's readiness to perform a given behavior, and it is considered to be the immediate antecedent of behavior" Adapted from (Ajzen, 1991). - BI1- Assuming I have access to a secure online hospital website, I will frequently use it - BI2- Assuming I have access to a secure online hospital website, I will recommend it to others
Quality	As a patient's judgment of, or impression about, the expected future services. Adapted from (Dagger et al., 2007). - QU1- The quality of the health services I will get from using a secure online hospital website to manage my health information will be very high - QU2- Using a secure online hospital website to manage my health information will improve the quality of healthcare services in my city

3.8 Reliability and Validity

A pilot study was conducted to investigate the survey's reliability through a test-retest method. It was also used to determine whether adjustments or changes in the survey were necessary. The sample for the pilot study involved 15 participants: students in a research methods course, editors, and educational administrators. The participants were asked to examine the survey organization, critique the questions and fill out the survey. Establishment of the survey instrument validity was conducted according to the three common validity criteria in the literature: content validity, criterion validity and construct validity (Litwin, 1995). Notes were

taken about their comments regarding respondents understanding or lack of understanding of survey questions, about the question sequences, and about the questions' options and scaling. The survey was then reviewed and redesigned according to comments received. After that, a reliability analysis for internal consistency was conducted for multi-item statements of the sixteen factors to measure Northern people's perceptions, attitudes and acceptance of the patient/physician electronic relationship. The result of the analysis was that the study instrument was reliable: The Cronbach's alpha Coefficient for overall internal consistency reliability was 0.80.

3.9 Assumptions

The fundamental assumption of this study was that each Canadian is a patient in his/her location throughout Canada and has a healthcare record number. An additional expectation was that Northern people did not have information and accurate knowledge of patient/physician electronic relationship.

3.10 Research Ethics and Confidentiality

In the e-health environment of the public, ethics play a vital role in the capacity to deliver quality and simple information according to people's skills and abilities through instruments such as surveys. Therefore, collecting human health information required applying ethical considerations and principles. This project received approval from the Laurentian University Research Ethics Board (See Appendix B). According to this approval, several considerations were applied to ensure that the study was conducted in an ethical manner. The first one is related to the participation of people in this study; each one was informed that his/her participation was voluntary and vital to the success of the study. As well, there was no direct benefit to their participation other than increasing their awareness in preparation for a desired future situation.

Another ethical consideration was related to the side effects of studying human issues. However, as shown in the consent form (see Appendix C), there were no psychological, emotional or health-related side effects associated with the survey. In addition, they had complete freedom to withdraw from this study at any time without penalty if there was a feeling of discomfort or stress. The consent form indicates that if they decide to fill out the survey, they will be asked to answer questions related to e-health innovative technology and to rate their relative response to potential factors related to their interactions, perceptions and attitude toward this technology. Lastly, participants were informed that their confidentiality was strictly protected and the input data was anonymous. Participants were also provided with information about the aggregate results of this survey. In addition, they were informed about the destination of the hard-copy data that was obtained; it will be stored in a secure password protected cabinet at Laurentian University.

Chapter 4 Presentation of Analysis and Results

4.1 Background

In this chapter, data results have been organized in a way that answers the main research questions and achieves the study objectives through quantifying some data as indicators for decision makers. Interpretation and discussion of these results will be explored in Chapter 5. Mainly, two types of analysis have been recorded within two sections. The first section is a comparative analysis of the physician-patient electronic relationship within the Northern healthcare domain. The results of this comparison have been tabulated as percentages for each question and represented using bar charts for age and sex categories. Data for Northern physicians were taken from the 2014 National Physician Survey (NPS). Data for Northern patients were collected from the first part of the study survey. Some questions are very similar between physicians and patients, therefore, at the end of this section, Z tests for two population proportions has been measured to see if there is a significant difference between physician and patient responses. The second section has been tabulated to answer some research questions, to address research objectives through exploring effected human factors, to understand the perceptions of the Northern people toward the physician-patient electronic relationship, and to increase their awareness at the same time. Several statistical tools have been used in this section, starting from a tabulation of Northern peoples' demographic data, a correlation analysis, ANOVA (one-way and univariate analysis) and a regression analysis.

4.2 A Comparative Analysis of Physicians' and Patients' Perceptions of E-health

The comparison will focus on sequential approaches from the general to the specific. The purpose of this approach is to know the physicians and patients' ability in some technologies and to understand their ability in the adaptation process for EMR-based-PHR innovative technology.

For example, the first part has been used to give the reader an overview about physician and patient knowledge in website navigation, social networking, and mobile applications and so on. After that, the questions became more specialized by focusing on their electronic relationship domain. The charts and tables below will provide an overview for the next chapter.

4.2.1 Descriptive Analysis

Table 4.1 shows the geographical information of Northern physicians by age and sex categories. The data contains physicians' responses in reference to their practice in website navigation. The Northern physicians' population numbered 2197 and the sample size was 323 for this question, where 19.8% of Northern physicians had practice in website navigation.

Table 4.1 *Northern physicians' website practice by sex and age categories*

		Sex		Age group						
		Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Yes		17.9%	23.8%	22.3%	19.8%	21.2%	20.7%	15.4%	**	19.8%
No		81.6%	75.4%	75.0%	80.2%	77.2%	79.3%	84.6%	**	79.6%
NR		.6%	.7%	2.6%	0.0%	1.5%	0.0%	0.0%	**	.6%
Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	**	100.0%
	N	1482	715	199	608	557	515	293	25	2197
	n	194	129	40	87	74	76	43	3	323

* NR = No response

Figure 4.1 and Figure 4.2 show the Northern physicians' website practice percentages by sex and age categories, respectively, 17.9% of the males practiced website and 23.8% of the females did. In terms of the age of Northern physicians': 22.3% of the survey participants practice website were under age 35 and 15.4% were above age 65.

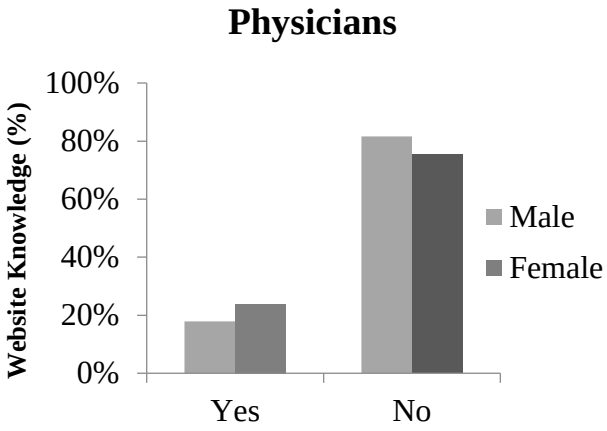

Figure 4.1 Northern physicians' website practice for males and females

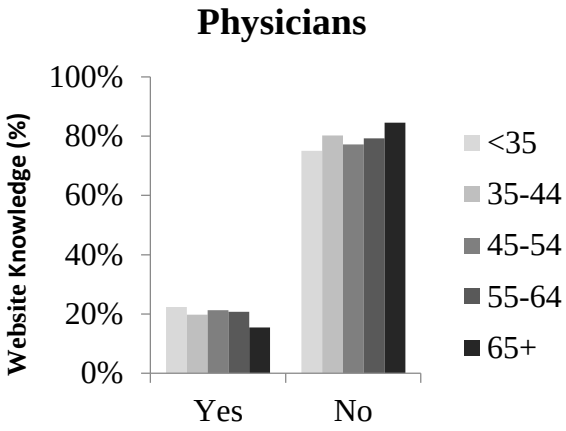

Figure 4.2 Northern physicians' website practice by age categories

Table 4.2 covers the geographical information of Northern people by age and sex categories. The data contains patients' responses on their usage of website navigation. The Northern people sample size was 325 for this question, where 91.7% of Northern patients have a good usage of website navigation.

Table 4.2 *Northern patients' website usage by sex and age categories*

		Sex		Age group						
		Male	Female	<35	35-44	45-54	55-64	65+	NR	Patients
Yes		89.1%	93.4%	96.4%	89.4%	87.5%	85.3%	50.0%	**	91.7%
No		6.3%	4.6%	2.1%	6.4%	7.5%	8.8%	40.0%	**	5.2%
NR		4.7%	2.0%	1.5%	4.3%	5.0%	5.9%	10.0%	**	3.1%
Total	%	100.1%	100.0%	100.0%	100.1%	100.0%	100.0%	100.0%	**	100.0%
	n	128	197	194	47	40	34	10		325

Figure 4.3 and Figure 4.4 show the Northern patients' website usage percentages by sex and age categories, respectively. Among those who have a good usage in website navigation: 89.1% of the males and 93.4% of the females did. In terms of the age of Northern patients' website usage, 96.4% of those under age 35 and 50% of those above age 65 were functional.

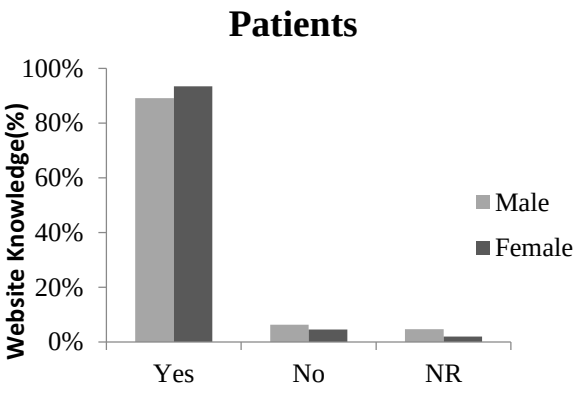

Figure 4.3 Northern patients' website usage for males and females

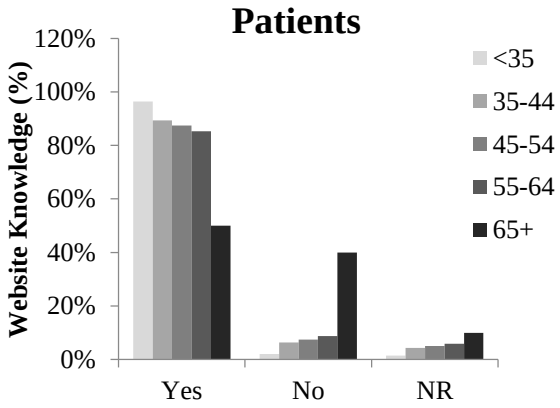

Figure 4.4 Northern patients' website usage by age categories

Table 4.3 contains percentages on Northern physicians' usage of social networks (e.g. Facebook and LinkedIn) by sex and age categories. The data shows physicians' responses on their usage of social networks, which varied between professional uses to absence of use. Northern physicians' population numbered 2197 and the sample size was 323 for this question, 7.5% of Northern physicians were professional users for social networks, 38.7% of Northern physicians used social networks for personal purposes, and more than half of them (56.9%) did not use social networks.

Table 4.3 *Northern physicians' social networks usage by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Professional use	7.7%	7.0%	9.7%	4.7%	11.6%	8.0%	3.8%	**	7.5%
Personal use	32.1%	52.4%	76.7%	42.1%	36.9%	31.1%	23.2%	**	38.7%
Don't use it	63.3%	43.8%	23.3%	56.0%	53.4%	65.1%	73.0%	**	56.9%
NR	.6%	1.5%	0.0%	0.0%	2.6%	1.0%	0.0%	**	.9%
N	1482	715	199	608	557	515	293	25	2197
n	194	129	40	87	74	76	43	3	323

Figure 4.5 and Figure 4.6 show the Northern physicians' social network use percentages by sex and age categories: 7.7% of males and 7.0% of females use social networks for professional purposes, as well as, 32.1% of males and 52.4% of females use social networks for personal purposes. For physicians aged 35 and under, 9.7% used social networks for professional purposes and 76.7% use them for personal purposes. Among those aged 65 and above, 3.8% used social networks for professional purposes and 23.2% used it for personal purposes.

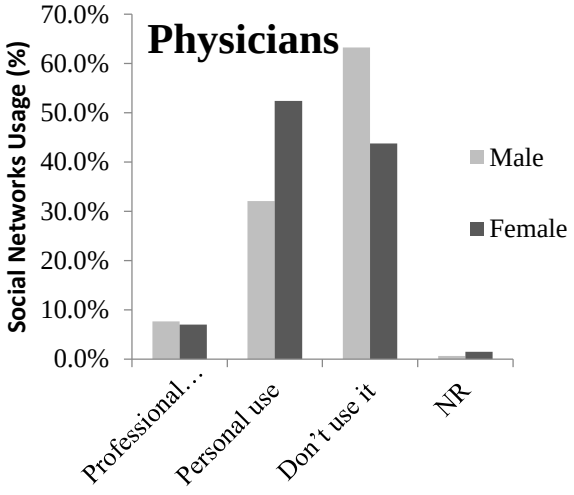

Figure 4.5 Northern physicians' social networks usage for males and females

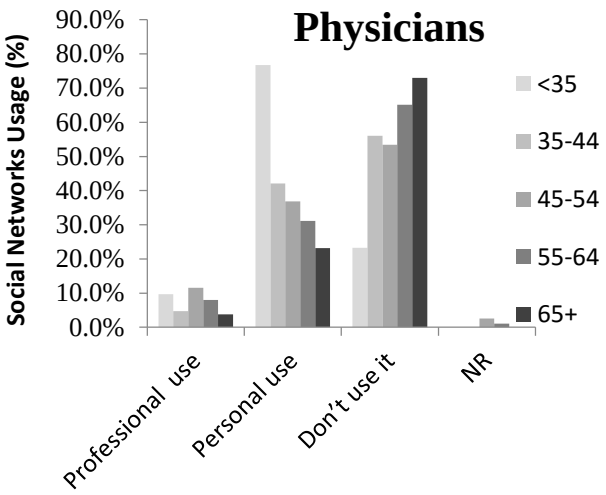

Figure 4.6 Northern physicians' social networks usage by age categories

Table 4.4 contains percentages for Northern patients' usage of social networks (e.g. Facebook and LinkedIn) by sex and age categories. The data show patients' responses on their usage of social network which varied between daily use to absence of use: 67.1% of Northern patients use social networks daily, 13.8% use weekly, 3.75% use monthly and 12.3 % never use them.

Table 4.4 *Northern patients' social networks usage by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Patients
Daily	58.6%	72.6%	71.6%	12.8%	8.7%	5.5%	1.4%	**	67.1%
Weekly	19.5%	10.2%	44.4%	20.0%	26.7%	8.9%	0.0%	**	13.8%
Monthly	3.9%	3.6%	50.0%	16.7%	25.0%	8.3%	0.0%	**	3.7%
Yearly	1.6%	0.5%	33.3%	0.0%	0.0%	66.7%	0.0%	**	0.9%
Never	14.8%	10.7%	22.5%	17.5%	12.5%	30.0%	17.5%	**	12.3%
NR	1.6%	2.5%	28.6%	14.3%	14.3%	42.9%	0.0%	7	2.2%
n	128	197	194	47	40	34	10		325

Figure 4.7 and Figure 4.8 show Northern patients' social networks percentages by sex and age categories respectively. The majority of participants indicated daily usage; 58.6% of males and 72.6% of females. In terms of the age of Northern patients who used social networks daily, 71.6% of the survey participants were under age 35 and 1.4% were above age 65.

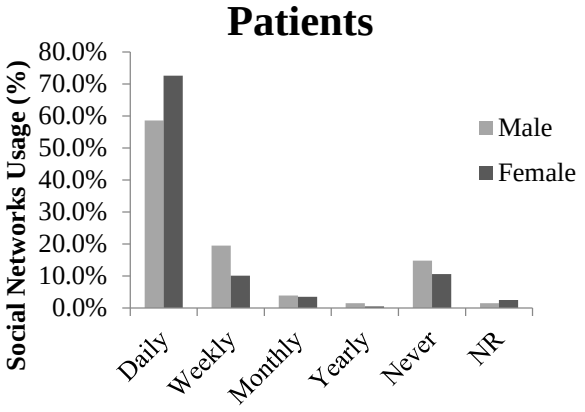

Figure 4.7 Northern patients' social network usage for males and females

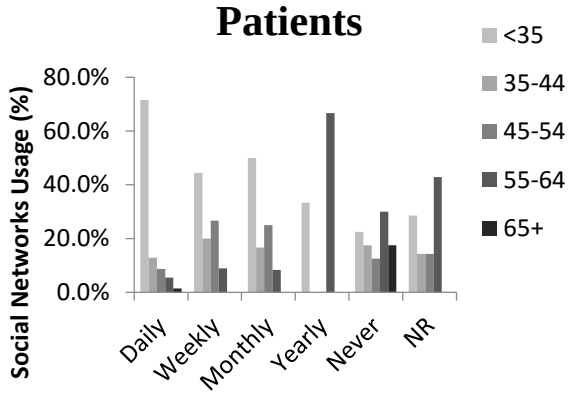

Figure 4.8 Northern patients' social network usage by age categories

Table 4.5 contains Northern physicians' usage of tele health or telemedicine technologies by sex and age categories: 50.9% of Northern physicians had used telehealth or telemedicine technologies in their practice.

Table 4.5 *Northern physicians' usage tele-health technologies by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Yes	51.0%	50.7%	40.2%	50.5%	56.3%	52.7%	46.8%	**	50.9%
No	44.8%	41.4%	45.4%	45.0%	37.9%	43.3%	49.4%	**	43.7%
Not sure	3.6%	7.9%	14.3%	4.4%	4.3%	3.9%	3.8%	**	5.0%
NR	.6%	0.0%	0.0%	0.0%	1.5%	0.0%	0.0%	**	.4%
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	**	100.0%
N	1482	715	199	608	557	515	293	25	2197
n	194	129	40	87	74	76	43	3	323

Figure 4.9 and Figure 4.10 show Northern physicians' usage percentages for tele-health or telemedicine technologies by sex and age categories, respectively, 51.0% of males and 50.7% of females use this technology for professional purposes. In terms of the age of Northern physicians' usage of tele-health or telemedicine technologies: 40.2% of the survey participants were under the age of 35, 50.5% were between 35 and 44. There is 6.6% difference in reported usage of tele-health or telemedicine between those aged <35 (40.2%) and those in the 65+ (46.8%) age groups.

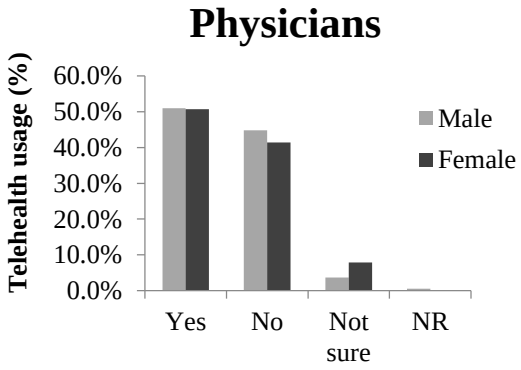

Figure 4.9 Northern physicians' Tele-health usage for males and females

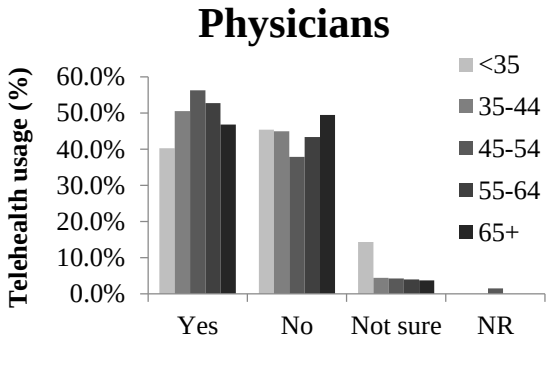

Figure 4.10 Northern physicians' Tele-health usage by age categories

Table 4.6 contains Northern patients' usage of tele-health or telemedicine technologies by sex and age categories: 20.9% of Northern patients had used tele-health or telemedicine technologies in their life.

Table 4.6 *Northern patients' usage to tele-health technologies by sex and age categories*

	Sex		Age group					
	Male	Female	<35	35-44	45-54	55-64	65+	Patients
Yes	19.5%	21.8%	23.2%	25.5%	17.5%	5.9%	20.0%	20.9%
No	71.9%	66.0%	63.4%	68.1%	72.5%	88.2%	80.0%	68.3%
Not Sure	8.6%	11.2%	12.9%	6.4%	7.5%	5.9%	0.0%	10.2%
NR	0.0%	1.0%	0.5%	0.0%	2.5%	0.0%	0.0%	0.6%
Total%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
n	128	197	194	47	40	34	10	325

Figure 4.11 and Figure 4.12 show the percentages of Northern patients' usage of tele-health or telemedicine technologies by sex and age categories. Among those: 19.5% of males and 21.8% of females use this technology. In terms of the age of Northern patients' usage of tele-health or telemedicine technologies: 23.2% of the survey participants were under age 35, 50.5% were between 35 and 44. However, there are considerable differences for the remaining age categories.

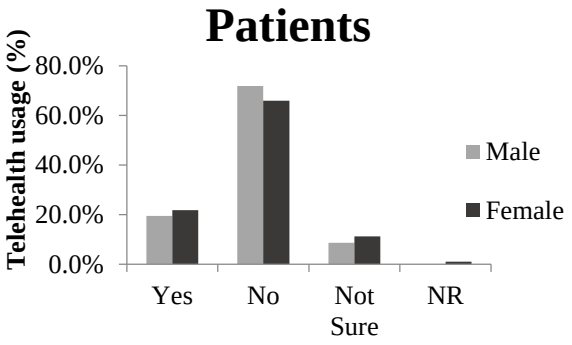

Figure 4.11 Northern patients' Tele-health usage for both males and females

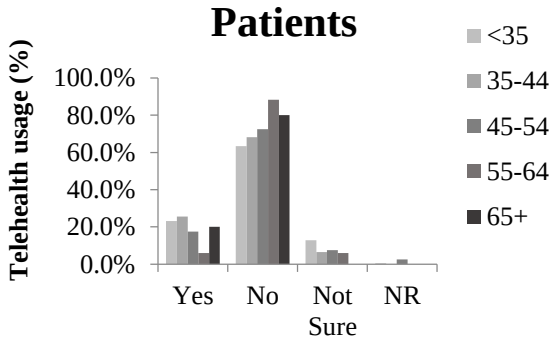

Figure 4.12 Northern patients' Tele-health usage by age categories

Table 4.7 contains Northern physicians' actual usage percentages for capturing health information in medical records, 11.2% of Northern physicians' use paper charts only, 49.3% use a combination of paper and electronic records and 39.5% use exclusively electronic records technologies in their practice.

Table 4.7 *Northern physicians' preferences for capturing health information by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Use paper charts	11.5%	10.5%	2.5%	8.8%	9.5%	13.0%	22.5%	**	11.2%
Combination of paper and electronic	54.5%	39.0%	51.6%	46.4%	57.6%	47.1%	41.8%	**	49.3%
Exclusively electronic records	34.0%	50.5%	45.9%	44.8%	32.9%	39.9%	35.7%	**	39.5%
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	**	100.0%
N	1428	719	214	613	555	499	241	25	2147
n	186	130	43	88	74	73	35	3	316

Figure 4.13 and Figure 4.14 show Northern physicians' usage percentages for capturing health information in the medical records by sex and age categories, respectively. Among those, male physicians who use paper charts only represented 11.5%, 54.5% use a combination of paper and electronic records and 34.0% use electronic records exclusively. Female physicians who use paper charts only represented 10.5%, 39.0% use a combination of paper and electronic records and 34.0% use electronic records exclusively. In terms of the age of Northern physicians' usage percentages for capturing health information in the medical records, for those under age 35, 2.5% use paper charts, 51.6% use a combination and 45.9% use electronic records exclusively. For those aged 60 and above, these results are 35.7% for electronic medical records alone, 41.8% for a combination, and 22.5% for exclusively paper charts as shown in Table 4.7.

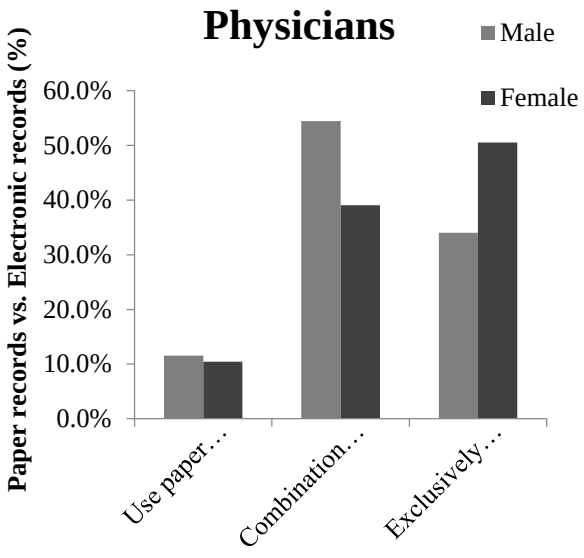

Figure 4.13 Northern physicians' paper records usage vs. electronic records usage for males and females

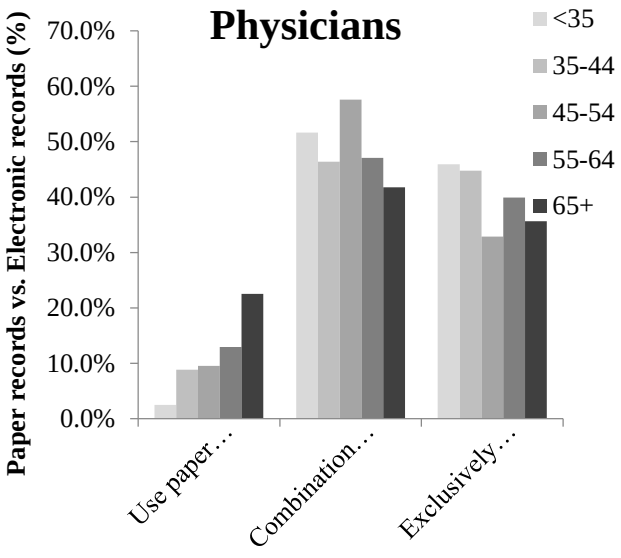

Figure 4.14 Northern physicians' paper records usage vs. electronic records usage by age Categories

Table 4.8 contains the percentages of Northern patients' preferences for capturing their health information in the medical records, 35.7% of Northern patients' prefer to use paper charts only, 41.8% prefer to use a combination of paper and electronic record and 17.2% prefer to use electronic records technologies in their practice.

Table 4.8 *Northern patients' preferences for capturing health information by sex and age categories*

	Sex		Age group					
	Male	Female	<35	35-44	45-54	55-64	65+	Patients
Use paper charts only	37.5%	34.5%	26.8%	38.3%	45.0%	58.8%	80.0%	35.7%
Combination of paper and electronic	36.7%	45.2%	53.6%	27.7%	25.0%	23.5%	10.0%	41.8%
Exclusively electronic records	21.9%	14.2%	17.0%	23.4%	20.0%	8.8%	10.0%	17.2%
NR	3.9%	6.1%	2.6%	10.6%	10.0%	8.8%	0.0%	5.2%
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
n	128	197	194	47	40	34	10	325

Figure 4.15 and Figure 4.16 show Northern patients' preferences percentages for capturing health information in the medical records by sex and age categories, respectively. Among those, male patients who prefer to use paper charts only represented 37.5%, 36.7% prefer to use a combination of paper and electronic records and 21.9% prefer to use electronic records exclusively. Female patients who prefer to use paper charts only represented 34.5%, 45.2% prefer to use a combination of paper and electronic records and 14.2% prefer to use electronic records exclusively. In terms of the age of Northern patients' preferences for capturing their health information in the medical records, as shown in Table 4.8, among those who were under age 35, 26.8% prefer to use paper charts only, 53.6% prefer to use a combination of paper charts and electronic records and 17.0% prefer to use electronic records exclusively. For those aged 60 and above, these results are 10.0% for electronic medical records alone, 10.0% for a combination, and 80% for exclusively paper charts as shown in Table 4.8.

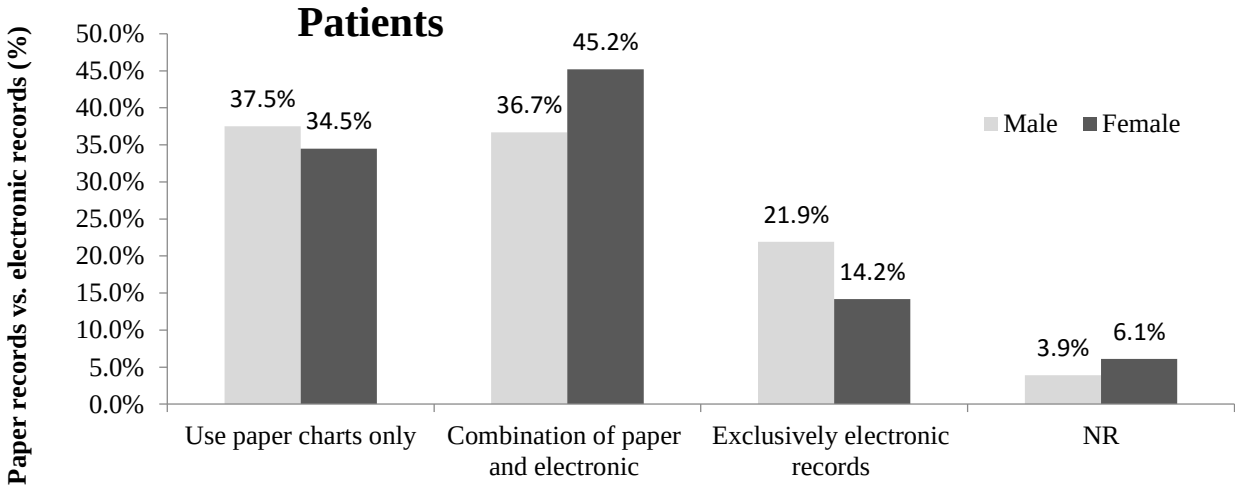

Figure 4.15 Northern patients' paper records usage vs. electronic records usage for males and females

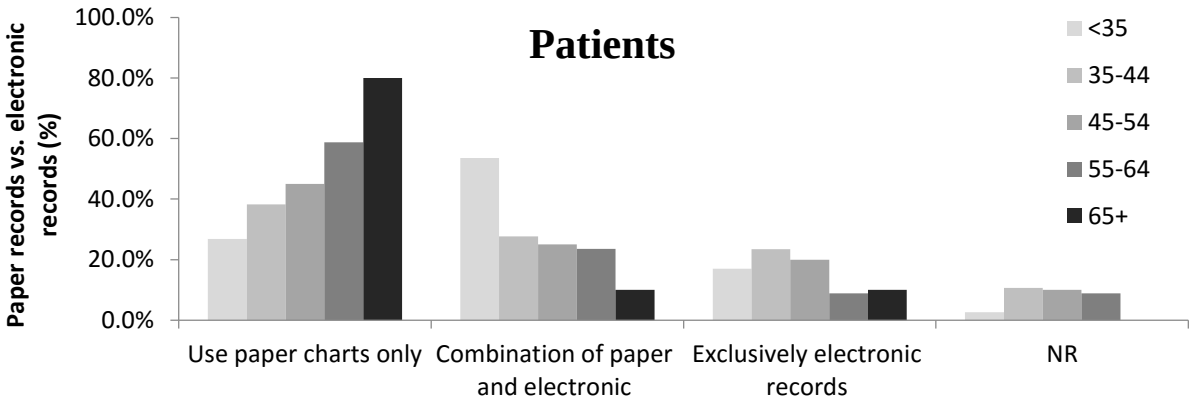

Figure 4.16 Northern patients' paper records usage vs. electronic records usage by age categories

Table 4.9 and Figure 4.17 contain percentages on reasons stated by Northern physicians' for not using electronic records to capture patient health information in the medical records, 16.2% of Northern physicians' cannot find a suitable software for their practice, 35.9% mentioned that electronic records consume their time and 42.2% mentioned that electronic records technology is not available in their work.

Table 4.9 *Northern physicians' reasons for not using electronic records*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Not available	**	**	**	**	**	**	**	**	42.2%
Too time consuming	**	**	**	**	**	**	**	**	35.9%
Planning to retire soon	**	**	**	**	**	**	**	**	29.2%
Too costly	**	**	**	**	**	**	**	**	28.5%
Lack of training	**	**	**	**	**	**	**	**	20.2%
Reliability concerns	**	**	**	**	**	**	**	**	17.1%
No suitable product for my practice	**	**	**	**	**	**	**	**	16.2%
Privacy concerns	**	**	**	**	**	**	**	**	13.1%
Other reason	**	**	**	**	**	**	**	**	7.8%
NR	**	**	**	**	**	**	**	**	0.0%
N	165	75	5	54	53	65	54	8	240
n	21	14	1	7	7	10	9	1	35

** Note: data not provided by source.

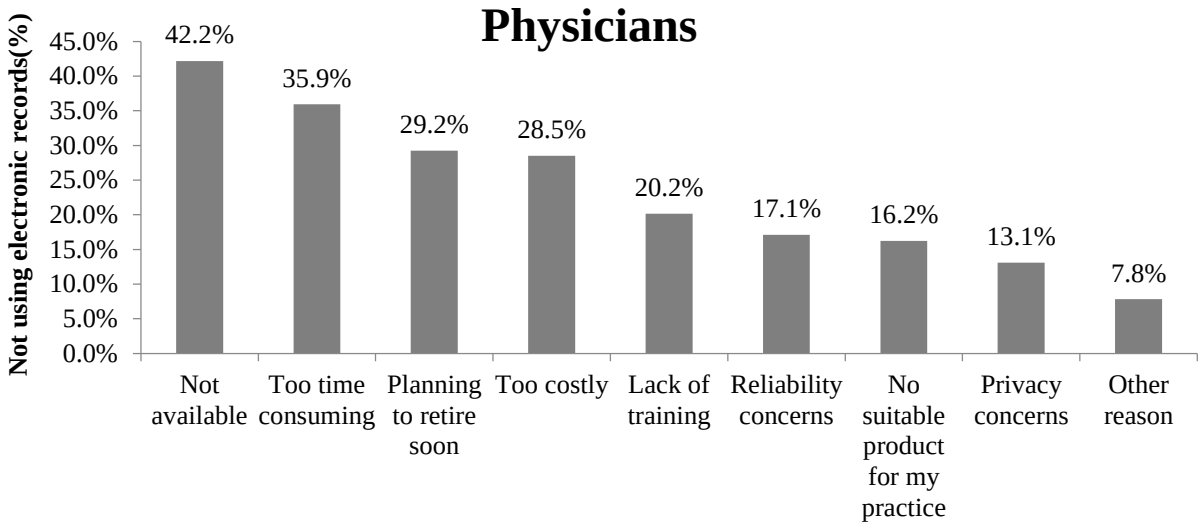

Figure 4.17 Northern physicians' reasons for not using electronic records

Table 4.10 contains percentages on reasons stated by Northern patients' for not using electronic records to capture their health information in the medical records. Northern patients' responses varied according to their age and sex. Figure 4.18 shows that 38.8% (24.5% + 14.3%) of Northern patients do not have access to electronic health records, 21.5% of Northern patients have concerns about their privacy. Among those who believe that electronic records are too costly, 80.0% were female and 20.0% were male. Nevertheless, Northern patient males and females showed similar result (50%) in their training needs to implement and understand the patient electronic records with their doctors. In terms of the age of Northern patients, among those who believe that electronic records are too costly, 40.0% were under the age of 35 and 20% were above the age of 65.

Table 4.10 *Northern patients' reasons for not using electronic records by sex and age categories*

	Sex		Age group					
	Male	Female	<35	35-44	45-54	55-64	65+	Patients
Don't have access to electronic health record	41.4%	58.6%	37.9%	10.3%	15.5%	27.6%	8.6%	24.5%
privacy concerns	35.3%	64.7%	51.0%	7.8%	23.5%	15.7%	2.0%	21.5%
not available (e.g., hospital's decision)	47.1%	52.9%	44.1%	17.6%	14.7%	14.7%	8.8%	14.3%
too time consuming	51.6%	48.4%	29.0%	25.8%	25.8%	9.7%	9.7%	13.1%
reliability concerns	34.6%	65.4%	50.0%	7.7%	19.2%	19.2%	3.8%	11.0%
lack of training	50.0%	50.0%	16.7%	25.0%	8.3%	20.8%	29.2%	10.1%
other reason	37.5%	62.5%	50.0%	12.5%	25.0%	12.5%	0.0%	3.4%
too costly	20.0%	80.0%	40.0%	0.0%	20.0%	20.0%	20.0%	2.1%
n	99	138	95	33	44	44	21	237

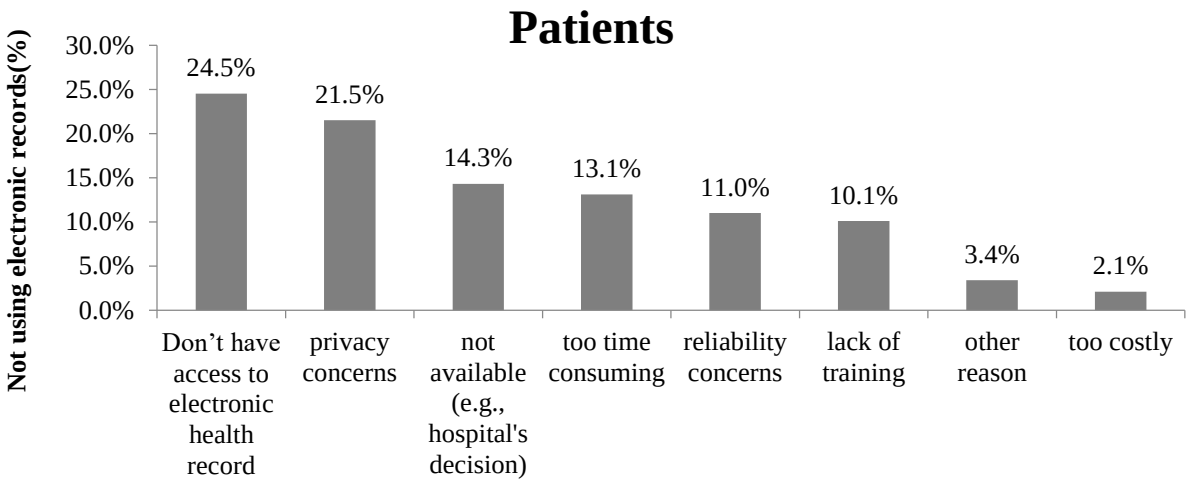

Figure 4.18 Northern patients' reasons for not using electronic records

Table 4.11 contains percentages of Northern physicians' responses for physicians reporting that they are not using electronic records in Table 4.9 and their preference for using electronic records in the future: 56.5% of Northern physicians prefer not to use electronic records in their practice in the future.

Table 4.11 *Northern physicians' electronic records usage in the future*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Yes	**	**	**	**	**	**	**	**	40.7%
No	**	**	**	**	**	**	**	**	56.5%
NR	**	**	**	**	**	**	**	**	2.7%
Total %	**	**	**	**	**	**	**	**	100.0%
N	165	75	5	54	53	65	54	8	240
n	21	14	1	7	7	10	9	1	35

Table 4.12 contains percentages of Northern patients' responses for patients reporting that they are not using electronic records in Table 4.10 and if they prefer to use them in the future: 63.8% of Northern patients' prefer to use electronic records in their healthcare services in the future. In terms of their sex, among those, 68.3% of males and 60.3% of females prefer to use electronic records in their healthcare services. In terms of the age of Northern patients, among those who prefer to use electronic records in their healthcare services, 54.4% were under age 35 and 3.3% were above age 65. Figure 4.19 shows Northern physicians' and patients' preferences to use electronic records in the future, it seem both prefer using this technology.

Table 4.12 *Northern patients' usage to electronic records in the future for sex and age categories*

	Sex		Age group					
	Male	Female	<35	35-44	45-54	55-64	65+	Patients
Yes	68.3%	60.3%	54.4%	14.4%	15.6%	12.2%	3.3%	63.8%
No	31.8%	39.8%	39.2%	9.8%	19.6%	19.6%	11.8%	36.2%
Total %	100.0%	100.0%						100.0%
n	63	78	69	18	24	21	9	141

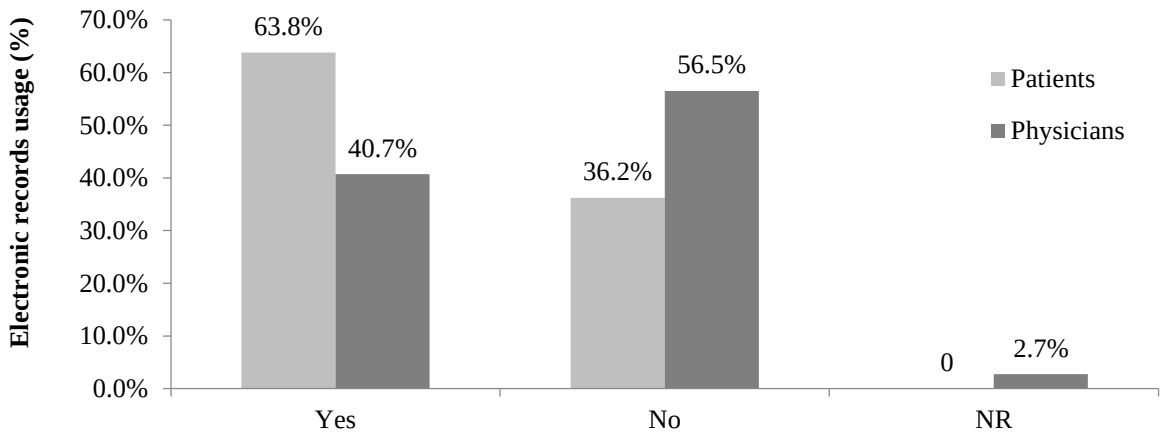

Figure 4.19 Northern physicians' and patients' electronic records usage preferences in the future

Table 4.13 contains percentages as a follow up for Table 4.12 and to explore what are the electronic functions that Northern patients prefer to use with their healthcare providers. Each function has been considered as a separate question. However, 51.2% of males and 48.8% of females prefer to use electronic records to enter and retrieve clinical notes. In terms of the age of Northern patients, among those who prefer to use electronic records to enter and retrieve clinical notes, 62.2% were under age 35 and 2.4% were above age 65. Figure 4.20 and Figure 4.21 contain percentages of Northern patients' preferences to use electronic records functions by sex and age categories.

Table 4.13 *Northern patients' preferences for electronic records functions by sex and age categories*

	Sex		Age group					
	Male	Female	<35	35-44	45-54	55-64	65+	Patients(n)
Records to enter and retrieve clinical patient notes	51.2%	48.8%	62.2%	13.4%	11.0%	11.0%	2.4%	82
Reminders for recommended patient care	41.2%	58.8%	61.9%	13.4%	12.4%	11.3%	1.0%	97
Ordering of lab tests	47.3%	52.7%	58.2%	13.2%	12.1%	13.2%	3.3%	91
Ordering of diagnostic tests	48.1%	51.9%	62.3%	13.0%	10.4%	11.7%	2.6%	77
Receipt of hospital visit and discharge information	47.4%	52.6%	64.1%	15.4%	7.7%	11.5%	1.3%	78
Clinical decision support tool	45.8%	54.2%	70.8%	6.3%	10.4%	10.4%	2.1%	48
All medications taken by a patient	46.3%	53.8%	62.5%	11.3%	8.8%	15.0%	2.5%	80
Warning for drug interactions	42.9%	57.1%	54.8%	19.0%	10.7%	13.1%	2.4%	84
Interface to pharmacy/ pharmacist	47.3%	52.7%	61.8%	10.9%	9.1%	16.4%	1.8%	55
Lab/ diagnostic test results	44.4%	55.6%	63.0%	9.9%	11.1%	13.6%	2.5%	81
Referral to other physicians	47.9%	52.1%	58.9%	16.4%	12.3%	8.2%	4.1%	73
Secure transfer of patient information	45.3%	54.7%	69.8%	15.1%	9.4%	3.8%	1.9%	53
Access to provincial/ territorial patient information systems	60.0%	40.0%	61.8%	9.1%	10.9%	16.4%	1.8%	55
Interface to non-doctor professional	48.8%	51.2%	69.8%	4.7%	9.3%	11.6%	4.7%	43

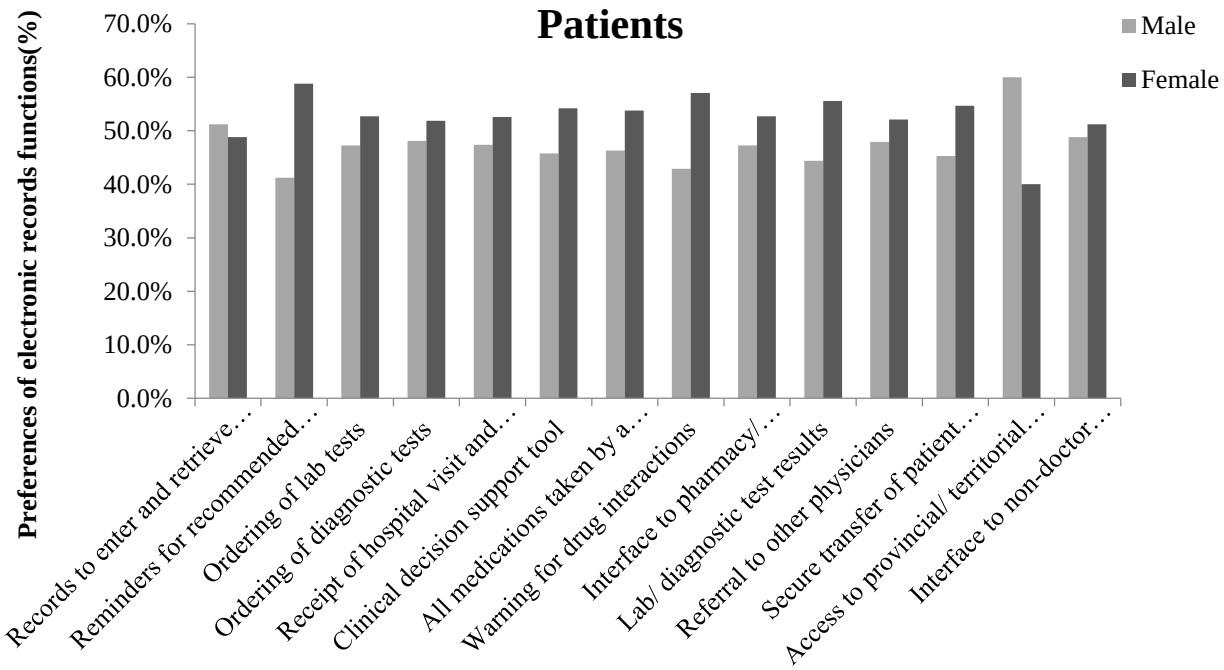

Figure 4.20 Northern patients' preferences of electronic records functions by sex categories

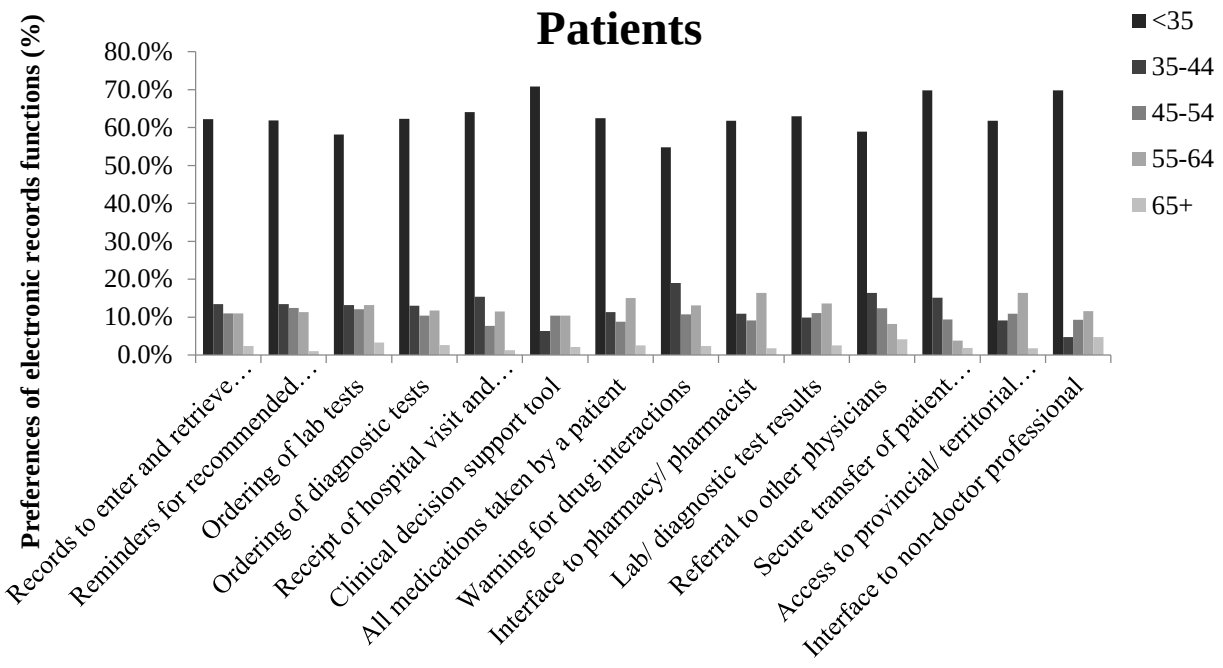

Figure 4.21 Northern patients' preferences of electronic records functions by age categories

Table 4.14 contains percentages of Northern physicians' preferences barriers in accessing electronic medical records. According to their experience, 52.2% of Northern Physicians believe that the most important barrier comes from the compatibility feature with other systems in their practice. In addition, 48.3% of Northern Physicians also mentioned that they experience technical glitches in the systems within their work. Also, 26.9% of Northern Physicians have faced barriers in firewalls and security issues. It seems that most of their barriers come from technical aspects: 52.2% for compatibility with other electronic systems, 48.3% for technical glitches/ reliability, and 26.9% for firewalls/ security issues.

Table 4.14 *Northern physicians' barriers in accessing electronic records by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Compatibility with other electronic systems	56.2%	44.4%	56.4%	44.2%	55.4%	58.7%	**	**	52.2%
Technical glitches/ reliability	46.8%	51.2%	59.7%	47.5%	49.8%	50.3%	**	**	48.3%
Firewalls/ security issues	30.3%	20.0%	26.9%	25.7%	29.7%	32.1%	**	**	26.9%
No barriers	20.3%	23.0%	15.1%	27.4%	12.7%	21.0%	**	**	21.2%
Lack of training	18.3%	14.3%	12.7%	13.4%	14.0%	26.8%	**	**	17.0%
Privacy	15.6%	14.7%	9.5%	12.5%	18.9%	14.7%	**	**	15.3%
Hardware availability	18.5%	9.0%	20.3%	14.6%	16.1%	15.7%	**	**	15.3%
Other	6.5%	7.3%	7.2%	4.2%	7.9%	6.9%	**	**	6.8%
NR	0.0%	.8%	2.5%	0.0%	0.0%	0.0%	**	**	.3%
N	1264	638	208	553	502	434	187	17	1902
n	165	115	42	80	67	63	26	2	280

Figure 4.22 and Figure 4.23 show Northern Physicians barriers in accessing electronic records by sex and age categories, 56.2% of males and 44.4% of females focus on compatibility barriers with other electronic systems. In addition, 56.4% were under age 35 and 58.7% were between 55- 64, as well as, 46.8% of males and 51.2% of females focus on the technical glitches barriers; 59.7% were under age 35 and 50.3% were between 55- 64.

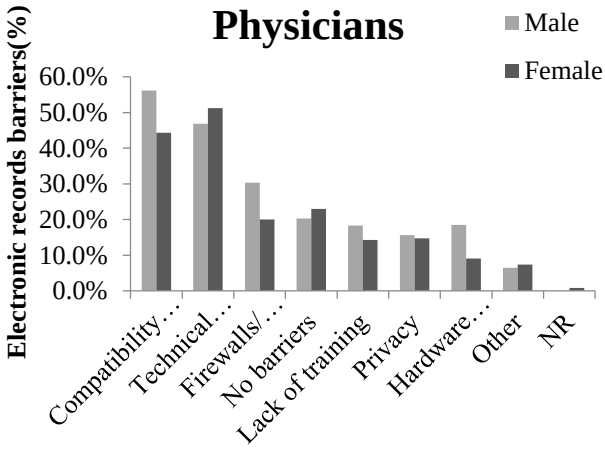

Figure 4.22 Northern physicians' barriers in accessing electronic records by sex categories

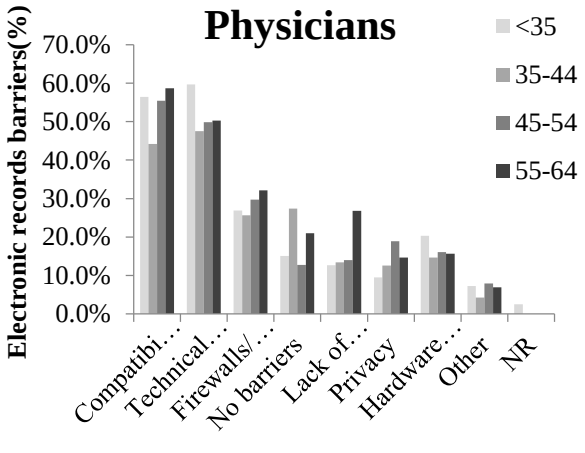

Figure 4.23 Northern physicians' barriers in accessing electronic records by age categories

Table 4.15 contains percentages of Northern patients' perceptions about their barriers in accessing electronic records: 19.4% of Northern patients believe that there is no barrier in accessing electronic records, 20.3% of Northern patients have concerns about privacy issues, and 16.0% of Northern patients expect that the lack of training will be a barrier in their e-health usage.

Table 4.15 *Northern patients' barriers in accessing electronic records by sex and age categories*

	Age		Sex group							
	Male	Female	<35	35-44	45-54	55-64	65+	Patients	n	N
Privacy	34.8%	65.2%	74.2%	9.1%	10.6%	3.0%	3.0%	20.3%	66	325
No barriers	46.0%	54.0%	73.0%	14.3%	6.4%	6.4%	0.0%	19.4%	63	325
Lack of training	42.3%	57.7%	53.9%	19.2%	13.5%	9.6%	3.9%	16.0%	52	325
Technical glitches/ reliability	29.2%	70.8%	87.5%	4.2%	6.3%	0.0%	2.1%	14.8%	48	325
Compatibility with other electronic systems	36.8%	63.2%	76.3%	7.9%	13.2%	0.0%	2.6%	11.7%	38	325
Hardware availability	31.0%	69.0%	75.9%	6.9%	3.5%	10.3%	3.5%	8.9%	29	325
Other	37.5%	62.5%	41.7%	33.3%	16.7%	8.3%	0.0%	7.4%	24	325
Firewalls/ security issues	31.6%	68.4%	52.6%	21.1%	15.8%	5.3%	5.3%	5.9%	19	325

Figure 4.24 and Figure 4.25 show Northern patients' perceptions about their barriers in accessing electronic records by sex and age categories. Among Northern patients, 46.0% of males and 54.0% of females believe that there is no barrier in accessing electronic records; 73.0% were under age 35 and 0.0% were above age 65. Among those of Northern patients, 34.8% of males and 65.2% of females have concerns about privacy issues; 74.2% were under age 35 and 3.0 % were above age 65. Among those of Northern patients', 42.3% of males and 57.7% of females expect that the lack of training will be a barrier in their e-health usage; 53.9% were under age 35 and 3.9% were above age 65.

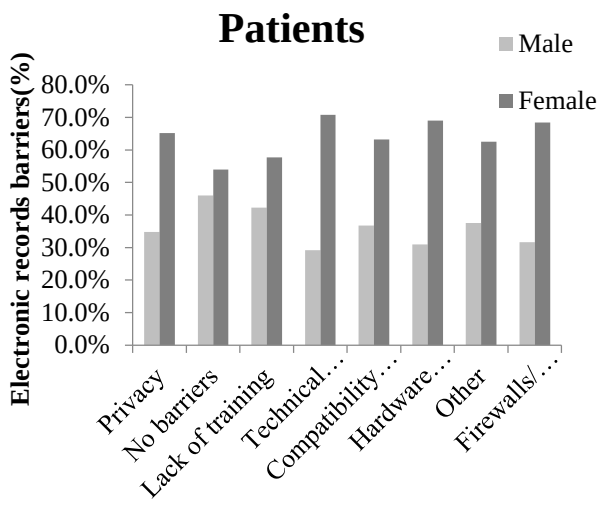

Figure 4.24 Northern patients' barriers in accessing electronic records by sex categories

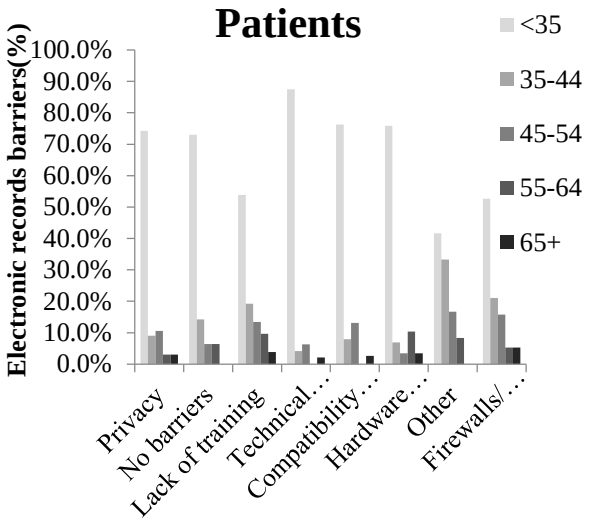

Figure 4.25 Northern patients' barriers in accessing electronic records by age categories

Table 4.16 contains percentages of Northern physicians' perceptions on their patients' abilities in managing electronic health information. A list of electronic health functions has been tabulated, 90.3% of Northern physicians' believe that their patient cannot manage their health information online.

Table 4.16 *Northern physicians' perceptions about patient ability in e-health by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
None of the above	86.3%	98.2%	**	93.9%	93.1%	85.5%	78.1%	**	90.3%
request appointments online	7.9%	.9%	**	1.4%	5.7%	12.2%	7.3%	**	5.6%
request prescription renewals online	7.0%	0.0%	**	3.3%	1.7%	4.1%	16.9%	**	4.6%
view health record online	3.3%	.9%	**	1.4%	1.2%	4.7%	5.7%	**	2.5%
add text, documentation to their record	1.6%	0.0%	**	1.4%	0.0%	0.0%	4.9%	**	1.1%
add measurements to their record	.6%	.9%	**	1.4%	1.2%	0.0%	0.0%	**	.7%
NR	.6%	0.0%	**	1.4%	0.0%	0.0%	0.0%	**	.4%
N	1095	561	134	472	439	363	223	25	1656
n	141	102	27	69	59	53	32	3	243

Figure 4.26 and Figure 4.27 show percentages of Northern physicians' perceptions on their patients' abilities in managing their electronic health information by age and sex categories, 86.3% of males and 98.2% of females believe that their patients' cannot manage their health information online; 93.9% were 35-45 and 78.1% were above 65.

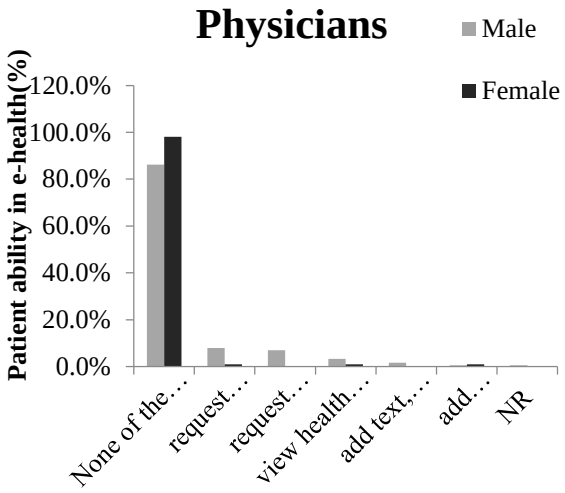

Figure 4.26 Northern physicians' perceptions about patient ability in e-health by sex categories

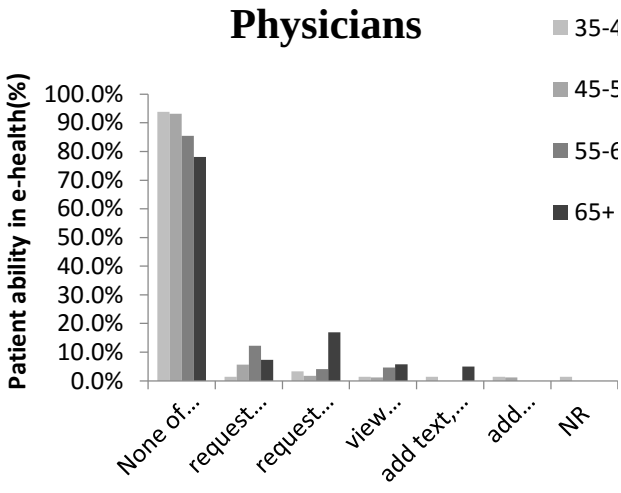

Figure 4.27 Northern physicians' perceptions about patient ability in e-health by age categories

Table 4.17 contains percentages of Northern patients' perceptions on their abilities in managing their electronic health information: 29.2% of Northern patients believe that they can request appointments online, 20.6% believe that they can request prescription renewals online. On the other hand, 45.2% of Northern patients believe that they cannot manage their health information online.

Table 4.17 *Northern patients' ability in using e-health by sex and age categories*

	Sex		Age group							
	Male	Female	<35	35-44	45-54	55-64	65+	Patients	n	N
None of the above	43.5%	56.5%	55.1%	12.9%	13.6%	13.6%	4.8%	45.2%	147	325
Request appointments online	45.3%	54.3%	60.0%	17.9%	11.6%	9.5%	1.1%	29.2%	95	325
Request prescription renewals online	41.8%	58.2%	59.7%	19.4%	14.9%	4.5%	1.5%	20.6%	67	325
View information from your health record online (e.g. lab test results)	49.1%	50.9%	65.5%	18.2%	10.9%	5.5%	0.0%	16.9%	55	325
N/A (e.g. hospital practice only)	15.8%	84.2%	78.9%	7.9%	7.9%	2.6%	2.6%	11.7%	38	325
Electronically add text and/or other documentation to their electronic record	53.3%	46.7%	63.3%	16.7%	16.7%	3.3%	0.0%	9.2%	30	325
Electronically add measurements (e.g. blood pressure readings) to your electronic record	60.7%	39.3%	64.3%	17.9%	10.7%	7.1%	0.0%	8.6%	28	325

Figure 4.28 and Figure 4.29 show Northern patients' perceptions on their abilities in managing their electronic health information by age and sex categories, 45.3% of males and 54.3% of females believe that they can request appointments online; 60.0% were under age 35 and 1.1% were above age 65. Among 147 participants, 43.5% of males and 56.5% of females believe that Northern patients cannot manage their health information online; 55.1% were under age 35 and 4.8% were above age 65.

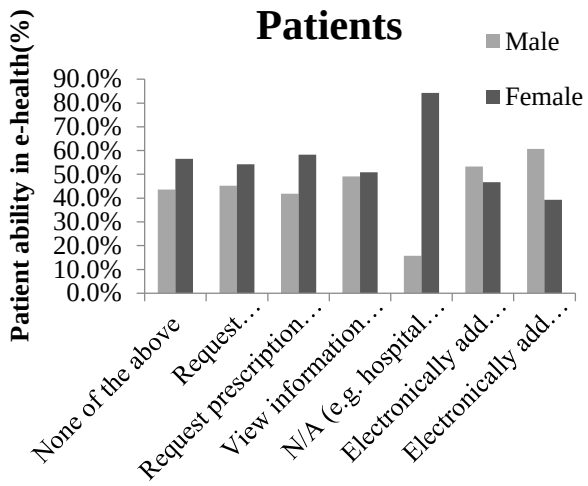

Figure 4.28 Northern patients' ability in e-health by sex categories

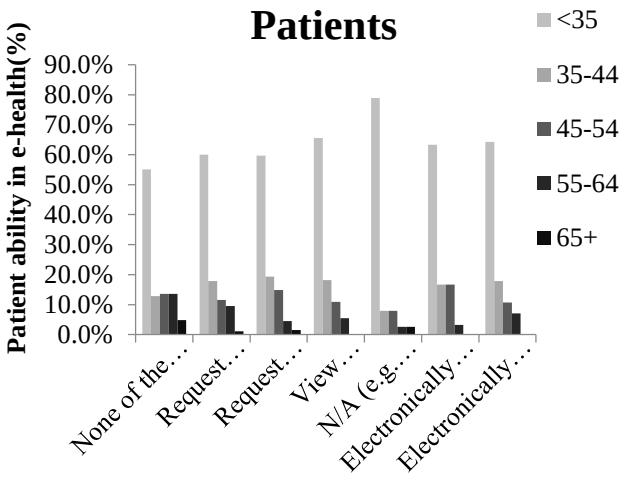

Figure 4.29 Northern patients' ability in e-health by sex categories

Table 4.18 contains percentages of Northern physicians' responses about whether they refer their patients to any websites: 67.3% of Northern physicians' responses were positive and 32.7% of Northern physicians were negative.

Table 4.18 *Northern physicians' referrals for their patients to any websites by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Yes	61.0%	79.9%	75.9%	64.4%	65.7%	68.8%	71.1%	**	67.3%
No	39.0%	20.1%	24.1%	35.6%	34.3%	31.2%	28.9%	**	32.7%
NR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**	0.0%
Total%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	**	100.0%
N	1412	702	199	608	549	491	241	25	2114
n	183	127	40	87	73	72	35	3	310

Figure 4.30 and 4.31 contains percentages of Northern physicians' responses about whether they refer their patients to any websites, by age and sex categories, 61.0% of males and 79.9% of females among those who said yes; 75.9% were under age 35 and 71.1% were above age 65.

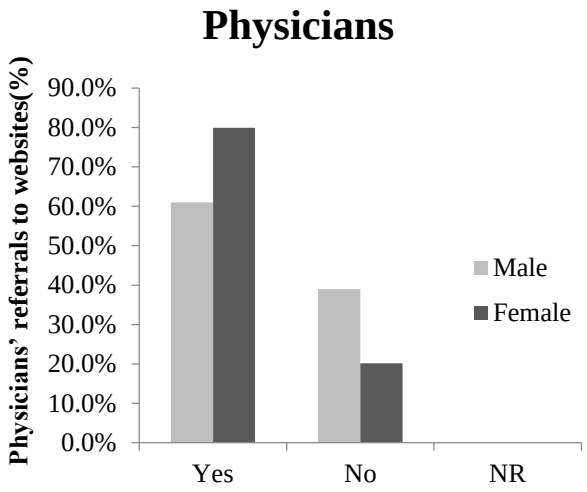

Figure 4.30 Northern physicians' referrals to websites by sex categories

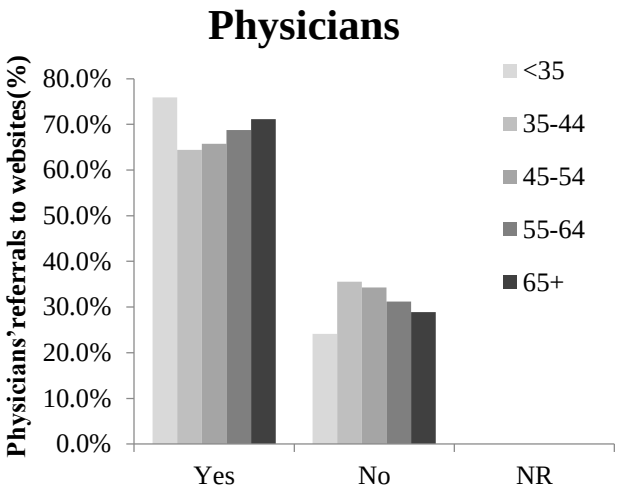

Figure 4.31 Northern physicians' referrals' to websites by sex categories

Table 4.19 contains percentages of Northern patients' responses about whether their doctors refer them to any websites, 17.2% of Northern patients responses were yes and 81.5% of them indicated that their family doctors did not refer them to any websites.

Table 4.19 *Northern patients' responses about their physicians' referrals to any websites by sex and age categories*

	Sex		Age group					
	Male	Female	<35	35-44	45-54	55-64	65+	Patients
Yes	18.7%	16.2%	18.6%	23.4%	15.0%	5.9%	10.0%	17.2%
No	80.5%	82.2%	80.4%	74.5%	85.0%	91.2%	90.0%	81.5%
NR	0.8%	1.5%	1.0%	2.1%	0.0%	2.9%	0.0%	1.2%
Total%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
n	128	197	194	47	40	34	10	325

Figure 4.32 and 4.33 show Northern patients' responses about their referrals from their doctors to any websites, by age and sex categories, 18.7% of Northern patients of males and 16.2% of females answered yes; 18.6% were under age 35 and 10.0% were above age 65.

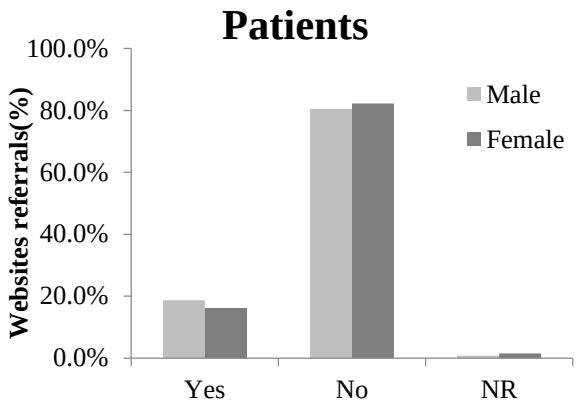

Figure 4.32 Northern patients' responses about their physicians' referrals to any websites by sex categories

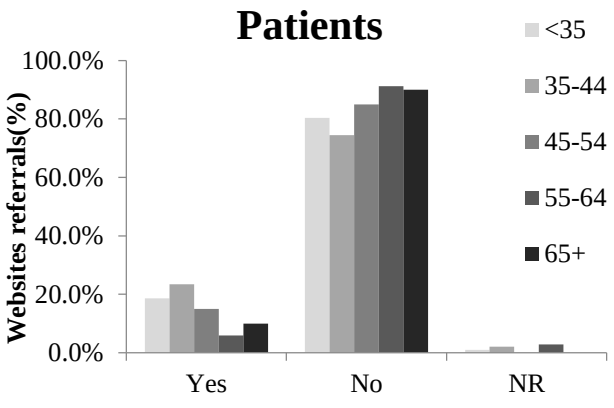

Figure 4.33 Northern patients' responses about their physicians' referrals to any websites by age categories

Table 4.20 contains percentages of Northern physicians' responses about the purpose for referring their patients to any websites. As shown in Figure 4.34, 90.6% of Northern physicians' mentioned that the main purpose was to get information about diseases, 73.3% of Northern physicians mentioned that they refer their patients to get information about their treatments, 61.7% refer patients to get information about their lifestyle/ disease and 63.9% refer patients to protect them by getting good knowledge about prevention information.

Table 4.20. *Northern physicians' purpose for websites referrals by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Disease information	90.8%	90.2%	93.8%	98.6%	84.8%	86.4%	**	**	90.6%
Treatment information	71.7%	75.8%	87.7%	72.3%	68.0%	63.3%	**	**	73.3%
Lifestyle/ disease prevention information	59.0%	71.4%	69.6%	66.4%	61.9%	67.0%	**	**	63.9%
Patient support	59.3%	65.5%	67.2%	56.6%	63.3%	72.0%	**	**	61.7%
Other	3.0%	3.2%	0.0%	3.3%	4.8%	3.9%	**	**	3.1%
NR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**	**	0.0%
N	861	561	151	391	361	338	171	8	1422
n	110	102	30	58	49	50	24	1	212

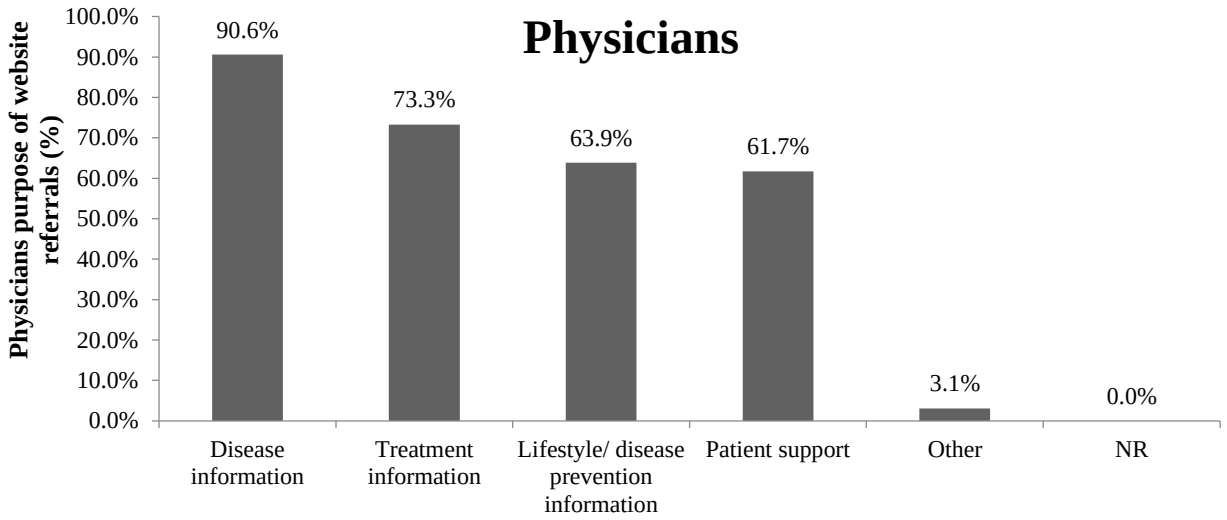

Figure 4.34 Northern physicians' purpose of website referrals

Table 4.21 displays the responses of Northern patients regarding the purpose of website referrals from their physicians. As shown in Figure 4.35, 8.3% of Northern patients mentioned that the main purpose was to get information about their diseases, 8.6% of Northern patients mentioned that doctors referee them to website to get information about their treatment, 8.3% of Northern patients said that that doctors refer them to website to get information about their lifestyle/ disease and 12.0% of Northern patients said that doctors refer them to websites to protect them by getting good knowledge about prevention information.

Table 4.21 *Northern patients' purpose for websites referrals by sex and age categories*

	Sex		Age group							
	Male	Female	<35	35-44	45-54	55-64	65+	Patients	n	N
Disease information	40.7%	59.3%	70.4%	18.5%	11.1%	0.0%	0.0%	8.3%	27	325
Treatment information	21.4%	78.6%	67.9%	21.4%	7.1%	3.6%	0.0%	8.6%	28	325
Patient support	37.0%	63.0%	48.2%	33.3%	14.8%	0.0%	3.7%	8.3%	27	325
Lifestyle/ disease prevention information	56.4%	43.6%	69.2%	15.4%	10.3%	2.6%	2.6%	12.0%	39	325
Other	31.6%	68.4%	26.3%	31.6%	21.1%	21.1%	0.0%	5.9%	19	325

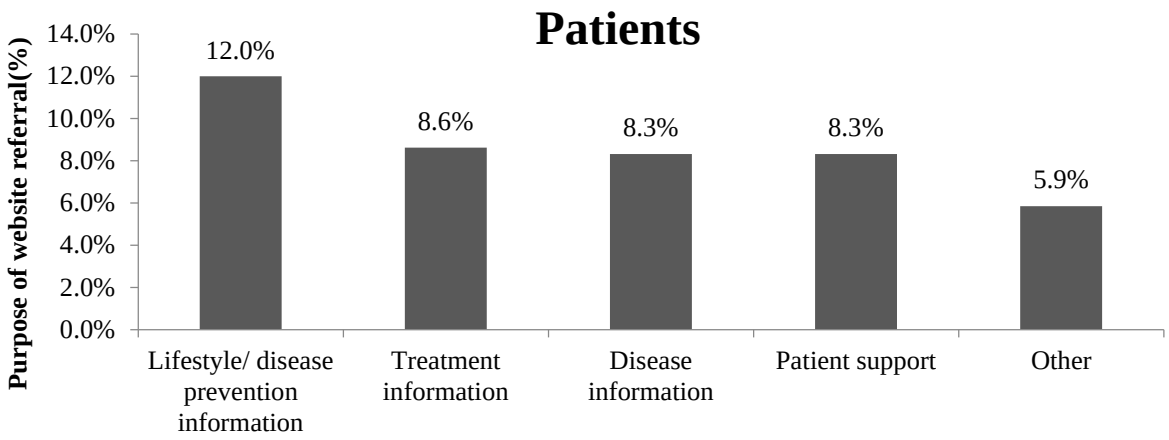

Figure 4.35 Northern patients' purpose for website referrals

Table 4.22 contains percentages of Northern physicians' responses about whether they recommend mobile applications for their patients or not, 16.5% of Northern physicians' responses were yes and 83.5% of them do not recommend mobile applications for their patients.

Table 4.22 *Northern physicians' recommendations for their patients to any mobile applications by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Yes	13.5%	22.5%	29.0%	9.8%	16.8%	11.9%	33.1%	**	16.5%
No	86.5%	77.5%	71.0%	90.2%	83.2%	88.1%	66.9%	**	83.5%
NR	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	**	0.0%
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	**	100.0%
N	1412	702	199	608	549	491	241	25	2114
n	183	127	40	87	73	72	35	3	310

Figure 4.36 and 4.37 show Northern physicians' responses about whether they recommend mobile applications for their patients or not, by age and sex categories, 13.5% of males and 22.5% of females answered yes; 29.0% were under age 35 and 33.1% were above age 65.

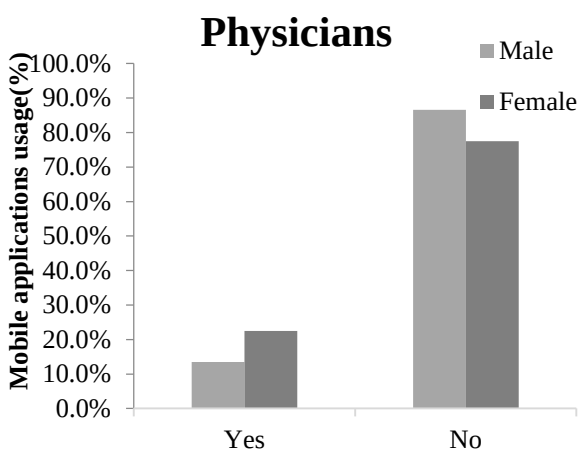

Figure 4.36 Northern physicians' recommendations of mobile applications by sex categories

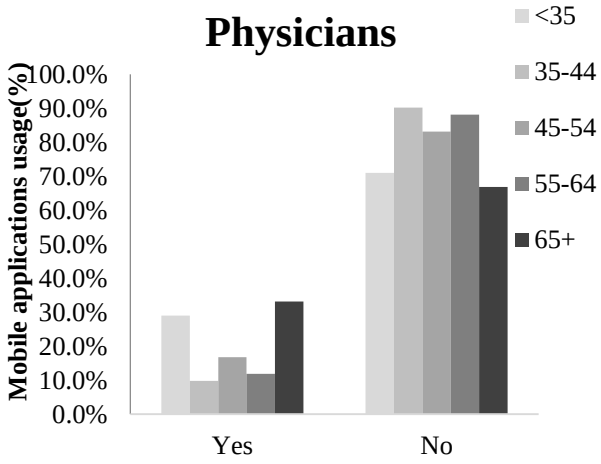

Figure 4.37 Northern physicians' recommendations of mobile applications by age categories

Table 4.23 contains percentages of Northern patients' responses about mobile application referrals from their physicians, 3.7% of the Northern patients' responses were yes and 95.1% of them do not recommend mobile applications from their physicians.

Table 4.23 *Northern patients' responses to their physicians' referrals about any mobile applications by sex and age categories*

	Sex		Age group					
	Male	Female	<35	35-44	45-54	55-64	65+	Patients
Yes	3.1%	4.1%	4.6%	0.0%	7.5%	0.0%	0.0%	3.7%
No	95.3%	94.9%	94.9%	93.6%	92.5%	100.0%	100.0%	95.1%
NR	1.6%	1.0%	0.5%	6.4%	0.0%	0.0%	0.0%	1.2%
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
n	128	197	194	47	40	34	10	325

Figure 4.36 and 4.37 show Northern patients' responses about their referrals from their doctors to any mobile applications in their life by age and sex categories, 3.1% of males and 4.1% of females answered yes; 4.6% were under age 35 and 0.0% were above age 65.

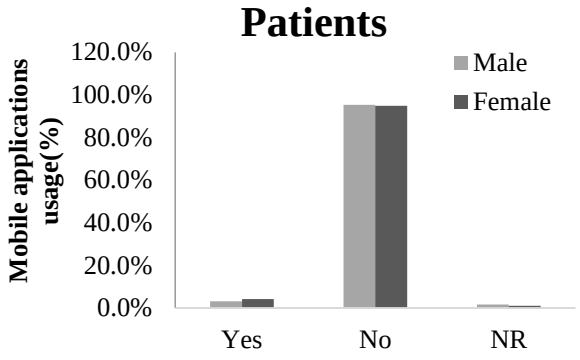

Figure 4.38 Northern patients' responses about their physicians referrals to any mobile applications by sex categories

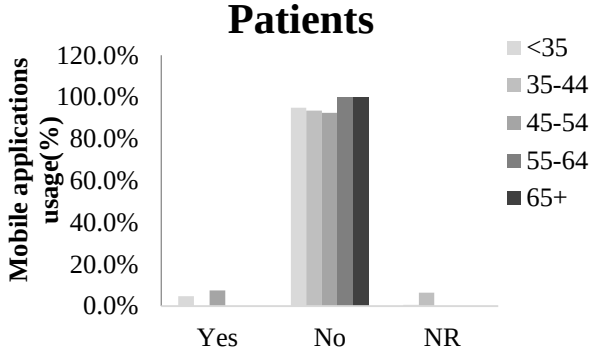

Figure 4.39 Northern patients' responses about their physicians referrals to any mobile applications by age categories

Table 4.24 contains percentages of Northern physicians' responses about the purpose of using mobile applications in their practice. As shown in Figure, 4.38, 55.7% of Northern physicians mentioned that the main purpose was to get information about health news, 66.2% of Northern physicians mentioned that they use mobile applications for self-management (guiding a health condition), 56.3% of Northern physicians said that they use mobile applications to monitor and track health issues, 23.6% of Northern physicians use mobile applications to support their patients, and 46.6% of them use it to prevent diseases.

Table 4.24 *Northern physicians' purpose for using mobile applications*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	Patients	Physicians
Health information/ news	**	**	**	**	**	**	**	**	55.7%
Self-management/ guiding a health condition	**	**	**	**	**	**	**	**	66.2%
Health monitoring/ tracking	**	**	**	**	**	**	**	**	56.3%
Patient support groups/ forums	**	**	**	**	**	**	**	**	23.6%
Healthy living/ disease prevention	**	**	**	**	**	**	**	**	46.6%
Other reasons	**	**	**	**	**	**	**	**	0.0%
NR	**	**	**	**	**	**	**	**	0.0%
Total	190	158	58	59	92	59	80	0	348
n	26	29	12	9	13	9	12	0	55

**Note: Data not provided by source

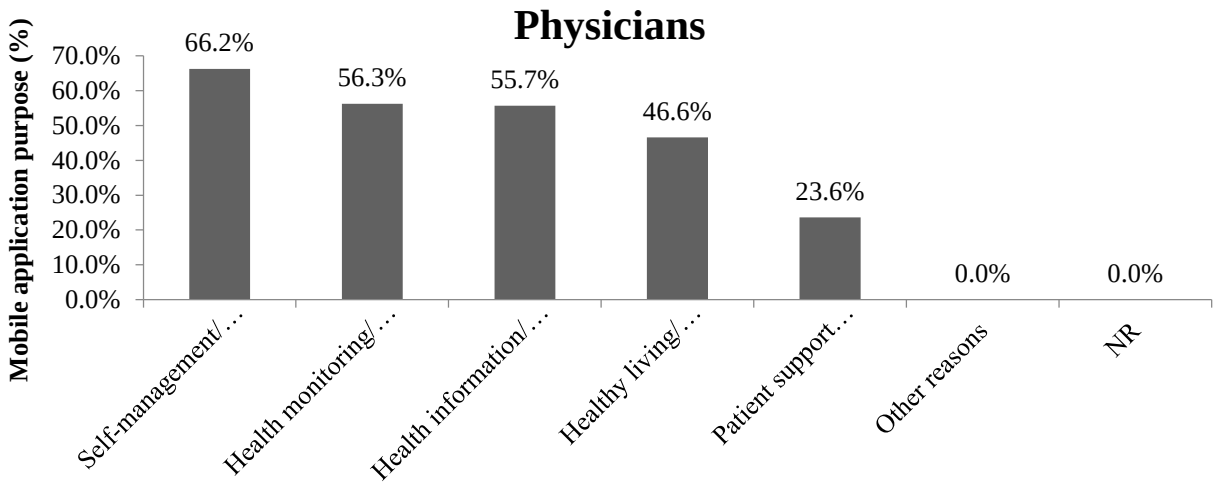

Figure 4.40 Northern physicians' purpose for using mobile applications

Table 4.25 contains percentages of Northern patients' responses about the purpose of using mobile applications in monitoring their health life. As shown in Figure 4.41, 4.3% of Northern patients mentioned that the main purpose was to get information about health news. 4.0% of Northern patients mentioned that they use mobile applications for self-management (guiding a health condition), 3.7% of Northern patients said that they use mobile applications to monitor and track health issues, 2.8% of Northern patients use mobile applications to support their needs and 2.8% of them use it to prevent diseases.

Table 4.25 *Northern patients' purpose for mobile applications usage for sex and age categories*

	Sex		Age group							
	Male	Female	<35	35-44	45-54	55-64	65+	Patients	n	N
Health information/ news	50.0%	50.0%	64.3%	14.3%	14.3%	0.0%	7.1%	4.3%	14	325
Self-management/ guiding a health condition	30.8%	69.2%	69.2%	15.4%	15.4%	0.0%	0.0%	4.0%	13	325
Health monitoring/ tracking	50.0%	50.0%	66.7%	8.3%	16.7%	0.0%	8.3%	3.7%	12	325
Patient support groups/ forums	55.6%	44.4%	55.6%	11.1%	33.3%	0.0%	0.0%	2.8%	9	325
Healthy living/ disease prevention	88.9%	11.1%	44.4%	11.1%	33.3%	0.0%	11.1%	2.8%	9	325
other reasons	44.4%	55.6%	33.3%	44.4%	22.2%	0.0%	0.0%	2.8%	9	325

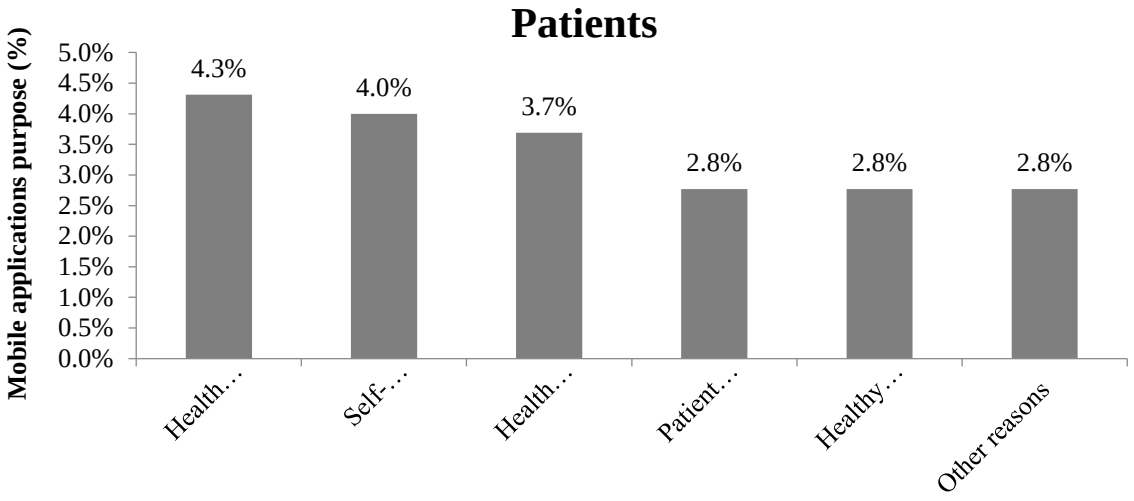

Figure 4.41 Northern patients' purpose for using mobile applications

Table 4.26 contains percentages of Northern physicians' responses about whether they use mobile applications for medical purpose: 60.7% of Northern physicians' responses were yes and 33.9% did not use it for medical purpose.

Table 4.26 *Northern physicians' usage to mobile applications for medical purpose by sex and age categories*

	Sex		Age group						
	Male	Female	<35	35-44	45-54	55-64	65+	NR	Physicians
Yes	58.1%	66.2%	95.1%	71.4%	60.4%	48.1%	37.1%	**	60.7%
No	35.8%	29.9%	4.9%	26.5%	35.5%	41.6%	52.6%	**	33.9%
Not sure	4.8%	3.0%	0.0%	1.1%	4.1%	8.7%	6.5%	**	4.2%
NR	1.3%	.9%	0.0%	1.0%	0.0%	1.6%	3.8%	**	1.2%
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	**	100.0%
N	1482	720	204	608	557	515	293	25	2201
n	194	130	41	87	74	76	43	3	324

Figure 4.42 and 4.43 show Northern physicians' responses about whether they use mobile applications for medical purposes, by age and sex categories, 58.1% of males and 66.2% of females who said yes; 95.1% were under age 35 and 37.1% were above age 65.

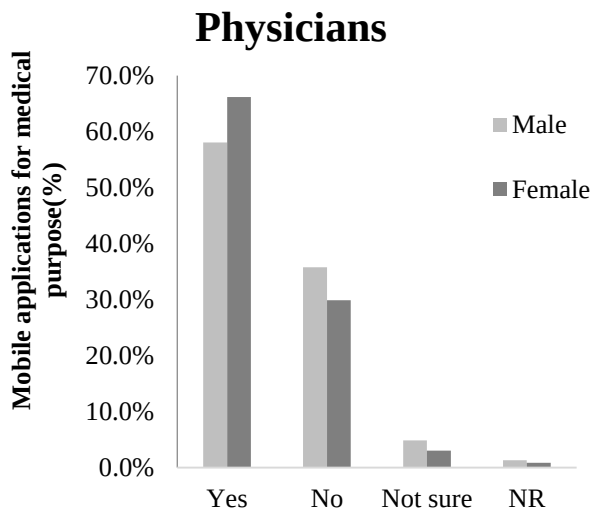

Figure 4.42 Northern physicians' usage of mobile applications for medical purpose by sex categories

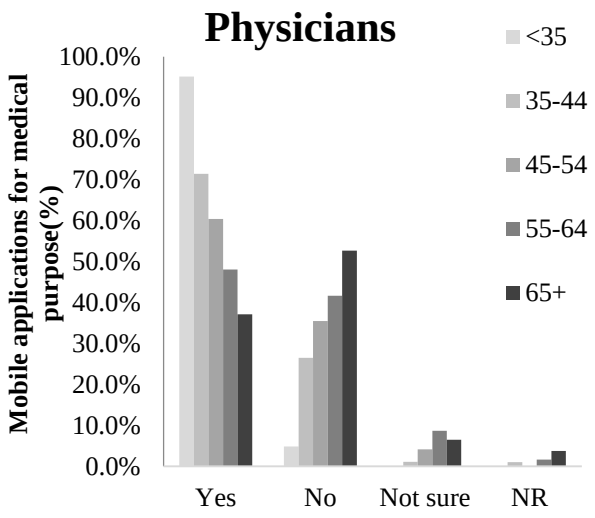

Figure 4.43 Northern physicians' usage of mobile applications for medical purpose by age categories

Table 4.27 contains percentages of Northern patients' responses about whether they use mobile applications for medical purposes: 20.3% of Northern patients' responses were yes and 71.4% of them did not use mobile applications for medical purpose. Figure 4.44 and 4.45 show Northern patients' responses about whether they use mobile applications for medical purposes by age and sex categories, 21.9% of males and 19.3% of females who answered yes; 25.3% were under age 35 and 10.0% were above age 65.

Table 4.27 *Northern patients' usage to mobile applications for medical purpose by sex and age categories*

	Sex		Age group					
	Male	Female	<35	35-44	45-54	55-64	65+	Patients
Yes	21.9%	19.3%	25.3%	19.1%	10.0%	8.8%	10.0%	20.3%
No	70.3%	72.1%	64.9%	74.5%	87.5%	82.4%	80.0%	71.4%
Not sure	7.0%	7.6%	8.8%	6.4%	2.5%	5.9%	10.0%	7.4%
NR	0.8%	1.0%	1.0%	0.0%	0.0%	2.9%	0.0%	0.9%
Total %	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
n	128	197	194	47	40	34	10	325

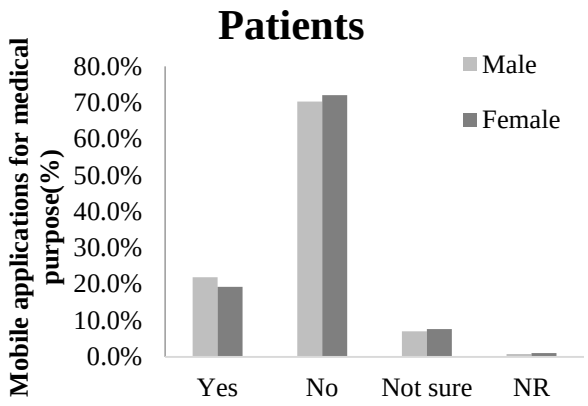

Figure 4.44 Northern patients' usage of mobile applications for medical purpose by sex categories

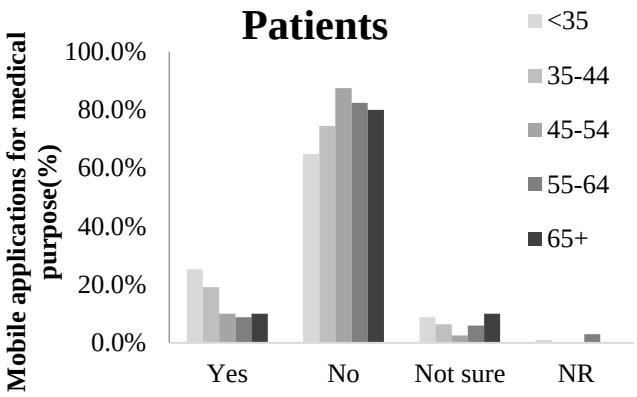

Figure 4.45 Northern patients' usage of mobile applications for medical purpose by age categories

The above tables described data on the percentages of Northern physicians' and patients' responses. Questions addressed technological skills at different levels in all physician-patient electronic relationship aspects. Therefore, the first thing that comes when the reader finishes the above descriptive data is the first research question on this dissertation:

Q1 Are there any differences in the technology skills of Northern physicians and patients in using e-health services?

To answer this question, a Z test for two population proportions will be used.

4.2.2 Z Test for two Population Proportions (Physicians vs. Patients)

The following null hypotheses have been tested to respond to the research question:

H01: There is no difference between the proportional usage of websites by physicians and patients in Northern Ontario.

H02: There is no difference between the proportional usage of tele health or telemedicine by physicians and patients in Northern Ontario.

H03: There is no difference between the proportional usage of mobile applications (App) by physicians and patients in Northern Ontario.

Table 4.28 *Z Test calculation of technology usage by physicians and patients*

Technology Usage	Users	p ^ "Yes"	N	Z-Score	p-value	Decision at p <0.05
Website usage	Physicians	0.199	321	-19.0119	0.00	Significant, reject H01
	Patients	0.946	315			
Telehealth or Telemedicine usage	Physicians	0.538	305	7.58	0.00	Significant, reject H02
	Patients	0.234	209			
Mobile applications (App) usage	Physicians	0.608	324	10.5066	0.00	Significant, reject H03
	Patients	0.203	325			

H04: There is no difference between the two populations in terms of proportions of capturing health information by exclusively using paper charts.

H05: There is no difference between the two populations in terms of proportions of capturing health information by using a combination of paper and electronic charts by physicians and patients in Northern Ontario.

H06: There is no difference between the two populations in terms of proportions of capturing health information by exclusively using electronic records.

Table 4.29 *Z Test calculation of capturing health information by physicians and patients*

Capturing health information	Users	p ^ "Yes"	N	Z-Score	p-value	Decision at p <0.05
Use paper charts only	Physicians	0.111.	316	-7.7527	0.00	Significant, reject H04
	Patients	0.377	308			
Combination of paper and electronic	Physicians	0.494.	316	1.3043	0.1936	Not significant, accept H05
	Patients	0.442	308			
Exclusively electronic records	Physicians	0.396.	316	5.8827	0.00	Significant, reject H06
	Patients	0.182	308			

H07: There is no difference between the two populations in terms of proportions in the preference to use electronic records in the future.

Table 4.30 *Z Test calculation of using electronic records in the future by physicians and patients*

	Users	p ^ "Yes"	N	Z-Score	p-value	Decision at p <0.05
Use electronic records in the future	Physicians	0.412	34	-2.4146	0.01596	Significant, reject H07
	Patients	0.638	141			

H08: There is no difference between the two populations in terms of perceptions regarding electronic healthcare self-management in physicians' responses about their patients, and in patients' responses about themselves in Northern Ontario.

Table 4.31 *Z Test calculation of healthcare self-management by physicians and patients*

Healthcare self-management	Users	p ^ "Yes"	N	Z-Score	p-value	Decision at p <0.05
Request appointments online	Physicians Patients	0.058. 0.292	243 325	-7.0275	0.00	Significant, reject H08
Request prescription renewals online	Physicians Patients	0.045 0.206	243 325	-5.5118	0.00	Significant, reject H08
View information from your health record online	Physicians Patients	0.025 0.169	243 325	-5.5047	0.00	Significant, reject H08
Electronically add measurements to your electronic record	Physicians Patients	0.008 0.086	243 325	-4.108	0.00	Significant, reject H08
Electronically add text or documents to their electronic record	Physicians Patients	0.012 0.092	243 325	-4.0306	0.00	Significant, reject H08
None of the above	Physicians Patients	0.901 0.452	243 325	11.058	0.00	Significant, reject H08
N/A (e.g. hospital practice only)	Physicians Patients	0.004 0.117	243 325	-5.2602	0.00	Significant, reject H08

H09: There is no difference between the two populations in terms of perceptions of website referrals in physicians' responses about their patients, and in patients' responses about their doctors in Northern Ontario.

Table 4.32 *Z Test calculation of website referrals by physicians and patients*

	Users	p ^ "Yes"	N	Z-Score	p-value	Decision at p <0.05
Website referrals for healthcare	Physicians Patients	0.671 0.172	310 321	12.7446	0.00	Significant, reject H09

H010: There is no difference between the two populations in terms of perceptions about the purpose of website referrals in physician's responses about their patients, and in patients' responses about their doctors in Northern Ontario.

Table 4.33. *Z Test calculation of the purpose of website referrals by physicians and patients*

Purpose of website referrals	Users	p ^ "Yes"	N	Z-Score	p-value	Decision at p <0.05
Disease Information	Physicians	0.906	212	18.9601	0.00	Significant, reject H010
	Patients	0.083	325			
Treatment Information	Physicians	0.731	212	15.414	0.00	Significant, reject H010
	Patients	0.086	325			
Patient Support	Physicians	0.618	212	13.2947	0.00	Significant, reject H010
	Patients	0.083	325			
Lifestyle/ Disease Prevention Information	Physicians	0.637	212	12.5079	0.00	Significant, reject H010
	Patients	0.12	325			
Other	Physicians	0.028	212	-1.6215	0.105	Not significant, accept H010
	Patients	0.058	325			

H011: There is no difference between the two populations in terms of proportions regarding the recommendation of mobile applications in physicians' responses about their patients, and in patients' responses about their doctors in Northern Ontario.

Table 4.34 *Z Test calculation of mobile applications recommends by physicians and patients*

	Users	p ^ "Yes"	N	Z-Score	p-value	Decision at p <0.05
Mobile applications recommends for healthcare	Physicians	0.165	310	5.3255	0.00	Significant, reject H011
	Patients	0.037	321			

H012: There is no difference between the two populations in terms of perceptions regarding the purpose of the mobile applications recommendation in physicians' responses about their patients, and in patients' responses about their doctors in Northern Ontario.

Table 4.35 *Z Test calculation of the purpose of mobile applications recommends by physicians and patients*

Purpose of recommend mobile application for healthcare	Users	p ^ "Yes"	N	Z-Score	p-value	Decision at p <0.05
Health information/ news	Physicians	0.564.	55	11.0499	0.00	Significant, reject H012
	Patients	0.043	325			
Self-management/ guiding a health condition	Physicians	0.655	55	11.6198	0.00	Significant, reject H012
	Patients	0.058	325			
Health monitoring/ tracking	Physicians	0.564	55	11.4035	0.00	Significant, reject H012
	Patients	0.037	325			
Patient support groups/ forums	Physicians	0.236	55	6.1281	0.00	Significant, reject H012
	Patients	0.028	325			
Healthy living/ disease prevention	Physicians	0.473	55	10.5552	0.00	Significant, reject H012
	Patients	0.028	325			
Other reasons	Physicians	0	55	-1.249	0.2113	Not significant, accept H012
	Patients	0.028	325			

4.3 Perceptions of EMR-based-PHR among People of Northern Ontario

4.31 Demographic Data

Table 4.36 presents the demographic information of a sample of Northern people that has been collected to explore their perception about patient-physician electronic relationships. As shown in Table 4.36, 60.6% (out of 325) of them were female and 39.4% were male. Since there are many studies focused on the e-health for senior people, this study focused on the technology generation. Therefore, we divided the age groups into three generations: < 35 Technology-Generation, 35-54 Semi Technology-Generation, and 55+ Early Technology-Generation. The following table presents all percentages for Northern people according to their demographic information.

Table 4.36 *Demographic data for a sample of Northern people*

	Demographics	Respondents Frequency	Percent
Sex	Male	128	39.4
	Female	197	60.6
	Total	325	100.0
Age	< 35 Technology-Generation	194	59.7
	35-54 Semi Technology-Generation	87	26.8
	55+ Early Technology-Generation	44	13.5
	Total	325	100.0
Ethnicity	Caucasian/White	202	62.2
	Aboriginal	18	5.5
	Black	21	6.5
	Asian	60	18.5
	Other	24	7.4
	Total	325	100.0
Degree	None-Degree	16	4.9
	Grade 12	90	27.7
	Diploma	90	27.7
	Bachelors	77	23.7
	Masters	47	14.5
	PhD	5	1.5
	Total	325	100.0

Figure 4.46 shows a hyper model of study variables using Davis' Technology Acceptance Model (TAM), Rogers' Innovation diffusion theory (IDT) and Taylor's and Todd's Decomposed Theory of Planned Behavior (DTPB). To answer the research questions, the interrelationship of questionnaire variables has been presented in this model. The model will be broken down according to the statistical tools that will be used.

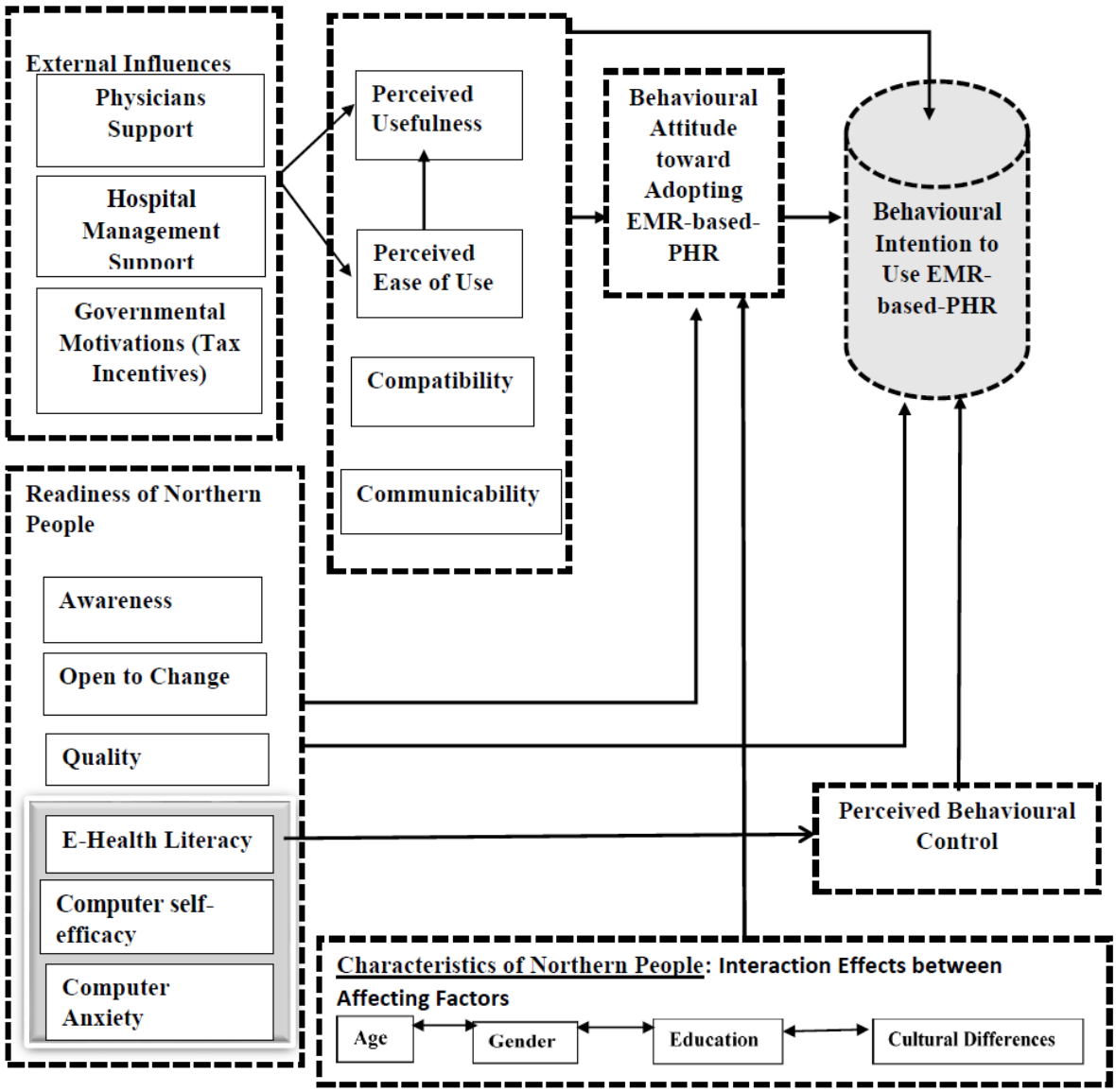

Figure 4.46 Hyper Research Model of Northern People perception toward EMR-based-PHR

4.3.2 Correlation Analysis

Table 4.37 shows the Item-Total Correlation, means, standard deviations and a correlation matrix at a .05 level of significance that has examined the strength of relations between variables in Figure 4.47. As shown in Table 4.37, most variables varied between positive moderate to positive strong correlations. The computer anxiety variable has a negative correlation with all variables.

Table 4.37 *Correlations among and descriptive statistics for all study variables*

	Variables	ITC	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-	Physicians Support	.755	3.7015	1.00623															
2-	Hospital Management Support	.734	3.7262	.99788	.748**														
3-	Governmental Motivations	.634	3.7292	1.11412	.577**	.608**													
4-	Perceived Ease of Use	.751	3.7487	.98867	.532**	.535**	.477**												
5-	Perceived Usefulness	.826	3.8062	1.00566	.644**	.603**	.523**	.820**											
6-	Compatibility	.832	3.7246	1.02455	.630**	.605**	.583**	.741**	.851**										
7-	Communicability	.752	3.4477	1.12644	.593**	.545**	.466**	.601**	.657**	.655**									
8-	E-health Literacy	.674	3.4503	.98515	.531**	.547**	.463**	.590**	.555**	.560**	.568**								
9-	Computer Self-Efficacy	.720	3.6631	.97001	.561**	.571**	.531**	.669**	.647**	.645**	.565**	.617**							
10-	Computer Anxiety	-.252	2.3272	1.01123	-.173**	-.187**	-.119*	-.283**	-.206**	-.197**	-.234**	-.259**	-.245**						
11-	Open to Change	.777	3.9815	.80911	.597**	.610**	.493**	.680**	.673**	.683**	.633**	.583**	.628**	-.259**					
12-	Awareness Toward E-health	.331	2.9600	.71006	.232**	.284**	.192**	.179**	.207**	.241**	.261**	.192**	.199**	.205**	.230**				
13-	Behavioural Attitude	.790	3.5800	1.01367	.654**	.618**	.503**	.566**	.681**	.671**	.694**	.518**	.551**	-.283**	.665**	.313**			
14-	Perceived Behavioural Control	.700	3.5462	.96754	.529**	.485**	.464**	.559**	.526**	.591**	.567**	.557**	.536**	-.169**	.613**	.318**	.644**		
15-	Behavioural Intention	.807	3.6154	.97011	.655**	.600**	.469**	.623**	.739**	.716**	.677**	.556**	.553**	-.227**	.673**	.302**	.763**	.571**	
16-	Quality of Healthcare Services	.770	3.4708	.91620	.580**	.540**	.482**	.582**	.664**	.674**	.661**	.541**	.540**	-.181**	.621**	.248**	.717**	.618**	.776**

Notes. N= 325, Statistical significance: *p < .05; **p < .01, Cronbach's Alpha=, 933, ITC= Item-Total Correlation.

4.3.3 One-Way Analysis of Variance (One-Way ANOVA)

To answer the second main research question (see below), one-way ANOVA has been used comparing demographic information group categories of Northern people and their behavioural attitude toward adopting EMR-based-PHR. The independent variable represented the four different categorical groups: 1) Age; 2) Sex; 3) Degree, 4) Ethnicity. The dependent variable was Northern people's behavioural attitude toward adopting EMR-based-PHR. See the following tables for the means, standard deviations and ANOVA for each demographic variable.

Q2: Why is Canada's level of compliance so low for innovative technology?

Q2-1 Canada is a multicultural country and has a mosaic of personality types. How will this variety affect the success of the innovative technology implementation? Or do sex, age, education and ethnicity have an effect on Northern people's attitude toward EMR-based-PHR innovative technology?

a) Age categories of people in Northern Ontario

H01: Age will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .064 > .05$).

Table 4.38 *Means and standard deviations on the measure of behavioural attitude toward adopting EMR-based-PHR by age categories*

Age	N	M	SD
<35	194	3.6443	.94529
35-54	87	3.6034	1.10269
55+	44	3.2500	1.08102
Total	325	3.5800	1.01367

Table 4.39 *One-way analysis of variance of behavioural attitude toward adopting EMR-based-PHR by age categories*

Source	SS	df	MS	F	Sig.
Between Groups	5.642	2	2.821	2.776	.064
Within Groups	327.278	322	1.016		
Total	332.920	324			

b) Sex categories of people in Northern Ontario

H02: Sex will have no significant effect on attitude toward adopting EMR-based-PHR.

The null hypothesis was supported (p = .417 > .05).

Table 4.40 *Means and standard deviations on the measure of behavioural attitude toward adopting EMR-based-PHR by sex categories*

Sex	N	Mean	SD
Male	128	3.6367	.97350
Female	197	3.5431	1.03973
Total	325	3.5800	1.01367

Table 4.41 *One-way analysis of variance of behavioural attitude toward adopting EMR-based-PHR by sex categories*

Source	SS	Df	MS	F	Sig.
Between Groups	.679	1	.679	.660	.417
Within Groups	332.241	323	1.029		
Total	332.920	324			

c) Degree educational categories of people in Northern Ontario

H03: Educational degree will have no significant effect on attitude toward adopting EMR-based-

PHR. The null hypothesis was not supported (p = .000 < .05).

Table 4.42 *Means and standard deviations on the measure of behavioural attitude toward adopting EMR-based-PHR by degree categories*

Degree	N	M	SD
None-Degree	16	3.0625	1.20934
Grade 12	90	3.3278	.98346
Diploma	90	3.5722	1.05085
Bachelors	77	3.8636	.80556
Masters	47	3.8936	1.00508
PhD	5	2.6000	1.14018
Total	325	3.5800	1.01367

Table 4.43 *One-way analysis of variance of behavioural attitude toward adopting EMR-based-PHR by sex categories*

Source	SS	df	MS	F	Sig.
Between Groups	25.635	5	5.127	5.322	.000
Within Groups	307.285	319	.963		
Total	332.920	324			

Because the result was significant at a .05 level, multiple comparisons for behavioural attitude toward adopting EMR-based-PHR by degree categories have been tested to evaluate the statistical significance of differences between means, and to show which groups differed from each other. Table 4.44 shows that there is a significant difference in the behavioural attitude toward adopting e-health between the groups that have bachelor's degrees and the no-degree groups (p =.037), as well as between the bachelor's degrees and Grade 12 (p =.007). In addition, there is a significant difference between the group that has master degrees and the no-degree groups (p =.042), as well as between the master degrees and Grade 12 (p =.019).

Table 4.44 *Multiple comparisons for behavioural attitude toward adopting e-health by degree categories*

(I) DEGREE	(J) DEGREE	MD (I-J)	SE	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Bachelors	None-Degree	.80114*	.26966	.037	.0280	1.5743
	Grade 12	.53586*	.15236	.007	.0990	.9727
	Diploma	.29141	.15236	.396	-.1454	.7282
	Masters	-.02998	.18167	1.000	-.5509	.4909
	PhD	1.26364	.45295	.062	-.0350	2.5623
Masters	None-Degree	.83112*	.28408	.042	.0166	1.6456
	Grade 12	.56584*	.17663	.019	.0594	1.0723
	Diploma	.32139	.17663	.455	-.1850	.8278
	Bachelors	.02998	.18167	1.000	-.4909	.5509
	PhD	1.29362	.46168	.060	-.0301	2.6173

*. The mean difference is significant at the 0.05 level.

d) Ethnicity categories of people in Northern Ontario

H04: Ethnicity will have no significant effect on attitude toward adopting EMR-based-PHR.

The null hypothesis was supported (P = .483 > .05).

Table 4.45 *Means and standard deviations on the measure of behavioural attitude toward adopting EMR-based-PHR by ethnicity categories*

Ethnicity	N	M	SD
Caucasian/White	202	3.5891	.98470
Aboriginal	18	3.2222	1.10110
Black	21	3.5476	1.08288
Asian	60	3.7083	1.00124
Other	24	3.4792	1.16544
Total	325	3.5800	1.01367

Table 4.46 *One-way analysis of variance of behavioural attitude toward adopting EMR-based-PHR by ethnicity categories*

Source	SS	df	MS	F	Sig.
Between Groups	3.575	4	.894	.868	.483
Within Groups	329.345	320	1.029		
Total	332.920	324			

4.3.4 Univariate ANOVA (Interaction effects)

Q2-2 Does the interaction of sex, age, education and ethnicity have an effect on determining the behavioural attitude of people in Northern Ontario toward EMR-based-PHR innovative technology?

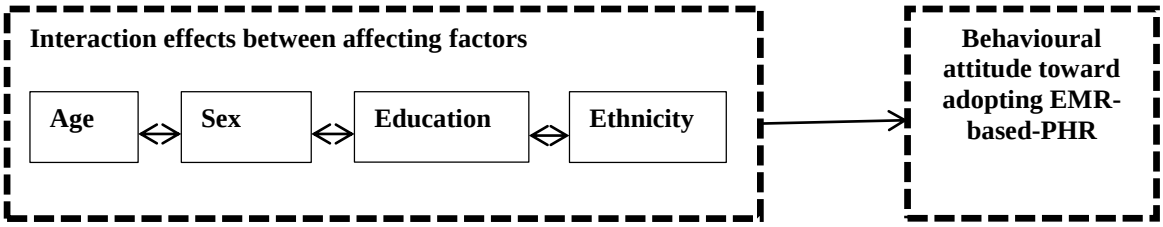

Figure 4.47 Interaction effects between characteristics of Northern people and their behavioural attitude toward adopting EMR-based-PHR

Univariate ANOVA will be used to assess the interaction effects (combined effects) of age, sex, education and ethnicity on the behavioural attitude of people in Northern Ontario toward adopting EMR-based-PHR innovative technology (see Table 4.47).

H05: The age and sex interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .509 > .05$).

H06: The age and degree interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .195 > .05$).

H07: The age and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .189 > .05$).

H08: The sex and degree interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .477 > .05$).

H09: The sex and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .165 > .05$).

H010: The degree and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .042 < .05$).

H011: The age, sex and degree interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .397 > .05$).

H012: The age, sex and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .074 > .05$).

H013: The age, degree, ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was not supported ($p = .007 < .05$).

H014: The sex, degree and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .310 > .05$).

H015: The age, sex, degree and ethnicity interaction will have no significant effect on attitude toward adopting EMR-based-PHR. The null hypothesis was supported ($p = .927 > .05$).

Table 4.47 *Univariate ANOVA: tests of between-subjects effects on the behavioural attitude of people in Northern Ontario toward adopting EMR-based-PHR by demographic data.*

Source	SS	df	MS	F	Sig.	Decision at p <0.05	Partial Eta Squared
Corrected Model	129.896[a]	85	1.528	1.799	.000		.390
Intercept	732.772	1	732.772	862.619	.000		.783
AGE	8.008	2	4.004	4.714	.010	Significant	.038
GENDER	.126	1	.126	.148	.701	Not Significant	.001
DEGREE	17.842	5	3.568	4.201	.001	Significant	.081
RACE	7.391	4	1.848	2.175	.072	Not Significant	.035
AGE * GENDER	1.151	2	.576	.678	.509	Not Significant	.006
AGE * DEGREE	10.590	9	1.177	1.385	.195	Not Significant	.050
AGE * RACE	8.573	7	1.225	1.442	.189	Not Significant	.041
GENDER * DEGREE	2.987	4	.747	.879	.477	Not Significant	.014
GENDER * RACE	5.572	4	1.393	1.640	.165	Not Significant	.027
DEGREE * RACE	23.555	16	1.472	1.733	.042	Significant	.104
AGE * GENDER * DEGREE	5.321	6	.887	1.044	.397	Not Significant	.026
AGE * GENDER * RACE	7.351	4	1.838	2.164	.074	Not Significant	.035
AGE * DEGREE * RACE	18.430	8	2.304	2.712	.007	Significant	.083
GENDER * DEGREE * RACE	5.093	5	1.019	1.199	.310	Not Significant	.024
AGE * GENDER * DEGREE * RACE	.130	2	.065	.076	.927	Not Significant	.001
Error	203.024	239	.849				
Total	4498.250	325					
Corrected Total	332.920	324					

a. R Squared = .390 (Adjusted R Squared = .173)

For the estimated marginal means of the non-significant factors, see Appendix A.

4.3.5 Regression Analysis

As a component of Figure 4.47, Figure 4.49 has been taken from Davis's ATM and Rogers' IDT. Regression analysis has been used to answer the third research questions with its branches.

Q3: what human barriers impede the adoption of EMR-based-PHR innovative technology in Northern Ontario?

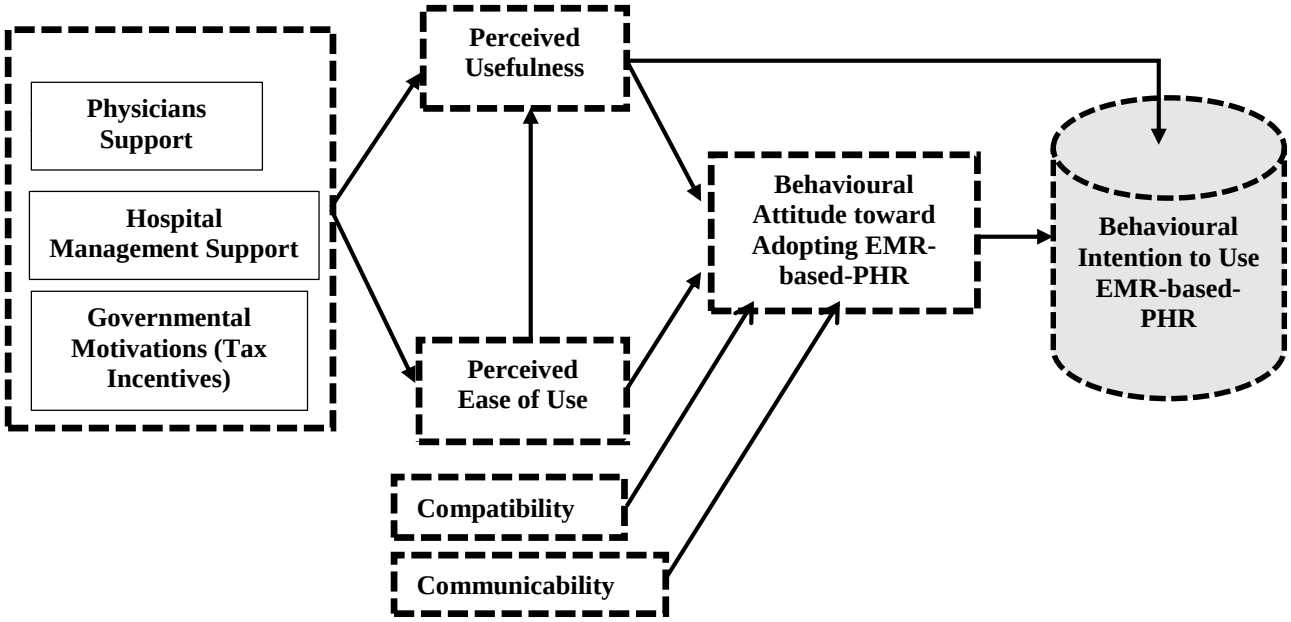

Figure 4.48 Characteristics of EMR-based-PHR innovative technology

Q3-1 Is the perceived usefulness variable of EMR-based-PHR predicted by the perceived ease of use variable toward adopting EMR-based-PHR?

H016: There is no significant prediction between the perceived ease of use variable and the perceived usefulness of EMR-based-PHR.

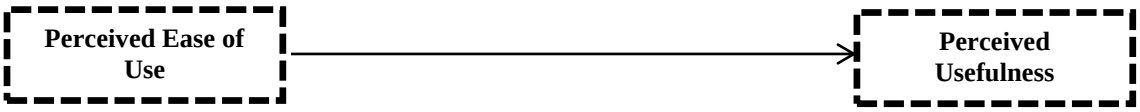

Figure 4.49 The influence of perceived ease of use on perceived usefulness

Table 4.48 shows that the model is statistically significant F (1, 323) = 661.455, p < .001, explaining 67.2 % of variance in the Perceived Usefulness of EMR-based-PHR and reject the null hypothesis (β = .820, p = .000 < .001).

Table 4.48 *Simple regression analysis of the influence of perceived ease of use on perceived usefulness variable*

	Variables	R	R2	B	SE	β	t	Sig.
Model1	(Constant)	.820[a]	.672	.681	.126		5.415	.000
	Perceived Ease of Use			.834	.032	.820	25.719	.000

Multiple Regression Analysis

Q3-2 Is the perceived usefulness variable of EMR-based-PHR predicted by the external factors for adopting EMR-based-PHR (Governmental Incentives, Physicians Support and Hospital Management Support)?

H017: There is no significant prediction between the external Influences (a. Physicians Support, b. Hospital Management Support and c. Governmental Motivations) and Perceived usefulness of EMR-based-PHR.

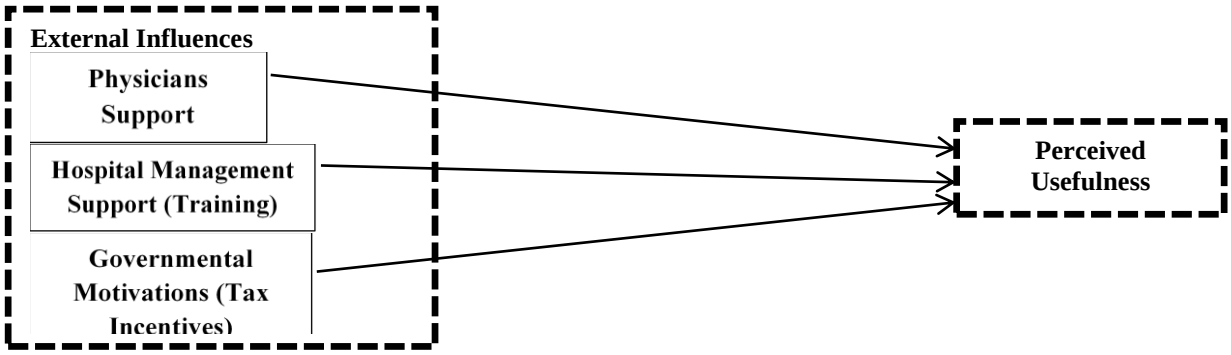

Figure 4.50 The influence of external variables on perceived usefulness variable

Table 40.49 shows that the model is statistically significant F (3, 321) = 93.380, p < .001, explaining 46.6 % of variance in the perceived usefulness of EMR-based-PHR and the results of Hypothesis 0 17 as the following:

a) The Physicians support variable cannot significantly predict the perceived usefulness of EMR-based-PHR. The null hypothesis was not supported (β = .390, p = .000 < .001).

b) The Hospital Management Support variable cannot significantly predict the perceived usefulness of EMR-based-PHR. The null hypothesis was not supported (β = .206, p = .002 < .01).

c) The Governmental Motivations variable cannot significantly predict the perceived usefulness of EMR-based-PHR. The null hypothesis was not supported (β = .173, p = .001 < .01).

Table 4.49 *Multiple regression analysis of the influence of external variables on perceived usefulness variable*

	Variables	R	R2	B	SE	β	T	Sig.
Model 1	(Constant)	.683[a]	.466	1.007	.173		5.808	.000
	Physicians Support			.390	.063	.390	6.172	.000
	Hospital Management Support			.208	.066	.206	3.172	.002
	Governmental Motivations			.156	.048	.173	3.269	.001

Q3-3 Is the perceived ease of use of EMR-based-PHR predicted by the external factors for adopting EMR-based-PHR (Governmental Incentives, Physicians Support and Hospital Management Support)?

H018: There is no significant prediction between the external Influences (a. Physicians Support, b. Hospital Management Support, and c. Governmental Motivations) and the perceived ease of use variable toward EMR-based-PHR.

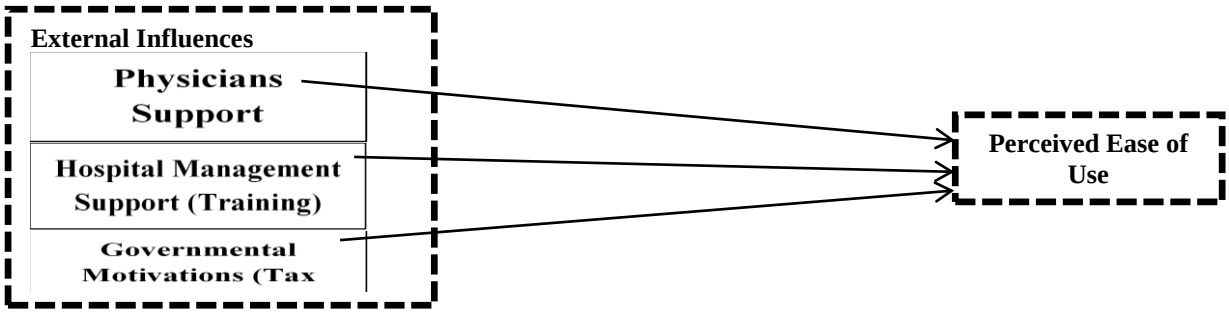

Figure 4.51 The influence of external variables on perceived ease of use

Table 4.50 shows that the model is statistically significant F (3, 321) = 57.111, p < .001, explaining 34.8 % of variance in the Ease of Use variable toward EMR-based-PHR and the results of Hypothesis 18 as the following:

a) The Physicians support variable cannot significantly predict the perceived ease of use of EMR-based-PHR. The null hypothesis was not supported (β = .247, p = .000 < .001).
b) The Hospital Management Support variable cannot significantly predict the perceived ease of use of EMR-based-PHR. The null hypothesis was not supported (β = .233, p = .001 < .01).
c) The Governmental Motivations variable cannot significantly predict the perceived ease of use of EMR-based-PHR. The null hypothesis was not supported (β = .193, p = .001 < .01).

Table 4.50 *Multiple regression analysis of the influence of external variables on the perceived ease of use variable*

	Variables	R	R2	B	SE	β	t	Sig.
Model1	(Constant)	.590[a]	.348	1.353	.188		7.181	.000
	Physicians Support			.242	.069	.247	3.531	.000
	Hospital Management Support			.231	.071	.233	3.245	.001
	Governmental Motivations			.171	.052	.193	3.305	.001

Q3-4 Is the behavioural attitude toward adopting EMR-based-PHR predicted by the technological characteristics of EMR-based-PHR innovative technology?

H019: There is no significant prediction between the technological characteristics of EMR-based-PHR (Perceived Usefulness, Perceived Ease of Use, Compatibility and Communicability) and the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR innovative technology.

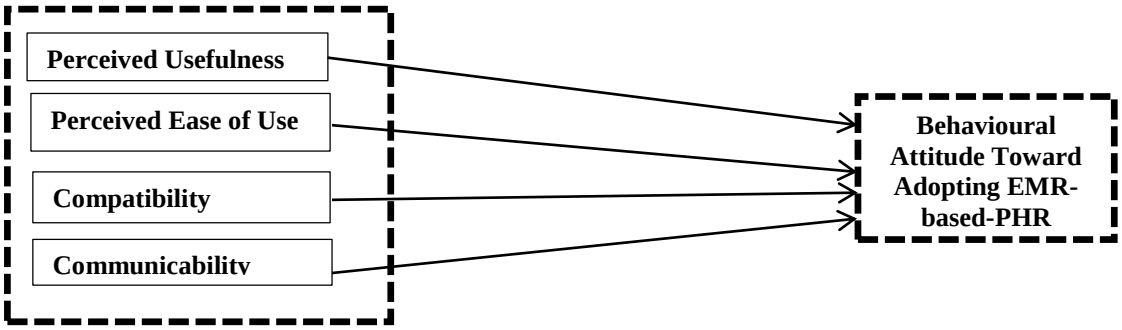

Figure 4.52 The influence of technological characteristics variables on the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR

Table 4.51 shows that the model is statistically significant F (4, 320) = 111. 737, p < .001, explaining 58.3 % of variance in the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR and the results of Hypothesis 019 as the following:

a) The Perceived Usefulness variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was supported (β = -.081 7, p = .210 > .05).
b) The Perceived Ease of Use variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β = .305, p = .000 < .001).
c) The Compatibility variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β = .204, p = .005 < .05).
d) The Communicability variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β = .409, p = .000 < .001).

Table 4.51 *Multiple regression analysis of the influence of technological variables on the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR*

	Variables	R	R2	B	SE	β	t	Sig.
Model1	(Constant)	.763[a]	.583	.700	.153		4.589	.000
	Perceived Ease of Use			-.083	.066	-.081	-1.257	.210
	Perceived Usefulness			.307	.083	.305	3.693	.000
	Compatibility			.202	.071	.204	2.858	.005
	Communicability			.368	.045	.409	8.237	.000

Q3-5 Is the behavioural attitude toward adopting EMR-based-PHR predicted by sociological and psychological aspects that relate to human factors?

H020: There is no significant predication and positive relationship between the sociological variables (Open to Change, Awareness toward E-health, and Quality of Healthcare Services) and the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR innovative technology.

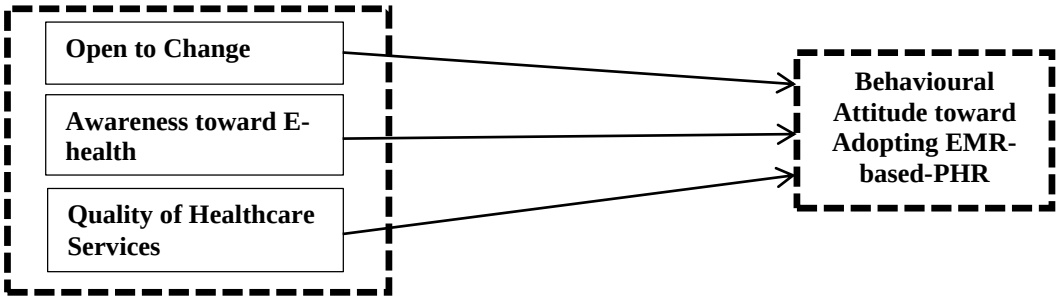

Figure 4.53 The Influence of sociological variables on the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR

Table 4.52 shows that the model is statistically significant F (3, 321) = 164. 277, p < .001, explaining 60.6 % of variance in the behavioural attitude toward adopting EMR-based-PHR and the results of H020 as the following:

a) The Open to Change variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β = .344, p = .000 < .001).
b) The Awareness toward e-health variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β = .116, p = .002 < .01).
c) The Quality of Healthcare Services variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β = .475, p = . 000 < .001).

Table 4.52 *Multiple regression analysis of the influence of sociological variables on the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR*

	Variables	R	R2	B	SE	β	t	Sig.
Model 1	(Constant)	.778a	.606	-.450	.211		-2.133	.034
	Open to Change			.431	.056	.344	7.648	.000
	Awareness toward E-health			.166	.052	.116	3.201	.002
	Quality of Healthcare Services			.525	.050	.475	10.513	.000

H021: There is no significant prediction and positive relationship between the psychological variables (E-Health Literacy, Computer self-efficacy, and Computer Anxiety) and the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR innovative technology.

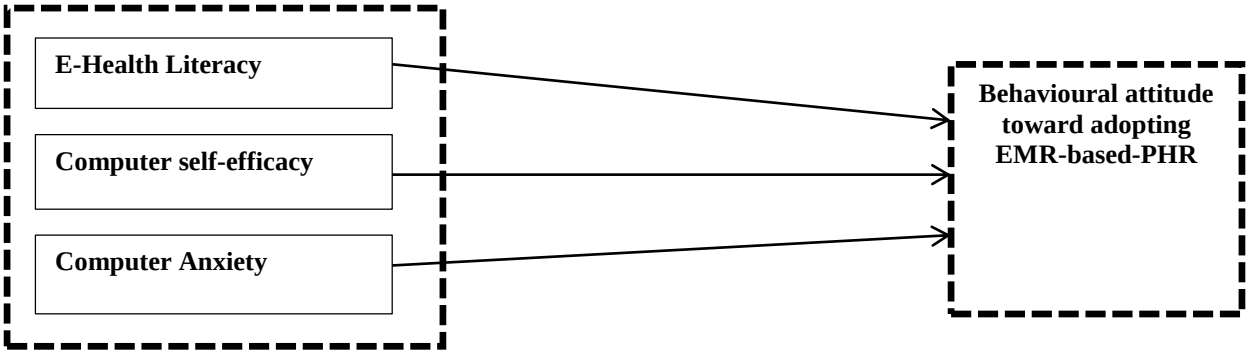

Figure 4.54 The influence of interdisciplinary variables on Northern people attitude toward adopting

Table 4.53 shows that the model is statistically significant F (3, 321) = 62. 706, p < .001, explaining 36.9% of variance in the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR and the results of H021 as the following:

a) The E-health Literacy variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β = .266, p = .000 < .001).

b) The Computer Self-Efficacy variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β = .356, p = .000 < .01).

c) The Computer Anxiety variable cannot significantly predict the attitude toward adopting EMR-based-PHR. The null hypothesis was not supported (β =. -126, p =. 007 < .05).

Table 4.53 *Multiple regression analysis of the influence of psychological variables on the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR*

	Variables	R	R2	B	SE	β	t	Sig.
Model 1	(Constant)	.608a	.369	1.568	.247		6.345	.000
	E-health Literacy			.273	.059	.266	4.673	.000
	Computer Self-Efficacy			.372	.059	.356	6.282	.000
	Computer Anxiety			-.127	.046	-.126	-2.735	.007

Hierarchical Multiple Regression Analysis

Q3-6 Is the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR predicted by a combination of interdisciplinary variables that relate to managerial, technological, sociological, and psychological human factors?

H022: There is no significant prediction between the combination of managerial, technological, psychological variables and the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR innovative technology.

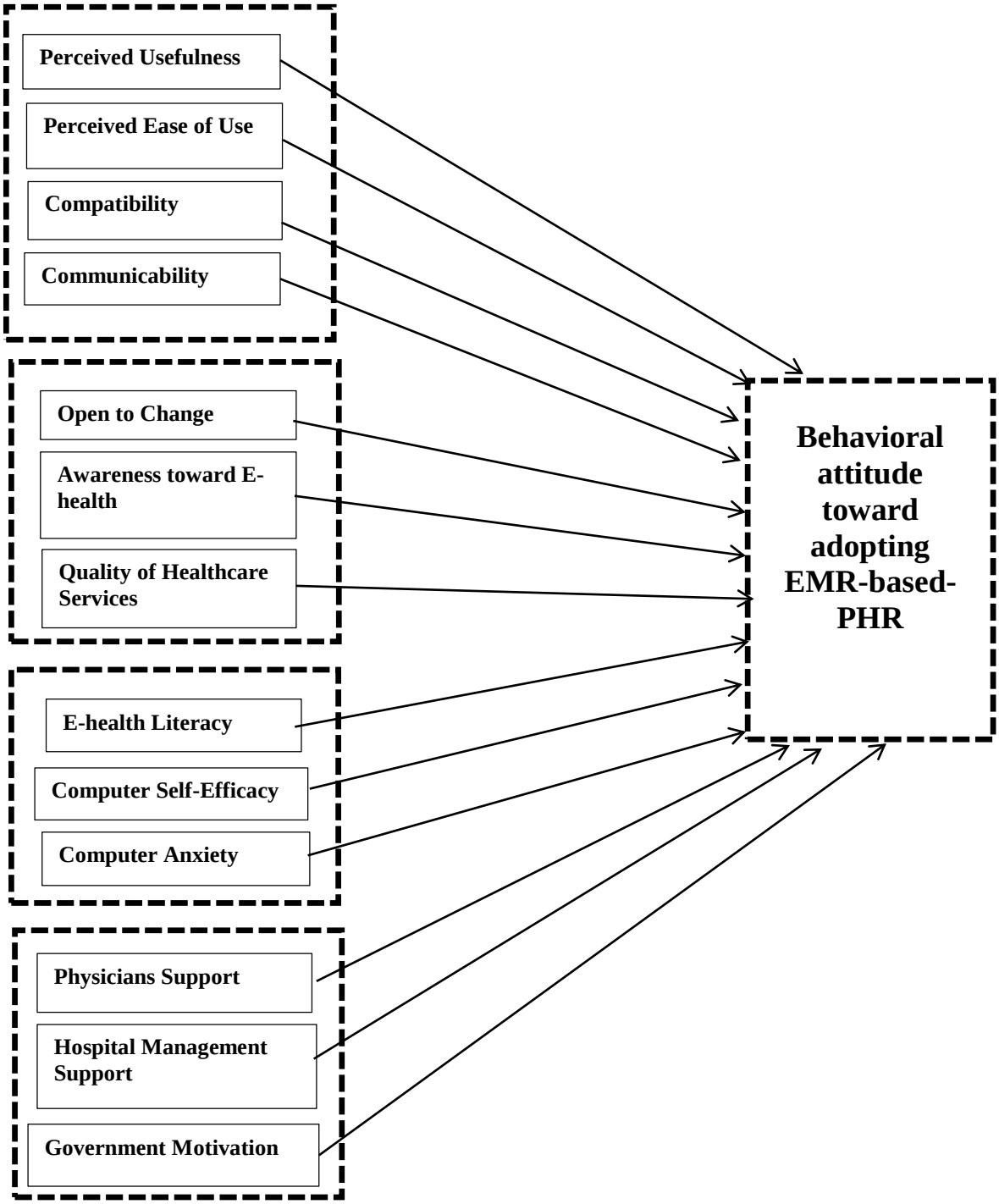

Figure 4.55 The Influence of Interdisciplinary Variables on the behavioural attitude of the people of Northern Ontario toward Adopting EMR-based-PHR

Table 4.54 shows the hierarchical multiple regression analysis results of the interdisciplinary influences predictors on the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR. As a result, in the final model, eight out of thirteen predictor variables were statistically significant, with quality of healthcare services recording a higher Beta value (β =. .277, p < .001) then the perceived usefulness (β = .209, p < .001) and communicability (β =. 190, p < .01)

Table 4.54 *Hierarchical multiple regression analysis of the influence of interdisciplinary variables on the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR*

	Variables	R	R2	B	SE	β	t	Sig.	Decision at p <0.05
Model1	(Constant)	.763[a]	.583	.700	.153		4.589	.000	
	Perceived Ease of Use			-.083	.066	-.081	-1.257	.210	Not significant
	Perceived Usefulness			.307	.083	.305	3.693	.000	Significant
	Compatibility			.202	.071	.204	2.858	.005	Significant
	Communicability			.368	.045	.409	8.237	.000	Significant
Model 2	(Constant)	.814[b]	.663	-.297	.200		-1.489	.137	
	Perceived Ease of Use			-.149	.061	-.145	-2.425	.016	Significant
	Perceived Usefulness			.246	.076	.244	3.247	.001	Significant
	Compatibility			.053	.066	.053	.795	.427	Not significant
	Communicability			.210	.044	.234	4.746	.000	Significant
	Open to Change			.264	.063	.211	4.168	.000	Significant
	Awareness Toward E-health			.133	.049	.093	2.734	.007	Significant
	Quality of Healthcare Services			.327	.055	.295	5.976	.000	Significant
Model 3	(Constant)	.825[c]	.680	.101	.221		.459	.647	
	Perceived Ease of Use			-.192	.063	-.187	-3.043	.003	Significant
	Perceived Usefulness			.266	.074	.264	3.581	.000	Significant
	Compatibility			.053	.065	.053	.808	.420	Not significant
	Communicability			.190	.044	.211	4.300	.000	Significant
	Open to Change			.235	.064	.188	3.685	.000	Significant
	Awareness Toward E-health			.194	.050	.136	3.891	.000	Significant
	Quality of Healthcare Services			.326	.054	.295	6.048	.000	Significant
	E-health Literacy			-.013	.046	-.013	-.283	.777	Not significant
	Computer Self-Efficacy			.020	.051	.019	.400	.689	Not significant
	Computer Anxiety			-.146	.036	-.146	-4.110	.000	Significant
Model 4	(Constant)	.835d	.696	.035	.217		.163	.871	
	Perceived Ease of Use			-.155	.062	-.151	-2.487	.013	Significant
	Perceived Usefulness			.211	.075	.209	2.831	.005	Significant
	Compatibility			.027	.065	.027	.415	.678	Not significant
	Communicability			.171	.044	.190	3.916	.000	Significant
	Open to Change			.190	.064	.152	2.989	.003	Significant
	Awareness Toward E-health			.176	.050	.123	3.554	.000	Significant
	Quality of Healthcare Services			.306	.053	.277	5.776	.000	Significant
	E-health Literacy			-.042	.046	-.040	-.904	.367	Not significant

	Computer Self-Efficacy	-.011	.051	-.010	-.213	.832	Not significant
	Computer Anxiety	-.144	.035	-.144	-4.128	.000	Significant
	Physicians Support	.133	.053	.132	2.502	.013	Significant
	Hospital Management Support	.067	.053	.066	1.253	.211	Not significant
	Governmental Motivations	.018	.039	.020	.461	.645	Not significant

a. Dependent variable: Behavioural Attitude Toward Adopting E-health

Q3-7 Is the behavioural intention of the people of Northern Ontario to use EMR-based-PHR predicted by a combination of interdisciplinary variables that relate to managerial, technological, sociological, psychological human factors, their behavioural attitude and perceived behavioural control?

H023: There is no significant prediction between the combination of managerial, technological, psychological variables, Northern people behavioural attitude and perceived behavioural control variables and the behavioural intention of the people of Northern Ontario to use EMR-based-PHR.

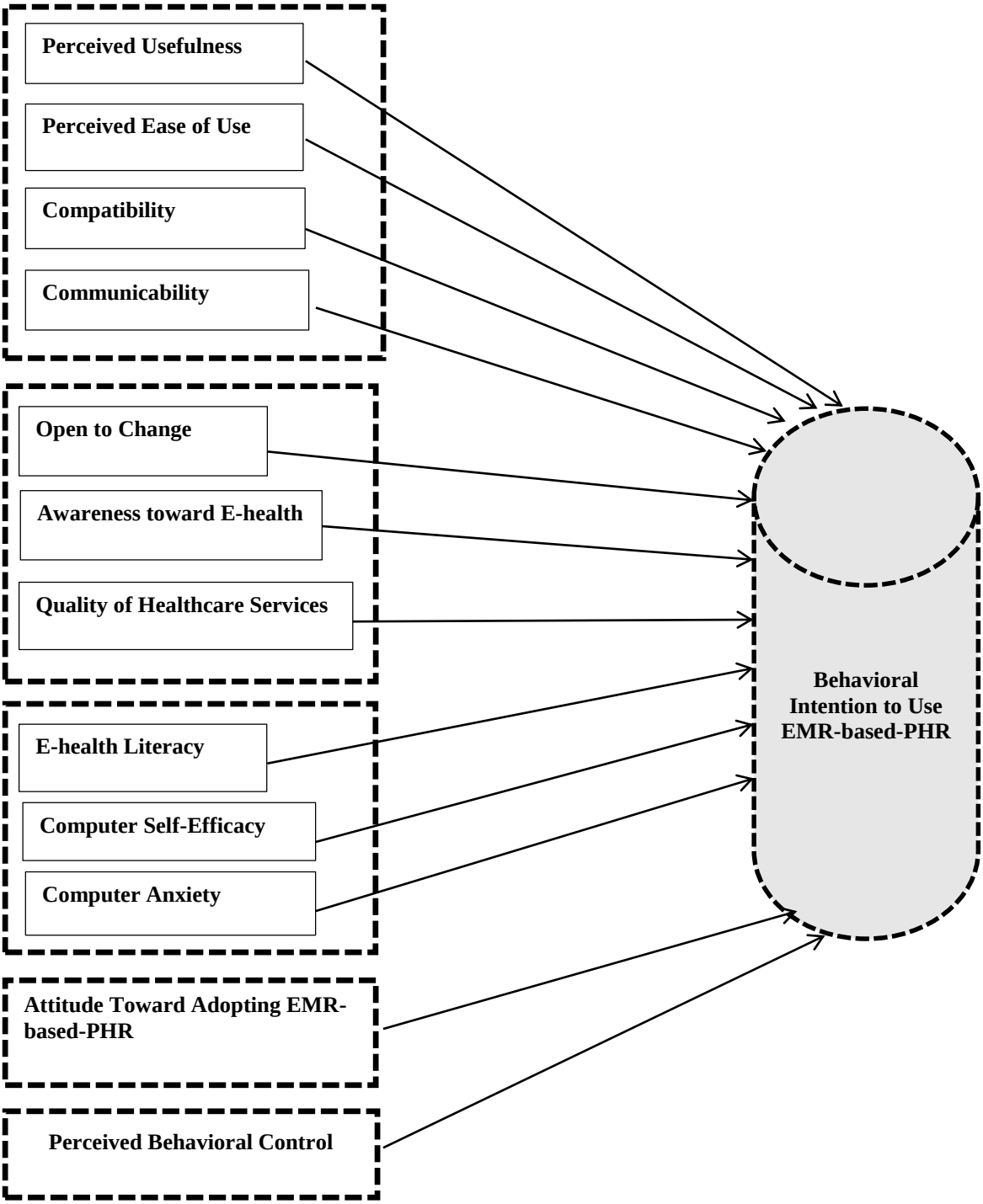

Figure 4.56 The Influence of Interdisciplinary Variables on the behavioural intention of the people of Northern Ontario to Use EMR-based-PHR

Table 4.55 shows the hierarchical multiple regression analysis results of the interdisciplinary influences predictors on the behavioural intention of the people of Northern Ontario toward adopting EMR-based-PHR. As a result, in the final model, five out of twelve predictor variables were statistically significant, with quality of healthcare services recording a higher Beta value (β = . 338, p < .001) then the perceived usefulness (β = .242, p < .001) and the behavioural attitude variable (β = . 190, p < .01).

Table 4.55 *Hierarchical multiple regression analysis of the influence of interdisciplinary variables on the behavioural intention of the people of Northern Ontario to use EMR-based-PHR*

	Variables	R	R2	B	SE	β	t	Sig.	Decision at p <0.05
Model 1	(Constant)	.789[a]	.623	.669	.139		4.816	.000	
	Perceived Ease of Use			-.034	.060	-.035	-.568	.571	Not significant
	Perceived Usefulness			.371	.076	.384	4.898	.000	Significant
	Compatibility			.204	.064	.215	3.172	.002	Significant
	Communicability			.262	.041	.305	6.450	.000	Significant
Model 2	(Constant)	.830[b]	.688	.403	.130		3.088	.002	
	Perceived Ease of Use			-.003	.055	-.003	-.048	.962	Not significant
	Perceived Usefulness			.254	.070	.263	3.612	.000	Significant
	Compatibility			.127	.059	.134	2.147	.033	Significant
	Communicability			.123	.041	.142	3.007	.003	Significant
	Behavioural Attitude			.380	.046	.397	8.198	.000	Significant
Model 3	(Constant)	.861[c]	.741	-.156	.168		-.929	.354	
	Perceived Ease of Use			-.048	.052	-.049	-.922	.357	Not significant
	Perceived Usefulness			.239	.065	.248	3.695	.000	Significant
	Compatibility			.040	.056	.043	.724	.470	Not significant
	Communicability			.049	.039	.057	1.285	.200	Not significant
	Behavioural Attitude			.222	.047	.232	4.702	.000	Significant
	Open to Change			.122	.055	.102	2.233	.026	Significant
	Awareness Toward E-health			.077	.041	.056	1.855	.065	Not significant
	Quality of Healthcare Services			.350	.048	.330	7.216	.000	Significant
Model 4	(Constant)	.862[d]	.744	-.068	.190		-.358	.720	
	Perceived Ease of Use			-.057	.055	-.058	-1.037	.300	Not significant
	Perceived Usefulness			.252	.065	.261	3.868	.000	Significant

	Compatibility			.045	.056	.048	.812	.417	Not significant
	Communicability			.043	.039	.050	1.109	.268	Not significant
	Behavioural Attitude			.212	.048	.221	4.367	.000	Significant
	Open to Change			.120	.056	.100	2.142	.033	Significant
	Awareness Toward E-health			.092	.044	.067	2.099	.037	Significant
	Quality of Healthcare Services			.348	.049	.329	7.118	.000	Significant
	E-health Literacy			.047	.040	.048	1.189	.235	Not significant
	Computer Self-Efficacy			-.050	.043	-.050	-1.147	.252	Not significant
	Computer Anxiety			-.033	.031	-.034	-1.046	.297	Not significant
	(Constant)	.863[e]	.745	-.072	.189		-.383	.702	
Model 5	Perceived Ease of Use			-.046	.055	-.046	-.820	.413	Not significant
	Perceived Usefulness			.234	.067	.242	3.509	.001	Significant
	Compatibility			.055	.056	.058	.975	.330	Not significant
	Communicability			.044	.039	.051	1.133	.258	Not significant
	Behavioural Attitude			.227	.050	.237	4.552	.000	Significant
	Open to Change			.129	.056	.107	2.290	.023	Significant
	Awareness Toward E-health			.099	.044	.073	2.243	.026	Significant
	Quality of Healthcare Services			.358	.049	.338	7.241	.000	Significant
	E-health Literacy			.056	.040	.056	1.381	.168	Not significant
	Computer Self-Efficacy			-.047	.043	-.047	-1.080	.281	Not significant
	Computer Anxiety			-.031	.031	-.032	-.977	.329	Not significant
	Perceived Behavioural Control			-.056	.043	-.056	-1.290	.198	Not significant

a. Dependent Variable: Behavioural Intention to Use EMR-based-PHR

Q3-8 Is the perceived behavioural control of the people of Northern Ontario to use EMR-based-PHR predicted by psychological human factors?

H024: There is no significant prediction and positive relationship between the psychological human variables and the perceived behavioural control of the people of Northern Ontario.

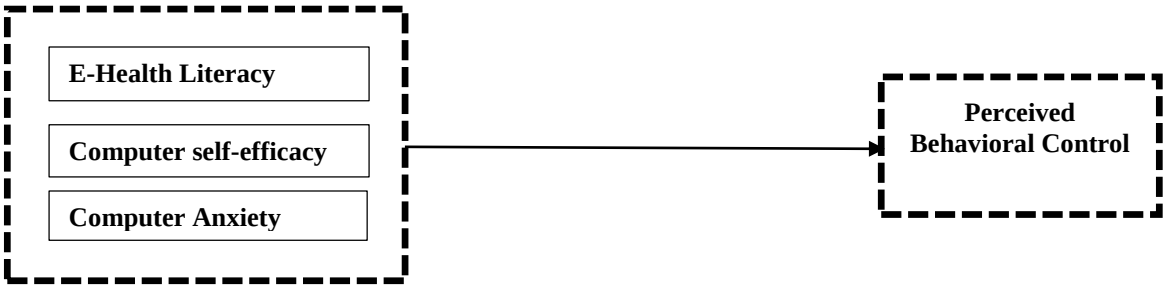

Figure 4.57 The influence of psychological variables on the perceived behavioural control of the people of Northern Ontario

Table 4.56 shows that the model is statistically significant, explaining 37% of variance in the perceived behavioural control of the people of Northern Ontario toward adopting EMR-based-PHR and the results of H024 as the following:

a) The Computer Self-Efficacy variable cannot significantly predict the perceived behavioural control of the people of Northern Ontario. The null hypothesis was not supported ($\beta = .310$, $p = .000 < .01$).

b) The Computer Anxiety variable cannot significantly predict the perceived behavioural control of the people of Northern Ontario. The null hypothesis was supported ($\beta = .002$, $p =. 962 > .05$).

c) The E-health Literacy variable cannot significantly predict the perceived behavioural control of the people of Northern Ontario. The null hypothesis was not supported ($\beta = .359$, $p = .000 < .001$).

Table 4.56. *Multiple regression analysis of the influence of psychological variables on the perceived behavioural control of the people of Northern Ontario*

	Variables	R	R2	B	SE	β	t	Sig.
Model1	(Constant)	.609[a]	.370	1.165	.236		4.941	.000
	E-health Literacy			.359	.056	.366	6.438	.000
	Computer Self-Efficacy			.310	.056	.311	5.493	.000
	Computer Anxiety			.002	.044	.002	.047	.962

a. Dependent Variable: Perceived Behavioural Control

Chapter 5 Research Findings, Implications and Recommendations

5.1 Background

Using the various data we have seen in chapter 4, this chapter will discuss the research questions linked with the study objectives, showing the principal research findings, implications and general recommendations in two parts. The first part will cover the first research question, by presenting the findings of comparative ratios related to physician/ patient electronic relationships as indicators that could help health policy makers with their future implementation of those relationships in Northern Ontario. The second part will cover the second and third research questions by highlighting the research model factors that have been evaluated by Northern patients and how the PHR system adoption has affected their attitude. The principal findings and implications are classified into four categories: managerial factors, technological factors, psychological factors, and sociological factors. Interdisciplinary factors that combine these are also addressed. The combined knowledge of these two parts helped to answer the last question, focusing on general strategies and recommendations for future users of EMR-based-PHR innovative technology in Northern Ontario.

Analysis of the research findings reveals the following trends:

- More Northern patients use websites, social media and mobile applications than Northern physicians.
- More female Northern patients and physicians use e-health services than their male counterparts.
- More of the younger generation of Northern patients and physicians use e-health services than older generations.

- Interdisciplinary factors of EMR-based-PHR were significant predictors of attitude and intention to adopt this innovative technology.
- Ease of use was the most important predictor among the technological factors in terms of attitude toward adopting EMR-based-PHR in Northern Ontario.

5.2 A Comparative Analysis of Physicians' and Patients' Perceptions of E-health

Objective 1: To explore factors that influence a group of Canadian people's attitudes toward EMR-based-PHR innovative technology, through investigating the impact of various individual perceptions and expectations, as well as behavioral and environmental factors on the adoption and use of this technology.

The first research question has been designed to investigate differences in the technological skills of Northern physicians and patients in the use of e-health services. The National Physicians Survey (NPS) in Northern Ontario reached an acceptable 14.7 % (323 respondents) response rate among the 2,197 authorized physicians (for a detailed description of the NPS methodology, see appendix D). The study survey for Northern patients received 325 respondents. The first question explored two personal characteristics (age and sex) of Northern physicians and patients according to their technological skills as indicators of usage of e-health services. Five categories of e-health services usage were measured: (a) website practice, (b) social networks usage, (c) tele-health usage, (d) mobile applications, and (e) electronic records. The first four categories have been considered IT indicators for future benchmarking for health policy makers, and the last category has been discussed separately for Northern physicians and patients.

5.2.1 The four IT indicators of the e-health usage among physicians and patients

Principal findings

The first research question involves a comparison of the differences in the technological skills of Northern physicians and patients in using e-health services (as shown in Table 4.28). The research findings indicated that the four IT indicators of the e-health usage among physicians and patients (i.e. website practice, social networks usage, tele-health usage, and mobile applications) have variations; therefore, general trends have been considered by taking an overview look at these variations. There was a significant difference in the percentages of website, social networks, tele-health and mobile applications usage between Northern physicians and patients. The results indicate that 19.8% of the 323 physicians were using websites, 38.7% were using social networks, 50.9% were using tele-health and 60.7% were using mobile applications. However, 91.7% of the 325 patients were using websites, 85.5% were using social media, 20.9% were using tele-health and 20.3% were using mobile applications. In terms of gender differences, a greater number of female Northern physicians and patients are using websites, social networks and electronic records than male Northern physicians and patients. More female Northern physicians also use mobile applications for medical purposes than male Northern physicians. The result was opposite, however, for male Northern patients. In this demographic, more used electronic records exclusively, and more used mobile applications for medical purposes than female patients. Male and female Northern physicians and patients are similar in their use of tele-health technologies.

According to age differences, younger people are more likely to use websites, social networks, and mobile applications and exclusively use electronic records than older people in both Northern physicians and patients. There was a negative relationship between age and physician usage of website and social networks; when the age increases, the usage decreases.

This relationship becomes positive between the age of Northern physicians and their usage of tele-health; when the age increases, the usage increases. This relationship was negative between Northern patients' age and their usage of tele-health.

Implications

The findings from surveying the Northern physicians and patients reveal more variances than similarities across website, social media, mobile application, and tele-health users. According to previous studies, there are inconsistent results between men and women in most technological applications usage. For example, the literature findings of the online health communications patterns of men and women are inconsistent in various studies impacted by several contextual and situational factors (Mo *et al.,* 2009). Generally, these studies that have sought help from health care providers have shown that men of different ages are also less likely than women to have information about a variety of health problems (Galdas *et al.,* 2005; Lane & Addis 2005; Mackenzie *et al.,* 2006; Mo *et al.,* 2009). In the online interaction with the healthcare providers, women have also shown a significant difference from men in adopting online rather than face-to-face interactions (Bellman *et al.,* 1993; Witmer & Katzman, 1997; Ybarra & Suman, 2008). A look at our Southern neighbours tells us that one in three American adults have gone online to search for information about the health conditions of their family and friends. Of the 3,014 American adults using online diagnosis, 41% mentioned that a medical professional confirmed their diagnosis (Fox & Duggan, 2013). As a result, American women and men of younger ages are more likely than women and men of older ages to seek online health information.

In addition, the last survey conducted by Pew Internet & American Life Project confirmed that younger men and women were more likely than older men and women to use

social networking sites between 2002 and 2015 in the United States (Perrin, 2015). In the same study, women were more likely than men to use social networking sites. Social networks failed to attract the older ages to the same extent as the young ones (Arjan *et al.*, 2008; Jones & Fox, 2009; Perrin, 2015). Nevertheless, there has been an improvement in the usage rate of social networks for both men and the older ages over time. Several studies, for example, show that older ages are the fastest growing demographic of Web users (Czaja & Sharit, 2009; Holt & Morrell, 2002; Jones & Fox, 2009; Perrin, 201; Xie, 2006).

Smartphones are changing the way of thinking for many people. The flexibility and ease of use of these devices enable people to find the information they need according to their location and time. The increased use of Smartphones and their applications is remarkable everywhere, evidenced through the amount of sales within Smartphone companies such as Apple or Samsung. This expansion is shown in a 2012 study conducted by Fox and Duggan. They found that 85% of the 3,014 adults in United States own a cell phone (3,014), and 53% of them own Smartphones. An encouraging finding is that 31% have used their phone to look for health information compared with 17% who had used their phones to look for health advice in 2010. Additionally, 19% of American Smartphone owners have at least one health app on their phone; they are using the health applications in many health areas such as exercise, diet, and weight (Fox & Duggan, 2012). According to Fox and Duggan (2012), American women are more likely than men to have Smartphones and to use them for health information (e.g. health text alerts).

In understanding the impact of the above IT indicators, it is important to declare that user characteristics in using any system are not equal in this study and others. Therefore, people may not be using these systems as a result of individual circumstances that inhibit them; this is not always a reflection on the usefulness of the systems or the user's technological capabilities.

Variation is normal, but may result in digital inequality and requires understanding of the differences in access to and use of any technology application (Hargittai, 2001; DiMaggio *et al.* 2004; Hargittai & Shaw, 2015). According to DiMaggio *et al.* 2004, digital inequality has been varied on five dimensions: in technical apparatus, autonomy of use, skills, in the availability of social support, and the variation of use (pp. 31-35). Because older ages are always behind younger ages in the adoption of technology applications, we must recognize the factors that influence their ability to use technology. We cannot deny that older people have obstacles in adopting new technologies, but these obstacles are not always related to willingness. For example, older people face physical and health challenges that make it difficult to use new technologies. In addition, some of them doubt thier benefits, thus they do not see the need to use them, and a majority of adults needs training to use this technology (Hanson, 2009; Smith, 2014; Zajicek, 2007). Older people may also be facing technical difficulties. For example, in website browsing, some difficulties include moving from page to page, using more time to complete tasks or select targets and links, revisiting sites, and difficulties finding new information (Hanson, 2009; Meyer *et al.*, 1997; Sayago & Blat, 2007; Tullis, 2007;).

Nevertheless, many older people are learning to use technology. For example, in 2014, the Pew Research survey showed that 47% of the 1,526 (un-weighted sample size) for those ages 65 or older now go online compared to 35% in 2008. In addition, 46% of them also use social networking sites, and 18% of seniors are using Smartphones (Smith, 2014). Though there has been some increase in technology use among older people, younger people are using technology far more frequently. Healthcare policy makers should build on this information to develop a long-term policy that focuses on the technology generation in the usage of e-health applications in order to use funding most effectively. With the general percentage of usage increasing overall,

successful electronic relationships are being established between physicians and patients, particularly in young ages. The results suggest that the usage of websites, social media and mobile applications relies on personal preferences more than other factors, which encourages more investigation in the field of humanist technology. Therefore, scholars are still investigating many factors that promote the acceptance and the adoption of any new innovative technology. They have suggested many approaches to encourage use of these technologies beginning with socioeconomic factors (Livingstone & Helsper, 2007; Nantapo *et al.,* 2015; Wang *et al.,* 2005), ranging to social psychology factors (Chang, 2015; Van der Heijden, 2003), and ending with technological factors (Yusof *et al.,* 2008). They have suggested using approaches that are effective in the planning and design of these systems, organizing, and presenting the information in a progressive way (Eighmey & McCord, 1998). While most technologies show a remarkable progress in the visualization of contents through impressive design, some users do not use or like to use the technology. In this case, if the internet, through its applications, is a valuable source for health information, clinicians, developers and health policy makers must consider the information that has been provided, setting strategies and procedures that provide trust. In the recommendations section, we will suggest procedures that could help in this.

5.2.2 Insight into e-health usage by understanding the dilemma in capturing health information.

5.2.2.1 Healthcare self-management

Principal Findings

The results indicated some agreements and some contradictions in the responses of both Northern physicians and patients (as shown in Tables 4.29 to 4.35). For example, there was a significant difference between Northern physicians' responses and patients' responses about healthcare self-management. Northern physicians have negative perceptions of patients' abilities

in managing their electronic health information. Of the 243 physician respondents, 90.3% believe that their patients cannot do simple electronic tasks, such as request appointments and prescription renewals online, view their health record online, and add measurements, text, and documentation to their record. On the other hand, only around 54.8% of the 325 Northern patients' respondents indicated they would be able to manage their electronic health information with the above mentioned electronic tasks. The self-management of healthcare of patients is usually achieved by using several technologies such as telehealth, websites and medical mobile applications. According to our results, for example, only 16.5% of the 310 Northern physicians refer their patients to mobile applications for several purposes, such as to get health information and news, self-management, health monitoring and tracking, healthy living and disease prevention. On the other hand, only 3.7 % of the 325 Northern patients agree that their physicians refer them to mobile applications. In another example, 67.3% of Northern physician respondents mentioned referring their patients to healthcare websites to get information about disease and treatment, disease prevention, and to support their patients in general. Unfortunately, there was a significant difference between Northern physicians' responses and those of patients; only 17.2% of Northern patient respondents agree that their physicians refer them to websites.

Implications

To our knowledge, this is the first study to compare the responses between physicians and patients toward one application or technology in the same region. Abstracting our results using only statistics may cause controversy and is not the most productive use of the data. Therefore, the implications of these results will focus on ideas for bringing physicians and patients together to benefit from these technologies, improving the quality of healthcare. In the healthcare self-management area, several examples of technology applications identified by

patients include personal medical records, online health information, social media, and mobile applications and other communications technology (Zulman *et al.,* 2015). This study has covered all of these applications that represent positive indicators in our population, particularly among young ages (the technology generation). Recently, the affordable technological platform that allows both physicians and patients to communicate easily and provide a quick access to online health information, social media, and patient health records is mobile technology (El-Gayar *et al.,* 2013). According to a 2015 Food and Drug Administration (FDA) estimation, 500 million users will use Smartphones around the world for health care applications, and in 2018, "50 percent of the more than 3.4 billion smartphone and tablet users will have downloaded mobile health applications."

Along with the growth of health technology applications, both Northern physicians and patients have to adopt mobile applications in healthcare settings. The literature shows mobile devices and their associated apps have increasingly been adopted by healthcare providers into their practices (Aungst *et al.,* 2014; Franko & Tirrell, 2012; Payne *et al.,* 2012; Sclafani *et al.,* 2013). Healthcare providers believe in the benefits of mobile devices as a flexible tool in accessing health information, which can lead to increased quality of life and productivity by decreasing the number of hospital admissions and repeat doctor visits (Aungst *et al.,* 2014; Cingi *et al.,* 2015; Goldbach *et al.,* 2014; Patel *et al.,* 2012). Patient interest in and acceptance of health mobile applications can provide high-quality care and assistance with health self-management through automated alerts (Ciemins *et al.,* 2010; Hsieh *et al.,* 2015; Zulman *et al.,* 2015). Mobile medical applications have benefited from the lower start-up and maintenance costs, less electricity requirement compared to computers, which makes them preferable in rural and

regional communities, along with improving accuracy and timeliness of data collection (Kanter *et al.,* 2014; Kaplan, 2006; Vélez *et al.,* 2014).

Increasing the adoption of mobile applications will enhance the self-management of patients in managing their healthcare. We think that a significant factor in this adoption is the encouragement that patients received from their physicians, particularly in identifying mobile medical applications that can be integrated into practice after careful review by physicians (Aungst *et al.,* 2014). In addition, their physicians have to identify the features that would be useful in these medical apps by guaranteeing complete and accurate health information within a secure environment (Lewis, 2013; Misra *et al.,* 2013). According to the results, the young generation are able and willing to use this technology in their healthcare self-management. Mobile health and its applications will inevitably permeate the healthcare industry. Future advancement in technologies will make them easy to use and available for everyone, younger or older, able or disabled. Currently, mobile health in many countries is a part of electronic health to improve interventions for health promotion, increase health education and prevent disease (Aranda-Jan *et al.,* 2014). In Canada, for example, both healthcare providers and patients have to utilize the opportunities of health communication technologies to share health information from several areas, utilizing the large and available funding opportunities that allocate several programs for e-health through commercial partners and governments. On the other hand, threats to the implementation of e-health must be minimized, for example, by increasing the workforce and reducing the workload of healthcare providers, and reducing the complexities of these technologies while providing high security tools that protect all information.

As well, a solid technological environment (network, internet and electricity access) that serves the demanding needs of big health data, along with an environment that facilitates

knowledge sharing in the daily work of healthcare providers must be provided. Building on this indicator, health organizations should take strategic actions to encourage healthcare providers to promote this technology rather than fear it. This fear may sometimes be related to financial issues rather than usability features. For example, most physicians ask their patients to revisit them to check their blood test, and this procedure will be reported as a visit fee. In this case, if patients can track their results by using their mobile device or other technology, there is no need to see the physician again, specifically if the results do not require follow-up. Some physicians may resist this technology and not recommend it to their patients. Therefore, health organizations should support these technologies not only by using soft tactics for adoption, but also by using hard tactics that could require physicians to use these technologies.

5.2.2.2 Capturing health information by Northern physicians

Principal Findings

In capturing health information, 39.5% of the 316 physician respondents are exclusively using electronic records in their work, and 49.3% are using a combination of paper charts and electronic records (as shown in Table 4.7). The reasons for not using electronic records include the availability of this technology in their work place, time consumption, lack of training, reliability and privacy concerns and plans to retire. Nevertheless, 40.7% of the respondents who do not currently use electronic records are planning to use them in the future. However, Northern physicians indicate some barriers in accessing electronic records. For example, 52% of the 280 Northern physicians' respondents are facing barriers in the technical aspects of the existing electronic records, such as their compatibility with other electronic systems. As well, the reliability issues (technical glitches), security issues, hardware availability and lack of training are significant.

Implications

The positive indicator is that the exclusive usage of electronic records and a combination of paper charts and electronic records among Northern physicians increased in the 2014 National Physician Survey to reach 88.8% (39.5% + 49.3%), which is above the usage rate of Ontario 83.8 % (34.9%+48.9%) and across Canada 78.7% (29.4%+49.3%). The negative indicator is that the usage rate of exclusive use of electronic records after 15 years of adoption with billions of dollars of federal funds in Canada does not match the success rate of other countries in terms of electronic record use. Health information exchange across organizations and care settings in Canada is among the lowest in surveyed countries (Protti, 2015). Promoting the adoption of EMR and overcoming challenges that inhibit its use requires innovation in many areas. Focusing on these results from an interdisciplinary perspective, there are several factors that must be considered in formulating study implications.

Despite the Canadian government's efforts to implement an optimal change management plan to encourage the adoption of EMR across Canada, there has been limited success. Focusing on Ontario, many opportunities have been provided by e-health Ontario to encourage the use of EMR. The Ontario Medical Association (OMA) has provided physician support in the selection, implementation and adoption of EMRs, as well as providing funding and grants toward physicians' adoption of an EMR Standards called "*EMR Adopter Funding*" (OMA, 2015). EMR Adopter Funding was proposed to support physicians' transformation from paper to electronic medical records through helping them with the costs, using both one-time and monthly payments. Additional support for EMR adoption includes more than simply funding, such as determining EMR specifications, selection of EMR vendors, and consulting with physicians. In addition to these, as mentioned in the study literature review, the support also includes a very

strong change management plan at no cost to EMR participants. Connecting the following results with the Canada Health Infoway Change Management plan, we realized that the Canadian government has applied the best theoretical and practical procedures by increasing funds, supporting education, removing barriers, establishing standards and identifying benefits to increase the adopters of EMR. Merging the results of this study, government support for physician adoption of EMR (e.g. grants and funding), and the facts related to age mentioned below will guide us to further investigation.

The first factor impeding physician use of EMR could be related to age. According to the last NPS in 2014, the percentage of physicians above age 55 were 41.9% in Canada (30, 012 out of 71, 628), 42.4% in Ontario (11, 602 out of 27, 364), and 36.5% in Northern Ontario (815 out of 2, 235). This means there are a significant number of Canadian physicians who can be considered members of the early technology generation, a generation with lack of earlier experience with technology starting with their study and reaching into their work practices. This generation is not like the recent technology generation who is studying, working and even dating by using the most recent technologies.

The second factor is related to the income of Canadian physicians-- it is one of the highest incomes across Canada and the world. According to the Canadian Medical Association (CMA): in Ontario, "the Ministry of Health and Long-Term Care pegs average gross billings for the province's doctors at $354 000 for 2013/14" (Collier, 2015, p.1). This fact reflects that the technology funding support of the OMA may not be one of the reasons that Canadian physicians are waiting to adopt the EMR.

The third factor is the shortage of Canadian physicians; the supply of physicians compared to the Canadian population is well below the Organization for Economic Co-operation

and Development (OECD) average (OECD, 2011; CMA, 2012). According to the CMA (2012), many Canadian physicians' "practices are at capacity and unable to take on new patients" (p.4). This resulted from the hard competition of the first-year enrolment at Canadian medical schools and the complexities in the licensing procedure for international accreditation. The Commission on the Future of Health Care in Canada indicated that "access to physicians and specialists varies significantly across the country, and some communities do not have access to the most basic health care services because they lack the necessary health care providers" (Romanow, 2002, p. 162). The shortage of family physicians and specialists also occurs in rural practice (Rourke, 2005); one of these regions is Northern Ontario, which needs more attention by the provincial government (Pong, 2008). Entering Canadian healthcare is a challenge also for international accreditations and immigrants alike; several barriers exist to completing the licensing procedure needed to practice medicine in Canada (Bourgeault & Neiterman, 2013). For example, according to the Canadian Institute for Health Information (2001), the licensing procedure includes passing several costly standardized exams, which can take two to six more years of postgraduate medical training (Bourgeault & Neiterman, 2013). As well, the regulations of the CMA impose limited access to the healthcare system to protect Canadian physicians. Cooper (2015) is a retired physician who asked the following question: "What does it mean to have a physician shortage?" He answered that a shortage of physicians could be a disaster on one hand because "the available supply of physicians would, in large part, determine which services physicians will provide" (p. 17). The other fact is physician autonomy, which means that physicians have complete freedom to make a diagnosis according to their best judgment, and in addition, by using their tools, whether electronic or not (Emanuel & Pearson, 2012). This fact reflects the high autonomy of Canadian physicians that enhances their authority in accepting or rejecting anything they choose.

As an aside, we mentioned in the literature review that there are many acts and standards for protecting patients' health information, which may prevent the use of EMR such as Protection and Electronic Documents Act (PIPEDA), Personal Information Protection Act (PIPA) and others. In addition, there are several technical barriers in the use of electronic records that have been noted in the above results, including the interoperability between systems, security issues, hardware availability, lack of training, etc. There also appears to be a lack of coordination not only between the provincial and federal governments, but also between different stakeholders in implementing e-health (Rozenblum *et al.,* 2011; Zinszer *et al.,* 2013). In an environment of the early technology generation, qualified physicians with high salaries, shortages of healthcare providers, complexities in accepting international accreditations, a lack of coordination between stakeholders, as well as technical barriers, after 15 years and $ 2.4 billion, there is a need to review and modify strategies and plan to address the many challenges.

5.3 Factors Associated with EMR-based-PHR perceptions among Northern People

Objective 1: To explore affected human factors for a group of Canadian people toward EMR-based-PHR innovative technology, through investigating the influences of various individual perceptions, expectations, behaviours, and environmental factors on the adoption and use of this technology.

Objective 2: To act as a proactive approach to raise the awareness of patient-driven e-health (engagement) in preparation of a desired future situation and to continue to support government decisions through adopting practices to successfully implement their plan.

Objective 3: To quantify EMR-based-PHR innovative technology usage and acceptance from the end-user perspectives within measurable factors in e-health outcomes.

5.3.1 Capturing health information by Northern patients

In determining the preferences of capturing health information among Northern patients, 17.2 % of the 325 respondents prefer exclusively electronic records in their healthcare, 41.8% prefer a combination paper charts and electronic records and 35.7% prefer paper charts only in their healthcare (as shown in Table 4.8). The reasons for those who do not prefer using electronic records varied also between the availability of this technology in their healthcare, time consumption, lack of training, and reliability and privacy concerns. Nevertheless, 63.8% of those respondents plan to use electronic records in the future. They prefer to use most electronic record functions in their healthcare, for example, as a clinical reminder, for entering and retrieving clinical notes, for ordering their lab tests and medications, for referring them by their physician to other physicians, etc. The results encourage us to further investigate their perceptions by focusing on several factors. Sixteen factors have been identified in this study survey, including: Physicians Support, Hospital Management Support, Governmental Motivations, Perceived Ease of Use, Perceived Usefulness, Compatibility, Communicability, E-health Literacy, Computer Self-Efficacy, Computer Anxiety, Open to Change, Awareness toward E-health, Behavioural Attitude, Perceived Behavioural Control, Behavioural Intention and Quality of Healthcare Services.

Relationship 1: Between characteristics of Northern people and their attitude to adopt

Principal Findings

The second research question seeks to understand why Canada's level of compliance is so low for innovative technology by focusing on EMR-based-PHR technology. Two sub-questions were integrated to answer the second question by determining the demographic factors and their interactions that affected Northern people's attitudes toward EMR-based-PHR

innovative technology. The first sub-question involves the personality types that have an effect on Northern people's attitudes toward EMR-based-PHR innovative technology. The findings indicated that the effect of age ($F (2, 322) = 2.776$, $p = .064$), sex ($F (1, 323) = .660$, $p = .417$), and ethnicity ($F (4, 320) = .868$, $p = .483$) were not significant in Northern people's attitudes, but one significant effect was found with educational degree level ($F (5, 319) = 5.322$, $p = .000$).

Additional analysis was conducted (multiple comparisons test) between six educational categories to indicate that statistically significant differences existed between the group that have bachelor's degrees and grade 12 ($p= .007$), the group that have master's degrees and the no-degree group ($p=.042$), and between the group that have master's degrees and grade 12 ($p=.019$). The second sub question goes further to find the interaction of sex, age, education and ethnicity in determining the behavioural attitude of people in Northern Ontario toward EMR-based-PHR innovative technology. The results indicate that there is interaction with a medium-effect size between the two variables degree and ethnicity ($p =.042 < .05$, $\eta 2= .104$). The effect of the type of degree and the type of ethnicity seems to be dissimilar in Northern Ontario toward adopting EMR-based-PHR innovative technology. The difference in the attitude between degree types is not the same for all ethnicity categories. In addition, there is interaction with a medium-effect size between age, degree and ethnicity. Results indicated a significant main effect for the three variables ($p =.007 < .05$, $\eta 2=083$). However, by a significant interaction between the three variables, the attitude toward adopting EMR-based-PHR effects were not the same for the three variables. On the other hand, the effect size between the variables indicate the percentage of variance in each of the effects (or interaction) and its associated error that is accounted for by that effect. Therefore, starting with degree types, the value of 0.081 indicates that 8.10% of the variance between subjects is accounted for by degree, though between the degree types and the

ethnicity types, the interaction accounts for a somewhat larger 10.4%. As well, between the degree types, age and ethnicity, the interaction accounts for slightly less than 8.30%. This means that we fail to reject our hypotheses that the interaction between the following factors will have no significant effect on the behavioural attitude of people in Northern Ontario toward EMR-based-PHR: age and sex; age and degree; age and ethnicity; sex and degree; sex and ethnicity; age, gender, and degree; age, sex, and ethnicity; sex, degree, ethnicity; and age, sex, degree, and ethnicity.

Implications

The pattern of results among Northern age, gender, ethnicity and their attitude toward PHR matches with the study hypothesis and our expectation. Generally, no demographic differences, except for education, were found to be significant in the behavioral attitude. This result is consistent with some studies and contradicts other studies in showing there is no significant effect of patient's user characteristics on their acceptance of health technologies. For example, Or and Karsh (2009) conducted a systematic review of patient characteristics and their effect on the acceptance of health technologies. They examined 39 studies and among them, age in 26 (67%) studies had a significant effect on the patient's acceptance, while in 11 it did not. Gender as a factor also showed no effect in 84% of these studies, but education as a factor did influence acceptance: 68% of 28 studies showed that acceptance increased with higher education, which is consistent with our results. It seems that patients with a bachelor's degree and higher have more ability to adopt the PHR system; this result is also consistent with other studies such as Ammenwerth *et al.* (2012), Mossaed *et al.* (2015),and Wen *et al.* (2010). It is implied that Northern people with higher education have a better attitude toward PHR compared with those having grade 12 and college education, which also means that they have better skills

in technology and health literacy. Generally, we believe that education is the most important factor in improving the ability to understanding health information and new technology (Agarwal & Prased, 1999; Jian *et al.*, 2012). Therefore, the group of Northern people with bachelor or master's degrees will be the first adopters, which could be helpful if they demonstrate their engagement with this technology in their communities in the future. More than half of our participants are placed in the technology generation category, which implies that dealing with e-health technology could become another application in addition to the many that they are already using in their routine life. Indeed, as we mentioned above, this result implies that working on e-health applications, as a long-term investment is more worthwhile than spending money for the early technology generation to adopt these systems. For example, investing in a new education system with an application such as an e-learning system will provide the most effective results.

5.3.2 Northern people's behavioral attitude toward adoption of EMR-based-PHR

To understand Northern people's perceptions and barriers toward adoption of EMR-based-PHR innovative technology, question number 3 has been divided into eight sub-questions distributed into managerial, technological, and sociological/psychological constructs that predict their attitude.

5.3.2.1 Governmental and managerial factors

Relationship 2: Between influencing external factors (Governmental Incentives, Physicians Support and Hospital Management Support) and the perceived usefulness variable of EMR-based-PHR

Relationship 3: Between influencing external factors (Governmental Incentives, Physicians Support and Hospital Management Support) and the perceived ease of use of EMR-based-PHR

Principal Findings

Multiple regression analyses were used to predict the perceived usefulness and perceived ease of use of EMR-based-PHR from a number of influencing variables: governmental incentives, physicians support and hospital management support (as shown in Tables 4.49 and 4.50). The variables explained 46.6 % of variance in the PU and 34.8 % of variance in the perceived ease of use. The results indicate positive predictive relationships between physician support and perceived usefulness ($\beta = .390$, $p = .000 < .001$), hospital management support and perceived usefulness ($\beta = .206$, $p = .002 < .01$), and the governmental incentives and perceived usefulness ($\beta = .173$, $p = .001 < .01$). In addition, the results indicate positive predictive relationships between physicians' support and perceived ease of use ($\beta = .247$, $p = .000 < .001$), hospital management support and perceived ease of use ($\beta = .233$, $p = .001 < .01$), and the governmental incentives and perceived ease of use ($\beta = .193$, $p = .001 < .01$).

Implications

For Northern people, ease of use and usefulness of PHR require support from their family doctors, hospital and the government. The findings indicate a significant role for physicians in supporting their patients, which is normal considering that patients often follow their physicians' instructions (Archer *et al.,* 2011). This is a promising future trend to accelerate the adoption of PHR among patients. Northern physicians have to encourage their patients to use e-health technologies, starting by establishing communication through the available technologies such as email. Sharing patients' parts of their EMR records will encourage patients to engage positively in health self-management (Archer *et al.,* 2011). In doing so, some physicians may fear that the electronic relationship will threaten their control, autonomy, and authority over their patients (Tang *et al.,* 2006). Other physicians will be concerned with potential risks, including inaccurate

information, the reliability of data, threats to patient privacy, interoperability of data, and lack of reimbursement (Kraan *et al.,* 2015; Li, 2015; Tang *et al.,* 2006; Spil & Klein, 2014; Wynia *et al.,* 2011). The lack of reimbursement also comes from losing visit fees through potentially reducing follow up visits. The electronic relationship will be a future requirement for all parties in reducing the waiting time created by the shortage of physicians; therefore, both physicians and patients must change their approach in accepting the trend toward electronic communication. Northern physicians must learn to encourage their patients to enter and use the health information accurately and build trust among their patients, motivating them to change the traditional way (Tang *et al.,* 2006).

To motivate both Northern physicians and patients using this technology, the policy makers in hospital management and government alike also play an important role. They have to reduce the fears of physicians and motivate the patients by taking real actions, such as considering the risks that have been anticipated by physicians (Wynia *et al.,* 2011), and presenting some degree of shared care and exchange of information (Iakovidis, 1998). They must also overcome the financial obstacles identified among Canadian physicians in providing patients access to their electronic records (Urowitz *et al.,* 2008), and consider the opportunity cost that the government will pay in the waiting list of patients among clinics and hospitals. Tang *et al.* (2006) suggest several examples of motivating people to use the PHR, arguing that "a tax deduction for PHR-related expenses may promote adoption" (p. 124). The support from the policy makers has to be done through a complete coordination of all parties. Our century has produced the technology generation that has the ability to use technology everywhere. Educational institutions have a role to play in enhancing the future usage of EMR based PHR among Canadians. Developing a curriculum plan with coordination between the health ministry

and education ministry to train the present and future generations through a simulation of these systems will reduce future barriers among many users. The electronic relationship between physicians and patients is similar to the electronic relationship between teacher and students using e-learning systems. This means that building a demo of a system that communicates the reality of EMR-based-PHR is not difficult; therefore, the existence of these demos in the education system will help make their use familiar over time.

5.3.2.2 Technological factors

Relationship 4: Between the perceived usefulness variable and the perceived ease of use variable toward adopting EMR-based-PHR.

Relationship 5: Between influencing technological factors (Perceived Usefulness, Perceived Ease of Use, Compatibility and Communicability) and the behavioural attitude toward adoption of EMR-based-PHR

Principal Findings

To examine relationship 4, a simple regression model indicates that the perceived ease of use variable has a strong and positive predictive relationship ($\beta = .820$, $p = .000 < .001$) with perceived usefulness (as shown in Tables 4.48 and 4.51). Moreover, to know which factors have more influence in relationship 5, a multiple regression was conducted by including the technological factors associated with behavioural attitude. The model explained 58.3% of variance in the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR. Generally, the model results presented a non-significant prediction and a negative influence of the perceived ease of use on the behavioural attitude ($\beta = -.081$ seven, $p = .210 < .05$). The results of another model presented a significant positive prediction of the perceived usefulness on the behavioural attitude ($\beta = .305$, $p = .000 < .001$), a significant positive

prediction of the compatibility on the behavioural attitude ($\beta = .204$, $p = .005 < .05$) and a significant positive prediction of the communicability on the behavioural attitude ($\beta = .409$, $p = .000 < .001$).

Implications

Northern people evaluate PHR in terms of its technological characteristics and perceived usefulness in their self-care. The technological characteristics that have been adopted from Davis TAM and Rogers IDT provide a framework for predicting users' attitudes toward using the PHR system in both healthcare and academic settings. The perceived usefulness, communicability and compatibility that should be offered by the PHR are considered to significantly affect Northern people's attitudes. The results indicated a positive relationship between Northern people's prior compatible experiences, needs, and values and their attitude toward adopting the PHR system that is consistent with several studies (Rogers, 1995; Agarwal & Prasad, 1997; Karahanna *et al.,* 1999).

In this result, perceived ease of use was considered the strongest predictor of the perceived usefulness of PHR technology use that matches with several studies (Bajaj & Nidumolu, 1998; Chau, 1996; Davis, 1989; Gefen & Keil, 1998; Hu *et al,* 1999; Igbaria *et al.,* 1997; Karahanna *et al.,* 1999; Kerr *et al.,* 2002; Kleijnen *et al.,* 2004). This means that Northern people are willing to adopt the PHR system, which proposes that Northern people will focus on the usefulness of the PHR itself in the future.

A PHR system that is perceived as easy to use and useful, will ultimately lead to effective results in improved healthcare outcomes (Kahn *et al.,* 2009; Ozok *et al.,* 2014). We also believe that the technology generation of Northern people appreciate accessing their electronic records online to save time instead of the long waiting time that they spend in their healthcare setting.

The PHR system is also compatible with these generations as indicated by their daily usage of social media, mobile applications and for those who completed education by using online systems. They are able and willing to communicate with their friends, peers and even teachers in a complete wireless communication technology environment. However, innovation is not only creating a great idea, as seen in Rogers' literature (2003), but also implementing these great ideas. The finding of this result implies actions that must be considered by healthcare policy makers, physicians and developers to improve the usability of PHR systems in the future. First, developers of PHR systems have to focus on decreasing the level of complexity in design, content and accessibility (Rogers, 2003), which will enhance the ease of use. As well, developers of PHR need to use simple technological strategies compatible with all ages and with their abilities to manage their health information. This includes applying the same design and contents of PHR systems on all technological platforms, including standalone, tethered and integrated PHR systems used on mobile devices or computers. Dealing with the same user interface on all technological platforms will give users a sense of familiarity with this technology as a part of their life. In addition, it is necessary to use uncomplicated terminology, since a number of patients believe that the medical terminology in most cases causes confusion (Ozok *et al.*, 2014). This result may provide the opportunity to predict Northern people's future adoption and also to apply PHR as a demo (prototype) in early stages to understand its ease of use. This demo will show that PHR systems are easy-to-use through organizing workshops for physicians and patients to increase their awareness and knowledge about the PHR and its benefits. As well, combining this result with the previous study of Curtis *et al.* (2011), which asks to apply the best practices on PHR systems (MyChart) at Sunnybrook hospital, will improve the usability of these systems. Examples of these practices will facilitate the usability in several ways; the health

information in the PHR should be up-to-date and presented in a cognitively accessible way, and the PHR should be technically accessible and help in the decision support (Curtis *et al.,* 2011). Second, establishing ease of use of the PHR system depends on physicians' level of support and their desire to develop an electronic relationship with their patients. Therefore, it is important to communicate with physicians by implementing a plan that encourages them to act as main supporters in the communication process with their patients. Physicians can collect information about patients' interests and abilities, and they can evaluate their abilities using several criteria. In addition, they have to generate awareness among their patients about the benefit of these technologies, particularly in the waiting time for healthcare. In addition, they can create a list of the potential patients who need advice and ask the hospital to create a special training program. Third, health policy makers must create the necessary environment to implement the PHR, providing information, resources, and support to help people in their usage. The support must be established in the early stages of the implementation by providing technical, financial, and other services that make using PHR a reality.

5.3.2.3 Sociological factors

Relationship 6: Between influencing sociological factors (Open to Change, Awareness toward E-health, and Quality of Healthcare Services) and the behavioural attitude toward adopting of EMR-based-PHR.

Principal Findings

The regression model explores relationship 6 by including sociological influences (Open to Change, Awareness toward E-health, and Quality of Healthcare Services) associated with behavioral attitude, the model explained 60.6 % of variance in the behavioural attitude toward

adopting EMR-based-PHR (as shown in Table 4.52). The model results indicate a significant positive prediction of the open to change on the behavioral attitude ($\beta = .344$, $p = .000 < .001$), a significant positive prediction of the awareness toward e-health on the behavioral attitude ($\beta = .116$, $p = .002 < .01$), and a significant positive prediction of the quality-of-healthcare-services on the behavioral attitude ($\beta = .475$, $p =. 000 < .001$).

Implications

The positive relationship between quality of healthcare and attitude toward adopting EMR-based-PHR confirms the need of people to improve their healthcare through the updated information technology. The perception of Northern people on the role of e-health in improving quality of healthcare is positive. This point itself also confirms that people believe that technology reduces interruptions to their daily routines when accessing healthcare and health information. As well, the result shows the positive level of awareness among Northern people and their openness to adapt to changes. The overall influence of the three variables on attitude toward adopting EMR-based-PHR is significant. These results need to be appreciated by health policy makers and physicians alike. Increased attention must be paid to expanding the personal health records in Northern Ontario. The results of this attention will ultimately lead to improving the quality of healthcare services. Better communication with physicians will lead to improving the quality of health services through the physician–patient electronic relationship (Vydra *et al.,* 2015; Wald *et al.,* 2007). Involving electronic messaging between physicians and patients alongside face-to-face communication can improve the quality of health services, lessen healthcare costs, and reduce unfavorable outcomes (Halamka *et al.,* 2008; Kittler *et al.,* 2004; Vydra *et al.,* 2015).

This result gives an understanding of Northern people's preferences, which is consistent with patient enthusiasm in exchanging health information, accessing electronic health systems to make informed decisions, as well as believing that the PHR system may improve the quality of healthcare services (Abramson *et al.,* 2014; Fisher *et al.,* 2009; Simon *et al.,* 2009). The attitude of Northern people toward change is positive in their desire to adopt EMR-based-PHR innovative technology. Health policy makers in Northern Ontario must utilize this indicator by conducting workshops that enable physicians to establish electronic communication with their patients and also to increase confidence among people to adopt the PHR system. In addition, their awareness was a significant predictor of Northern people adopting the PHR system. That means that benefit from having access to their health information requires more support from all stakeholders, in particular through open discussions with their physicians (Ross & Lin, 2003; Wiljer *et al.,* 2008). People's awareness of PHR benefits will engage them in both electronic and face-to-face interaction in the future. The engagement will develop through education materials, which will be created through physician cooperation by encouraging patients to ask more questions online (Glowacki, 2015; Gruman *et al.,* 2010; Hoffmann & Worrall, 2004)

One of the study objectives is increasing the awareness of the PHR system among Northern people. Generally, several studies showed that most people are unaware of the benefits of having a PHR in their healthcare and some worry about security issues (Glowacki, 2015; Gearon, 2007; Nazi, 2013). As a result, a greater awareness of healthcare information combined with public oriented resources will have led many Northern patients to increasingly use the Internet (Tang *et al.,* 2006). A positive factor is that educated people with high awareness will lead to more choices for PHR functionality, which requires developers to revise their current

PHR offerings and improve them. This will also improve the quality of healthcare services (Halamka et al., 2008; Silow-Carroll *et al.,* 2012).

5.3.2.4 Psychological factors

Relationship 7: Between influencing psychological factors (E-Health Literacy, Computer Self-efficacy, and Computer Anxiety) and the behavioural attitude toward adopting EMR-based-PHR.

Relationship 8: Between influencing psychological factors (E-Health Literacy, Computer self-efficacy, and Computer Anxiety) and the perceived behavioural control toward adopting EMR-based-PHR

Principal Findings

The regression model here investigates the psychological influences (E-Health Literacy, Computer self-efficacy, and Computer Anxiety) associated with behavioral attitude. The model explains 36.9% of variance in the behavioural attitude of the people of Northern Ontario toward adopting EMR-based-PHR (as shown in Table 4.53). The results indicate a significant positive prediction of the e-health literacy factor for the behavioral attitude ($\beta = .266$, $p = .000 < .001$), a significant positive prediction of the computer self-efficacy factor on behavioral attitude ($\beta = .356$, $p = .000 < .01$), and a significant negative prediction of computer anxiety on behavioral attitude ($\beta = -.126$, $p =. 007 < .05$). Another multiple regression analysis was conducted to examine the influences of the psychological factors associated with perceived behavioral control; the model explains 37% of variance in the perceived behavioral control, which is similar to the previous result. The model results indicate a significant effect and a positive influence of the e-health literacy on the perceived behavioral control ($\beta = .366$, $p = .000 < .001$). A significant effect and a positive influence of the computer self-efficacy on the perceived behavioral control

(β = .311, p = .002 < .01), and a non-significant effect of the computer anxiety on the perceived behavioral control (β = .002, p =. 962 >005).

Implications

Although Northern people indicate their acceptance of e-health technologies, some physicians worry about patient ability, anxiety, distress and confusion, which brings a greater work load for healthcare providers (Earnest *et al.,* 2004; Walker *et al.,* 2011; Woods *et al.,* 2013). Therefore, using computer anxiety, computer self-efficacy and e-health literacy as predictors of PHR acceptance will reduce Northern physicians' worries. In our results, computer self-efficacy and e-health literacy play a significant role in shaping Northern people's attitudes, with no significant effect of computer anxiety. These results are consistent with others that have used these variables as predictors of acceptance of new technologies (Compeau & Higgins, 1995; Compeau *et al.,* 1999; Hsu & Chiu, 2004; Kim & Abner, 2015; Mossaed *et al.,* 2015; Venkatesh, 2000; Tripathi *et al.,* 2009; Wen *et al.,* 2010). This result confirms their suggestions, by encouraging a positive behavioural attitude by Northern people toward the PHR system in several ways. Encouragement will be through support from Northern healthcare institutions, including medical staff. This will be achieved through training programs and workshops that have mechanisms to increase the level of computer self-efficacy and decrease anxiety, which by default will also increase the level of e-health literacy.

Low computer self-efficacy affects the usage of new technology due to concerns regarding privacy and security in the adoption of PHR (Jian *et al.,* 2012). However, the present study did not find this result, leading to the acceptance of its hypothesis. In addition, computer anxiety has a direct negative relationship with attitudes toward using new technology such as PHR, which is consistent with other studies in this finding (Archer & Cocosila, 2014; Venkatesh

et al., 2003). For e-health literacy, this result implies that Northern people do not indicate a lack of health literacy as a factor affecting PHR adoption. In e-health tasks, mixed results were found in Northern people's PHR self-management skills. In addition, it was found that a low percentage of Northern people believed in their ability to perform several tasks online. Because the present study explores only perception of ability for future use, this result is reasonable and can be remedied with future support from healthcare stakeholders. Generally, the skills to increase health literacy in PHR adoption require real practice by actually using this system. To fully engage Northern people in the PHR system, we suggest using health literacy principles that have developed through educational materials and focusing on privacy and security issues (Tripathi *et al.,* 2009; Wen *et al.,* 2010).

Additionally, further research should explore the understanding of e-health literacy in relation to users' characteristics, particularly age and education differences. Less computer or health literacy is usually present in older patients, who bring with them a negative attitude toward technology such as PHR systems (Or & Karsh, 2009; Patterson *et al.,* 1997). In addition, some studies show that patients with a higher level of education have improved health literacy compared with those patients who are less educated (Levinson *et al.,* 2005; Mossaed *et al.,* 2015; Peters *et al.,* 2009). To obtain thorough evidence, this study focuses on several variables simultaneously concerning initial steps in the adoption of PHR. Therefore, future research should investigate those specific variables to show the change in Northern people's self-efficacy, anxiety and their level of health e-literacy regarding PHR. However, low computer efficacy and high computer anxiety lead to low usage of PHR, which results in wasted government expenditure in these e-health systems. The model of these three variables explains the relatively low percentage concerning our ability to predict the behavioral attitude of Northern

people toward PHR. This implies that our model must include more variables that may be directly affecting this population.

5.3.2.5 Interdisciplinary factors

To implement new technology (e.g. PHR systems), we need to understand how different factors including human, technological, organizational, and sociological simultaneously affect adoption (Karsh & Holden, 2007). Therefore, merging all factors demonstrates two relationships, detailed below.

Relationship 9: Interdisciplinary variables' (managerial, technological, sociological, and psychological) prediction of behavioural attitude of the people of Northern Ontario toward adopting of EMR-based-PHR.

Principal Findings

A hierarchical multiple regression analysis was conducted to examine the influences of the interdisciplinary factors associated with behavioral attitude. The model of technological predictors was statistically significant ($F(4, 320) = 111.737$; $p = .000 < .001$) and explained 58.3% of variance in the behavioral attitude (as shown in Table 4.54). After entry of sociological factors at model 2, the model has been improved and the total variance explained as a whole was 66.3%, ($F(7, 317) = 89.042$; $p = .000 < .001$). The introduction of sociological factors explained an additional 8% variance in the behavioral attitude. After entry of psychological variables at model 3, the model improved slightly and explained an additional 1.7% to become 68%, ($F(10, 314) = 66.867$; $p = .000 < .001$). After entry of managerial variables in the final model, a slight improvement, an additional 1.6%, was shown on the model; therefore, the total variance explained as a whole was 69.6%, ($F(13, 311) = 54.897$; $p = .000 < .00$). As a result, in the final model, eight out of thirteen predictor variables were statistically significant, with quality of

healthcare services recording a higher Beta value (β =. .277, p < .001) than the perceived usefulness (β = .209, p < .001) and communicability (β =. 190, p < .01). This positive result guides us to extend our analysis to examine more variables from several technological acceptance models in the literature.

Relationship 10: Between influencing the combination of interdisciplinary variables (managerial, technological, sociological, psychological, the behavioural attitude and perceived behavioural control) and the behavioural intention of the people of Northern Ontario toward adopting of EMR-based-PHR.

A second hierarchical multiple regression analysis was conducted to examine the influences of the interdisciplinary factors of relationship number 10 associated with behavioural intention. The model of technological predictors was statistically significant (F (4, 320) = 132.028; p= .000 < .001) and explained 62.3% of variance in the behavioural intention. After entry of the behavioral attitude at model 2, the model was improved, and the total variance explained as a whole was 68.8%, (F (5, 319) = 140.912; p=.000 < .001). The introduction of the behavioral attitude variable explained an additional 6.3% of variance in the behavioural intention. After entry of sociological variables at model 3, the model also was improved and explained an additional 6.1% to become 74.1%, (F (8, 316) = 112.968; p=.000 < .001). After entry of psychological variables at model 4, the model was improved slightly and explained an additional 3.7% to become 74.4%, (F (11, 313) = 82.565; p=.000 < .001). After entry of the perceived behavioural control variable in the final model, a slight improvement, an additional 0.01%, was shown on the model; therefore, the total variance explained as a whole was 74.5%, (F (12, 312) = 75.983; p=.000 < .00). As a result, in the final model, five out of twelve predictor variables were statistically significant, with quality of healthcare services recording a higher Beta

value (β =. 338, p < .001) than the perceived usefulness (β = .242, p < .001) and the behavioral attitude variable (β =. 190, p < .01).

Implications

The implications of the interdisciplinary results simply reflect the combined previous findings and implications. According to the above results, we believe that the adoption of EMR-based-PHR innovative technology in Northern Ontario requires several perspectives to succeed. This confirms that interdisciplinary studies can solve complex problems in real life, requiring serious efforts from all stakeholders. However, one of the greatest barriers to applying electronic records in Canada described in the literature is the lack of coordination among stakeholders. Therefore, the present study implies that healthcare policy makers must consider the sixteen variables with their findings and implications together. Accordingly, they should build a sub plan of change management for PHR adoption and connect it to the original change management plan of EMR adoption mentioned in our study by considering all these variables in conjunction with the coming recommendations.

Objective 4: To align strategies and resources according to Canadians' expectations in order to develop a framework for meaningful use of the EMR-based-PHR innovative technology in a cost-effective and sustainable manner.

5.4 Recommendations

The results of the statistical analyses in this study have led us to the development of recommendations in the areas of educational, technical, governmental and managerial, physician, and financial supports. The following are recommendations for healthcare policy makers to increase the adoption of EMR-based-PHR innovative technology in Northern Ontario for both patients and physicians.

5.4.1 Educational Support

- Establish a high school course for students in electronic computer applications to teach them how they can conduct daily life transactions not just in e-health applications, but also in e-passport, e-banking and other e-business applications.
- Provide elective courses for university students in e-government transactions that include health, education, business and required courses for nursing and medical students in e-health applications including EMR and PHR.
- Provide seminars and workshops about the cost/benefits of these applications, and how, for example, the EMR-based-PHR system will save people time and money and improve the quality of their healthcare.
- Provide counselling and assistance through training manuals and a framework for all users.

5.4.2 Technical support

- We recommend a new strategy to solve technical problems that are related to EMR-based-PHR systems, through providing a scalable reliable e-health network that solves technical glitches, solves interoperability problems and provides compatible systems for all users, whether providers of service or receivers.
- To guarantee adoption of PHR by Northern people adoption in the future, we recommend that the most important constructs for the policy makers to work on are ease of use and the perceived usefulness of the PHR. Both constructs must be synchronized through simplifying the usage and maximizing the benefits at the same time and encapsulating them in secure domain.
- PHR developers must consider all users' needs in designing a user-friendly interface that enhances Northern people's perception of PHR usefulness and ease of use. The

consideration of user needs has to cover gender, education level and all age categories in accessing their records. For example, including features that enable visual and hearing impaired users to control their data by minimizing or maximizing the font size, changing the colors and cursor help information.

- As a proactive procedure for semi and early technology generations in performing technology tasks, we recommend standardizing the record design, terminologies, security features and communication process among all healthcare providers and patients to simplify the process, particularly in the initial stage of the implementation.
- As we discussed in the literature, there are several options to store patients' records. Therefore, to provide flexibility to store and maintain these records, we recommend providing patients with several storage options to save their data on USB, mobile devices, laptops and desktops.
- To reduce patients' security fears, minimize patient errors, and interruptions of PHR service, we recommend that special procedures should be included in the design and implementation of PHR systems that create a control environment to protect PHR software/hardware, data exchanges and all parties' information.
- Since we believe that physicians play the most important role in the adoption process of PHR, we recommend a plan that combines physicians, administrative staff, and patients in designing the future PHR system.

5.4.3 Governmental and managerial support

- The most important issue noted in the literature is the lack of coordination between all stakeholders in the implementation process. Therefore, we recommend a national strategy improving coordination between the human, technological, organizational, and

governmental perspectives for implementing a PHR (patient portal) that combines the joint efforts of the four perspectives.

- Coordination requires massive efforts to change and develop new regulations and policies that are able to remove legal barriers in sharing health information, financial barriers in considering electronic communication unreimbursed from the physician side, and other barriers including attitude, time and workload.
- We recommend that Canada Health Infoway adopt a directive and transformational leadership style in applying their change management by working on resistance among healthcare providers with hard tactics.
- We recommend a strategy that enhances the engagement of all parties in a practical way, through establishing an electronic communication process that begins with simple tasks, such as reading some results and making appointments through email, which gradually enhance both computer and health literacy.
- We recommend providing motivational systems for those who help in the adoption process from all parties, such as health care providers, patients, e-health developers and administrative people.
- Learning from others in their faults and experiences will help all stakeholders in the implementation process; we recommend that policy makers must develop a benchmark with similar stories such as Sunnybrook's MyChart in Toronto to learn from weaknesses and strengths in the implementation process of their PHR system.
- The adoption process of a new technology is usually simplified by increasing people's awareness about its benefits. Knowing its potential for reducing the waiting time in the Canadian healthcare system will make them appreciate the usage of PHR system. Therefore,

we recommend that healthcare policy makes establish a strategy to increase Canadian awareness about e-health systems as a future trend in their lives and as a tool that will facilitate and improve their healthcare services.

- The slow adoption of the use of EMR among Canadian physicians despite huge financial support from the government raises questions regarding management of this problem. We believe that the power of Canadian physicians comes from the current shortage of physicians, which creates high workloads and makes less willing to learn to use e-health systems in their practice. Therefore, we recommend that health policy makers modify their strategy in increasing the number of physicians in several ways such as:
    a) Reduce the regulations on international degrees when immigrating physicians come from accredited medical schools and place those doctors who have recently immigrated in a practical training program with physicians in the field to gain relevant practice, rather than requiring they spend many years to qualify their degrees.
    - Collaborate with international medical schools, according to Canadian standards, to qualify students to work in the Canadian healthcare system. The intention of this strategy is to facilitate easier movement between healthcare systems in different countries, providing international experience for medical students and physicians.
    - A new agreement strategy should be established as a declaration of e-health benefits from healthcare policy makers, physicians and patients to accept implement and use the e-health applications.
    - A new change management plan that has a clear future vision should be recognized by Canada Health Infoway including healthcare policy makers, physicians, patients, e-health applications developers, medical schools, researchers and all related parties whether

legally, socially, economically and psychologically by municipal, provincial, territorial and federal governments.

- A new strategy to support Canadian rights in accessing their health information, reduce computer anxiety, and improve e-health literacy through physicians and training programs.

5.4.4 Physician support for their patients

- PHR as a patient system completely depends on EMR as a physician system; therefore, we recommend that the Canadian government should combine patients and physicians together as partners in both adoption and implementation approaches through one-to-many relationships. For example, each family physician has a complete responsibility on his/her patient list to follow up and support them in this domain.
- We recommend a gradual culture shift in the healthcare system through encouragement by physicians to replace some of the face-to-face communication to online communication, particularly in taking appointments, following up with good results, completing referral charts, and prescribing drugs.
- Many physicians might hesitate about dealing with their patients electronically, but our results indicate that technology generations are able and willing to communicate online. We recommend that physicians have to support and motivate their patients and increase their belief in themselves.

5.4.5 Financial and motivational support

- Measuring the e-health usage and performance among healthcare providers will create a follow-up system to distinguish them in their performance and approach the problems at the

same time. Therefore, we recommend a measurement system such as a balanced scorecard of e-health usage that enables follow-up and progress in the adoption process.

- New federal funding should be allocated to support a sub-management change plan facilitating patient adoption of the PHR system.
- The federal government should provide funding for all educational supports and research initiatives, such as training programs in hospitals, online materials, and assistive technology for people with disabilities.
- Through coordination with provincial governments and the Health Ministry, educational institutions should offer credit courses with tuition relief in e-health applications.

Chapter 6 Conclusions, Contributions, and Future Research

6.1 Background

This final chapter highlights the study conclusions through summarizing the most salient points in the previous chapters. In addition, it describes the added value and the contribution of this study in the research setting. General future directions are formulated as a guideline for researchers who would like to follow the progressive adoption and implementation of the EMR-based-PHR innovative technology in Northern Ontario.

6.2 Conclusions of the Research

Canada is one of the modern countries that always tries to develop its information technology infrastructure to satisfy Canadians' needs. One of the development policies is allocating time and money to adopt innovative technologies in the service sector. For example, while Canada allocated billions of Canadian federal dollars for the health and education sectors to use and adopt the innovative technology, we see that Canada's rank in innovation compared to other countries is still low. Focusing on one important sector in Canada, this study investigated Canadian perceptions toward one application in the healthcare sector related to e-health applications. Therefore, this study was conducted to achieve four objectives. The first explored interdisciplinary factors that affect a group of Canadians' attitudes toward one application in the healthcare sector called the PHR system as a part of the future electronic communication process between physicians and patients. As a proactive approach, two objectives have been linked with the first one: to increase the awareness of those people about PHR system concepts, benefits and electronic tasks, and to quantify their perception about PHR system within measurable factors to be used by the healthcare policy makers in future implementation processes. The final objective was a result of these measured factors, suggesting strategies that could help healthcare policy

makers in the implementation process of the EMR-based-PHR innovative technology in a cost-effective and sustainable manner.

To achieve the study objectives, two approaches were employed by using empirical research methods to answer several research questions. The first approach was a comparative analysis between Northern physicians and patients to explore their perspectives about the electronic communication process in their relationships. The data included secondary data from the NPS related to Northern physicians and primary data collected through a survey of Northern patients. That second approach explored sixteen interdisciplinary factors, including governmental, managerial, technological supports, as well as sociological and psychological variables, and their impact on the attitude of Northern patients toward adopting the EMR-based-PHR innovative technology. The survey of Northern patients used to collect primary data was conducted to address both approaches; the first part of the survey was used to make comparisons, and the second part related to the interdisciplinary factors of the second approach.

Several statistical tests were conducted in both approaches to test the study hypothesis, including descriptive analysis, Z Test for two population proportions, One-Way ANOVA, Univariate ANOVA and Regression Analysis. The study findings also indicate several interpretations and implications. Generally, the principal findings of the comparative analysis demonstrate that Northern patients use websites, social media and mobile applications more than Northern physicians. Female Northern physicians use e-health services more than their male counterparts, and more female Northern patients would like to use e-health services than the male patients. In addition, the younger generation of Northern patients and physicians use, and would like to use, e-health services more than older generations. The principal findings of the second approach demonstrate that those interdisciplinary factors of EMR-based-PHR were

significant predictors of Northern people's attitudes towards and intention to adopt this innovative technology. However, the findings of the Northern patients' survey show that those people welcomed the implementation of EMR-based-PHR innovative technology in their region. The younger age appreciated this technology, in particular the females, who prefer to contact their healthcare providers by using several e-health applications. A small number of Northern people do not like the change and implicitly resist the introduction of the patient-physician electronic relationship in their healthcare services. The Canadian healthcare providers have to consider many issues in the implementation of EMR-based-PHR innovative technology in Northern Ontario, such as asking healthcare providers to encourage their patients to communicate electronically in some basic tasks. Regarding the technological aspect, the complexity of these systems should be reduced in the future because ease of use was the most important technological factor impeding attitudes toward adopting EMR-based-PHR in Northern Ontario. The provision of strong educational materials that lead physicians and patients to use electronic communication in their healthcare services is also important.

6.3 Contributions of the Research

The contribution of this study is its uniqueness in this region and in achieving its objectives at the same time. This is the first study that predicts Northern people's perceptions of adopting the PHR system through interdisciplinary factors in Northern Ontario. As well, this is the first study to compare answers between healthcare providers and healthcare receivers in the same region to explore both parties' perspectives on e-health applications.

The study has contributed to society by increasing the awareness of a group of people. We believe that those who filled out the survey have received valuable information about e-health applications in the Canadian healthcare sector. The knowledge acquired by these people

will spread through their relationships (relatives or friends) to include a greater number of Northern people. The study also contributes to the related decision makers in Northern Ontario in their implementation of e-health applications in the future; it acts as a ready-made quantitative study to use as a benchmark in their future decisions. Finally, the study has contributed to community e-health research by studying factors from several disciplines and applying those factors to serve technology implementation.

6.4 Future Research Directions

To generalize the adoption of PHR system among Canadian provinces, we suggest future research that covers other areas in Canada. A future study to measure the development of Northern patients' perceptions toward e-health applications has been recommended in this study to provide another milestone in the progress of Northern people's perceptions. We also recommend future research to measure factors from the perspectives of the Canadian health organizational context that are related to the implementation process of the PHR system.

In addition, we suggest future research that has the ability to measure Northern people's attitudes and perceptions according to a real demo of the PHR system that is able to transfer paper records to electronic records. The measurements could use some of the present study's interdisciplinary factors in real-life application to study actual perceptions (e.g. self-efficacy, anxiety and their level of health e-literacy regarding PHR). Finally, we suggest future research that increases the awareness of e-health applications through defining practical benefits for both physicians and patients to encourage success in the use of these applications.

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Appendices

Appendix A: Estimated Marginal Means

1. GENDER

GENDER	Mean
Male	3.492[a]
Female	3.390[a]

a. Based on modified population marginal mean.

2. RACE

RACE	Mean
Caucasian/White	3.652[a]
Aboriginal	3.173[a]
Black	3.632[a]
Asian	3.415[a]
Other	3.109[a]

a. Based on modified population marginal mean.

3. AGE * GENDER

AGE	GENDER	Mean
<35 Technology Generation	Male	3.565[a]
	Female	3.775[a]
35-54 Semi Technology Generation	Male	3.491[a]
	Female	3.498[a]
55+ Early Technology Generation	Male	3.346[a]
	Female	2.638[a]

a. Based on modified population marginal mean.

4. AGE * DEGREE

AGE	DEGREE	Mean
<35 Technology Generation	None-Degree	3.917[a]
	Grade 12	3.382[a]
	Diploma	3.777[a]
	Bachelors	3.879[a]
	Masters	3.586[a]
	PhD	3.000[a]
35-54 Semi Technology Generation	None-Degree	2.111[a]

	Grade 12	2.933[a]
	Diploma	3.126[a]
	Bachelors	3.623[a]
	Masters	4.550[a]
	PhD	2.750[a]
55+ Early Technology Generation	None-Degree	2.438[a]
	Grade 12	2.592[a]
	Diploma	2.691[a]
	Bachelors	3.750[a]
	Masters	3.417[a]
	PhD	3.000[a]

a. Based on modified population marginal mean.

5. AGE * RACE

AGE	RACE	Mean
<35 Technology Generation	Caucasian/White	3.681[a]
	Aboriginal	3.458[a]
	Black	3.729[a]
	Asian	3.987[a]
	Other	3.283[a]
35-54 Semi Technology Generation	Caucasian/White	3.719[a]
	Aboriginal	3.375[a]
	Black	3.437[a]
	Asian	3.174[a]
	Other	3.700[a]
55+ Early Technology Generation	Caucasian/White	3.563[a]
	Aboriginal	2.333[a]
	Black	.[b]
	Asian	2.750[a]
	Other	1.833[a]

a. Based on modified population marginal mean.

b. This level combination of factors is not observed, thus the corresponding population marginal mean is not estimable.

6. GENDER * DEGREE

GENDER	DEGREE	Mean
Male	None-Degree	2.900[a]

	Grade 12	3.479[a]
	Diploma	3.328[a]
	Bachelors	3.497[a]
	Masters	4.183[a]
	PhD	2.875[a]
Female	None-Degree	2.667[a]
	Grade 12	2.882[a]
	Diploma	3.318[a]
	Bachelors	4.032[a]
	Masters	3.862[a]
	PhD	.[b]

a. Based on modified population marginal mean.

b. This level combination of factors is not observed, thus the corresponding population marginal mean is not estimable.

7. GENDER * RACE

GENDER	RACE	Mean
Male	Caucasian/White	3.713[a]
	Aboriginal	4.000[a]
	Black	3.333[a]
	Asian	3.178[a]
	Other	3.306[a]
Female	Caucasian/White	3.582[a]
	Aboriginal	2.806[a]
	Black	4.050[a]
	Asian	3.651[a]
	Other	2.940[a]

a. Based on modified population marginal mean.

8. AGE * GENDER * DEGREE

AGE	GENDER	DEGREE	Mean
<35 Technology Generation	Male	None-Degree	3.875[a]
		Grade 12	3.242[a]
		Diploma	3.552[a]
		Bachelors	3.966[a]
		Masters	3.406[a]
		PhD	3.000[a]

	Female	None-Degree	4.000[a]
		Grade 12	3.465
		Diploma	3.957
		Bachelors	3.792[a]
		Masters	3.946[a]
		PhD	.[b]
35-54 Semi Technology Generation	Male	None-Degree	1.000[a]
		Grade 12	4.000[a]
		Diploma	3.349[a]
		Bachelors	2.870[a]
		Masters	4.640
		PhD	2.750[a]
	Female	None-Degree	2.667[a]
		Grade 12	2.400[a]
		Diploma	2.993
		Bachelors	4.375[a]
		Masters	4.438[a]
		PhD	.[b]
55+ Early Technology Generation	Male	None-Degree	2.875[a]
		Grade 12	3.667[a]
		Diploma	2.850[a]
		Bachelors	3.500[a]
		Masters	5.000[a]
		PhD	3.000[a]
	Female	None-Degree	2.000[a]
		Grade 12	2.233[a]
		Diploma	2.531[a]
		Bachelors	4.000[a]
		Masters	2.625[a]
		PhD	.[b]

9. AGE * GENDER * RACE

AGE	GENDER	RACE	Mean
<35 Technology Generation	Male	Caucasian/White	3.718[a]
		Aboriginal	3.500[a]
		Black	3.467[a]
		Asian	3.910[a]
		Other	3.111[a]
	Female	Caucasian/White	3.644[a]

		Aboriginal	3.437[a]
		Black	4.167[a]
		Asian	4.065[a]
		Other	3.542[a]
35-54 Semi Technology Generation	Male	Caucasian/White	3.843[a]
		Aboriginal	5.000[a]
		Black	3.000[a]
		Asian	2.729[a]
		Other	4.250[a]
	Female	Caucasian/White	3.595[a]
		Aboriginal	2.833[a]
		Black	3.875[a]
		Asian	3.917[a]
		Other	3.333[a]
55+ Early Technology Generation	Male	Caucasian/White	3.603
		Aboriginal	4.000[a]
		Black	.[b]
		Asian	2.500[a]
		Other	2.000[a]
	Female	Caucasian/White	3.503[a]
		Aboriginal	1.500[a]
		Black	.[b]
		Asian	2.833[a]
		Other	1.750[a]

10. GENDER * DEGREE * RACE

GENDER	DEGREE	RACE	Mean
Male	None-Degree	Caucasian/White	3.250[a]
		Aboriginal	3.750[a]
		Black	4.000[a]
		Asian	1.750[a]
		Other	.[b]
	Grade 12	Caucasian/White	3.798
		Aboriginal	3.250[a]
		Black	2.750[a]
		Asian	.[b]
		Other	.[b]
	Diploma	Caucasian/White	3.846
		Aboriginal	.[b]

		Black	3.333[a]
		Asian	3.667[a]
		Other	2.583
	Bachelors	Caucasian/White	3.381
		Aboriginal	4.000[a]
		Black	2.625[a]
		Asian	3.750[a]
		Other	4.583[a]
	Masters	Caucasian/White	4.125
		Aboriginal	5.000[a]
		Black	4.000[a]
		Asian	4.475[a]
		Other	3.750[a]
	PhD	Caucasian/White	3.500[a]
		Aboriginal	.[b]
		Black	.[b]
		Asian	2.250[a]
		Other	.[b]
Female	None-Degree	Caucasian/White	3.833[a]
		Aboriginal	2.750[a]
		Black	.[b]
		Asian	1.500[a]
		Other	2.500[a]
	Grade 12	Caucasian/White	2.958
		Aboriginal	2.000[a]
		Black	3.500[a]
		Asian	3.350[a]
		Other	2.875[a]
	Diploma	Caucasian/White	3.742
		Aboriginal	2.875[a]
		Black	4.125[a]
		Asian	3.625[a]
		Other	2.444
	Bachelors	Caucasian/White	3.875
		Aboriginal	3.000[a]
		Black	4.250[a]
		Asian	4.389
		Other	.[b]
	Masters	Caucasian/White	3.667

		Aboriginal	3.500[a]
		Black	.[b]
		Asian	3.946[a]
		Other	5.000[a]
	PhD	Caucasian/White	.[b]
		Aboriginal	.[b]
		Black	.[b]
		Asian	.[b]
		Other	.[b]

11. AGE * GENDER * DEGREE * RACE

AGE	GENDER	DEGREE	RACE	Mean
<35 Technology Generation	Male	None-Degree	Caucasian/White	.[a]
			Aboriginal	3.750
			Black	4.000
			Asian	.[a]
			Other	.[a]
		Grade 12	Caucasian/White	3.727
			Aboriginal	3.250
			Black	2.750
			Asian	.[a]
			Other	.[a]
		Diploma	Caucasian/White	4.125
			Aboriginal	.[a]
			Black	3.333
			Asian	4.500
			Other	2.250
		Bachelors	Caucasian/White	3.643
			Aboriginal	.[a]
			Black	4.250
			Asian	3.389
			Other	4.583
		Masters	Caucasian/White	3.375
			Aboriginal	.[a]
			Black	3.000
			Asian	4.750
			Other	2.500
		PhD	Caucasian/White	.[a]
			Aboriginal	.[a]

			Black	.[a]
			Asian	3.000
			Other	.[a]
		None-Degree	Caucasian/White	.[a]
			Aboriginal	4.000
			Black	.[a]
			Asian	.[a]
			Other	.[a]
		Grade 12	Caucasian/White	3.375
			Aboriginal	3.000
			Black	3.500
			Asian	3.700
			Other	3.750
		Diploma	Caucasian/White	3.450
			Aboriginal	3.750
			Black	5.000
			Asian	4.250
			Other	3.333
	Female	Bachelors	Caucasian/White	4.000
			Aboriginal	3.000
			Black	4.000
			Asian	4.167
			Other	.[a]
		Masters	Caucasian/White	3.750
			Aboriginal	.[a]
			Black	.[a]
			Asian	4.143
			Other	.[a]
		PhD	Caucasian/White	.[a]
			Aboriginal	.[a]
			Black	.[a]
			Asian	.[a]
			Other	.[a]
35-54 Semi Technology Generation	Male	None-Degree	Caucasian/White	.[a]
			Aboriginal	.[a]
			Black	.[a]
			Asian	1.000
			Other	.[a]
		Grade 12	Caucasian/White	4.000

		Aboriginal	.[a]
		Black	.[a]
		Asian	.[a]
		Other	.[a]
	Diploma	Caucasian/White	3.714
		Aboriginal	.[a]
		Black	.[a]
		Asian	2.833
		Other	3.500
	Bachelors	Caucasian/White	3.500
		Aboriginal	.[a]
		Black	1.000
		Asian	4.111
		Other	.[a]
	Masters	Caucasian/White	4.000
		Aboriginal	5.000
		Black	5.000
		Asian	4.200
		Other	5.000
	PhD	Caucasian/White	4.000
		Aboriginal	.[a]
		Black	.[a]
		Asian	1.500
		Other	.[a]
Female	None-Degree	Caucasian/White	3.833
		Aboriginal	1.500
		Black	.[a]
		Asian	.[a]
		Other	.[a]
	Grade 12	Caucasian/White	2.800
		Aboriginal	.[a]
		Black	.[a]
		Asian	.[a]
		Other	2.000
	Diploma	Caucasian/White	3.714
		Aboriginal	2.000
		Black	3.250
		Asian	3.000
		Other	3.000

		Bachelors	Caucasian/White	3.625
			Aboriginal	.[a]
			Black	4.500
			Asian	5.000
			Other	.[a]
		Masters	Caucasian/White	4.000
			Aboriginal	5.000
			Black	.[a]
			Asian	3.750
			Other	5.000
		PhD	Caucasian/White	.[a]
			Aboriginal	.[a]
			Black	.[a]
			Asian	.[a]
			Other	.[a]
55+ Early Technology Generation	Male	None-Degree	Caucasian/White	3.250
			Aboriginal	.[a]
			Black	.[a]
			Asian	2.500
			Other	.[a]
		Grade 12	Caucasian/White	3.667
			Aboriginal	.[a]
			Black	.[a]
			Asian	.[a]
			Other	.[a]
		Diploma	Caucasian/White	3.700
			Aboriginal	.[a]
			Black	.[a]
			Asian	.[a]
			Other	2.000
		Bachelors	Caucasian/White	3.000
			Aboriginal	4.000
			Black	.[a]
			Asian	.[a]
			Other	.[a]
		Masters	Caucasian/White	5.000
			Aboriginal	.[a]
			Black	.[a]
			Asian	.[a]

		Other	.[a]
	PhD	Caucasian/White	3.000
		Aboriginal	.[a]
		Black	.[a]
		Asian	.[a]
		Other	.[a]
Female	None-Degree	Caucasian/White	.[a]
		Aboriginal	.[a]
		Black	.[a]
		Asian	1.500
		Other	2.500
	Grade 12	Caucasian/White	2.700
		Aboriginal	1.000
		Black	.[a]
		Asian	3.000
		Other	.[a]
	Diploma	Caucasian/White	4.062
		Aboriginal	.[a]
		Black	.[a]
		Asian	.[a]
		Other	1.000
	Bachelors	Caucasian/White	4.000
		Aboriginal	.[a]
		Black	.[a]
		Asian	4.000
		Other	.[a]
	Masters	Caucasian/White	3.250
		Aboriginal	2.000
		Black	.[a]
		Asian	.[a]
		Other	.[a]
	PhD	Caucasian/White	.[a]
		Aboriginal	.[a]
		Black	.[a]
		Asian	.[a]
		Other	.[a]

Appendix B: Approval for Conducting Research Involving Human Subjects

LaurentianUniversity
UniversitéLaurentienne

APPROVAL FOR CONDUCTING RESEARCH INVOLVING HUMAN SUBJECTS
Research Ethics Board – Laurentian University

This letter confirms that the research project identified below has successfully passed the ethics review by the Laurentian University Research Ethics Board (REB). Your ethics approval date, other milestone dates, and any special conditions for your project are indicated below.

TYPE OF APPROVAL / New X / Modifications to project / Time extension	
Name of Principal Investigator and school/department	Jamil Razmak, Human Studies, supervisors, Cynthia Whissell, Psychology, Charles Belanger, Management
Title of Project	Innovative technology is simple-- change management and human beings are complex: a study of three tales in regional communities
REB file number	2015-02-03
Date of original approval of project	March 6, 2015
Date of approval of project modifications or extension *(if applicable)*	
Final/Interim report due on: *(You may request an extension)*	March 2016
Conditions placed on project	

During the course of your research, no deviations from, or changes to, the protocol, recruitment or consent forms may be initiated without prior written approval from the REB. If you wish to modify your research project, please refer to the Research Ethics website to complete the appropriate REB form.

All projects must submit a report to REB at least once per year. If involvement with human participants continues for longer than one year (e.g. you have not completed the objectives of the study and have not yet terminated contact with the participants, except for feedback of final results to participants), you must request an extension using the appropriate LU REB form. In all cases, please ensure that your research complies with Tri-Council Policy Statement (TCPS). Also please quote your REB file number on all future correspondence with the REB office.

Congratulations and best wishes in conducting your research.

Rosanna Langer

Rosanna Langer, PHD, Chair, *Laurentian University Research Ethics Board*

Appendix C: Consent to Participate in Research

Laurentian University
Université Laurentienne

Consent to Participate in Research

Dear participant,

You are invited to participate in a survey entitled "Innovative technology is simple-- change management and human beings are complex: a study of three tales in regional communities" conducted by Jamil Razmak under the supervision of Dr. Cynthia Whissell from the Department of Psychology and Dr. Charles Belanger from the Department of Management at Laurentian University. The main purpose of this study is to explore the reasons for Canada's slow progress in implementing the use of electronic health innovative technology from the perspective of end-users such as yourself.

Your participation is voluntary, there is no psychological, emotional or health-related side effect associated with the survey. You have complete freedom to withdraw from this study if you experience a feeling of discomfort or stress at any time; you can withdraw without penalty. If you decide to fill out the survey, you will be asked to answer general questions related to e-health innovative technology and to rate your response to potential factors related to your interaction with, perception of, and attitude towards this technology. The survey will take approximately 20-30 minutes to complete.

Your participation is very important to the success of the study; however, there is no direct benefit to your participation other than increasing your awareness of the e-health situation. The future potential benefits to the scientific and scholarship community are to quantify Personal health record-based-Electronic Medical record innovative technology usage and acceptance from the end-user's perspective with measurable factors in e-health outcomes.

Your input is anonymous; this survey will not contain information that will identify you and the aggregated results from this survey will be used for academic purposes only.The hard copies of data obtained will be stored in a secure password protected cabinet in my supervisor's office at Laurentian University. The electronic data will be stored on my personal laptop. Access to computer files will be password protected. If you are interested in knowing the results of this study, you can browse the following webpage (http://jamilrazmakphr.co.nf/) on or after November 5, 2015; a report will be published there.

If you have any questions or concerns about the research, please feel free to contact me: Jamil Razmak at jrazmak@laurentian.ca or my supervisors: Dr. Cynthia Whissell at cwhissell@laurentian.ca or at (705) 675-1151 ext. 4251 or Dr. Charles Belanger: charles5@magma.ca at (705) 675-1151 ext. 3613.

If you have any questions about this research or any ethical concerns about your participation in the research, please contact the Research Ethics Officer in Laurentian University Research Office, whose telephone number is: 705-675-1151 ext 2436 (or toll free at 1-800-461-4030) and whose email address is ethics@laurentian.ca

Thank you for your time!

Name of Participant (please print)	Signature of Participant	Date

Appendix D: 2014 National Physician (NPS): Methodology/Design

National Physician Survey (NPS): Introduction

The National Physician Survey (NPS) is an ongoing collaborative initiative led by the College of Family Physicians of Canada (CFPC), the Canadian Medical Association (CMA) and the Royal College of Physicians and Surgeons of Canada (Royal College), with technical support from the Canadian Institute for Health Information (CIHI). All practicing physicians, medical residents and medical students in Canada are surveyed. The overall goal is to compile and maintain an up-to-date physician workforce database.

2014 National Physician Survey (NPS): Methodology/Design

The 2014 NPS evolved from questions used in the previous editions of the survey (2004, 2007, 2010, and 2013). Starting in 2012, the NPS made a number of changes to the survey. At that time, 2012 surveys were exclusively administered electronically. As well, surveys became shorter and focused on specific themes. The 2014 NPS survey focused on the **use and impact of information technology** on physicians in Canada. Initially stakeholders, internal to co-leader organizations and externally relevant health based organizations, were consulted. A working group was implemented to review and refine the questions from previous survey editions and stakeholder consultations. The goal of the refinement process was to reproduce a concise, user-friendly questionnaire relevant to the area of focus.

The 2014 NPS targeted the following constructs: demographics, patient care settings, use of electronic medical records (EMR); barriers to EMR use, electronic tools; clinical benefits experience by use of EMR's; EMR impact on productivity, and patient quality care; sharing of electronic record data; mobile applications; use of electronic tools in patient chronic conditions and care; telehealth technologies; and social media. The rationale for the questionnaire content was:

1. To repeat questions from earlier surveys;
2. To improve questions from previous editions of the NPS;
3. To focus on the use and impact of information technology on Canadian physicians;
4. To add new questions in response to new and/or developing issues.

The survey consisted of 25 questions, mostly close-ended. Some questions consisted of several sub-sections and multiple response categories, and thus the resulting database included about 300 data elements with more than three million data points. Most importantly, the breakdown into the following demographics (i.e., province, gender, age, physician type) was believed to help facilitate research and policy development for particular cohorts of physicians or patient populations.

The questionnaire and survey communications were available in both English and French. The questions were piloted in the January 2014 with a variety of physician committees and national specialty societies, and finalized in March 2014. The survey received ethical approval from the University of Saskatchewan Behavioural Research Ethics Board in January, 2014.

NATIONAL PHYSICIAN SURVEY | SONDAGE NATIONAL DES MÉDECINS

2014 National Physician Survey (NPS): Mailing List & Data Collection

Mailing List

The 2014 NPS was administered as a voluntary self-reported online survey. All physicians licensed to practise in Canada were invited to participate. The email contact lists were generated from the NPS Masterfile. The NPS Masterfile was populated with information from the CMA membership system, the CFPC membership database, and the Royal College membership database. All licensed physicians in full or part-time practices, locums, or employed in a medically related field, or on leave were eligible to respond to the survey. Medical students, residents, and retired physicians were not eligible.

Once fully populated, an NPS survey ID, not related to any existing member ID in any of the membership databases, was assigned to each record in the NPS Masterfile. The total number of cases in the NPS mailing database was 73,106. Email invitations contained a unique personalized link to the e-questionnaire. These links resulted in unique case numbers being recorded in the response database. These case numbers were used to ensure the confidentiality of physician responses. This system also ensured reminder emails were sent only to physicians who had not already responded. As well, the case numbers assigned to a physician can be used to link to future NPS surveys for longitudinal cohort analysis, if permission was granted by the physician.

Data Collection

The invitation e-mail and reminders were sent to all practising physicians in the NPS mailing database for whom a valid email address was available. Communications were sent in either English or French, depending on the physician's language of preference. The estimated time of survey completion was 15-20 minutes.

Of the 73,106 cases in the NPS mailing databases, 64,236 physicians were directly contacted via email. No email addresses were available for the remaining physicians. These physicians were accounted for by applying the weighting method; please see section below: *Sampling weights, estimation weights, and non-response adjustments.*

The data collection period lasted from Monday, April 28 – Thursday, July 3, 2014. Physicians were contacted on four separate occasions.

- An invitation to participate was sent on Monday, April 28, 2014.
- First reminder was sent on Monday, May 12, 2014.
- Second reminder was sent on Monday, May 26, 2014.
- A final reminder was sent on Monday, June 9, 2014

All responses were captured directly into one database.

Upon survey completion physicians were automatically directed to the online prize draw form. Participating physicians were eligible to enter a cash prize draw. Two $1,000 prize draws were available - an early bird prize available to physicians who had completed the survey by May 30, 2014 was drawn on June 9, 2014, and a draw for all other participating physicians during the data collection period drawn on Wednesday, July 9, 2014 . The winners' contact information was, and remains, completely separate from the questionnaire responses. The winners were contacted via

email, and given a choice to either donate the funds to a registered charity of their choice, or have the funds sent directly them.

2014 National Physician Survey (NPS): Response Rate

Of the 64,236 physicians contacted, 427 were found to be ineligible. An additional 8 physicians took advantage of the NPS Link finder. The NPS Link finder allowed any physician to complete the survey from non-direct means. Of the 63,817 physicians were invited to complete the 2014 NPS or found themselves through the link finder, 10,191 replied to the survey for an overall study response rate of 16 %.

National level estimates based on the 2014 NPS study results are considered accurate within +/- 0.97%, 19 times out of 20.

Sampling Weights, Estimation Weights, and Non-response Adjustment

Using weights to adjust for non-responses

Non-responses are typical of a census. Non-responses for eligible physicians were a result of physicians not responding to the survey, or physicians not being aware of the survey. Physicians with non-valid email were unable to receive direct NPS correspondence, since all communication was conducted electronically; however, they may have been made aware of the survey though other means and used the link finder to complete the survey. Response rates varied between demographic groups, leading to the possibility of unweighted estimates being unrepresentative, or biased.

To account for such potential bias, a method was used to weight data in such a manner as to be more representative of the total physician population. Weights are consistently used when analysing the 2014 NPS data. The non-response adjustments were performed at the provincial level by physician type, age-group, and sex, using the method of calibration (reference: Survey Methods and Practices. Statistics Canada catalogue no.12-587-XPE, 2003.) The reference population for this calibration was determined from the 2014 NPS frame file.

Eligible Population: The total population of eligible physicians (71,628) is estimated, Eligibility was difficult to determine for all 73,106 physicians listed on the initial NPS mailing list (especially taking into account all physicians did not possess an email address). Of the 73,106 physicians on the initial list, eligibility could be determined for 10,398 physicians, of whom 207 were ineligible resulting in 10,191 being eligible. The weighting and non-response adjustment process included both the 10,191 physicians who responded to the survey and the 207 found to be ineligible, and the process assumes the same ineligibility rate (by demographic group) among the indeterminate cases (i.e., cases representing those who did not reply to the questionnaire or those who did not have an email address) described earlier. This allows the estimation of the number of ineligible physicians among the *62,708* physicians whose eligibility was not confirmed. This method produces an estimate of 71,628 eligible physicians.

Appendix E: Curriculum Vitae

Name:	**Jamil Razmak**
Post-secondary Education and Degrees	• Al-Zaytoonah University, Amman, Jordan, 1998-2002 B.A. • The Arab Academy for Banking and Financial Sciences (AABFS), Amman, Jordan, 2002-2004 MSc. • Laurentian University, Sudbury, Ontario, Canada, 2011-2012 MBA. • Laurentian University, Sudbury, Ontario, Canada, 2013-2017 Ph.D.
Honours and Awards:	• Province of Ontario Graduate Scholarship (OGS) 2014-2015. • Joseph-Armand Bombardier Canada Graduate Scholarships 2015-2018.
Related Work Experience	• Graduate Research and Teaching Assistant, Laurentian University, Sudbury, Ontario, Canada, 09/2011-present. • Business Lecturer, Qassim University, Qassim, Saudi Arabia, 09/2005-08/2011. • Business Lecturer, Al-Zaytoonah University, Amman, Jordan, 02/2004-09/2005.