USER ACCEPTANCE OF WIRELESS TEXT MESSAGING IN TELEHEALTH

USER ACCEPTANCE OF WIRELESS TEXT MESSAGING IN TELEHEALTH: A CASE FOR ADHERENCE

By

MIHAIL COCOSILA, M.S., M.A.Sc., Ph.D. (Engineering)

A Thesis

Submitted to the School of Graduate Studies

in Partial Fulfillment of the Requirements

for the degree

Doctor of Philosophy

McMaster University

DOCTOR OF PHILOSOPHY (2007) McMaster University

(Business Administration) Hamilton, Ontario

TITLE: User Acceptance of Wireless Text Messaging in Telehealth: A Case for Adherence

AUTHOR: Mihail Cocosila

SUPERVISOR: Dr. Norm Archer

NUMBER OF PAGES: xiii, 242

Abstract

This work is an investigation of user acceptance of a prototype solution utilizing wireless text messaging (or SMS - i.e., short messaging service) to improve people's adherence. Insufficient adherence, also known as medical non-compliance, is a major cause of failure in self-management programs, causing significant losses to all healthcare stakeholders.

Innovative mobile healthcare solutions, based on portable devices like cell phones, may address some non-adherence aspects by helping outpatients to follow treatments agreed with their health providers. Although this seems a win-win situation, a verdict on the overall usefulness of such an approach cannot be formulated before exploring outpatient acceptance, as this is a novel technology that targets a new area of implementation. Accordingly, this research investigates key factors that may influence the acceptance of a mobile healthcare solution based on SMS to support improved adherence to healthy behaviour, with special attention to motivation (the 'pro' factors) and perceived risk (the 'con' factors).

As a means of investigation, a one-month longitudinal experiment with two groups of subjects (an intervention group and a control group) was utilized. Data were analyzed with quantitative and qualitative techniques: descriptive statistics, partial least squares modelling, and content analysis.

Findings show that users are aware of the potential usefulness of such a pioneering application. However, enjoyment is the unique reason for adopting, and perceived financial and psychological risks the main obstacles against adopting, an SMS-based solution for improving adherence to healthy behaviour. Furthermore, a business analysis shows that users are concerned about usefulness features, even when asked about financial aspects.

These results, together with encouraging findings about the effectiveness of the application, open the way for medical-led research to investigate if long-term mobile healthcare initiatives customized to patient needs are also beneficial for outpatient adherence and health outcomes.

Acknowledgements

The completion of this work would not have been possible without the support I received from faculty, friends, companies, and family over the last few years. As it is virtually impossible to acknowledge each of them individually in this page, I am enumerating below the most outstanding of them only.

First and foremost, I would like to express my deepest gratitude to my supervisor, Dr. Norm Archer. His permanent guiding and feedback, both on the content and writing style of my thesis, as well as the financial and overall support were essential in helping me to complete my doctoral studies in general and this work in particular.

Then, I have the pleasure to acknowledge the feedback and advice received from the members of my dissertation committee: Dr. Brian Haynes and Dr. Yufei Yuan. Their constructive feedback on my dissertation proposal and constant advice in general helped me to focus and strengthen my research and discover encouraging findings.

I would also like to thank several former doctoral students in the School of Business of McMaster University, Michael Bliemel, Alexander Serenko, and Ofir Turel, for their valuable suggestions formulated during our discussions and exchange of ideas.

I am also grateful to Professor Peter Vilks, from the School of Business of McMaster University, for the very important help in recruiting participants for the experiment described in this dissertation.

I cannot omit in this brief enumeration the support and advice I received from Professor Thomas Brownell from Ferris State University. His kind words of encouragement gave me the confidence and determination to go on this road.

Last, but not least, I would like to thank all my family members, wife, son, and parents, for their constant support, encouragement, and, especially, understanding.

Table of Contents

List of Figures

List of Tables

List of Appendices

Chapter 1: Introduction

1.1 Problem Statement

This work addresses the problem of user adoption of wireless text messaging as a support for improving adherence to healthy behaviours. *Insufficient adherence* (following the recommendations of healthcare providers), also known as medical *non-compliance*, is a major cause of failure in self-management programs for chronic illnesses (e.g., diabetes, asthma, congestive heart disease) in out-of-hospital conditions, resulting in reduced quality of life for the client and additional costs to all healthcare stakeholders.

Innovative mobile healthcare interventions may target some aspects of insufficient adherence by helping *outpatients* (i.e., patients in primary care or home care) to follow the treatments and perform the behavioural changes agreed with their health providers, while saving the healthcare system and society's resources. One possible mobile healthcare approach is to use the widely popular *wireless text messaging* (or *SMS* - i.e., *short messaging service*) to give remote help to people, thus assisting in coping with some forms of *unwitting* non-adherence (such as forgetfulness, lack of confidence, or lack of skills), by maintaining contact with a virtual (and friendly) healthcare provider, while continuing to live an active and dynamic life.

Although such an approach looks like a win-win situation for both patients and the healthcare system, a verdict on its usefulness cannot be formulated before exploring outpatient acceptance of mobile healthcare. This is an issue about a novel technology that targets a new and sensitive area of implementation. Accordingly, this research adopts a *user-centric perspective* by investigating key factors that may influence the user acceptance of a mobile healthcare solution based on wireless text messaging. The solution is proposed to improve outpatient adherence, with special considerations for positive factors (i.e., *motivation*) and negative factors (i.e., *perceived risk*). For this reason, the research adopts as a study framework the adherence to a healthy behaviour of well people and collects their impressions of experience with wireless text messaging intended to support adherence.

The research presented in this work is at the intersection of three domains of human knowledge: *information systems*, *consumer behaviour*, and *healthcare research*, with a considerable weight to the application of socio-behavioural research regarding user adoption of a new technology. The goal of this work is to represent a *small but firm step* in increasing theoretical and practical knowledge with respect to the patient (or virtual patient) viewpoint on mobile technology employment in adherence interventions. Moreover, this research measures user motivators and demotivators with respect to using a technology that, in addition to improving adherence, may also intrude and disturb. However, the goal is to build a basis from an information systems (IS) viewpoint for

future healthcare-lead research to investigate the real-life benefits of using mobile information technology to address adherence of outpatients with chronic illnesses.

Some parts of this chapter have been extracted from journal articles previously published or submitted for publication (Cocosila and Archer 2004; Cocosila and Archer 2005a; Cocosila and Archer 2005b). These parts are clearly marked by footnotes.

1.1.1 What is Wireless Text Messaging?

Wireless text messaging, also known as short message (or *messaging*) service (or *system*) (SMS) is a channel of text communications, available on virtually every modern digital mobile phone, that permits sending brief text messages between cell phones, other handheld devices, and even the wired Internet. SMS started as simple person-to-person text messaging over the *GSM* (*Global System for Mobile Communications*) digital mobile phone standard that was implemented in Northern Europe in the mid 1980s. Today SMS is available on a wide area of networks, including the more modern *3G* (*third generation*) ones, with increased video and audio capabilities. However, not all text messaging systems around the world use SMS, some notable exceptions being the specific designs of *SkyMail* (J-Phone) and *Short Mail* (NTT Docomo) in Japan. Some handheld device e-mail messaging systems such as *i-mode* (NTT Docomo) or *BlackBerry* (RIM) typically use standard Web e-mail protocols such as *SMTP* (*Simple Mail Transfer Protocol*) over *TCP/IP* (*Transmission Control Protocol/Internet Protocol*), and not SMS (Wikipedia 2005).

SMS uses a special path, the *signaling link*, of the wireless network to send messages via a store-and-forward mechanism (i.e., not in real-time) to a *Short Message Service Centre* on the mobile telephone network. SMS messages have the disadvantages of asynchronism, bounded length (up to 160 characters because of the limited capacity of the signaling link), and of the lack of a guarantee regarding message delivery time or of delivery at all (Wikipedia 2005). However, there is a bright side to SMS in its reduced intrusiveness of minimal text communication, relative simplicity, and low cost (because of the use of the signaling link) compared to mobile voice communications (BBC 2005a).

Due to its cost features, text messaging has rapidly become a global success, with over 100 billion messages sent worldwide every month at the end of 2002 (Nokia 2005), and over 360 billion more recently (Tomnay, Pitts et al. 2005; Wikipedia 2005). With about 100 messages sent on average by every inhabitant of the planet every year at a cost of about $0.10 U.S. per message, revenues in excess of $50 billion U.S. for mobile cell phone operators are generated (Wikipedia 2005). Therefore, SMS has become a highly successful data service (Haung and Ho 2005), and it could be said to be the 'killer application' in wireless communications (Kivimaki and Fomin 2001).

The social implications of using SMS are equally impressive. Short messages have become particularly popular among young urban people, with remarkable numbers of users in Europe, Asia (minus Japan and Korea but particularly in China where 18 billion short messages were sent in 2001), South Africa, and Australia (Wikipedia 2005). SMS has become "a form of *mass communication* in many countries" (Grinter and

Eldridge 2003). Moreover, SMS among the younger generation often leads to a new form of language. Thus, "cryptic messages such as *BHL8 (Be home late)* or *WRU (Where are you?)* are popular nowadays among European teenagers" (Yuan and Zhang 2003, p. 40). *Dot mobile*, a U.K. mobile-phone service that targets students, plans to make classical literature more accessible by condensing important works into SMS messages. Thus, the famous "*To be or not to be, that is the question*" sentence in Shakespeare's Hamlet could become, "*2b? Nt2b? ???*" (Associated Press 2005).

Beyond the hype about the present and future of wireless text messaging, it is a fact that the popularity of this service continues to increase around the world in parallel with the spread of cell phones. Statistics show that there are over 1.3 billion cell phone users worldwide, including 140 million American, 320 million European, and 200 million Chinese subscribers (Tomnay, Pitts et al. 2005) and the figures continue to grow. The growth rate is at a slower tempo in North America (Wikipedia 2005) for reasons that are beyond the scope of this work.

1.1.2 What is Adherence?

"Patient compliance and adherence are synonyms. Adherence can be defined as the extent to which patients follow the instructions they are given for prescribed treatments. Thus, if a person is prescribed an antibiotic to be taken as one tablet four times a day for a week for an infection, but takes only two tablets a day for five days, his/her adherence would be 36% (10 / 28 = 36%). The term, adherence, is intended to be non-judgmental, a statement of fact rather than of blame of the patient, prescriber, or treatment" (Haynes, Yao et al. 2005, p. 2).

Insufficient adherence to prescribed medication or behavioural changes necessary for medical regimens is ubiquitous. "Of those [patients] who enter the medical care system, more than a third may drop out, especially during the first few months. While in care, the average consumption of medication has been found to be about 50%, with a very wide range from none to substantially more than 100%. Compliance with instructions to lose weight or stop smoking is substantially lower, with long-term success rates less than 10%" (Haynes, McDonald et al. 2002, p. 2880).

There is no general agreement in the literature on the causes of adherence and, respectively, non-adherence. However, there is unanimity in showing that adherence is a complex phenomenon generated by a multitude of factors. A primary classification divides them into patient-related and external influences (WHO 2003; Cocosila and Archer 2004). Patient-related factors arise from inner psychology and attitudes and are under the individual's control. They have the most significant impact on adherence but also mediate other categories of factors.[1]

External influences are the traits of the patient or of the environment not under the patient's control. They are related to the individual's socio-demographic and economic traits (e.g., race, age, gender, socio-economic status, job, family situation), health

[1] From Cocosila, M. and N. Archer (2005a). "A framework for mobile healthcare answers to chronically ill outpatient non-adherence." Informatics in Primary Care **13**(2): 145-152., p. 146

condition (e.g., symptoms, disabilities, progression of illness), therapy offered (e.g., form of medication and treatment, duration), healthcare team (skills, workloads, reimbursement) and system (e.g., medication distribution, social attitudes, government regulation). Since the above factors are closely related, interventions for improving outpatient adherence must include a carefully designed complex of several responses, acting simultaneously over a long period of time in order to achieve persistent and positive results.[2]

1.1.3 Why Study Wireless Text Messaging as a Support for Outpatient Adherence?

Today's society is seeing a global contradiction between patient demands for better quality of healthcare and the ability of the healthcare system to meet their expectations (Grimson and Grimson 2002). This is the background for the combined pressures from chronic diseases and conditions that represented 54% of the burden (i.e., lost years of healthy life) of all illnesses worldwide in 2001 and will exceed 65% in 2020 according to the World Health Organization (WHO 2003).[3]

Confronted with the above problems, the healthcare system is under great strain to find alternative ways of treatment (Cocosila, Archer et al. 2006). Keeping patients out of hospitals while providing them the best treatment conditions possible should be a win-win situation for both patients and society. Unfortunately, lack of patient adherence to treatment is a serious obstacle to this approach. Research has consistently shown that adherence is typically no more than 50% on average (Dezii 2000; Bayliss, Park et al. 2001; WHO 2003). Various statistics clearly indicate dire consequences of insufficient adherence (Cocosila, Archer et al. 2006):

- reportedly "125,000 people die each year" in the U.S.A. because of medication non-compliance, costing the healthcare system and business over $100 billion per year (Walker 2001);
- "more than $113 million worth of prescription drugs in Canada have been wasted due to non-compliance or a change in drug or dosage" per year (German 2000); and,
- "annual hospitalization costs of medication non-compliance" is "US$0.735 billion in Ontario, Canada" (representing 0.8% of all health-care costs) and "US$13.35 billion in the U.S." (1.7% of total costs) (Cleemput, Kesteloot et al. 2002).

"The struggle of the healthcare system to deal with chronic illnesses and low adherence in outpatient conditions, together with recent technological advances in mobile communications and data services, lead to an innovative idea: improve outpatient adherence through the use of mobile information technology (IT) solutions" (Cocosila, Archer et al. 2006). The need for solutions to address insufficient adherence has been suggested frequently in the medical literature (Haynes, McDonald et al. 2002; McDonald, Garg et al. 2002; Haynes, McDonald et al. 2004; Haynes, Yao et al. 2005).

---

[2] Ibid., p. 146
[3] Ibid., p. 145

Accordingly, "current methods of improving adherence for chronic health problems are mostly complex and not very effective, so that the full benefits of treatment cannot be realized", "high priority should be given to fundamental and applied research concerning innovations to assist patients to follow medication prescriptions for long-term medical disorders" (Haynes, Yao et al. 2005, p. 1), and, "it is time that additional efforts be directed towards developing and testing innovative approaches to assist patients to follow treatment prescriptions" (Haynes, McKibbon et al. 1996, p. 383).

Previous exploratory work has described factors influencing patient adherence and suggested several directions of action (e.g., *monitoring* and *reminding* about disease self-management activities, *consulting* with healthcare professionals, *receiving support* from social groups, *notification* about interesting information, or *education* about disease and treatment), where mobile solutions empowered by wireless technology may help (Cocosila and Archer 2005a).[4]

As described above, wireless text messaging applications have qualities that make this mobile service suitable for most of the possible interventions to address patient adherence through portable devices: ubiquity, low intrusiveness, low cost, and relative simplicity. Therefore, it is justified to test the use of SMS for adherence-improving interventions of dynamic and active people who want to cope with some forms of unwitting non-adherence (such as forgetfulness, insufficient motivation, or lack of skills). Such applications are also suitable for improving adherence to healthy behaviour of well people.

Early applications of SMS to improve adherence have been pioneered in various parts of the world (Europe, Australia, Asia, and North America) and have shown encouraging results for various interventions in the remote care of patients. However, all these studies have lacked a scientific perspective of the patient viewpoint regarding the use of SMS for adherence. Previous exploratory work has shown that, despite their undeniable advantages, mobile healthcare solutions may face patient technology acceptance problems for various reasons (Cocosila and Archer 2005a; Cocosila and Archer 2005b). Since a mobile IT solution such as an SMS-based one cannot help to improve outpatient adherence and satisfaction if the technology is not accepted, user adoption of this new technology in healthcare should be investigated first because it is an indicator of future success (Ammenwerth, Kaiser et al. 2003). A realistic verdict on the overall usefulness of an SMS approach for adherence cannot be formulated before exploring outpatient acceptance on a rigorously scientific and methodological basis.

[4] From Cocosila, M. and N. Archer (2005b). "Mobile healthcare initiatives for improving outpatient adherence: Opportunities and barriers." International Journal of Electronic Business 3(6): 512-533., p. 514

1.2 Research Objective

This research, which is one of the first of its kind done in Canada, aims at scrutinizing as a **general research issue** what key factors influence user acceptance of wireless text messaging if SMS is used as an adherence support tool for healthy behaviour. At a **more specific level** the focus of the research is on the role of the dyad *motivation-perceived risk* in the user behavioural intention to use SMS for achieving better adherence.

The aim of this research is to perform an early implementation study that would provide empirical evidence on the contribution of perceived risk and motivation, both seen as multifaceted variables, on user behavioural intention to adopt a specific mobile support system. The **overall objectives** of the research are to examine:

1) how much of the intention to use SMS is explained by perceived risk and motivation;
2) what are the time and financial limitations that people would accept for using such a technology with this precise purpose; and,
3) whether there is any difference in adherence to taking vitamin C (as a healthy preventative behaviour) between a group of people receiving reminders through SMS and another group of people receiving no reminders.

To reach these objectives the study uses a quantitative and qualitative approach that involves conducting a field experiment on adherence to a regimen of taking vitamin C, supported by an SMS-based prototype called *TMT* (*Text Messaging Telehealth*), designed specifically for this study. Data are collected and analyzed from a group of TMT users and a control group of non-users. The outcomes from the study would be useful for both theory and practice in three domains: information systems, consumer behaviour research, and healthcare.

1.3 Theoretical and Practical Significance

This research uses the **fundamental support** of the theories and models of **technology acceptance,** of **perceived risk**, and of **motivation** in an empirical investigation of the key factors that may influence the acceptance of a mobile healthcare adherence solution based on wireless text messaging. This study includes a comprehensive literature review in the areas of motivation, perceived risk, technology acceptance, medical adherence, and wireless text messaging, asks eight research questions, and proposes an original **theoretical model** and research hypotheses.

The theoretical model and hypotheses are drawn from the theories exposed above and from original issues pertaining to the particularities of this research regarding the technology and specific users targeted. This model integrates the multifaceted construct

of perceived risk drawn from consumer behaviour literature (Kaplan, Szybillo et al. 1974; Brooker 1984; Stone and Grønhaug 1993; Stone and Mason 1995) in the motivational model used in information systems literature (Davis, Bagozzi et al. 1992; Igbaria, Parasuraman et al. 1996; Venkatesh 1999; Venkatesh, Morris et al. 2003) thus allowing an in-depth analysis of the influence of the perceived risk-motivation link on user intention to adopt SMS as a support for adherence improvement.

This research will **advance theoretical knowledge in information systems** for several reasons. First, few studies have investigated the technology acceptance of telemedicine in general (and only from the provider's side). Second, there is a scarcity of research about acceptance of mobile IT in healthcare. Third, there is a lack of research about patient acceptance of technology in general. Fourth, it is difficult to identify a clear stream of research on perceived risk influence in IS to date. Fifth, very few studies have included perceived risk constructs (including risk components) adapted from marketing research in IT acceptance.

Investigation of this research topic is **important for mobile technology** because:

- It helps understanding the possible acceptance and usage of SMS in a specific area, different from the usual communication or leisure use; and,
- Proving how and why a simple but solid application may work might also encourage the use of mobile technology by other stakeholders in healthcare (e.g., home care nurses, primary care physicians, etc.).

Performing this research is **equally important for healthcare knowledge**. First, it tests virtual patient perceptions early, before taking on the costly deployment of mobile healthcare systems with complex human and technical consequences (Cocosila and Archer 2005). Second, it is an initial small step that offers solid ground for future healthcare-led research on the actual medical outcomes of mobile IT interventions that target outpatient adherence. Third, it opens the way for building future mobile healthcare interventions that can target particular patients, segmented according to their views. Fourth, it fills a knowledge void for cost-effectiveness analysis of mobile healthcare interventions for outpatient adherence.

1.4. Outline of the Dissertation

This work consists of six chapters. Chapter 1 has briefly addressed the problem under investigation by answering some key questions regarding the motivation and opportunity of studying this problem, and has presented the objective of the research and its significance for theory and practice.

Chapter 2 presents a literature review of outpatient adherence and of mobile interventions addressing adherence, with a closer look at text messaging. Special attention is devoted to the justification of using mobile IT to address some forms of

outpatient adherence. The chapter ends with a presentation of the main research topic of this work, along with the eight research questions it is proposed to study.

Chapter 3 comprises a literature review and critique in the domains of motivation, perceived risk, and technology acceptance, all related to the research topic, followed by constructing the study's theoretical model. This model is based on a motivational model in information systems, enriched with perceived risk. Seven research hypotheses developed from the research questions and based on the theoretical model are proposed.

Chapter 4 describes the methodological approach used to test the hypotheses and answer the research questions. This includes the experimental design, participant recruitment and selection, quantitative and qualitative data collection, and data analysis approaches.

Chapter 5 starts with the findings of a pilot study. Then the largest part of this chapter is allocated to presenting the data analysis and findings of the main study, beginning with an analysis of user demographics. Second, results from tests of the theoretical model are given, referring to the measurement model, structural model, effect size, and influence of the control variables. Third, results from qualitative data analysis regarding the user reasons to accept or reject such a system are discussed. Fourth, an analysis is given of the business-related data and adherence-related data captured from the study.

Chapter 6 contains a discussion of the study results and the conclusions from the research, including: answers to the research questions and hypotheses of Chapters 2 and 3, the theoretical and practical contributions of the study, and finally the study's limitations, and possible directions for future research.

Chapter 2: Wireless Text Messaging for Outpatient Adherence

2.1 Introduction

The purpose of this chapter is to examine the relevant literature in the field of outpatient adherence, to scrutinize current limitations in the medical world in dealing with this problem, and to bring literature support to answering the questions "Why mobile solutions for outpatient adherence?" and "Why wireless text messaging for adherence?". To achieve these goals, Section 2.2 describes the concept, importance, and limitations of outpatient adherence, Section 2.3 explains why and how mobile solutions in general, and wireless text messaging in particular, could address problems of insufficient adherence, and Section 2.4 outlines the research topic and research questions.

Significant parts of this chapter have been extracted from co-authored journal articles previously published (Cocosila and Archer 2004; Cocosila, Coursaris et al. 2004; Cocosila and Archer 2005a), and these parts are clearly marked by footnotes.

2.2 Outpatient Adherence: Concept, Importance, and Limitations

Patient adherence is a topic that is becoming more and more widespread in the medical literature as being commonly associated with long-term therapies for chronic illness. Chronic diseases and conditions are either infectious (e.g., HIV-AIDS, tuberculosis) or non-communicable (e.g., diabetes, hypertension, or asthma) illnesses having several distinct features in terms of:

- duration (permanent or necessitating a long period of care);
- consequences (caused by non-reversible pathological deterioration and associated with remanent disability); and,
- treatment (necessitating multidisciplinary management and special conditions and training for patient rehabilitation) (Cheah 2001; WHO 2003).

Because of the long-term treatment required, maintaining high adherence for these illnesses becomes a fundamental issue, especially in outpatient conditions where chronically ill patient contact with healthcare providers is infrequent. The focus on adherence occurs within the more general context of a "revolution ... under way in healthcare" since "after decades of patriarchal provision of services, governments are now accepting that patients should have a say in what is provided" (Richards 1999).[5]

[5] From Cocosila, M. and N. Archer (2004). M-healthcare approaches for improving outpatient adherence in self-management of chronic diseases, Working Paper No. 8, McMaster University eBusiness Research Centre (MeRC), Hamilton, Ontario., p. 8

This subsection presents the concept of patient *adherence* (more popularly known as *compliance*, or sometimes as *concordance*), its importance for *outpatients* (i.e., patients cared in outpatient conditions such as home care or primary care), and the limitations of current approaches to deal with cases of low adherence or non-adherence.

2.2.1 Concept of Outpatient Adherence[6]

Some attempts to define adherence related it to medication only (MSH 2004). Thus adherence was understood as "the extent to which the patient follows medical instructions" (WHO 2003). However, this definition had some drawbacks:

- "medical": is insufficient in describing the whole range of interventions used to treat chronic diseases; and,
- "instructions": implies the patient to be only a passive, consenting recipient of expert treatment advice.

Today's perception of adherence is broader in that adherence to any regimen also reflects a behaviour (Bayliss, Park et al. 2001; Mallion and Schmitt 2001). From a more general perspective there are two types of therapeutic behaviours:

- medically-related (e.g., seeking medical attention and advice, filling prescriptions, taking medication as prescribed, obtaining immunizations, attending follow-up appointments); and,
- individual-related (e.g., following personal hygiene rules, smoking or not, following dietary habits or various levels of physical activity) (Mallion and Schmitt 2001; WHO 2003).

Contemporary acceptance of patient adherence also means the breaking down of "the wall between patients and professionals" (Richards 1999). Healthcare professionals are now acknowledging that patients have always had views and priorities that the healthcare system could not perceive. Consequently a patient's treatment adherence should not be perceived today as anything other than a shared medical decision based on collaboration and communication between patient and provider (Holman and Lorig 2000; Osborne 2002, p. 3). The collaboration view is based on:

- informing and explaining to the patient the medical problem;
- sharing of views, perceptions and beliefs;
- exploring alternative therapeutic means;
- negotiating a regimen;
- discussing adherence;
- making a clinical decision; and,

[6] Ibid., p. 8-10

- setting a follow-up plan (Coulter, Entwistle et al. 1999; Richards 1999; Forkner-Dunn 2003).

Consequently, a more encompassing definition of adherence is: "the extent to which a person's behaviour – taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a healthcare provider" (WHO 2003).

In describing the above aspects of patient adherence some recent studies use the term "*concordance*" (Ferner 2003; Banning 2004), although other authors disagree upon the equivalence of the terms (Haynes, Yao et al. 2005). A significantly larger number of works use the term "*compliance*" (Cohen 1979; Stephenson, Rowe et al. 1993; Haynes, McDonald et al. 2002; Haynes, Yao et al. 2005). Although "*compliance*" is still a very popular term, recent studies consider it inappropriate in today's environment for several reasons:

- it is linked to the traditionally unequal model of healthcare that assumes the physician is superior to the patient (who is seen only as a passive recipient of healthcare);
- it suggests that a dependent person has to carry out the advice, suggestions, or orders given by a professionally dominant person; and,
- the negative variant - *non-compliance* - is misleading since it bears the significance of an unwillingness to follow a medical treatment and may even be considered a symptom of the disease, or a disease itself (Nurse Week 2004).

Recent research has been categorical in showing that patients want the decisions about their medical condition to be shared between physicians and themselves, and any contemporary treatment must display two key features for effective clinical practice:

- involving patients as active partners in their own care with health professionals; and,
- fostering good communication between patients and healthcare professionals (Nurse Week 2004).

Consequently, health practitioners should learn how to talk *with* (not *to*) patients (Lowes 1998; MDNetGuide 2004). Using "*adherence*" is more appropriate than "*compliance*" because the former term suggests the patient's agreement to the recommendations and active involvement in the treatment are essential conditions. However, there is still a debate in the literature about the time succession of events:

- should the patient's agreement be *prior* to making a clinical decision on the prescribed treatment by the health professional and the patient? or,
- should the decision be made mainly by the physician, who must have the ability to inform and convince the patient about the best treatment? (Ende, Kazis et al. 1989; WHO 2003).

Treatment adherence also resonates with another recent concept, "*patient centred medicine*", that means "treating patients as partners, involving them in planning their healthcare, and encouraging them to take responsibility for their own health" pioneered by family physicians at the University of Western Ontario, in the 1970s (Lowes 1998).

2.2.2 Importance of Adherence[7]

Research has been unanimous in showing that adherence is an essential component for any self-management program of a chronic disease. For instance, a wealth of studies has examined the implications of adherence for outpatient diabetic care (Sulway 1980; Diehl 1985; Wing 1985; Ruggiero 1990; Paes 1997; Lutfey and Wishner 1999; Burge 2001; Biermann, Dietrich et al. 2002; Kuo 2003). All these researchers have demonstrated that increased compliance achieved through self-monitoring of blood glucose rewarded patient efforts in stabilizing blood sugar levels and improving their general state of health.

Although in some isolated cases low adherence may be beneficial (Cleemput and Kesteloot 2002, Hepke, Martus et al. 2004), in general non-adherence is harmful to the care of all chronic illnesses from multiple points of view:

- ***Patients.*** Non-adherence may lead to medical complications and to the triggering of other diseases with increased risks of morbidity and mortality. Duration of treatment (at least during the onset phase) would be very likely extended for non-adherent patients and this may generate hospitalization and absenteeism. As an intangible consequence, psychosocial complications of diseases and lower quality of life may follow (Pfizer 1996; Dezii 2000; WHO 2003). Also, not to be neglected is the effect induced in healthcare personnel since non-adherence may mislead physicians, cover up psychological aspects, and cause needless changes in therapy with ricochet effects on the patients themselves (Dezii 2000; Weiner 2004).
- ***Healthcare professionals.*** Non-adherence obviously wastes professional resources by unnecessary diagnostic tests, appointments, and follow-ups. From a more sensitive viewpoint, the lack of adherence has been shown to violate professional beliefs, norms, and expectations about professional relationships with patients. Non-adherence challenges professional skills in maintaining correct therapeutic relationships with patients. It may also challenge their ability to conceal discouragement and sometimes even anger, when patients systematically ignore advice (Nurse Week 2004; Weiner 2004).
- ***Healthcare system and society.*** Poor adherence can have dramatic consequences in the waste of human effort and other resources on patients who do not need them when these resources are diverted from patients who most need extra services (Dezii 2000; DCMR 2003; Nurse Week 2004). For instance, failure to take medication correctly (although, as shown above, this is only one aspect of

[7] Ibid., p. 10

non-adherence) has been estimated to cost the U.S. economy $100 billion per year (Nurse Week 2004). Transcending immediate monetary consequences, lack of adherence is the primary cause of sub-optimal clinical benefits, causing psychosocial complications from disease, and waste of healthcare resources in general (WHO 2003). Good adherence based on well-informed and involved patients is also likely to increase patient satisfaction (and hence reduce the risk of litigation) and would thus work towards everyone's advantage (Richards 1998).

2.2.3 Adherence Factors[8]

Because of the complexity of the topic, there is a debate in the literature over the categories of factors affecting adherence. One reasonable approach is to consider a primary division into (Figure 2.1):

- patient related-factors: all of the factors under patient control that contribute to the experience with a treatment, and,
- external influences: all of the factors outside of a patient's control that have the potential to impact adherence (CPC 2002).

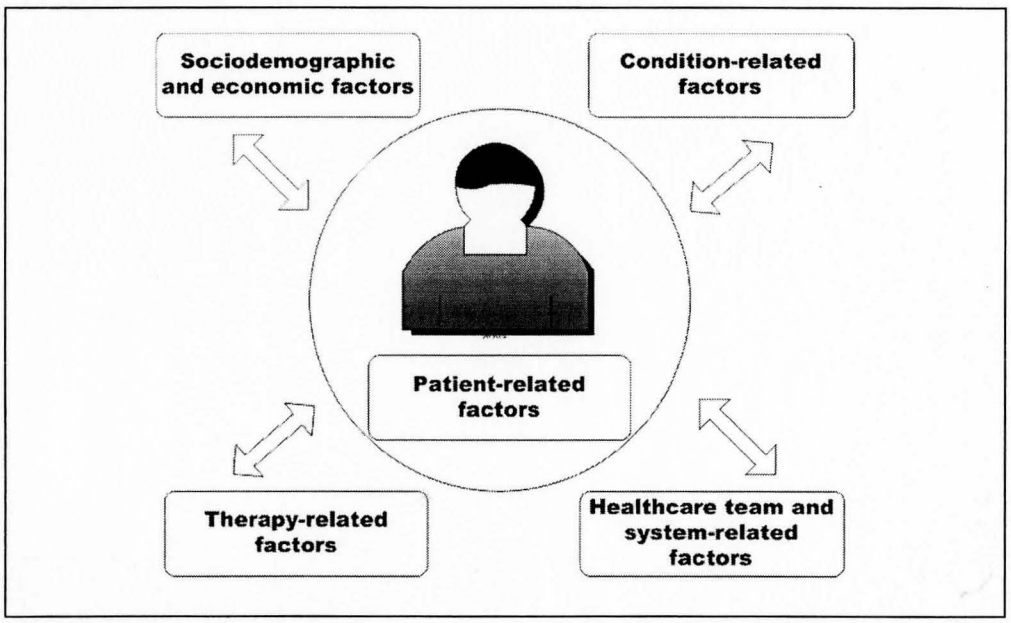


Figure 2.1 Categories of Factors Affecting a Patient's Adherence (adapted from (WHO 2003))

A. Patient-related factors spring from psychological/behavioural/attitudinal/ lifestyle issues associated with the patient and are usually related to concrete concerns about medication (based on side-effects, symptoms, and experiences) as well as to more abstract worries about the long-term effects and dependence on medication (WHO 2003).

[8] Ibid., p. 12-16

Some patient-related factors that are more or less under patient control and that, reportedly, decrease adherence are:

- forgetfulness or misunderstanding of treatment instructions;
- stress and anxieties about medication and its effects;
- state of motivation/apathy/hopelessness;
- lack of knowledge and skill in managing the disease treatment;
- unperceived need for treatment;
- unperceived progress/efficacy of treatment;
- unperceived health risk associated with the disease;
- negative beliefs regarding the treatment;
- negative expectations of treatment outcomes;
- misunderstanding/non acceptance of the disease or diagnosis;
- rejection of monitoring;
- frustration with healthcare provider work style/waiting too much for consultations;
- unperceived need for follow-up consultations or counselling sessions;
- fear of complexity or of dependence on the drug regimen; and,
- anxiety over the possible social stigmatization associated with the disease (Dezii 2000; Mallion and Schmitt 2001; CPC 2002; WHO 2003; Weiner 2004).

Studies have been unanimous in agreeing on the importance of this category of factors and their interactions with factors in other categories. For instance, little can be done through various other interventions for a patient who does not perceive the need for treatment.

B. External influences spring from elements beyond patient control. External influences could be further divided into four subcategories: socio-demographic and economic, condition-related, therapy-related, and healthcare team and system-related.

(a) Socio-demographic and economic factors. Socio-demographic factors refer to elements that are partially characteristic of the patient but not under his/her control such as: race, gender, marital status, age, educational level, and health status. According to some studies, these factors have a relatively small influence on adherence (WHO 2003). Other researchers published more detailed opinions stating that, although there is no indication of a strong correlation of adherence with age and sex (Mallion and Schmitt 2001; CPC 2002):

- elderly patients have an objective tendency for poor compliance because of cognitive and functional (kinetic and dynamic) impairments;

- senior patients have less desire to make decisions and to be informed about their treatment;
- adolescents are less adherent than younger children or adults because of an age-induced tendency of rebellion against the regimen's control over their lives, as well as of peer-related issues; and,
- some children who need to take responsibility for their own treatment, because their parents are single or away from home while working, may also display poor adherence (Ende, Kazis et al. 1989; WHO 2003).

Many other factors belong to the socio-economic category:

- socio-economic status/income/high cost of medication;
- job/unemployment;
- education/literacy;
- living/environmental conditions;
- family conditions/harmony; and,
- culture (including race-generated) beliefs about illness and treatment.

There are divergent opinions in the literature about the influence of the socio-economic factors on adherence (Mallion and Schmitt 2001; CPC 2002; WHO 2003; Nurse Week 2004). For instance, research has not shown that patients who are uneducated or are from lower social and economic groups are less adherent (CPC 2002; Nurse Week 2004) as it would be tempting to assume.

(b) Condition-related factors. These factors refer to specifics of the illness, symptoms, and treatment and are closely connected with the illness stage of the patient. Some determinants of adherence in this category are:

- severity/absence of the symptoms;
- awareness/acceptance/knowledge about the disease state;
- knowledge about the implications of non-adherence/benefits of therapy;
- nature and severity of the possible disability (physical, psychological, social and/or vocational);
- stage and rate of progression of the disease; and,
- the availability and commonality of effective treatments (CPC 2002; WHO 2003; MSH 2004; Nurse Week 2004).

The above factors can influence the patient's adherence directly but they may also serve as mediators by modifying the patient's risk perception and beliefs about following the prescribed treatment. The impact of the above factors may also be moderated by some

other factors such as usual co-morbidities (e.g., depression in diabetes) and drug and alcohol abuse (WHO 2003).

Trying to infer logical connections between condition-related factors and adherence may be erroneous. For instance, studies have shown that patients with less severe health problems were more eager to make decisions on their treatment and follow the prescribed regimen, compared to patients with more advanced illnesses (Ende, Kazis et al. 1989; Nurse Week 2004). On the other hand, other studies have found that ill people who have no or few symptoms (e.g., most hypertensive patients) had difficulties in accepting treatment or life style changes necessary to prevent the onset of possible problems (e.g., cardiac events) (Lowes 1998; Mallion and Schmitt 2001).

(c) Therapy-related factors. Researchers have reported that the characteristics of therapies associated with certain diseases may not have a larger influence on adherence than other factor categories, but they may influence the magnitude of these categories. Common elements in this category are:

- form and complexity of the medical regimen;
- product and packaging of the medicine;
- duration/frequent changes/previous failures of the treatment;
- outcomes of the treatment (not noticeable, delayed onset, prophylactic use);
- the immediacy of beneficial effects;
- significant adverse reactions/side effects; and,
- the availability of medical support to help to deal with therapy problems (Dezii 2000; Mallion and Schmitt 2001; CPC 2002; WHO 2003; AMA 2004; Weiner 2004).

A logical analysis of how the above factors influence adherence may lead to unrealistic conclusions. For instance, adverse effects have been shown to arise if a patient fails to take a drug as instructed (Dezii 2000). However, the patient may think that adverse effects are caused by the medication itself and drop it altogether, with dire consequences for adherence and the entire treatment.

(d) Healthcare team and system-related factors. Studies and trials have been categorical in demonstrating that organizational variables and, especially, good patient-provider relationships and communication, as well as the faith of the patient in his/her physicians, nurses, and pharmacists are essential for the acceptance and adherence to prescribed treatment (Kaplan, Greenfield et al. 1989; Mallion and Schmitt 2001; MSH 2004; Nurse Week 2004). Particularly important is the "*first encounter*" when the healthcare professional must spend sufficient time with the patient so as to gain his/her confidence and be sure the patient fully understands the medical problem and the necessary treatment (Dezii 2000). However, many other factors have a negative effect:

- inappropriate knowledge and beliefs of healthcare professionals in managing chronic diseases;
- brief consultations preceded by a long waiting time;
- unsuitable communication and interpersonal style of the physician;
- inappropriate counselling, prescribing, or support tools;
- lack of incentives and feedback on performance for healthcare professionals;
- lack of tools for continuity of care provided by healthcare workers;
- inadequate or non-existent reimbursement for treatment by health insurance plans;
- inappropriate medication distribution systems;
- incapacity of the system to medically educate patients and provide follow-up;
- inability of the system to encourage community support and self-management of diseases;
- undeveloped social attitudes on adherence and on effective interventions for improving it;
- social negative beliefs and habits regarding chronic diseases and drugs;
- inappropriate government regulation about certain specific diseases; and,
- insufficient news information, and more or less informed opinions available in the media and on the Web about diseases and adherence to treatment (Richards 1998; Dezii 2000; CPC 2002; WHO 2003).

Some studies have directed attention to unexpected effects of changes in the healthcare delivery system that may place the physician-patient relationship at risk (Kaplan, Greenfield et al. 1989). For instance, a patient may wait too long before receiving a consultation by a very skilled but busy and overworked physician. Paradoxically, such a patient, especially if he/she has the impression of not being treated with sufficient compassion, may "retaliate" through non-adherence (Dezii 2000). In such situations the symptoms and treatment may be overshadowed by the patient's feelings.

2.2.4 Limitations of Outpatient Adherence

Medical research captured in systematic reviews has shown the seriousness and complexity of the low adherence phenomenon which "is a ubiquitous problem" (Haynes, McDonald et al. 2002, p. 2880):

- "At a theoretical level, the nature and determinants of noncompliant behavior are complex and not well understood" (McDonald, Garg et al. 2002, p. 2869);
- "Typical adherence rates are about 50% for medications and are much lower for lifestyle prescriptions and other more behaviorally demanding regimens" (Haynes, McDonald et al. 2002, p. 2880);

- "Compliance rates for short-term self-administered therapies average about 75% initially, but decline to less than 25% for the completion of antibiotic therapy for acute infections" (Stephenson, Rowe et al. 1993, p. 2779).

In resonance with the multidimensionality and consequences of low adherence, "current methods of improving adherence for chronic health problems are mostly complex, labor-intensive, and not predictably effective" (McDonald, Garg et al. 2002, p. 2868). Furthermore, the weight of adherence becomes even more important nowadays with the increasing number of self-administered treatments in outpatient conditions. Therefore, there is a definite need for better understanding and managing non- or low adherence (Stephenson, Rowe et al. 1993; McDonald, Garg et al. 2002).

2.3 Wireless Text Messaging to Address Outpatient Adherence Limitations

"The problems of outpatient adherence on one hand, and the remarkable development of mobile information and communications in recent years on the other, led to the idea of an innovative approach for chronically ill outpatients: improving adherence with the use of mobile and wireless information technology" (Cocosila and Archer 2005a, p. 146). This stems from recommendations in the medical literature (Haynes, McDonald et al. 2002; McDonald, Garg et al. 2002; Haynes, McDonald et al. 2004; Haynes, Yao et al. 2005). For instance, as this literature is urging:

- "Current methods of improving adherence for chronic health problems are mostly complex and not very effective, so that the full benefits of treatment cannot be realized. High priority should be given to fundamental and applied research concerning innovations to assist patients to follow medication prescriptions for long-term medical disorders" (Haynes, Yao et al. 2005, p. 1); and,
- "It is time that additional efforts be directed towards developing and testing innovative approaches to assist patients to follow treatment prescriptions" (Haynes, McKibbon et al. 1996, p. 383).

2.3.1 Why Mobile Solutions for Outpatient Healthcare?

"Despite its undeniable advantages, the existing approach of outpatient self-management poses several challenges, *most of them gravitating around non-adherence*, that mobile information technology may address" (Cocosila and Archer 2004, p. 16). Research has also shown that self-management educational interventions may lead to positive outcomes for patient conditions across various diseases associated with high incidence and treatment cost such as chronic heart failure, asthma, diabetes, and hypertension (Chin 2002; Wolf, Guevara et al. 2002; Celler, Lovell et al. 2003). Therefore, it seems reasonable to transfer the responsibility for monitoring indicator levels to patients, thereby improving their mobility, education, active participation, responsive attitude, and self-confidence, while at the same time contributing to the overall efficiency of the healthcare system (Rohm and Rohm 2002). Last but not least,

self-management could help in enhancing behavior modification and treatment plan compliance through a combination of education and intervention.[9]

Despite their advantages, existing approaches of self-management pose several challenges:

- Difficulty in tracking patient compliance with prescribed treatment plan (e.g., incomplete diaries) due to the self-management system's inability to support the patient in this task or the patient's disorganized nature;
- Uncertainty in patient decision-making due to the absence of a decision support system. Education, which is mostly conducted offline, is a passive form of decision-making support that is constrained by the patient's cognitive ability (e.g., a patient has to remember what the various blood glucose levels imply and remember to act accordingly in various scenarios after a self-test);
- Inability to maintain a constant connection between the patient and the healthcare system, due to the inherent off-line link between all parties (e.g., in case of an emergency while being mobile it is difficult for a patient to receive immediate assistance);
- Untimely sharing of information due to the time lag involved between data collection and patient-physician consultation.[10]

Furthermore, every patient responds differently to a particular chronic disease (i.e., symptoms and condition progress). While patients may be equipped with knowledge gained through education sessions and consultations, applying lessons learned can be quite challenging, due to the patient's possibly disorganized nature, unstructured lifestyle, inadequate decision-making skills, and/or mobility (i.e., may not be reachable, available, or capable to attend appointments or perform self-tests). In the absence of advanced tools for patient compliance with prescribed treatment plans, these factors can hinder the success of self-management programs.[11]

Mobility in the context of communication and information "should not be understood simply as a new distribution channel, a mobile Internet, or a substitute for PCs" (Yuan and Zhang 2003). A mobile IT solution is justified only by the particular location of the user who needs an information or communication service, or by the utility or urgency of that service (Mennecke and Strader 2003). All three elements justify the use of mobile solutions to improve outpatient adherence in self-management programs for chronic illnesses:

- ***Location***. Outpatients, as all people, have inherent mobility when changing spatial positions for work, school, shopping, walking, or various other activities. Given the diversity and the constant changing of their physical locations, it is

[9] From Cocosila, M., C. Coursaris, et al. (2004). "M-healthcare for patient self-management: A case for diabetics." International Journal of Electronic Healthcare **1**(2): 221–241., p. 223

[10] Ibid., p. 224

[11] Ibid., p. 224

important for them to have self-confidence and feel that they can stay in contact with nurses or doctors as well as with social support groups.

- ***Utility.*** For the success of disease self-management it is important, if not essential, for patients with certain diseases to be monitored continuously so that their medical condition remains within safe (i.e., acceptable) limits. Also, the patients must constantly remember to comply with prescribed treatment plans (e.g., take pills, start or stop a medication or a diet, visit a doctor for periodical consultations, etc.). Automated reminders are easily arranged through mobile IT solutions.
- ***Urgency.*** In most cases, time is not a critical factor for patients with chronic illnesses. However, in extreme cases when their health becomes unstable, some patients may need fast intervention. Mobile IT capabilities could enhance patients' perceived level of safety and security and improve their general level of optimism.

An important characteristic of any mobile solution is the ***identification of a unique person,*** as stressed by Junglas and Watson (2003) and Watson, Leyland et al. (2002). Thus any communication between a mobile device and health providers would be automatically linked with the mobile device owner's identity.

Additional reasons for providing mobile solutions to patients can be found in the collection and analysis of patient data. By utilizing electronic devices for this purpose, there is significant potential to improve the quality of care for outpatients because of increased convenience and accuracy. This can also assure prompt interventions when abnormal medical conditions are registered.

It is *unwise to expect mobile solutions to improve adherence automatically.* Mobile solutions should aim at *facilitating the communication and exchange of data between the patient and the healthcare provider.* Consequently, to maximize the chances of success, any mobile solution aimed at enhancing outpatient adherence should target several adherence factors within the complexity of clinical interventions, where improving the patient-health provider relationship is a key factor. Starting from the recommendations of pertinent medical research (Haynes, McDonald et al. 2002), six possible mobile healthcare solutions (monitoring of health parameters, reminding about taking a medicine or performing a behavioural change, consulting with health providers, receiving support from family and peers, keeping informed, and being educated about the disease and treatment) and their envisioned benefits have been described in previous work (Cocosila and Archer 2005a). These solutions address adherence factors and extend existing ways of communication and data exchange between outpatients and the healthcare system (e.g., mail, landline telephone, or the Web), encompassed under the definition of telemedicine (Bashshur, Shannon et al. 2005).

Today's patients are more socially active, knowledgeable, computer-literate, and better informed than ever and this has the potential to bring fundamental changes in healthcare (PricewaterhouseCoopers 1999; Ball and Lillis 2001; Grimson and Grimson

2002) because people want dynamic and flexible healthcare that will match their lifestyles and expectations.

2.3.2 Possible Mobile Interventions to Improve Adherence

The medical literature has shown that behavioural interventions are one way of increasing patient adherence (Haynes, McKibbon et al. 1996). Thus "a primary focus of self-care interventions for chronic illness is the encouragement of an individual's behavior change necessitating knowledge sharing, education, and understanding of the condition" (Wantland, Portillo et al. 2004). For instance, it has been shown that "diet adherence is a key determinant in minimizing the risk of diabetic health complications" (Kahn 1999).

Adherence is usually compromised by several elements working concurrently (Gerber 1986), and single-factor interventions are not productive (WHO 2003). Therefore, for maximized effectiveness and efficiency, mobile interventions should be one component of more complex clinical models that would adopt a patient-centered perspective and involve specific elements depending on the patient, treatment, disease, and the healthcare system. Table 2.1 summarizes the benefits of the interventions that mobile solutions can provide in improving patient adherence (Cocosila and Archer 2004), discussed in more detail in the following.[12]

These suggested interventions come from the recommended directions of action formulated in the literature (Stephenson, Rowe et al. 1993; Haynes, McDonald et al. 2002; McDonald, Garg et al. 2002; Haynes, Yao et al. 2005) and from following the examples of similar interventions carried on through other channels such as mail, landline telephone and, more recently, the Web. For instance, a meta-analysis of studies published between 1996 and 2003 had as an objective the comparison of chronically ill patient knowledge and behavioral change outcomes for clients participating in Web-based interventions in contrast to those in non-Web-based interventions. This meta-analysis found an improvement in outcomes for the participants in the first category in terms of: "increased exercise time, increased knowledge of nutritional status, increased knowledge of asthma treatment, increased participation in healthcare, slower health decline, improved body shape perception, and 18-month weight loss maintenance" (Wantland, Portillo et al. 2004).

[12] From Cocosila, M. and N. Archer (2005a). "A framework for mobile healthcare answers to chronically ill outpatient non-adherence." Informatics in Primary Care **13**(2): 145-152., p. 147

Table 2.1 Suggested Interventions to Improve Outpatient Adherence by Mobile Solutions[13]

Intervention	Adherence factors involved	Possible benefits
Monitoring	Patient-related Condition-related Therapy-related	Diminishing forgetfulness, stress, and anxieties; Improving motivation, knowledge, and skills in managing the treatment and disease in general.
Reminding	Patient-related Condition-related Therapy-related	Reducing forgetfulness, treatment stress, and anxieties; Controlling aggravating factors; Increasing optimistic attitude, self-confidence, and motivation.
Consulting	Patient-related Condition-related Therapy-related Healthcare team and system-related	Reducing the effects of stress, anxieties; Diminishing consequences of insufficient knowledge or skills; Improving self-confidence and optimistic attitude.
Supporting	Patient-related Social and economic interventions	Diminishing the feeling of isolation; Providing encouragement; Improving self-confidence.
Informing	Patient-related Social and economic interventions	Improving patient knowledge; Fighting patient anxieties, misunderstanding, and negative beliefs.
Educating	Patient-related Social and economic interventions	Improving adherence following persistent and personalized application of the other interventions.

Monitoring. Provides tighter control and management of the disease (Magrabi, Lovell et al. 2001) by patient self-testing, measuring, and recording results so as to track their variation in time. Compared to wired solutions (e.g., landline telephone or Web), mobile monitoring offers better flexibility and convenience by being potentially always available to the patient.

Reminding. Refers to notifying patients about taking specific medication, performing self-tests and measurements, refilling prescriptions, following a certain diet or exercising, coming to a consultation (Shea, DuMouchel et al. 1996) and, in certain situations, receiving feedback from the healthcare system about complying. Mobile solutions offer excellent opportunities for reminding because they are always with the

[13] Ibid., p. 147

user and allow real-time exchange of information in a personalized and unobtrusive manner (e.g., voice, text, and tactile vibrations).

Consulting. Good relationships and communications between patient and the healthcare providers are essential for adherence because successful patient self-management does not mean eliminating physicians from the picture. On the contrary, beyond the traditional thinking that places a stress on a doctor's more 'mechanistic' traits like science and skill, recent reports acknowledge the predominance of more "nebulous factors like aggressiveness and consistency and ingenuity" (Gawande 2004) for a doctor's results. Therefore the 'human' side of the medical care must be a sine-qua-non ingredient of IT-assisted self-management. Compared to other channels of communication, mobile solutions allowing synchronous (e.g., phone type), asynchronous (e.g., text messaging or e-mail), or mediated (through automated software performing basic routine tasks) transmissions (including voice-text conversion and multimedia) are pervasive and more flexible (Revere and Dunbar 2001).

Supporting. Although today's patients are much more educated and informed about their health problems, they still need human interaction, support, and counselling (Meichenbaum and Turk 1987, p. 212) from peers and other members of the community. As mobile communications continue to grow in reach and capability, they may help support adherence interventions with the same efficacy that Web support groups have demonstrated (Mazzi and Kidd 2002) but with the additional advantages of flexibility and convenience (e.g., multimedia messaging services allowing image transmission and dialogue with the wired Web). Similarly, another Web intervention reported by Wantland, Portillo et al. (2004) showed that "those sites that incorporated the use of a chat room demonstrated increased social support scores."

Informing. Interventions directing patients to "relevant, individually tailored materials" in Web adherence-enhancing interventions "reported longer Web site session times per visit and more visits" (Wantland, Portillo et al. 2004). Common mobile devices (e.g., cell phones) have limited ability to offer information because of the restrictions of the user interface. However, they could be timelier in informing about volatile sources of information thus directing patients to useful news in other media (e.g., TV and radio broadcasts, newspapers, or Web sites).

Educating. According to Bodenheimer et al. (2002), self-management education and collaborative care are the two equally significant sides of the patient-physician partnership paradigm that are currently emerging in chronic disease care. Self-management education must be present in adherence interventions since it has been proven to be effective in improving chronically ill patient clinical outcomes (Bodenheimer, Lorig et al. 2002). However, since education is a complex and lengthy process, it is difficult for mobile solutions (as for other types of online solutions such as Web-based education) to address it adequately. A better education could be acquired

through the constant application of other mobile interventions [...] discussed, stimulating a combination of productive information and action for the patient.[14]

It must be also stressed that it would be ***unrealistic to expect wireless and mobile devices to successfully address the profound causes of intentional non-adherence related to patient factors***. Nothing can succeed when it is against patient will or when an individual is dissatisfied with the healthcare system, provider, or treatment. However, all of the proposed mobile IT interventions would likely ***target some important sources of unwilling non-adherence*** such as forgetfulness, (testing) stress, and anxieties, as well as the lack of knowledge and skills in applying the treatment, and self-managing the disease in general. Appropriate feedback and encouragement facilitated by wireless devices could foster optimistic attitudes, self-confidence, and motivation, especially if an alerting feature is included (Magrabi, Lovell et al. 2001).[15]

2.3.3 Existing Applications

Advances in wireless and Internet technology have already made possible the development of new healthcare services. Various devices and solutions, more or less portable, have been utilized in an attempt to address these changes: computers, telephones, pagers, alarms (Dunbar, Madigan et al. 2003). Research utilizing such new services showed promising results although most of the studies were small and without a control group (Laster, Maring et al. 1996; Frick, Lavreys et al. 2001; Revere and Dunbar 2001; Dunbar, Madigan et al. 2003).

Two of the most popular types of studies have included remote monitoring and disease management for patients in homecare. A synthesis of some existing or proposed mobile applications, as mentioned in the literature, is presented in Table 2.2.

[14] Ibid., p. 148
[15] Ibid., p. 148

Table 2.2 Existing or Proposed Applications of Mobile Healthcare Addressing Outpatient Adherence

Study	Type of intervention	Stage of mobile IT implementation	Disease
Husemann (2004)	Monitoring of vital measurements	Proposed	Not specified
Duan (2003)	Not specified	Proposed	Asthma, diabetes
Hoise (1999)	Not specified	Proposed	Asthma, diabetes
Weingarten, Henning et al. (2002)	Monitoring	Not specified	Diabetes
Wexler (2001)	Monitoring health parameters, alerting	Proposed	Diabetes
Dunbar, Madigan et al. (2003)	Reminding about taking medication and behavioural changes	Implemented	HIV
Erickson, Ascione et al. (1998)	Reminders about taking the medications	Implemented	Asthma
Conlin (2000)	Patient information and communication with physicians	Implemented	Not specified
Wirelessnewsfactor (2000) Conlin (2000)	Reminding about taking medication	Implemented	Not specified
Huseman (2004)	Monitoring of medication taking	Implemented	Not specified
Maglaveras et al. (2002)	Monitoring	Not specified	Not specified
ProWelness (2004)	Monitoring	Implemented	Diabetes
Van Impe (2001)	Monitoring	Implemented	Not specified
Bludau (2003)	Monitoring blood pressure, pulse rate, or temperature in hospitals	Implemented	Not specified
Poropudas (2001)	Monitoring	Not specified	Not specified

Trials of distance monitoring of blood glucose or blood pressure with the help of a computer showed improved outcomes and efficiency, together with more active participation of patients (Balas and Iakovidis 1999). Extrapolating from the success of preliminary results with the *Telephone-Linked Care* technology, Friedman et al. (1997) suggest that "the market demand for technology-based delivery systems used by patients in their homes will be strong". Husemann (2004) sees a future in the emerging field of information-based medicine for solutions like monitoring vital measurements on-the-go or for pill dispensers reminding the patients to take the appropriate medicine.

Electronic monitoring is constantly expanding, and innovative devices and applications are becoming increasingly available for a variety of diseases. In particular, analysts foresee wireless medical devices helping chronically ill outpatients with asthma or diabetes (Hoise 1999; Duan 2003) and distance monitoring of diabetic patients has already proven to ameliorate clinical outcomes (Weingarten, Henning et al. 2002).

Wexler (2001) reports on a development by the *IMetrikus Company* that allows diabetics to test their health parameters and upload the results to a Web site. The future could, reportedly, bring a Web-free solution using a direct connection between the glucose monitor and a cell phone, without patient intervention. Furthermore, a healthcare alert triggering feature could also be incorporated.

A study of 25 HIV-positive participants included sending them between 3 and 8 text message reminders per day about taking their medication. Patients perceived the resulting behavioural changes positively. Subjects participating in the study for a median of 208 days and using two-way alphanumeric pagers "expressed high satisfaction with the messaging system and reported that it helped with medication adherence" (Dunbar, Madigan et al. 2003).

Medtronic CareLink™ Network has been promoting a remote Web-based monitoring service for patients with implanted cardiac devices. Patients can send timely information to their clinic from a regular phone (Medtronic 2004).

WellMed Inc. developed a wireless application allowing patient data transmission (e.g., health or insurance information) and communication with healthcare providers (e.g., physicians) (Conlin 2000). *SmartMeds.com* and *AT&T Wireless* from the U.S.A. have jointly developed a wireless solution for reminding patients to take prescribed medications and allowing patient feedback about complying with reminders (Conlin 2000; Wirelessnewsfactor 2000).

IBM researchers pioneered an information technology solution to track vital health signs and send them to remote sites. The device includes a pillbox and a wristwatch-like blood pressure monitor able to communicate via a Bluetooth short-range radio connection to a cell phone. The phone, in turn, sends the data to healthcare personnel. Only authorized personnel are able to view the patient data. This technology is thought to reduce the number of check-ups, hospitalization periods, and patient health risks (Husemann 2004).

In recent years significant work has been underway in Europe on Internet or wireless remote monitoring. Maglaveras et al. (2002) advocate the "necessity for restructuring medical knowledge for education delivery to the patient" and exemplifies this by the novel idea of a contact centre enabled by wireless technology to manage the home care of patients remotely.

Patients using *ProWelness,* a Web-based information system for remotely managing several chronic diseases including diabetes, are able to record specific disease management activities daily by fixed phones or cell phones. The philosophy behind the system is based on the two key elements essential for the success of a chronic disease

(e.g., diabetes) management: "careful self-care and good communication with the care team" (ProWellness 2004).

Following the implementation of a three-year project financed by the *British Engineering and Physical Sciences Research Council*, doctors in the U.K. were able to monitor remotely the health condition of patients by analyzing medical data gathered by a device communicating through a cell phone (Van Impe 2001).

Bludau (2003) describes a platform for patient home monitoring by hospital physicians. The solution uses Bluetooth-enabled modular sensors and cell phone technology to send data such as blood pressure, pulse rate, and temperature.

Arbonaut, from Finland, and *Virtual Medical World Solutions*, from the U.K., have been developing a platform for real-time remote monitoring. This solution targets patients with a "stable medical condition that allows a near normal life but may suddenly deteriorate and put life at risk" (Poropudas 2001).

The above examples illustrate early attempts to use information technology for gathering and delivering real time medical information in order to improve the quality of care for patients cared for remotely. As both fixed and mobile solutions have been developed, an issue to be discussed is the justification from the perspective of a cost/benefit analysis for the use of mobile approaches in these situations.

2.3.4 Why Wireless Text Messaging for Adherence?

Mobile phones are definitely the booming communication tools of recent years. Wireless text messaging also known as short message (or *messaging*) service (or *system*) (SMS) has, according to many analysts, become the most successful data service of mobile commerce (Haung and Ho 2005).

SMS capabilities are incorporated in all modern cell phones. They allow sending and receiving simplified text-based messages up to 160 characters long or about 25 words on the signaling link which is distinct from the voice channel of cell-phone networks (Haung and Ho 2005). Using SMS as a communication tool, in comparison with the voice channel, while preserving all cell phone capabilities, especially in terms of portability and convenience, is cheaper and disturbs the user and/or the user's social context less (BBC 2005a). Due to these qualities, text messaging applications have been already used in interventions regarding outpatient adherence to behavioral changes that could fall into the above-suggested categories of *reminding*, *monitoring*, *informing*, and *educating*. A synthesis of early trials using SMS for adherence is presented in Table 2.3 below.

Table 2.3 Summary of Text Messaging Trials Addressing Outpatient Adherence

Study	Type of SMS application	Form of intervention	Number of participants	Outcome
Downer, Meara et al. (2005)	Reminding for appointments	Reminding	4,427	Decrease of missed appointments
Dyer (2003)	Reminding for appointments	Reminding	Not specified	Decrease of missed appointments
Anna, Jose-Maria et al. (2004)	Reminding for preventive vaccination	Reminding	4,895	Decrease of missed shots
Tomnay, Pitts et al. (2005)	Partner notification	Informing	Not specified	Not specified
Neville, Greene et al. (2002)	Reminding for daily asthma activities	Reminding, educating	30	Likelihood of better compliance
Rodgers, Corbett et al. (2005)	Fostering smoking cessation	Reminding, informing, educating	1,705	Doubling of smoking quit rates
Franklin, Waller et al. (2003)	Support of young diabetics	Reminding, monitoring, informing, supporting, educating	Not specified	Project under development
Bos, Hoogstraten et al. (2005)	Reminding for appointments	Reminding	343	No difference from control group
Bauer, Percevic et al. (2003)	Monitoring and feedback	Monitoring, educating	30	Project under development
Gammon, Arsand et al. (2005)	Children monitoring by parents	Monitoring, educating	15	Not specified
Ferrer-Roca, Cardenas et al. (2004)	Diabetics monitoring and feedback	Monitoring, educating	23	Not specified
Dunbar, Madigan et al. (2003)	Reminding, monitoring, feedback, support	Reminding, monitoring, informing, educating	25	Positive self-reported

For instance, text messaging has been used to address the first and "most severe form" (Haynes, McDonald et al. 2002, p. 2882) of outpatient non-adherence - insufficient attendance at outpatient clinics. Sending patients reminders about upcoming visits proved in a controlled trial with 4,427 patients at *Royal Children's Hospital of Melbourne, Australia*, that the failure rate to attend was significantly lower in the intervention group (14.2%) compared to the control group (23.4%) with $p<0.001$ (Downer, Meara et al.

2005). The study further emphasizes SMS advantages for such applications in terms of low cost for the sender (i.e., healthcare center), and less staff resources used.

A similar initiative was developed in *London, U.K.*, in 2002. Sending patients SMS automated reminders about upcoming appointments at a department of *Homerton Hospital in Hackney*, led to a decrease of missed appointments of about 8%. The reported financial figures for this implementation give reasons of optimism. Thus, sending patients text messages at 5 pence (less than 10 U.S. cents) each was judged as a success since the savings significantly offset the costs (Dyer 2003). The market for such applications seems considerable, according to the cited study, since the total cost of missed appointments amounted to about $716 million U.S. in England alone per year.

An application reminding patients about the next vaccine dose, sent by SMS, increased compliance with a vaccination schedule for hepatitis A+B and A (Anna, Jose-Maria et al. 2004). A trial with two control groups developed at the *International-Clinic Vaccination Centre in Spain* proved a higher compliance in the intervention group (88.4%) compared to the two control groups (80.7% and 77.2%) for the second vaccination with Vaccine A+B dose, one month after the first shot. The results are remarkable since "noncompliance is more frequent in preventive treatments due to their very nature" (Anna, Jose-Maria et al. 2004, p. 504). Accordingly, it was noticed that compliance decreased in time for both intervention and control groups while continuing to remain higher in the intervention group (e.g., 47.1% vs. 26.9% and 23.6% for the third vaccination dose, 6 months after the primary shot).

An *Australian* study refers to partner notification for the effective control of sexually transmissible infections. SMS was suggested as a possible channel to do this because of ease, convenience, and immediacy, but some ethical considerations have yet to be resolved (Tomnay, Pitts et al. 2005).

A text messaging application was used in the *U.K.* for daily reminders to young people with asthma to use an inhaler. Beyond that, the application also offered health education tips and safety messages (Neville, Greene et al. 2002). The application involved 30 participants and was reported as a success. It had as a distinctive feature the use of a virtual friend called "Max" addressing young people in a colloquial and friendly style like: "Bonjour, c'est Max. Hav U taken Ur inhaler yet?" or "Yo dude, its Max reminding U2 takeur inhaler" (Neville, Greene et al. 2002).

A randomized controlled trial on 1,705 smokers in *New Zealand* proved that sending SMS messages providing personalized content regarding smoking cessation advice, motivational support (e.g., success stories, feedback about prolonged life and money savings), and some form of enjoyment (sports, travel, trivia, etc.) led to more people quitting smoking in the intervention group than the control group after 6 weeks (28% vs. 13%) (Rodgers, Corbett et al. 2005). About 50% of the SMS messages were related to quitting smoking and 50% to enjoyment.

"Sweet Talk" is a text messaging application reportedly under development at the *University of Dundee's (U.K.) Children and Adolescent Diabetes Team and Applied*

Computing Division with the purpose of increasing the efficacy of young people with Type 1 diabetes for managing this chronic disease. Patients are sent daily goal specific messages, and weekly reminders and motivational messages. They are also sent reminders about clinic appointments. Following a pilot that tested group suggestions, messages come at random times of the day and the service is made friendlier by ending all messages with a "smiley". Young patients are encouraged to ask questions by text messaging and the most interesting questions and answers are then broadcast as newsletters to encourage reciprocity and a feeling of group support. Patients may also send their blood glucose levels without any text and then they receive feedback. Preliminary results with the system indicated a 73% recruitment rate of the eligible clinic population thus leading to possible promising results (Franklin, Waller et al. 2003).

A result discordant with the above positive anecdotal evidence is reported by Bos, Hoogstraten et al. (2005) who tested a reminding service targeting 343 patients of the orthodontic clinic at the *Academic Centre of Dentistry Amsterdam, the Netherlands*. Three groups received reminders about upcoming appointments either by telephone, mail, or SMS for 3 weeks, while a control group received no treatment. The study reports that no differences were found between the intervention groups and the control group and, furthermore, 20% of the patients felt "negative or very negative about the reminders and considered them to be a waster of time and money" (Bos, Hoogstraten et al. 2005, p. 355). However, the majority of the participants felt positive or very positive about receiving a reminder, indicating as their preferred reminding channel, mail (56.3%), telephone (26.0%), and SMS (17.7%).

Patients with bulimia nervosa, an eating disorder, were the target of an SMS application developed in Germany. The intervention consisted of offering bulimic patients released from a *German hospital for psychosomatic medicine* a 6-month program during which they are able to send weekly text messages on their bulimic symptoms and receive general feedback and tailored information. Thirty patients were initially enrolled in this ongoing study, which was triggered by "the need for cost-effective treatments and the new options of technical progress" and the results on "acceptance, practicability, and effectiveness" were the sought outcomes (Bauer, Percevic et al. 2003, p. 11).

Parents of children with Type 1 diabetes were involved in a text messaging system for adherence described by Gammon, Arsand et al. (2005). Thus, a prototype system developed at the *Norwegian Centre for Telemedicine* has been sending automatically the glucose readings from children's glucometers through Bluetooth to their cell phones and from there, through SMS, to their parents' cell phones. The purpose was to involve each family in their children's diabetes self-management. A trial using 3 transmissions a day for 4 months involved 15 children and 30 parents. The study reached some interesting conclusions showing that "it is unclear if or how this will improve child-parent interactions and/or health outcomes", however "user enthusiasm suggests that such systems might find a consumer market regardless of whether or not they ultimately improve health outcomes" (Gammon, Arsand et al. 2005).

Twenty-three diabetic patients have been using SMS to send data such as blood glucose levels or body weight to a server for 8 months (with an average of 33 messages per months) in research project in *Spain*. The server has been sending acknowledgements and monthly averages of health results (e.g., glycosylated haemoglobin). The results showed a good acceptance of the SMS system for diabetes while at the same time capturing various concerns of the patients (Ferrer-Roca, Cardenas et al. 2004).

A good reference study for using text messaging in adherence initiatives is reported by Dunbar, Madigan et al. (2003). The following describes this study. The research utilized two-way pagers for HIV patients, and was, according to the authors, the first of its kind. The study utilized two-way messaging as follows:

- Healthcare-to-patient: for conveying reminders, continuous support, education, and encouragement; and,
- Patient-to-healthcare: for receiving patient feedback on rates of adherence, side effects, and impressions of the pager technology.

The study was conducted in an *HIV/AIDS clinic in Seattle, Washington* during 1997-1998. The initial study duration was 4 months, but due to patient enthusiasm it was extended to 6 months. Patients were sent up to 20 line messages with only 4 lines visible on the screen at a time. Pagers could also be programmed for silent or audible alerts. Patients could reply through standard pre-stored messages or by composing messages of their own through a soft key interface. Depending on their dosage schedules, patients were sent between 3 and 8 messages daily as follows:

- Reminders (e.g., to take the medication and follow the dietary requirements);
- Informing (e.g., providing information and questions about adherence, medication side effects, food, sleeping habits, etc. as well as about the text messaging system use);
- Educational (e.g., describing appropriate food habits, possible side effects and reinforcing the importance of adherence); and,
- Entertainment (e.g., jokes, news, quizzes).

The system allowed basically 24-hour day communication between patients and investigator. The "call me" or other urgent messages sent by the patients were identified by the system and directed to the investigator's pager for immediate attention. One advantage of such a system is that it logged the time when messages were sent and when a reply was received (to calculate the response time) and the percentage of the messages answered (as the response rate).

The study included 25 subjects and was not controlled. Patient satisfaction data were collected for the first 10 study participants on a multi-item scale at 4 weeks, 8 weeks, and 12 weeks. Subsequent participants did not fill in any survey because the responses where overwhelmingly positive. However, all participants received a 4-

question survey 3 weeks before the end of the study and answered an exit interview where they were asked if they would stay in such a program if it were offered to them.

The results were significantly positive. Nineteen participants (i.e., 76%) stayed in the program for more than 3 months, 79% of the participants reported that the pager improved their adherence to the medication regimen, 47% of pager replies indicated that patients loved the intervention, and 86% of those completing the exit interview indicated that they would continue to stay in such a program, if offered. The most appreciated pager features were "the medication reminders and content of the entertaining messages" (Dunbar, Madigan et al. 2003, p. 14). Patients disliked mostly the pager size. The work schedule for the investigator was very light: about 30 minutes per day to review messages and one day per month to review message schedules.

The main advantage of such a system was to collect real-time information about self-reported adherence, but also about symptoms, side-effects, and mood that are factors that potentially affect adherence. As an important limitation to the study, the authors acknowledged to have used a convenience sample based on willingness to participate. The conclusion was that new wireless technology might better contribute to improving adherence through higher customization. The ideal system would combine automation with personalization, thus not requiring extensive staff time (Dunbar, Madigan et al. 2003).

2.4 Research Topic

2.4.1 Why Study Outpatient Acceptance of Text Messaging Telehealth?

A careful examination of the available literature, as depicted in Section 2.3 and especially in Sub-section 2.3.4 above, shows that there have been some more-or-less scientific attempts to examine the use of wireless text messaging in telehealth, especially for the case of outpatient adherence. ***However, there is a void regarding the scientific examination of patient perspectives.*** Studies mostly restricted their outcomes to behavioural issues (e.g., decrease of missed appointments or missed vaccination shots) without examining patient perceptions. When investigated, patient viewpoints were gathered in a general and hardly scientific way (e.g., by a limited number of questions of general acceptance or satisfaction). Furthermore, the impressions were usually collected in studies reporting small numbers of participants.

Despite the apparent win-win situation of introducing innovative technology approaches such as text messaging in the telecare of outpatients, previous conceptual research has identified both opportunities and barriers to using mobile information technology for supporting adherence. A significant portion of these refer to patients, as key stakeholders in today's healthcare system.

A. Patient opportunities. Recent research has demonstrated the importance of behavioural changes for patient health states in general (Institute for the Future, 2003).

Encouraging behavioural transformations towards a healthier lifestyle is acknowledged as being at least as significant for a chronically ill person as the treatment itself. It is also clear that behavioural changes must be individualized since every patient is unique. Mobile technology offers the distinctive possibility of personalization, thus allowing the high customization of interactions with patients, seen as "segments of one" (Sofian, Newton et al. 2000), with the healthcare providers. Change of patient behaviour regarding their conditions and lifestyles, would therefore result in positive medical and social consequences.[16]

(a) Medical aspects. The concept of telemedicine is not new (Bashshur 1995), and it refers to "an effective substitute for in-person medical care and...an efficient tool in developing integrated systems of care", according to Bashshur et al. (2005). Telemedicine has been traditionally supported by regular mail, landline telephones, and more recently, the Internet and satellite communications, to connect outpatients with the healthcare system. Mobile solutions are superior to these channels because they offer anytime and anywhere service to patients, irrespective of their physical location. Thus, mobile solutions may be better for fulfilling the requirements of long-term home care. This does not imply patient neglect, but instead means fostering continuing contact between them and the healthcare system. Such continuous contact is more likely to predict and avoid serious complications since "preventing is better than curing" (Maglaveras, Koutkias et al. 2002). Mobile solutions would also help to combat outpatient non-adherence that often leads to collateral complications and even to the triggering of other diseases.[17]

(b) Social aspects. Non-adherent patients not only suffer medical complications, long treatments, and hospitalization, but also face absenteeism and intangible consequences such as psychosocial complications (e.g., isolation, damage of social status) and lower quality of life (Dezii 2000; WHO 2003). Obviously, patients are interested in living a life as normal and active as possible, amid family, friends, and co-workers, rather than in a hospital environment. Therefore outpatients are likely to be interested in solutions allowing them mobility at work, school, vacation, etc. while at the same time having a virtual permanent connection with their healthcare providers. In this way, patients with certain diseases could live a better quality life while following the necessary treatment (e.g., performing self-tests, taking prescribed medications, following certain diets, pursuing physical exercise, etc.). Mobile solutions, by virtue of being customizable and always accompanying the person, should facilitate a high degree of patient involvement in the self-management of their diseases and conditions. This should improve patients' adherence and help them to progressively develop responsive attitudes, self-confidence, optimism, satisfaction, and improved education and mobility (WHO 2003).[18]

---

[16] From Cocosila, M. and N. Archer (2005b). "Mobile healthcare initiatives for improving outpatient adherence: Opportunities and barriers." International Journal of Electronic Business 3(6): 512-533., p. 514-515

[17] Ibid, p. 514-515

[18] Ibid, p. 514-515

B. Patient issues or barriers. There are several types of patient factor that may obstruct the use of mobile initiatives for telehealth in general and for outpatient adherence in particular.

(a) Intrinsic factors. Patient-related factors are clearly pivotal for any adherence-related issue (Dezii 2000; WHO 2003). These factors spring from patient psychological, attitudinal and behavioural traits, and are associated with beliefs and concerns about disease, medication and treatment as a whole. Even the most competent healthcare professionals are unable to improve patient adherence without their active and conscious involvement. For instance, little can be done for a patient who is in a state of hopelessness about the treatment for his/her illness, although the actual disease may be benign if treated. In situations when patient-related factors of adherence are not favourable to healing interventions (e.g., patient does not accept being monitored or reminded about taking medications), the most advanced technology is useless.[19]

(b) Difficulties with technology. Despite a patient's willingness to adhere to a treatment by using novel information technologies to improve performance, difficulties may occur with some patients in following recommendations. For instance, research has shown that social and demographic factors (e.g., race, gender, age, social status, education) have a minor influence on adherence (WHO 2003). However, elderly patients appear to have an objective tendency to poor adherence and involvement in their treatment because of cognitive and functional impairment that may combine with the necessity of taking more medications. If mobile devices pose usability problems, especially due to their limited input/output capabilities, it is likely that elderly patients will have difficulties in using complicated mobile devices. Besides seniors, some other categories of people (e.g., low-income or minorities) may exhibit discomfort and resistance to using cutting edge technologies and devices because of a lower level of experience or familiarity (Moyer, Stern et al. 1999). Other patient categories that may have difficulties with mobile device support include those who for various external reasons (e.g., factors related to their conditions, therapies, healthcare teams, or even the healthcare system) have difficulties in adopting pro-adherence attitudes (WHO 2003). In addition, complex and non-robust devices and programs are more likely to be rejected by patients (Mazzi and Kidd 2002).[20]

(c) Interaction with devices. There are also questions regarding patient interactions with mobile devices. For example, would patients prefer highly automated devices to perform medical measurements (e.g., blood glucose or blood pressure) and transmit the results to a homecare call centre without human intervention, or would they prefer to be actively involved in this process? The first approach may be more convenient but may also not be welcomed by patients who would like to be better informed about their health status and treatment, and to be involved actively in their treatment. A related issue is how 'tightly' to design the patient interaction with the mobile device. Trying to collect or to remind "too much data too often" (Mazzi and Kidd 2002) through a mobile

[19] Ibid, p. 514-515
[20] Ibid, p. 515-516

solution may unnecessarily irritate the patient and seriously hamper the whole adherence-improving initiative because it would be socially awkward and intrusive for many people. Patient discomfort with limited input-output capabilities of mobile devices is also an important issue. Trying to enter/receive a large amount of written information through mobile devices is much more difficult, when compared to using a desktop or laptop computer.[21]

(d) Security and privacy. Telemedicine technology requires appropriate encryption to ensure patient trust when transmitting personal data online. A still very popular opinion is that wireless communications have a lower level of security and privacy than those using wired channels. Patients may, therefore, be reluctant to use wireless devices to exchange data about their health condition and treatment, even if these data are unlikely to be critical or sensitive. However, security and privacy of wireless communications in healthcare are regulated and patients' fears are likely to be unjustified. For example, the U.S.A. has issued related guidelines through *Health Insurance Portability and Accountability Act (HIPAA)* whereas Canada has adopted the more general *Personal Information Protection and Electronic Document Act (PIPEDA)* at the federal level and more specific regulations at the provincial level (e.g., *Personal Health Information Protection Act (PHIPA)* in the province of Ontario).[22]

Taking into account the above and based on a search of the available literature, the proposed study is believed to be one of the first of its kind done in Canada at least. It aims to ***fill the void of a scientific perspective of the patient viewpoint regarding text messaging use in telehealth, having outpatient adherence as a case study***. This work aims at scrutinizing as a general research issue what key factors influence user acceptance of wireless text messaging if SMS is used as an adherence support tool for promoting healthy behaviour.

2.4.2 Research Questions

This research investigates empirically some user perceptions regarding the use of an application of SMS to support adherence. At a more specific level, the focus of the research is on the role of the dyad of *opportunities* and *barriers* on user behavioural perceptions of using SMS to support adherence. As will be shown in Chapter 3, based on the literature review, *motivation* and *perceived risk* (both seen as multidimensional constructs) were considered to be the most appropriate factors describing patient attitudes *for* or *against* the use of the technology. For a plethora of methodological, practical, theoretical, and ethical reasons that will be explained in Chapter 4, adherence as investigated in this study refers to a preventive regimen for healthy behaviour. For scientific soundness, the research is based on a theoretical socio-behavioural model, built in Chapter 3 and drawn from reputable literature that examines user acceptance of new technology. Therefore, the overwhelming weight of the research is in the information systems field. The study is structured around the research questions depicted in Table 2.4.

---

[21] Ibid., p. 517-518
[22] Ibid., p. 517-518

Table 2.4 Information Systems Research Questions

No.	Research question
RQ1	What are the influences of the various dimensions of perceived risk on the perceived overall risk associated with the use of wireless text messaging in telehealth?
RQ2	What is the influence of perceived overall risk on the motivation associated with the use of wireless text messaging in telehealth?
RQ3	What are the influences of motivation and perceived risk on the intention to use wireless text messaging in telehealth?
RQ4	How appropriate is the proposed risk-motivation theoretical model in explaining the intention to use wireless text messaging in telehealth?
RQ5	What are the characteristics of the user population who are positive towards the use of wireless text messaging in telehealth?
RQ6	What are the main opportunities and barriers, from the users' viewpoint, regarding the intention to use wireless text messaging in telehealth?

The study of the literature showed that, besides the above salient research questions, other elements of interest may be captured in a study of this nature. One of these is the business aspect of an SMS intervention targeting outpatient adherence. Various studies have demonstrated that the lack of adherence can cause significant financial losses. "Using mobile devices to improve adherence would presumably counterbalance some of these financial losses but an important question is: *At what cost could this be done?*" (Cocosila, Archer et al. 2006).

Insufficient adherence of chronically ill outpatients has many and complex negative consequences, so it appears that any small improvement in adherence resulting from the use of mobile solutions would be welcome. However, from a business point of view, the potential benefits must be compared with the costs required to achieve these benefits. As discussed previously, mobile solutions may help to improve outpatient adherence only if embedded in more complex clinical interventions. Evaluating the costs of such complex interventions is beyond the scope of this work, and, therefore, the focus here is on the costs associated with the mobile healthcare component alone. However, even this is difficult to evaluate because mobile healthcare is a relatively new field and little solid financial data are available. Nonetheless, costs can be classified as capital and operating, as presented in Figure 2.2.

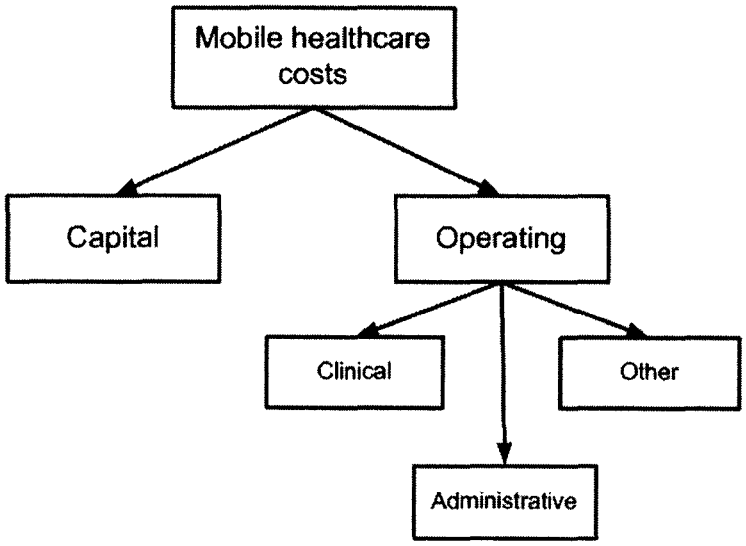


Figure 2.2 Costs of Mobile Solutions to Improve Outpatient Adherence

Capital costs refers to the costs of buying and deploying the infrastructure (e.g., wireless servers, database servers, computers, mobile devices, software) and costs of training people and creating or modifying some jobs (e.g., IT and healthcare personnel to operate the wireless call centres for outpatients) (Cocosila, Archer et al. 2006). ***Operating costs*** refer to the costs associated with continuously providing the mobile services to the outpatients. These costs can be further subdivided into *administrative* (e.g., costs of operating the servers and computers, costs of wireless communications between patients and call centres, salaries of IT people involved in the project), *clinical* (e.g., reimbursement for home care nurses working in call centres, or for additional work by other healthcare providers such as physicians and surgeons), and *other categories* (e.g., cost of renting technology which was not bought upfront) (Cocosila, Archer et al. 2006). Operating costs can be significantly reduced if there is a significant amount of automation in the mobile healthcare solution, combined with patient segmenting and prioritizing (Cocosila, Coursaris et al. 2004).

According to some analysts, mobile healthcare may be beneficial if it costs no more than $5-10 daily to operate a mobile healthcare device in contrast with the $900 required by a single visit to the emergency room (ER) (Edwards 2002). The same applies if a device to monitor diabetes remotely would cost about as much as a visit to the ER (Duan 2003). A few analysts even speculate that some chronically ill people would accept paying part of mobile healthcare costs directly (Duan 2003) because of savings in travel time and reduced absenteeism. Empirical data seem to agree with this view. For instance, a study performed by Barner, Mason, and Murray (1999) on 116 adult asthma patients revealed that outpatients would be willing to pay a mean amount of $29.50 U.S. for a self-management program in total. The patients were willing to stay in such a program for 8 weeks on average. Both the amount and the duration were influenced by

several patient factors such as health state and history, education about the disease, and access to healthcare.

Therefore, increasing economic pressures, as described in Chapter 1, may require patients to share the costs of health education programs. Even if a program is fully financed by the healthcare system, it is also useful to know for how long people would like to stay in such a program before the expected outcome, to improve their self-management skills and health outcomes (Barner, Mason et al. 1999). Consequently, this study will be investigating also a business model research question, as depicted in Table 2.5.

Table 2.5 Business Model Research Question

No.	Research question
RQ7	How much would users agree to pay and for how long would they stay in a program using wireless text messaging telehealth as a support in improving adherence to a healthy behaviour regimen, if usage is not free?

Starting from the limitations and insufficient solidity of previous studies investigating the use of SMS to improve adherence, this research also attempts to answer a healthcare research question described in Table 2.6.

Table 2.6 Healthcare Research Question

No.	Research question
RQ8	Would a wireless text messaging telehealth service that reinforces adherence to healthy behaviour improve this adherence over time?

The healthcare research question for this study follows the recommendations of Haynes, Sackett et al. (2005) and contains the *PICOT* elements: *Patients*, *Intervention*, *Comparison group*, *Outcomes*, and *Time* (Haynes, Sackett et al. 2005, p. 11). As such, the complete healthcare research question for the present study is: "Among competent and consenting students in a Canadian university familiar with wireless text messaging and using cell phones who are taking a 500 mg vitamin C pill daily for prophylactic reasons, does the addition of wireless text messaging reminders and reinforcers, by an automated system, increase the vitamin taking adherence over a one-month period compared with subjects who follow the same vitamin C treatment but do not receive any text messages?". The elements of this question should be fully understood after reading Chapters 3 and 4 of this work. Furthermore, this is obviously a lengthy question and, as in many practical cases, a shorter form should be used. Consequently the concentrated form in Table 2.6 is suggested. However, it is important that the elements of *PICOT* be

kept in mind, so reported study results "would not be overgeneralized" (Haynes, Sackett et al. 2005, p. 12).

As the overwhelming weight of this study is in the IS field, the business model and healthcare questions, RQ7 and RQ8, are *secondary research questions*. They meet all the recommendations for secondary research questions as stated by Haynes and collaborators (2005) and the reasons should be fully understood through the experimental methodology described in Chapter 4:

- Secondary research questions are asked at the beginning of the investigation, thus avoiding 'data-driven' results (or results developed after only partial data collection and interpretation);
- IS research results are not compromised since participants are asked just a few questions regarding the secondary research questions in the pre- and post-study surveys, together with the other questions; and,
- Secondary research questions do not alter the research budget because they simply add a few questions to surveys that would be conducted anyway.

2.5 Summary

This chapter has described the concept of outpatient adherence stressing its importance especially for chronically ill patients cared for in outpatient conditions. Thus, the insufficient adherence has significant negative consequences for all main stakeholders in healthcare: patients, healthcare professionals, healthcare system and society. *Adherence*, or *compliance*, is a complex and insufficiently understood phenomenon that can affect all patients and has a rate of 50% on average. Various factors depending on patients as well as on patient socio-demographics and environment, medical condition, treatment, therapy, as well as healthcare team and system affect it. Because of the limitations of traditional methods in dealing with insufficient outpatient adherence, a possible innovative approach would be to address it by mobile IT solutions.

Mobile healthcare solutions have clear advantages that may justify their use for some chronically ill patients in outpatient conditions: reach of a uniquely identified person beyond the specific location of that person (within the area of coverage), portability, utility of the service (including for some urgent and unexpected situations). Based on recommendations from relevant medical literature, mobile solutions could address all major factors of patient non-adherence through a suite of interventions: monitoring, reminding, consulting, supporting, informing, and educating. However, a realistic view must acknowledge that *mobile solutions could probably not improve adherence by themselves*. They should rather enrich more complex clinical interventions by facilitating a broader and timely dialogue between patient and the healthcare system. Also, it should be noted that *even the most sophisticated technology could not address the inner causes of patient non-adherence* coming from some individuals' negative attitude

and beliefs. Therefore, mobile solutions should *target more realistically only the unwitting forms of low adherence* such as forgetfulness, lack of skills, lack of confidence, or anxiety.

Reminding and monitoring are the most popular interventions of early implementations of electronic and mobile solutions addressing outpatient self-management of chronic illnesses and insufficient adherence to the treatment. Out of the solutions implemented strictly through portable devices, *reminding based on text messaging* approach proved to lead to encouraging results in several studies done in various countries. The incontestable qualities of wireless text messaging (or SMS) in terms of popularity on modern portable communication devices (cell phones especially), low cost, and low intrusiveness are certainly an explanation.

On the other hand, all the published studies or Web information reporting such early implementations **lack a scientific perspective (or any perspective at all) regarding patient viewpoint** about using the text messaging in telehealth interventions (such as monitoring and reminding). This perspective is important because, in their attempt to help more closely, mobile solutions may rather intrude and bother people. Consequently, users may eventually not adopt such solutions and thus the whole approach of helping people through a sophisticated technique may fail.

Accordingly, this study adopts as a main area of research interest the broad *investigation of factors favouring and of factors not favouring the adoption of SMS to support adherence.* More specifically, this research proposes to investigate the influence of the dyad motivation-perceived risk on the user intention regarding SMS use in telehealth, and the factors moderating this influence. Besides the main research questions centered around the technology adoption issue, this study is also investigating a business case research problem which is intended to *enrich knowledge about the patient willingness to partially support such programs*. A final secondary research question regards the *effectiveness of a SMS-based solution addressing the adherence of well people to a healthy regimen* (taking vitamin C for prophylactic reasons) over a limited period of time (one-month period).

In conclusion, this chapter has outlined a research focus and defined *eight research questions* that should be answered in the study proposed in the remainder of this work. Adopting an end-user perspective is believed to make this whole study resonate with **today's approach to patient-centric healthcare,** which has a significant need for research performed in a scientific manner, as the subsequent chapters of this study will show.

Chapter 3: Theoretical Model

3.1 Introduction

As previous research has shown, "the fiscal challenges to [contemporary] healthcare have increased the tendency to shift patient care to ambulatory conditions while at least maintaining the same quality of care, compared to hospital settings. Unfortunately, the success of this approach to healthcare is hindered by patient non-adherence. Mobile solutions may help in addressing patient non-adherence, with positive human and financial benefits for all major stakeholders: patients, healthcare professionals, health insurance, and disease management companies and governments. At the same time, most of these stakeholders face barriers in adopting such solutions for various reasons: behavioural, organizational or technological" (Cocosila and Archer 2005b, p. 530). "More research is necessary in examining the advantages and disadvantages of mobile solutions in helping outpatients improve their adherence from the perspective of technology acceptance. Despite the apparently objective help brought by a certain technology, complex issues de-motivating patients to actually adopt that technology (e.g., social awkwardness, intrusiveness, or ease of use for first-time users like elderly patients) may constitute considerable barriers" (Cocosila and Archer 2005b, p. 531).

This chapter adopts a user perspective in examining the problem of acceptance of a wireless text messaging intervention to support adherence to healthy behaviour. This vision springs from previous research which has shown that users would have both reasons to accept such a technology (encompassed under the general term of ***motivation***) and reasons to worry about possible drawbacks to the technology (encompassed under the term of ***perceived risk***). Thus, Section 3.2 discusses intrinsic and extrinsic motivation, Section 3.3 examines the concept of perceived risk applied to information systems, Section 3.4 outlines extant technology acceptance research relevant for this study, Section 3.5 presents the proposed theoretical model, and Section 3.6 formulates the hypotheses for the proposed research.

3.2 Intrinsic and Extrinsic Motivation

Previous research has shown motivation to be a determinant of behaviour in various situations (Deci and Ryan 1985; Venkatesh and Speier 1999). As recognized researchers in the domain of motivation put it, "to be motivated means to be moved to do something" (Ryan and Deci 2000, p. 54). Therefore, motivation is "the degree to which an individual wants and chooses to engage in certain specified behaviors" (Mitchell 1982, p. 82).

Although most theories of motivation consider it as a unitary phenomenon, more recent research shows motivation to be a *multifaceted*, *intentional*, and *individual-dependent* phenomenon (Mitchell 1982). People differ not only in their level of motivation (i.e., 'how much motivation') but also in the orientation of their motivation (i.e., 'what type of motivation'). In particular, speaking from a marketing perspective, consumers were seen either as trying to solve problems or as looking for fun and enjoyment (Hirschman and Holbrook 1982; Childers, Carr et al. 2001). Therefore a dichotomous characterization of motivation divides it into two distinct categories more formally called *intrinsic motivation* and *extrinsic motivation* (Ryan and Deci 2000). While extrinsic motivation refers to performing an activity for achieving an outcome that is external to that activity (e.g., improving performance, obtaining a pay), intrinsic motivation is related to performing an activity for no apparent reason except the activity itself (Moon and Kim 2001).

3.2.1 Intrinsic Motivation

Intrinsic motivation represents "doing of an activity for its inherent satisfactions rather then for some separable consequence" (Ryan and Deci 2000, p. 56). This type of motivation was indicated by experimental studies showing that persons engage in various behaviours when driven by exploratory, curiosity, or playful reasons, even in the absence of a reinforcement or reward (Ryan and Deci 2000). Thus, intrinsic motivation refers to the performance of an activity "for no apparent reason other than the process of performing it" (Moon and Kim 2001, p. 218).

Although, from one perspective, intrinsic motivation exists within individuals, from another point of view it is generated in individuals' interaction with activities. Thus, the same individual may be more intrinsically motivated for some tasks while being less motivated by other activities (Ryan and Deci 2000). Exploratory research in applied psychology has shown that intrinsic motivation is affected by at least two factors: task characteristics and individuals' attributions about the perceived causes of their actions (Deci 1975; Hirst 1988).

In terms of operational definitions, one way to capture intrinsic motivation has been to use a "free choice" measure (Ryan and Deci 2000, p. 57). Thus, in some experiments people were exposed to a task under reward or no-reward conditions for a certain period of time. After a quiescent period they were allowed to express a 'free choice' of returning to the task or not. If people chose to return to the task without any external reason for doing so (e.g., no reward) the task was judged as displaying intrinsic motivation for the individuals. The other approach to capture intrinsic motivation was to use personal self-reports regarding interest and enjoyment in the activity by itself (Ryan and Deci 2000).

3.2.2 Extrinsic Motivation

Unfortunately, in real life most activities are not, strictly speaking, intrinsically motivated. Therefore the explanation for people performing tasks that are not necessarily pleasant and interesting resides in the other facet of motivation: extrinsic motivation. This

is "a construct that pertains whenever an activity is done in order to attain some separable outcome" (Ryan and Deci 2000, p. 60). In other terms, extrinsic motivation helps achieving "valued outcomes that are distinct from the activity itself" (Moon and Kim 2001, p. 218). Such possible outcomes could be a monetary reward or a performance in certain activity. In contrast to intrinsic motivation which is seen as a one-stage attitude, extrinsic motivation has four stages, as depicted in Figure 3.1, in ascending order in terms of autonomy, internalization, and integration (Ryan and Deci 2000):

- *External regulation* - is the least autonomous form of extrinsic motivation, where activities are done exclusively to satisfy an external demand or to meet an imposed reward. It is the least motivated state, next to *amotivation* which means the lack of intention to act because of various reasons (e.g., not valuing the activity, feeling not competent for it, or not believing in its outcome);
- *Introjected regulation* - implies performing activities, still mostly due to external pressure (i.e., for approval from others) but in combination with ego involvement (e.g., for self-approval);
- *Identification* - assumes that an individual has identified the importance of a certain behaviour and endorses the goals of that task as proper to that individual; and,
- *Integrated regulation* - is the most 'intrinsic' form of extrinsic motivation and occurs when the external regulation has been assimilated by the individual as a self goal. Although it shares many traits with intrinsic motivation, integrated regulation is still a form of extrinsic motivation because it is related to some outcome separate from the behaviour. Because of this, any greater integration of extrinsic motivation will not make it become an intrinsic motivation.

In terms of influences on personal behaviour "consequences are decreasingly positive from intrinsic motivation to amotivation" (Vallerand 1997, p. 322).

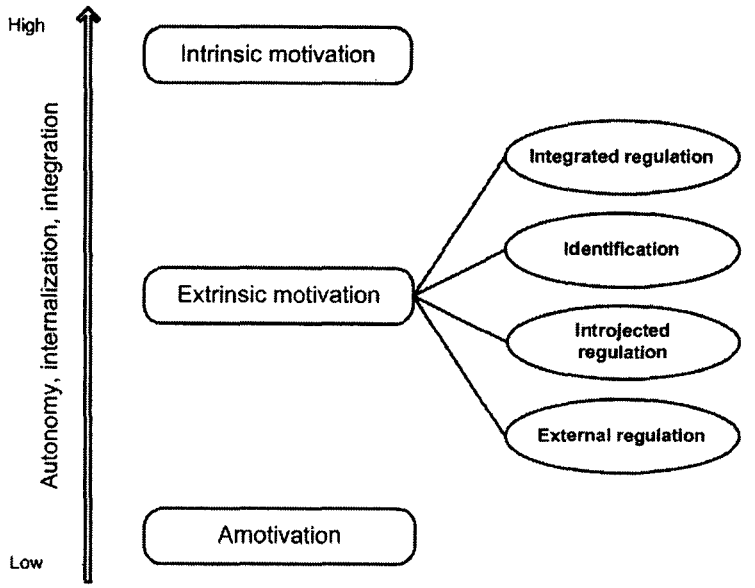


Figure 3.1 Extrinsic Motivation and Intrinsic Motivation Taxonomy (adapted from (Ryan and Deci 2000, p. 61))

Ryan and Deci (2000) looked more closely at the implications of autonomy and competence for the two forms of motivation as well as for the outcome of activity involving motivation. Thus, both intrinsic and extrinsic motivations are closely related to autonomy and competence. Experimental research has shown that more autonomous extrinsic motivation has positive results for people becoming more engaged in an activity, diminishing the likelihood of dropping out, and displaying greater psychological well-being. Adopting as one's goal an external reward or objective necessitates that the individual understands the goal and has also the skills to attain it. Also, positive performance feedback augments intrinsic motivation whereas negative feedback diminishes it. According to Ryan and Deci (2000), studies have proven that autonomy-supporting (in contrast to controlling) teachers, for instance, induce in their students greater intrinsic motivation, curiosity, and interest.

Developing a sense of *relatedness* in individuals (e.g., providing the individuals a sense of belonging for external goals) and promoting individual *competence* related to goals facilitates internalization of these goals. If support for *autonomy* is added, "people not only feel competent and related, but also self-determined, as they carry out extrinsically valued activities" (Ryan and Deci 2000, p. 65). The support of these three basic human needs is the premise for maintaining an intrinsic motivation and making individuals more self-determined with respect to extrinsic motivation.

Research has shown that there is a *definite link* (or, even, *interdependency*) between the two forms of motivation. Thus, a large body of research demonstrated that extrinsic motivation "can sometimes conflict with intrinsic motivation" (Benabou and Tirole 2003, p. 490) because extrinsic rewards can diminish intrinsic motivation as it

shifts people from internal to external causality. This happens also for threats, deadlines, and other forms of pressure, because these are experienced by people as controllers for their behavior. Conversely, the opportunity to choose for themselves enhances intrinsic motivation because it gives a greater sense of autonomy (Ryan and Deci 2000).

Experiments have shown consistently that individuals receiving rewards display better compliance at the beginning of an experiment, and then drop their compliance below that of individuals receiving no rewards. Research showed, for instance, that explicit incentives are sometimes counter productive for compliance (Benabou and Tirole 2003).

Goal setting, which is usually related to extrinsic motivation, may have an influence on intrinsic motivation as well. For instance, receiving feedback on fulfilling a task may also provide information about the level of performance accomplished in that task, and hence, of individual effectiveness (Hirst 1988).

3.3 Perceived Risk

Recent research has shown that consumer opinions, evaluations, and adoption intentions for technology vary with the perceptions of usage risks (Featherman and Fuller 2003). Although perceived risk has been included in a large number of marketing studies, examining and measuring it as a psychological construct are relatively recent (Stone and Grønhaug 1993).

3.3.1 Concept of Perceived Risk

Perceived risk has been extensively studied in psychology, first in association with gambling behaviour (Lim 2003). Various mathematical models have been used in an attempt to express the concepts of perceived risk (Jia, Dyer et al. 1999). Usually in disciplines such as game theory, economics, or psychology, risk is associated with a choice or a decision leading to both potentially positive and negative outcomes (Pennings and Smidts 2000; Butler, Dyer et al. 2005). Thus, risk in these disciplines is a state of either loss or gain, with several possible events to which some measure of probability can be attached (Jia and Dyer 1996).

In contrast to these studies, in consumer behaviour risk is seen as having only potentially negative outcomes because of being a subjective expectation of loss, or a disadvantage (Stone and Grønhaug 1993). From a terminology point of view, risk in marketing is more related to the *uncertainty* concept in other disciplines since in a situation of uncertainty there is not enough information to attach a probability to each possible outcome. This relationship to risk in marketing was first seen by Bauer (1960) to involve a high degree of uncertainty because of the "limited cognitive capacity of the actor" (Stone and Grønhaug 1993). However, despite the fact that the term of *perceived uncertainty* would be more suitable than that of *perceived risk*, over the years the

discrimination between the two has become blurred in consumer research (Stone and Grønhaug 1993).

The first studies discussing risk taking aspects of consumer behaviour were done in the early 1960s (Lim 2003). Many authors refer to Bauer's (1960) study as being the seminal work in the area of risk from the consumer's perspective, when the concept of *perceived risk* was coined (Featherman and Fuller 2003; Laroche, McDougall et al. 2004; O'Cass and Griffin 2004). Bauer first showed that a consumer's purchasing actions involve risk because they "will produce consequences which he cannot anticipate with anything approximating certainty, and some of which at least are likely to be unpleasant" (Bauer 1960, p. 24). Thus, Bauer indicated perceived risk to be the keystone of the difference between consumer *browsing* and consumer *buying* (Ahn, Park et al. 2001).

"The majority of research on perceived risk is focused on traditional purchasing situations" (Cunningham, Gerlach et al. 2004). Thus, perceived risk has been seen as "those beliefs about the risks associated with product (service) purchase" (Engel, Blackwell et al. 1986, p. 109). In the same line of thinking, Cox and Rich (1964) saw perceived risk as the amount of uncertainty perceived by a consumer, relative to a purchase act (Ahn, Park et al. 2001; Lee, Park et al. 2001). Thus, perceived risk in marketing is seen as "the nature and amount of risk perceived by a consumer in contemplating a particular purchase action" (Cox and Rich 1964, p. 33).

Perceived risk was seen as having two components: *uncertainty* (from the likelihood of unfavorable outcomes) and *consequences* reflecting the importance of a loss or seriousness of an outcome (Laroche, McDougall et al. 2004). Other early research agreed that perceived risk is a combination of two separate components termed differently: *probability of loss* and *consequence of that loss* (Peter and Ryan 1976).

It is acknowledged that, although perceived risk attracted much research, a clear conceptualization failed to appear, due probably to the complexity of the concept (Bielen and Semples 2004): "there is ... lack of conformity regarding the conceptualization, definition, and operationalization of uncertainty and consequences (the two components of risk)" (Conchar, Zinkhan et al. 2004). Because there is still much confusion in consumer studies in defining perceived risk, an accurate definition is recommended before developing a study in this field (Lim 2003).

The research of Stone and Mason (1995) showed that risk influences attitude formation directly. Risk is seen as being encompassed within attitude, with the notable difference between the two being that while attitude comprises both favourable and unfavourable beliefs, risk refers only to negative perceptions. However, research trying to link perceived risk to personality traits has offered inconclusive results (Schaninger 1976).

Perceived risk is context-based in the consumer behaviour literature (Conchar, Zinkhan et al. 2004). Since the 1960s, various studies have shown that risk perceptions in purchasing differ both on an individual basis and on a situation basis (Ko, Jung et al.

2004). Early research showed that consumers have preferences for various methods of risk reduction associated with different types of loss (Roselius 1971).

3.3.2 Dimensions of Perceived Risk

In the early 1970s there was important effort dedicated to measuring risk and building a formal model of risk and its components, and many studies developed arbitrary measures with little standardization amongst them (Bettman 1973). Since then two approaches have crystallized in the risk literature regarding risk measures: either to consider risk as a global construct or to investigate some risk facets. As perceived risk was seen as depending on only two components, probability of losing and the importance of what can be lost (Kim and Lennon 2000), a widely used procedure was to measure probabilistically the uncertainty and then to weight the result by an importance measure (Stone and Mason 1995). For instance, Murphy and Enis (1986) adopted the first approach, regarding perceived risk as a customer's subjective assessment of making a mistake in purchasing (Ahn, Park et al. 2001). Similarly, Taylor (1974) believed that risk perception could influence the consumer decision-making process.

However, today an increasing stream of consumer behaviour research acknowledges that, in order to reduce the effects of perceived risk (which are purely negative), research must recognize and measure the effects of various types of risk (Lim 2003). Thus, based on the general concept of risk in consumer behaviour, early empirical studies in the 1960s attempted to discern between several risk facets. Consumer behaviour researchers identified several types of risk, coming from insufficient performance, or from danger, cost, or health hazard associated with a purchase (Ahn, Park et al. 2001; Lee, Park et al. 2001). After Roselius (1971) showed that there are four types of potential loss associated with a purchase (i.e., hazard, ego, money and, most remarkably, time), Jacoby and Kaplan (1972) were the first to propose a classification of perceived risk into five clearly identified categories: financial, physical, psychological, social, and performance (or functional) (Ahn, Park et al. 2001).

Although other works have suggested additional dimensions of risk, the five dimensions proposed by Jacoby and Kaplan (1972), plus the time dimension previously found by Roselius (1971), are widely accepted as the salient dimensions of perceived risk in much of the relevant work in the area (Havlena and DeSarbo 1990; Laroche, McDougall et al. 2004). Hence, the six most important dimensions of risk refer to (Lim 2003):

- *Perceived financial risk* (or *economic risk*) is associated with the possible loss of money when purchasing a product or a service or in the after-purchase process (e.g., repairing or replacing a defective product);
- *Perceived performance risk* refers to the product/service not working as expected or working properly for too short a time period;
- *Perceived social risk* is associated with other people's opinions or acceptance regarding a consumer's purchase, resulting in possible disapproval by family or friends;

- *Perceived physical risk* (or *health risk*) expresses the individual's fear of the product/service being purchased to be harmful for health;
- *Perceived psychological risk* refers to the mental stress associated with a purchase: individuals may be distressed by questions regarding the worthiness of buying a certain product or about its reliability; and,
- *Perceived time risk* refers to the time loss associated with a purchase (e.g., searching for a product, waiting for its delivery, etc.).

In addition to these risks, there is a *perceived overall risk* that is a trade-off measure between the various components (Jacoby and Kaplan 1972; Featherman and Pavlou 2003). For instance, browsing various online stores in order to find a good deal for a laptop computer leads to an increased perceived time risk but, if a convenient product is found, the financial and performance risks (at least) would be lower.

The above six dimensions, graphically presented in Figure 3.2 and outlined in Table 3.1, are generally the most frequently mentioned in marketing research on the facets of perceived risk. It should be noted, however, that Lim's (2003) opinions are that these 'classical' dimensions of perceived risk are in fact, consequences, having as sources four types of risk (technology, vendor, consumer, and product), but this opinion seems singular to date.

Table 3.1 Main Types of Perceived Risk in Consumer Behaviour

Type of perceived risk	Description
Financial	Monetary loss associated with a purchase
Performance	Purchased product does not work properly
Social	Loss of status in a social group following a purchase
Physical	Product is harmful to individual health
Psychological	Mental stress because of unsuccessful purchase
Time	Wasting time when making a bad purchase

It is acknowledged that "several investigations have also indicated that the four, five or six major dimensions of perceived risk can account for a substantial portion of overall perceived risk" (Chen and Chang 2005), although there may be other dimensions particular to various domains (e.g., strategic risk in the banking industry (Gewald and Dibbern 2005)) that may be equally important in these domains.

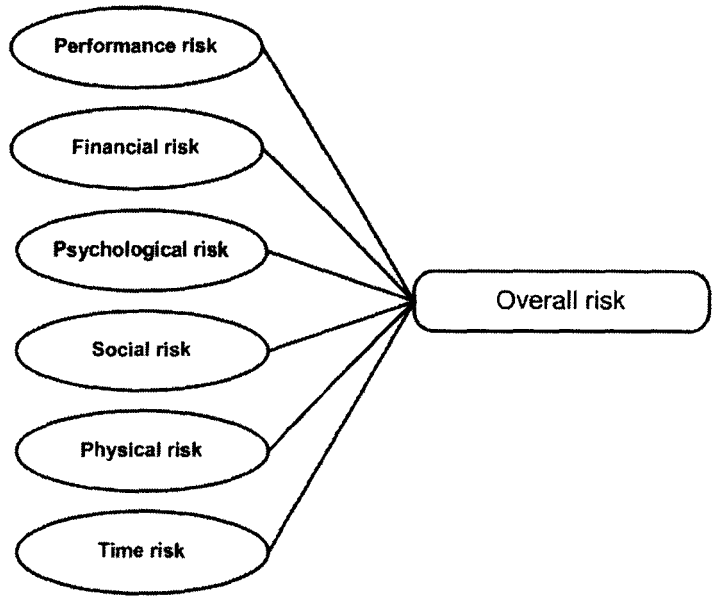


Figure 3.2 The 'Classical' Facets of Perceived Risk in Consumer Behaviour Research

Research in consumer behaviour has shown that the six types of risk explain a significant part of the variation in the overall perceived risk (Kim and Lennon 2000). The study of Jacoby and Kaplan (1972), which is unanimously recognized by the perceived risk literature as the first to test the influence of the facets of perceived risk on overall risk, utilized 5 types of risk (performance, financial, psychological, social, and physical). These explained an average of 74% of the variance in the overall perceived risk, taken across 12 different products, with performance risk being the most outstanding cause of variance in overall risk (Kaplan, Szybillo et al. 1974). A replication of this study with the same 5 types of risk found similar results showing also high correlations of the facets with the overall risk (Table 3.2) (Kaplan, Szybillo et al. 1974). The five components accounted for 73% of the variance ($p<0.01$) in the overall perceived risk, thus allowing the authors to conclude that the 5 dimensions could predict the overall risk fairly well. It was also remarked that perceived psychological risk had a fairly high correlation with the other dimensions of risk (Table 3.3) and physical risk displayed the lowest correlation with the other facets (between 0.16 and 0.33) (Kaplan, Szybillo et al. 1974).

A similar study done by Brooker ten years later (1984) used the same approach while adding another dimension of perceived risk (time), as introduced by Roselius (1971), that proved to have a high impact in this study. The six dimensions of perceived risk explained 62.9% ($p<0.05$) of the variance in the overall risk. Performance and time were the most important components of perceived overall risk while physical risk was, again, the least important and had the lowest correlations with the other components (between 0.178 and 0.358). The results are presented in Tables 3.2 and 3.3.

A study by Stone and Grønhaug (1993), which examined the risk perceptions regarding the purchase of a personal computer, found financial risk to be of the highest

importance, probably due to the high cost of the product, with the six 'classical' dimensions capturing 88.8% of the variance in overall risk. Physical risk was, again, the least important component and psychological risk had a fairly high correlation with all the other components (Tables 3.2 and 3.3). Similarly, an analysis of the influence of the components of perceived risk reported by Jih, Wong et al. (2005) showed that five principal components of perceived risk (i.e., time, functional, financial, social, and physical) explained 63.94% of the variance in the overall risk.

Table 3.2 Correlations of Perceived Risk Components with Perceived Overall Risk

Study	Perceived risk components					
	Perfor-mance	**Financial**	**Psycho-logical**	**Social**	**Physical**	**Time**
Kaplan, Szybillo et al. (1974)	0.79 (p<0.01)	0.76 (p<0.01)	0.69 (p<0.01)	0.67 (p<0.01)	0.33 (p<0.01)	Not tested
Brooker (1984)	0.619 (p<0.05)	0.549 (p<0.05)	0.444 (p<0.05)	0.425 (p<0.05)	0.266 (p<0.05)	0.602 (p<0.05)
Stone and Grønhaug (1993)	0.174	0.679 (p<0.001)	0.560 (p<0.001)	0.248 (p<0.001)	0.126	0.428 (p<0.001)

Table 3.3 Correlations of Perceived Risk Components with Perceived Psychological Risk

Study	Perceived risk components				
	Performance	**Financial**	**Social**	**Physical**	**Time**
Kaplan, Szybillo et al. (1974)	0.61 (p<0.01)	0.67 (p<0.01)	0.79 (p<0.01)	0.16 (p<0.01)	Not tested
Brooker (1984)	0.361 (p<0.05)	0.292 (p<0.05)	0.362 (p<0.05)	0.190 (p<0.1)	0.261 (p<0.05)
Stone and Grønhaug (1993)	0.303 (p<0.001)	0.352	0.376 (p<0.001)	0.367 (p<0.001)	0.463 (p<0.001)

Most of the above six dimensions are relevant for perceived risk in various areas of research in general (Lim 2003). However, to complicate the picture, the relative importance of risk dimensions was believed to vary according to the product category (Laroche, McDougall et al. 2004; Chen and Chang 2005). For instance, when buying two different products (e.g., a computer and a cell phone) the total amount of perceived risk may be similar but the proportion of risk dimensions may differ substantially between the two products. Thus, for the computer financial risk may be deemed high because of the higher price, whereas for the newer cell phones with many additional features performance risk may be comparatively high, especially for first-time users. The

remaining categories of risk would be of lower magnitude if there were the same amount of overall perceived risk for the two products.

As the literature indicates, the mid 1990s papers of Stone and collaborators advanced the concept of the influence of risk facets on overall risk by showing that such a relationship also exists between a multiple item measure of the overall risk and multi-item measure of the six (most popular) dimensions of risk (Stone and Grønhaug 1993; Stone and Mason 1995).

3.3.3 Perceived Risk in Information Systems

In recent years perceived risk has become an increasingly popular construct in IS studies (Kim and Lennon 2000) targeting mostly individual people and, sometimes, organizations (e.g., Ratnasingham and Pavlou (2003) examined perceived risk from the perspective of an organization that adopted e-commerce). Risk perception in IT has general properties of technology risk perceptions but also some peculiar characteristics (Sjöberg 2002).

Risk in IS has been mostly associated with online shopping. Thus "researchers found perceived risk to be a significant factor affecting Internet consumer behavior" (Cunningham, Gerlach et al. 2004). This happens because online shopping leads to a higher perception of risk due to the inability to inspect merchandise (Kim and Lennon 2000). Intangibility, especially through its mental component, is a major characteristic of the electronic market and an important determinant of perceived risk (Ahn, Park et al. 2001; Bielen and Semples 2004).

Issues are even more visible regarding the services market. Services tend to be seen by customers as riskier purchases, in general, compared to products, partly because of the intangibility, i.e., "something without physical evidence that cannot be touched or seen, that is difficult to define, describe or be grasped mentally" (Laroche, McDougall et al. 2004). This is also partially explained by the lack of information when making purchase decisions for services compared to goods (Bebko 2000). Previous service marketing research showed service evaluation to be more subjective, due to mental evaluation compared to product evaluation which is based on physical inspection. However, empirical IS research found that the mental intangibility facet was the most salient 'causal' determinant of resultant risk concerns, together with generality (Featherman and Wells 2004).

Another issue is familiarity with the new technology. For instance, an empirical survey of 192 US subjects and 155 Korean students showed the perceived risk of people without online experience to be significantly higher than that of experienced online shoppers (Ko, Jung et al. 2004). Furthermore, consumers perceiving a high risk tend to spend more time on information seeking activities (Kim and Lennon 2000).

The most important problem regarding perceived risk in IS seems to be linked to the perception of insufficient security of the e-commerce channel. Thus, perceived risk is likely to affect decisively consumer behaviour in Internet shopping "because consumers perceive higher levels of risk toward B2C [business to consumer] e-commerce when they

consider security to be insufficient" (Lim 2003). To capture the above aspects, especially when referring to risk in the e-commerce context, many recent studies in IS have added other facets to the 'classical' six dimensions of individual perceived risk from consumer behaviour research (Table 3.4):

- *Perceived personal risk* refers to individuals suffering some harm because of their purchase behaviour (e.g., credit card identity theft) (Lim 2003);
- *Perceived privacy risk* deals with uncertainty or fear that online businesses may collect customers' personal information and use it inappropriately or disclose it to third parties (Jarvenpaa and Todd 1996; Featherman and Pavlou 2003; Lim 2003);
- *Perceived source risk* expresses individual apprehension of buying online from unknown businesses (Lim 2003); and,
- *Perceived opportunity loss risk* is "the risk that by taking one action a consumer will miss out on doing something else he/she would really prefer to do" (Ahn, Park et al. 2001).

Table 3.4 Additional Types of Risk in Information Systems

Type of perceived risk	Description
Personal	Personal harm when making a purchase
Privacy	Loss of control over personal information
Source	Loss because of the unreliability of vendors
Opportunity loss	Missing an opportunity by doing something else

Despite the fact that many recent studies speak of a number of IS-specific perceived risk factors, an opposite view comes from some studies which have found a low perceived risk associated with IT in general. A possible explanation they offer for this is that IT, unlike more traditional technology (e.g., nuclear power), cannot be easily replaced. For instance, people are asking for more trust when shopping on the Internet but do not want to replace the technology altogether (Sjöberg 2002). Thus, a study done in 1999 with a representative sample of the Swedish population revealed that negative experience with IT affected a very low percentage of the respondents (below 3%) (Sjöberg and Fromm 2001). A related issue is that people generally do not see a direct threat in IT use (e.g., a risk to their health). Furthermore, people tend to see the risk as referring to others and not to themselves, i.e., the risk is perceived as a general issue and not a personal one (Sjöberg 2002). In conclusion, a balanced view is that, besides the good things about IT (e.g., the Internet revolution) there are also risks that must be considered (Sjöberg 2002). Table 3.5 summarizes the dimensions of perceived risk found in various studies (general marketing and IS-specific).

Table 3.5 Dimensions of Perceived Risk in the Literature (adapted from Lim (2003, p. 220))

Study	Risk Dimension										
	Financial	Performance	Social	Physical	Psychological	Time-loss	Personal	Privacy	Source	Opportunity	Strategic
Roselius (1971)	X			X	X	X					
Jacoby and Kaplan (1972)	X	X	X	X	X						
Lutz and Reilly (1974)		S	X								
Korgaonkar (1982)	S		X								
Gemunden (1985)	X	X	X								
Festervand, Snyder et al. (1986)	S	S				S					
McCorkle (1990)	X	X	X			X			X		
Simpson and Lakner (1993)	S	X	X	X	X						
Grewal, Gotlieb et al. (1994)	X	X									
McLain (1995)				X							
Darley and Smith (1995)	X	X	X	X	X	X					
Jarvenpaa and Todd (1996)	X	S	X				S	X			
Van den Poel and Leunis (1996)	X	X									
Fram and Grady (1997)	S										
Korgaonkar and Wolin (1999)	S								S		
Vellido, Lisboa et al. (1999)	S	S									
Cheung and Lee (2000)	X										
Nyshadham (2000)									S		
Tan and Teo (2000)	S								S		
Ahn, Park et al. (2001)	X	X				X				X	
Bielen and Semples (2004)	X	X	X	X	X	X					
Laroche, McDougall et al. (2004)	X	X	X		X	X					
O'Cass and Griffin (2004)	X		X	X	X	X					
Chen and Chang (2005)	X	X	X	X	X	X					
Gewald and Dibbern (2005)		X	X		X			X			X

Note: X - Dimension included in studies; S - Dimension found to be significant in the studies.

3.4 Technology Acceptance Research

Studying "how and why individuals adopt new information technologies" (Venkatesh, Morris et al. 2003, p. 427) has been a popular area of research in information systems for some time (Ahn, Park et al. 2001; Lee, Park et al. 2001). Scholars have examined technology acceptance by individuals through models that have as outcomes usage intention or actual usage of a technology. An extensive investigation of the information systems literature, captured in the comparative study of Venkatesh, Morris et al. (2003), identified eight prominent competing theories or models of technology diffusion or acceptance. Their essential characteristics are synthesized in Table 3.6 (it includes also Venkatesh, Morris et al. (2003) user acceptance theory based on a unified vision):

Table 3.6 Theories and Models of Technology Acceptance in an Individual Context (adapted from (Venkatesh, Morris et al. 2003, p. 428))

Theory and/or model	Characteristics	Main constructs
Theory of Reasoned Action (TRA) (Fishbein and Ajzen 1975)	TRA is a basic theory of human behaviour, drawn form social psychology. It has been used to predict various behaviours including technology acceptance.	Attitude toward behaviour; Subjective norm
Technology Acceptance Model (TAM) (Davis 1989; Davis, Bagozzi et al. 1989)	TAM was tailored and extensively used for technology acceptance in IS context. TAM2 (Venkatesh and Davis 2000) is an extension of TAM (adding the *subjective norm* construct) and is used mostly in organizational contexts.	Perceived usefulness; Perceived ease of use
Motivational Model (MM) (Davis, Bagozzi et al. 1992)	Considers general motivation theory as a determinant of behaviour. MM has been used in IS to explain new technology adoption and use.	Extrinsic motivation; Intrinsic motivation
Theory of Planned Behaviour (TPB) (Ajzen 1991; Taylor and Todd 1995a)	Represents an extension of TRA by adding the construct of *perceived behavioural control* as a determinant of the behavioural intention to use a technology. Decomposed TPB (DTPB) is a related model that decomposes *attitude*, *subjective norm*, and *perceived behavioural control* into belief structures.	Attitude toward behaviour; Subjective norm; Perceived behavioural control
Combined TAM and TPB (C-TAM-TPB) (Taylor and Todd 1995b)	Integrates *perceived usefulness* from TAM into TPB.	Attitude toward behaviour; Subjective norm; Perceived behavioural control; Perceived usefulness
Model of PC Utilization (MPCU) (Thompson, Higgins et al. 1991)	Developed from Triandi's (1977) theory of interpersonal behaviour and is suitable for predicting user behaviour or intention for IT.	Job-fit; Complexity; Long-term consequences; Affect toward use; Social factors; Facilitating conditions
Innovation Diffusion Theory (IDT) (Rogers 1995)	Used to study the sociological impact of innovations in various domains since the 1960s and more recently in IS, especially after the works of Moore and Benbasat (1991; 1996).	Relative advantage; Ease of use; Image; Visibility; Compatibility; Results demonstrability; Voluntariness of use
Social Cognitive Theory (SCT) (Bandura 1986)	Applied by Compeau and Higgins (1995a; 1995b; 1999) to study computer utilization but can be extended to the acceptance of technology in general.	Outcome expectations-Performance; Outcome expectations-Personal; Self-efficacy; Affect; Anxiety
Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris et al. 2003)	Draws from the preceding models by attempting to "integrate fragmented theory and research on individual acceptance of information technology into a unified model that captures the essential elements of eight previously established models" (Venkatesh, Morris et al. 2003, p. 467).	Performance expectancy; Effort expectancy; Social influence; Facilitating conditions

Of the models presented in Table 3.6 Theory of Reasoned Action, Technology Acceptance Model, Theory of Planned Behaviour, Decomposed Theory of Planned Behaviour, and the Motivational Model were found to be the most frequently used and confirmed in the technology adoption literature.

3.4.1 Salient Technology Acceptance Models

Theory of Reasoned Action (TRA). This theory was introduced by Fishbein and Ajzen (1975) and states that a person's behaviour is uniquely determined by behavioural intention and this in turn depends on *attitude* (i.e., "an individual positive or negative feeling towards performing the target behavior", according to Taylor and Todd (1995a)), and *subjective norm* (i.e., a "person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Dillon and Morris 1996)). Attitude regarding behaviour is determined by a person's beliefs about the consequences of that behaviour as well as by the evaluation of the worth of the consequences (Teo and Pok 2000). Subjective norms, in their turn, are determined by the perceived expectations from significant individuals or groups as well as by the person's motivation to comply with these expectations (Teo and Pok 2000). According to the same study, any other factors influencing behavioural intention and behaviour (e.g., user characteristics, system design, task features) are mediated by attitude and subjective norm. A block model of TRA is presented in Figure 3.3.

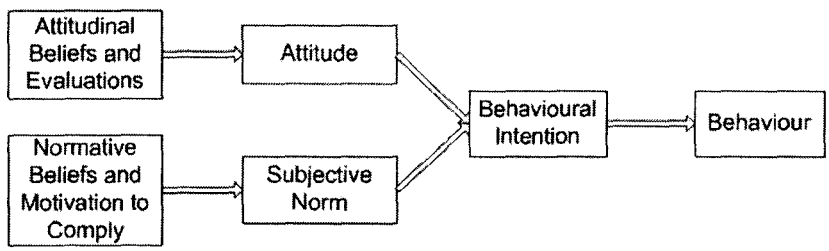


Figure 3.3 The Theory of Reasoned Action (TRA)

Technology Acceptance Model (TAM). This was first introduced by Davis (1989) for the purpose of explaining and predicting IT acceptance. It postulates that two beliefs (*perceived usefulness* and *perceived ease of use*) have a major impact on a user attitude, behavioural intention, and actual use of a system and, consequently, are the only determinants of attitude towards use (as shown in Figure 3.4) (Davis, Bagozzi et al. 1989; Ahn, Park et al. 2001; Lee, Park et al. 2001). Perceived usefulness reflects how "a person believes that use of the system will enhance his or her performance" while perceived ease of use measures the belief that "using the system will be free of effort" (Dillon and Morris 1996).

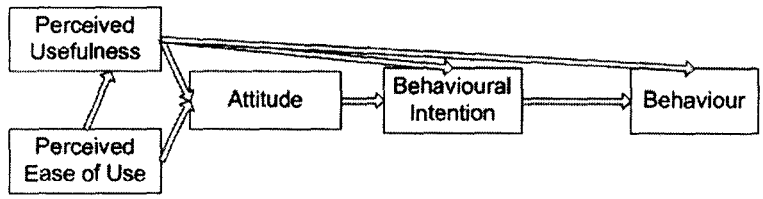


Figure 3.4 The Technology Acceptance Model (TAM)

This model is derived from the TRA but is different in two aspects: it excludes subjective norm as an antecedent of the behavioural intention, and it considers a direct path between perceived usefulness, behavioural intention, and behaviour (Taylor and Todd 1995a). All other external variables existing in TRA but not included in TAM are seen as impacting on behavioural intention and actual behaviour only through perceived ease of use and perceived usefulness (Davis, Bagozzi et al. 1989). In contrast to the original TAM, attitude toward using a certain technology has been omitted in more recent adoption studies such as TAM2 (Karahanna, Straub et al. 1999; Venkatesh 1999; Venkatesh and Davis 2000) since it proved to have a weak influence in predicting behavioural intention or actual use of the system (Wu and Wang 2005).

The model has gained wide popularity among scholars due to rich empirical support (Ahn, Park et al. 2001; Lee, Park et al. 2001). A literature review shows TAM to be an important tool for explaining or predicting end user acceptance of information technology (Hu, Sheng et al. 1999). Some critics, however, object to the fact that most empirical studies have used as subjects students, users, or executives in an academic or business organization context (Hu, Sheng et al. 1999).

Theory of Planned Behaviour (TPB). This is also considered to be an extension of TRA (Ajzen and Fishbein 1980; Ajzen 1991), but is more enriched to better reflect the situation in which people do not have complete volitional control in forming a behavioural intention towards using a technology (Ajzen 1991; Teo and Pok 2000). The enhancement of the model includes *perceived behavioural control*, as well as *attitude* and *subjective norm*, as determinants of behavioural intention. This model is depicted in Figure 3.5.

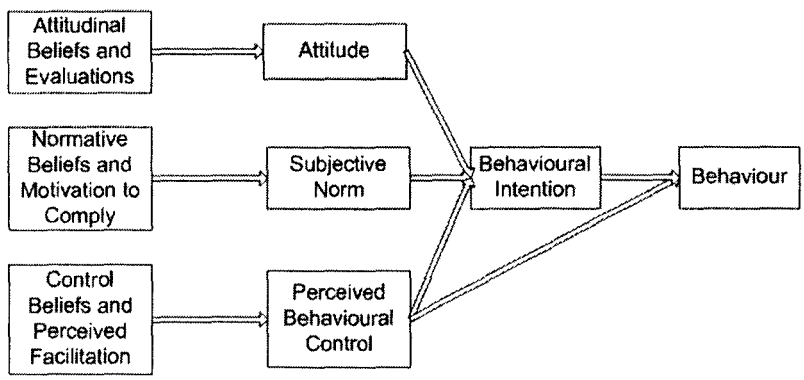


Figure 3.5 The Theory of Planned Behaviour (TPB)

Perceived behavioural control in the TPB model influences both behavioural intention and actual behaviour, and expresses a person's perceptions on the constraints to his or her behaviour due to internal or external factors (Ajzen 1991). Azjen has demonstrated the applicability of this theory in many fields (Hung, Ku et al. 2003). A substantial body of empirical evidence suggests that TPB is most suitable for explaining individual behaviour in predicting the acceptance of new technologies (Hung, Ku et al. 2003). Recent fields of application were the adoption of WAP-enabled mobile phones (Teo and Pok 2000), WAP services (Hung, Ku et al. 2003), and virtual banking (Liao, Shao et al. 1999). In the field of healthcare, one application was the investigation of telemedicine technology adoption by physicians (Chau and Hu 2002).

Decomposed Theory of Planned Behaviour (DTPB). This theory builds on TPB but investigates more in depth *attitude*, *subjective norm*, and *perceived behavioural control* by decomposing them into more detailed constructs (as shown in Figure 3.6) (Taylor and Todd 1995a). In doing so the model incorporates elements from the innovation diffusion literature (Teo and Pok 2000). Due to the decomposition of large belief structures into simpler elements, DTPB is able to better identify specific elements that may influence adoption and usage of technology. Thus the model becomes "more managerially relevant" (Teo and Pok 2000). Furthermore, according to the same study, the model's simple and stable set of belief structures can be applied across many settings. Because DTPB includes several determinants of behavioural intention and actual use, as compared to TAM, some researchers consider DTPB more appropriate to use, despite the popularity of TAM, for investigating technology acceptance in settings where influence of other people or perceived constraints are significant (Ajzen 1991; Teo and Pok 2000).

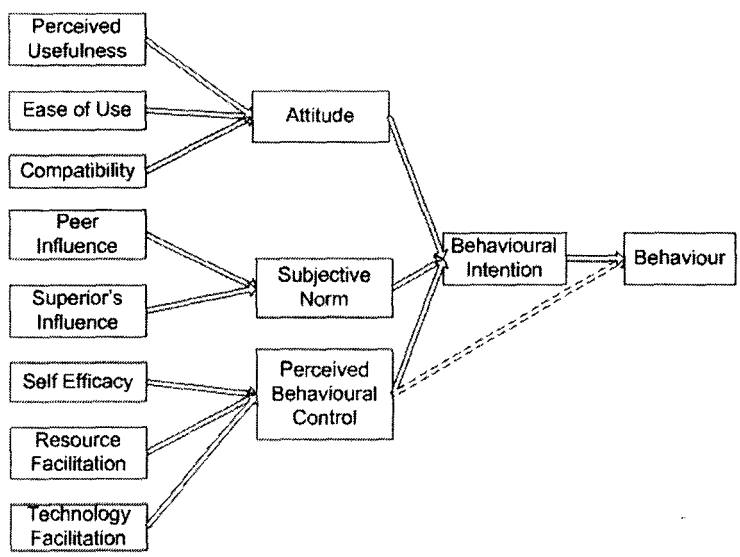


Figure 3.6 The Decomposed Theory of Planned Behaviour (DTPB)

Motivational Model (MM). This model is derived from motivational theory. It was first introduced in IS through the seminal study of Davis, Bagozzi et al. who used it for the adoption of a new technology (Davis, Bagozzi et al. 1992; Venkatesh, Morris et al. 2003), and its development continued through the studies of Igbaria and collaborators (Igbaria, Schiffman et al. 1994; Igbaria, Parasuraman et al. 1996), and Venkatesh and collaborators (Venkatesh and Speier 1999; Venkatesh, Speier et al. 2002).

The approach to using this model is similar to using TRA to study individual behaviour regarding the introduction of a new technology, referring to a specific area of adoption (i.e., particularly similar to TAM) (Venkatesh and Speier 1999). Accordingly, there are some similarities and dissimilarities between MM and TAM from both a conceptual and an operational point of view (Venkatesh, Speier et al. 2002).

A. Similarities with TAM. MM shows that, in accordance with the motivational research in psychology, and somewhat in parallel with TAM beliefs, *behavioural intention* (BI) to use a technology is determined by two key drivers: *extrinsic motivation* (EM) and *intrinsic motivation* (IM) (Figure 3.7) (Venkatesh and Speier 1999). Thus, it is believed that people accept and make an effort to use an application because it is both useful (i.e., it offers some external rewards) and enjoyable (Igbaria, Iivari et al. 1995).

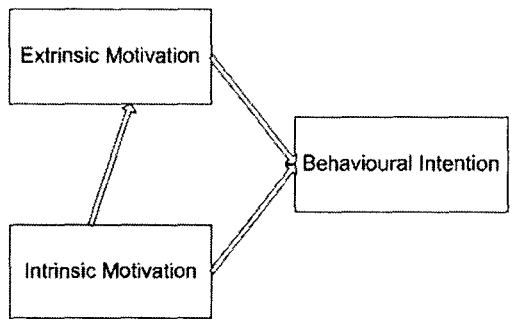


Figure 3.7 The Motivational Model (MM)

The parallelism with TAM goes even further. Thus, there is a close similarity between EM and *perceived usefulness* (PU) of TAM (or, according to Igbaria (1995) PU is an example of EM). In some prior research, PU, which is an outcome expectancy, or "a person's estimate that a given behavior will lead to certain outcomes" (Bandura 1977, p. 79), was used as a surrogate to measure extrinsic motivation to use a system (Venkatesh and Speier 1999). Both EM and PU were termed by Venkatesh, Morris et al. (2003) as *performance expectancy* - i.e., "the degree to which an individual believes that using the system will help him or her to attain gains in job performance" (p. 447).

During the decade that has elapsed since the introduction of MM, researchers have come to the conclusion that the two constructs are similar. In fact, Davis measured the two constructs with the same items in his introduction to the two models (Davis 1989; Davis, Bagozzi et al. 1992). Therefore, there is sufficient reason to believe that the two

constructs represent, in fact, one single construct (Venkatesh, Speier et al. 2002). This is usually termed *perceived usefulness* since TAM is more popular than MM.

B. Dissimilarities with TAM. Another key construct of the MM is intrinsic motivation (IM). Previous research associated it with the meaning of *enjoyment* (Davis, Bagozzi et al. 1992; Venkatesh 1999) or *perceived enjoyment* (Igbaria 1995), and has shown positive implications of the IM on BI: a willingness to spend more time with a task, a lower anxiety and better mood regarding a task, and a facilitation of volitional behaviour (Venkatesh and Speier 1999; Venkatesh, Speier et al. 2002). According to the cognitive evaluation theory, a higher IM of a task leads to higher levels of effort accepted by the user to perform that task (Deci 1975; Venkatesh and Speier 1999). Thus, the performance of any behaviour is driven by a basic cognitive mechanism called *locus of causality*. A higher IM means a locus of causality internal to a specific individual and this causes the individual's behaviour to be driven mostly by intrinsic factors rather than external rewards (Deci 1975; Venkatesh and Speier 1999).

Most of the work in technology acceptance so far has been from the perspective of extrinsic motivation (Moon and Kim 2001). However, intrinsic motivation should not be overlooked because it may compromise user acceptance: "insufficient satisfaction and enjoyment can undermine the adoption of otherwise productive computer systems" (Davis, Bagozzi et al. 1992, p. 1128). Accordingly, in recent years, although not using an actual MM, some well-recognized work in IS has used TAM enriched with IM to investigate the influence of motivation upon behavioural intention to use a technology. Since the initial TAM had no IM construct, this was added later in the studies of Venkatesh (1999) and used by other researchers. For instance, Moon and Kim (2001) studied an extension of TAM by adding *perceived playfulness* as a construct representing IM.

A significant difference between TAM and MM is the construct of *perceived ease of use* (PEOU) extant in TAM (and associated with the actual use of a technology) but not included in MM. This later model uses only IM to express reasons, other than external goals, that make an individual accept and use a technology. Since in some recent research PEOU and IM have been utilized together in the same model, there are contradictory opinions upon the relationship between PEOU on the one side and PU and IM on the other side. For instance, both the study of Davis, Bagozzi et al. (1992) and the later studies of Venkatesh, Speier et al. (2002) and Venkatesh (2000) agree that PEOU is an antecedent of PU, as in TAM. Thus, Davis, Bagozzi et al. (1992) found in two separate studies a strength (β) of 0.27 ($p=0.000$) and 0.19 ($p=0.005$) of the relationship between PEOU and PU.

Regarding the relationship between PEOU and IM, consistent with the postulate of MM that *any external variable influences BI only through EM and IM*, Davis, Bagozzi et al. (1992) found that PEOU is an *antecedent* of IM (measured in their study as enjoyment) with a significant strength in the relationship: 0.52 ($p=0.000$) in one study and 0.26 ($p=0.000$) in another. This type of dependency was confirmed by other studies:

- Igbaria and collaborators (1995) found that PEOU is an antecedent of enjoyment with an effect beta of 0.35 ($p<0.001$);
- Teo, Lim et al. (1999) reported a 0.34 ($p<0.001$) effect of PEOU on enjoyment in a study of intrinsic and extrinsic motivation of Internet usage;
- Al-Gahtani and King (1999) obtained a 0.185 ($p<0.01$) strength between PEOU and enjoyment;
- Van der Heijden (2004) reported a 0.59 ($p<0.001$) influence of PEOU on perceived enjoyment for a predominantly hedonic system; and,
- Lee, Cheung et al. (2005) found PEOU as an antecedent of perceived enjoyment (beta of 0.52, $p<0.05$) in a study regarding the adoption of Internet-based learning.

Contrary results were reported by Venkatesh (2000) who found a dependency from IM to PEOU with a strength of 0.09 (not significant), 0.19 ($p<0.05$), and 0.24 ($p<0.01$) in a study integrating PEOU in TAM. Venkatesh, Speier et al. (2002) found, again, in a study integrating TAM and MM that IM is an antecedent of PEOU with a strength of 0.45 ($p<0.001$).

3.4.2 Technology Acceptance Research in Telehealth

Literature regarding theoretically sound technology adoption investigations in the field of telemedicine and telehealth is scarce. Telemedicine means using information technology and telecommunications to deliver healthcare services over distance and time (McLaren 2003). Its success depends on solving both technological and managerial challenges. One fundamental managerial challenge insufficiently addressed by scientific tools is technology acceptance by the targeted users (Chau and Hu 2001). Thus, after the initial enthusiasm of four decades ago, telemedicine projects have been in decline for various reasons, including user technology acceptance challenges (Hu, Sheng et al. 1999).

Essentially, all technology acceptance studies regarding telemedicine that are available in the literature have targeted healthcare professionals (Hu, Chau et al. 1999). Furthermore, they have proved to be limited in scope (e.g., areas of healthcare services examined), size (e.g., number of participants) and deficient in theoretical foundation (e.g., absence of theoretical models of technology adoption popular in IS) (Hu, Chau et al. 1999; Chau and Hu 2001).

For instance, Hu, Sheng et al. (1999) and Hu, Chau et al. (1999) applied a reduced TAM model, excluding actual behaviour, to investigate physician acceptance of telemedicine technology. Although the explained variance in physician intention to use the technology was not low (44% in the study of Hu, Sheng et al. (1999), for instance), both studies concluded that TAM is insufficient in explaining the attitude and intention of physicians. Reasons for this failure are believed to lie in the characteristics of the healthcare process and/or the peculiarities of the physician's profession (Hu, Sheng et al. 1999). They further suggest that a promising approach is to investigate intention-based theories such as TPB or an integration of TAM with these theories.

Other authors have modified the initial TAM model or attempted to compare its predictive capabilities with those of TPB. The results showed that TAM is no better than TPB in explaining the acceptance of information technology (Hung, Ku et al. 2003). Chau and Hu (2001) compared TAM, TPB, and DTPB for testing user acceptance of information technology by individual professionals. The final model reported a relatively low variance explained of behavioural intention to use this technology (40%), and this may suggest that the inclusion of additional factors in TAM and TPB is needed to better predict technology acceptance by individual professionals.

A notable exception is the study of Wilson and Lankton (2004b) that modeled patient acceptance of e-delivered telecare. The study was motivated by the observation that e-health is continually extending: a survey of 440 healthcare organizations found that more than 80% of them have been providing an e-heath activity to their patients, and over 50% provided some advanced e-health application tailored to the patients (e.g., test results, prescription refills, and physician-patient communication). This showed a tendency toward specialized applications that are a big step forward, compared to the generalized health applications for mass markets (Wilson and Lankton 2004b). Such a development of remote services supported by the Web appeared in an effort to meet patient demands for a new approach to quality of care, as described in Chapters 1 and 2 of this work. However, according to the same study, "it is clear that patients desire a range of services to be brought on line by their own healthcare provider. What is less clear is whether the services offered by health providers are services that patients desire" (p. 241).

Wilson and Lankton used an integration of TAM and MM to explain patient acceptance of provider-delivered e-health. However, this integrated model did not provide a fit better than either TAM or MM (each accounted for 70% of the variance explained in the behavioural intention) to explicate patient behavioural intention to use provider-delivered e-health. Their study found the perceived ease of use-extrinsic motivation construct to have a significantly positive influence on the behavioural intention to use e-health, as predicted by TAM and MM, but the intrinsic motivation to not have a significant influence, contrary to MM precepts. The authors suggested that the models they used are suitable for this purpose and can be applied with confidence due to extensive pre-existing research in other domains. However, they also recommend improvements to the models, to capture new constructs and associations, based on theoretical support, to allow findings to be related to other research and facilitate generalization (Wilson and Lankton 2004b).

3.4.3 Technology Acceptance Research in Mobile Information Systems

As mobile information technology is relatively new, there is not a substantial body of literature regarding its adoption that is based on solid theoretical models in this field. An overview of the available studies reveals a diversity in the models utilized, reflecting inconsistency of views that are understandable for a new area of research.

Teo and Pok (2000), for instance, adapted DTPB to test the adoption of WAP-enabled mobile phones among Internet users, considering this model to be most suitable

for the unique features of mobile devices: ubiquity, portability, and adaptability for conveniently receiving and disseminating personalized information. The model, tested with two samples, explained only 10.6% and 17.2% of the variance in behavioural intention to adopt this type of cell phone. The authors suggest that other features of the cell phones (e.g., newer technologies like 3G) and constructs (i.e., a 'pay' construct) should be taken into account in future research. Lu, Yu et al. (2003) used a modified TAM to test technology acceptance for the wireless Internet. Hung, Ku et al. (2003) used a model evolved from TPB to detect through an empirical study the critical factors of WAP service adoption. The model had an explanatory power of 12%. The authors stated that this low explanatory power was due to measures of actual use instead of behavioural intention to use technology, by the possible unsuitability of TPB in this domain, and by the unfamiliarity of the majority of the respondents (81.3%) with WAP services.

Recent research has integrated elements from innovation diffusion theory, perceived risk, and cost, into TAM to investigate mobile commerce acceptance (Wu and Wang 2005). The most striking finding of this study was that cost had only a small effect (beta = 0.11, $p<0.05$) on behavioural intention to use the technology, and perceived risk had a positive influence (beta = 0.14, $p<0.01$). The first issue was explained by the authors as due to utility benefits (e.g., use of the mobile device for an urgent need) outweighing the cost factors, and also that the sample respondents had a relatively high income. The perceived risk influence is more puzzling but an explanation found by the authors is that consumers had online experience, were familiar with the mobile commerce context and, knowing the advantage and risks of such operations, they were still willing to pursue these transactions despite the risks. As even the authors acknowledged, such findings necessitate much further research, especially because mobile commerce is still in its infancy (Wu and Wang 2005).

TAM was also used in a study investigating motivation and barriers to adoption of 3G mobile multimedia services (Pagani and Schipani 2004). Adopting an end-user perspective, the study found that usefulness, ease of use, price, and speed of use were the most important factors.

In several works addressing the adoption of mobile services, Pedersen and his collaborators have used models derived from TPB. An examination of these studies shows the use of psychometric measures departing significantly from those popular in the widely cited technology adoption literature. Furthermore, the studies obtained quite different results depending on the mobile service examined (Pedersen 2002; Pedersen, Nysveen et al. 2002; Pedersen, Nysveen et al. 2003). This proves once more that this research domain is still in its infancy and more research is needed to find appropriate theories and models.

3.4.4 Integrating Technology Acceptance, Motivation, and Perceived Risk

Investigation of the literature shows previous attempts to integrate motivation and perceived risk constructs into technology acceptance models. The Davis, Bagozzi et al. (1992) study is considered to have opened the door for the use of motivation theory in IS. The model tested in this study is remarkable by its expressiveness and, at the same time,

parsimony (as shown in Figure 3.7). This study attempted to answer the questions "do people use computers at work more because they are useful or because they are enjoyable to use?" (p. 1111) and reached some interesting conclusions which are presented below.

The model used perceived usefulness (identical with the TAM construct) to express EM and enjoyment to express IM. Testing user intention, referring to use of word processing software and a business graphic program, the authors found high beta values (Table 3.7) demonstrating that "usefulness and enjoyment together represent a simple yet powerful explanation of what influences computer usage intention" (p. 1125). It was categorically shown that usefulness has a strong impact on usage intention but, in addition, enjoyment explains "significant variance in usage intentions, beyond that accounted for by usefulness alone" (p. 1113). Usefulness and enjoyment explained 62% of the variance of usage intentions in the first study and 75% in the second study as reported by Davis, Bagozzi et al. (1992).

Table 3.7 presents the strength (in terms of path coefficient β and significance level p) between the constructs of the MM in studies which used this model, starting with Davis, Bagozzi et al. (1992). Many studies of motivation tend to find perceived usefulness as a stronger determinant than enjoyment for adoption intentions (Teo, Lim et al. 1999). It is interesting to note that the strengths varied, largely depending on the type of the technology or of technology use: *more utilitarian* (i.e., biased toward usefulness) or *more hedonic* (i.e., biased toward enjoyment). This distinction is clear in a recent study of Van der Heijden (2004) that shows that, even for otherwise utilitarian systems, hedonic value can be pivotal for user acceptance.

Table 3.7 Strength of the Influence of Intrinsic Motivation (IM) and Extrinsic Motivation (EM) on Behavioural Intention to Use Technology (BI) - Results of Empirical Studies

Study	Technology investigated	IM Construct	EM Construct	IM-EM β (p)	IM-BI β (p)	EM-BI β (p)
Davis et al. (1992)	Word process. software	Enjoyment	Usefulness	Not tested	0.16 (0.002)	0.68 (0.000)
Davis et al. (1992)	Bus. graphic programme	Enjoyment	Usefulness	Not tested	0.15 (0.016)	0.79 (0.000)
Moon (2001)	Web	Perceived playfulness	Perceived usefulness	Not tested	0.245 (0.001)	0.269 (0.001)
Atkinson and Kydd (1997)	Course-related use of Web	Enjoyment	Usefulness	Not tested	0.149 (0.182); -0.174 (0.202)	0.502 (0.000); 0.443 (0.000)
Atkinson and Kydd (1997)	Enjoyment-related use of Web	Enjoyment	Usefulness	Not tested	0.308 (0.001); 0.252 (0.051)	0.136 (0.255); 0.040 (0.694)
Venkatesh and Speier (1999)	Computer training	IM	EM	Not tested	0.14 (0.05) 0.33 (0.01)	0.34-0.61 (0.01)
Liaw (2002)	Web	Web enjoyment	Web usefulness	0.78 (0.01)	0.16 (0.05)	0.68 (0.01)
Venkatesh et al. (2002)	User training	IM	EM	0.27 (0.001)	0.07 (n.s.)	0.44 (0.001)
Venkatesh et al. (2003)	New technol. (voluntary settings)	IM	EM	Not tested	0.22-0.24 (0.01)	0.47-0.50 (0.001)
Venkatesh et al. (2003)	New technol. (mandatory settings)	IM	EM	Not tested	0.19-0.21 (0.01)	0.44-0.49 (0.001)
Wilson and Lankton (2004b)	E-healthcare	IM	PU-EM	0.70	Not reported	0.70
Van der Heijden (2004)	Web	Perceived enjoyment	PU	Not tested	0.25 (0.001)	0.15 (0.001)
Van der Heijden et al. (2005)	Mobile services	Hedonic value	Utilitarian value	Not specified	0.15 (0.060)	0.53 (0.000)
Shang et al. (2005)	Online shopping	Fashion involvement	PU	Not tested	0.09 (0.05)	(n.s.)
Lee et al. (2005)	Internet-based learning	Perceived enjoyment	PU	Not tested	0.17 (0.05)	0.19 (0.05)

Perceived risk was also found to play an important role in adoption-related empirical research in the IS field (Bielen and Semples 2004). Table 3.8 presents results drawn from studies which integrated perceived risk into adoption models. As the table shows, perceived risk was considered in these models as an antecedent of various constructs: perceived usefulness, attitude, or behavioural intention to adopt the technology.

The most remarkable contribution in this area comes from the work of Featherman and Pavlou who, in separate studies (Featherman 2001; Featherman and Fuller 2003; Pavlou 2003; Featherman and Wells 2004), or in joint work (Featherman and Pavlou 2003) have integrated the concept of perceived risk into TAM.

Empirical research has examined how risk perceptions surrounding e-services affect the system evaluation process, and the moderating effect of perceived risk on the classical technology acceptance model (TAM) (Featherman and Fuller 2003). Thus perceived risk was found to be a significant inhibitor of usefulness and adoption intention (Table 3.8). The same effects on these two important constructs were observed in the study of Featherman and Wells (2004) regarding the intangible effects of e-services on artificiality, perceived risk, and adoption.

Consistent with the previous Internet banking literature, Chan and Lu (2004) found that perceived risk is important for potential users that tend to see the risk as decreasing the usefulness of the service. The link was not found significant for previous users of the service.

In an empirical experiment investigating the adoption of mobile technology among the employees of several major companies in Taiwan, perceived risk (defined as "the user's subjective expectation of suffering a loss in pursuit of the desired outcome of using mobile commerce" (Wu and Wang 2005, p. 723)) was found to have a significant (and puzzling) positive influence on behavioural intention to use. This is a surprising finding without any immediate explanation except that, as authors pointed out, consumers may engage in online transactions for the relevant advantages of this type of commerce despite the level of risk they perceive.

Table 3.8 Strength of the Influence of Perceived Risk on Constructs in Technology Adoption Models

Study	Technology investigated	Target construct	Strength β (p)
Teo and Pok (2000)	WAP-enabled mobile phones	Attitude	0.17-0.27 (0.05)
Lee, Park et al. (2001)	E-commerce	Perceived usefulness	0.237 (0.000) (transaction risk) 0.077 (0.337)-rejected (product/service risk)
		Bahavioural intention	0.285 (0.024) (transaction risk) 0.443 (0.010) (product/service risk)
Featherman and Pavlou (2003)	E-services	Perceived usefulness	0.199 (0.01) 0.125 (0.033)
		Adoption intention	0.284 (0.001) 0.164 (0.022)
Featherman and Fuller (2003)	E-services	Perceived usefulness	0.147 (0.001)
		Adoption intention	0.383 (0.001)
Chan and Lu (2004)	Internet banking	Perceived usefulness	Not significant (users) 0.22 (0.01) (potential adopters)
Featherman and Wells (2004)	E-services	Perceived usefulness	0.521-0.624 (0.001)
		Adoption intention	0.231-0.323 (0.001)
Wu and Wang (2005)	Mobile commerce	Behavioural intention	0.14 (0.01) - positive influence of risk
Wu and Wang (2005)	Mobile commerce	Behavioural intention	0.11 (0.05) - influence of cost

3.5 Proposed Theoretical Model

This section proposes a theoretical model to investigate the user acceptance of text messaging telehealth for promoting adherence. This model has as its starting point prior conceptual research which examined opportunities and barriers of mobile healthcare to address outpatient adherence. It is also based on the key observation that user acceptance of technology in healthcare is similar to other areas, where emerging information technology has led to improved productivity only if technology is accepted and used (Venkatesh 1999).

The duality motivation-demotivation associated with early implementation of a new technology in a new area implies many unknowns and uncertainties. Therefore, a

theoretical model was sought that would reflect the dyad *pro-against* the technology from the user point of view. These two opposing aspects were considered to be best captured using the theories of motivation and perceived risk. Consequently, the fundaments of this model are based on the intersection of the theories of motivation and perceived risk, both applied in information systems research and with original characteristics pertaining to the particularities of the technology and the specific users targeted. The model is seen as a set of individual components which are interconnected and influence each other on some specific paths. In proposing the model components and their expected reciprocal influences, this research is based on previous research in information systems, human-computer interaction, healthcare, consumer behaviour, and sociology.

3.5.1 Why Choose a Motivational Model?

Although a significant body of research has used TAM to study the introduction of a new technology (Venkatesh 1999), this research follows the Davis, Bagozzi et al. (1992) way of thinking for the following reasons (some are explained in more detail in the experimental design discussion in Chapter 4):

- This is an investigation of *not a definitive system* but rather of a *simplified early application*, text messaging telehealth (TMT), in a new domain (adherence support);
- Previous IS and behavioral research has demonstrated the predictor role of behavioural intention to use a technology upon actual use (Ajzen 1991; Taylor and Todd 1995a; Venkatesh, Morris et al. 2003). As this current research is not dealing with a definitive system, the final outcome of the research model is the behavioral intention to use IT and not the actual use of a specific technology;
- Participants in the experiment are expected to be familiar with SMS, so *usability and ease of use should not be an issue* for them, especially since the application tested, TMT, is much simpler than regular SMS messaging;
- Compared with a pre-implementation stage, ease of use has been found to have less influence on usefulness and little or no influence on behavioural intention, after users are exposed to and become more accustomed to a system for a period of time (Szajna 1996; Teo, Lim et al. 1999);
- The theoretical model should be *parsimonious*, the focus being on the combined effect of motivation and demotivation on behavioural intention to use *in principle* such an application; and,
- User feedback and theoretical and practical conclusions of this research should lead to the *construction of a more definite application* in which usefulness and ease of use can be tested, together with effectiveness, in addressing outpatient adherence, in a combined healthcare-information systems study.

As Venkatesh, Morris et al. (2003) acknowledge, there are controversial views regarding the influence of intrinsic motivation on behavioural intention. While some researches demonstrate a direct effect between them, other papers believe intrinsic

motivation is an antecedent of effort expectancies such as perceived ease of use. In an attempt to resolve this dispute, Venkatesh, Morris et al. (2003) showed that attitudinal constructs (including attitude toward behaviour from the technology acceptance model, intrinsic motivation from the motivational model, affect toward use, and affect) "are significant only when *specific cognition* - in this case, constructs related to performance *and* effort expectancies - are *not* included in the model" (p. 455).

This research aims at bringing another contribution to solving this controversy by attempting to answer the question: *Does intrinsic motivation directly influence the behavioural intention?* For this reason, the research uses the initial model of Davis, Bagozzi et al. (1992) and does not take into account the perceived ease of use. Another reason for this is that the research aims to keep the technology acceptance investigation at a more general level. The discussion *does not address a well-established IT system but rather a manner of IT intervention.* Thus, the research aims at judging comparatively the motivators and de-motivators for people to accept a type of mobile IT individualized intervention without restricting the discussion to a system that is not yet definitive. This is similar to involving people early, not necessarily in the design of a real system but, rather, in the development of a generic way of dealing with a salient healthcare problem.

User concerns must be addressed in the early stages of system development (in the analysis and design stage of a new technology) for practical reasons. Waiting until after the deployment of a system to study user perceptions and feedback is "probably dangerous at best" (Venkatesh, Speier et al. 2002, p. 311). After a system is in use, it is usually too late to see the real impact on design, with serious consequences for system acceptance and success. Venkatesh, Speier et al. (2002) study stresses on the importance of early and short-term perceptions of users regarding acceptance decisions. Their belief is that if users do not accept a system "fixes to that system redesign or encouragement from others are not likely to play a major role in getting users to adopt the system over time" (Venkatesh, Speier et al. 2002, p. 312).

Another reason for using the original motivational model (MM) is for its crispness. "The goal of any research model is to explain the variation associated with perceptions and behaviors as fully as possible. This goal must be balanced against the parsimony of any model (e.g., measuring 10 variables that explain an additional 2% of variances over the existing model would explain greater variance but would be less parsimonious)" (Venkatesh, Speier et al. 2002, p. 304). Thus MM is a general and parsimonious model predicting adoption intention of a technology. It is expected that when applying this model to the user adoption of SMS for healthy behaviours, additional variables would account for the variance in the criterion variable (behavioural intention). The only alteration brought to MM is the incorporation of perceived risk. Thus a model is developed that allows an in-depth analysis of the influence of perceived risk-motivation link on the users' intention to adopt SMS, as a support for adherence improvement.

3.5.2 What Types of Perceived Risk to Include?

Previous IS studies have investigated potential factors that discourage the use of technology, such as anxiety, distrust, resource barriers, or risk (Cenfetelli 2004).

Perceived risk has been an important barrier generally used at an overall level. In order to obtain a more refined analysis of the de-motivation factors for using an SMS application as support for adherence, this research takes into account some of the 'classical' dimensions of perceived risk that are usually used in the marketing literature. Arguments for including or not each of the six traditional dimensions are presented below (although for fully understanding the reasoning, it would also be helpful to read the discussion under the experimental design in Chapter 4):

- *Perceived financial risk* is included in the model. This type of risk refers to a possible loss of money when subscribing for a service that may not be necessary or may not bring the expected benefits. Empirical research has shown that, from the consumer's perspective, cost has a significantly negative effect on behavioural intention to use a mobile technology (Wu and Wang 2005). Although for this experiment participants would not lose money (they will be fully compensated), in consumer behaviour research, money issues are always important (Grewal, Gotlieb et al. 1994), even when the scope of the study is not explicitly financial.
- *Perceived performance risk* is not included in the model. As the experiment refers to a very simple use of SMS (in which participants are asked to read about one daily message and reply to some messages by sending a one-letter answer), and as the participants are required to be familiar with SMS, it is believed that performance risk is not an issue.
- *Perceived social risk* is included in the model. This type of risk is associated with other peoples' opinions, resulting in possible disapproval by family or friends about using the service. For example, individuals may be put in embarrassing social situations if other people see them using the service, indicating that they can not manage by themselves some presumably simple activities and are receiving external help to remember. If the system were being used for patients with real chronic illnesses, social issues could be more serious since using the system in a social context can indicate the presence of an illness that the participant might rather not want to be known to others.
- *Perceived physical risk* (or *health risk*) is not included in the model. Interpretations of health and safety risk are linked to the likelihood of harm and the seriousness of this potential harm (McLain 1995). This would relate to the health risk individuals may see in using a mobile device. There is contradictory information on the possible health hazards caused by excessive use of cell phones (BBC 2005b), but the danger that people (and, especially, current users of cell phones) perceive is negligible. Recent research has shown that only a small minority of young users are interested in the risks of health hazards from cell phone use (Madell and Muncer 2004; Cocosila, Turel et al. 2006; Cocosila, Turel et al. forthcoming). A survey of 1,340 secondary-school students in Teesside in northeast England showed that only 9.1% of the respondents indicated "fear that using mobile may damage health" (Madell and Muncer 2004, p. 365) as a reason for not using a cell phone. In general, this type of risk was found to have the

lowest importance of all dimensions in marketing studies (as shown in Subsection 3.3.2).

- *Perceived psychological risk* is included in the model. This risk facet refers to the mental stress associated with subscription for the service. It is believed that this type of risk will have *the highest importance for this study*. First, individuals may be distressed by questions regarding the worthiness of buying a certain product or about its reliability. Second, for a service the situation is more distressful due to its intangibility. Third, for a first application of a new service (hence, for which there are no feedback or recommendations from friends or family), the situation is even more acute - people are likely to be distressed by not knowing if they made the right or wrong decision about subscribing for such a service. Due to its threefold importance, this type of risk is considered to mediate the influence of the other risk facets, similar to Stone and Grønhaug's study (1993).
- *Perceived time risk* is not included in the model. This type of risk refers to the time loss associated with a purchase (e.g., searching for a product, waiting for its delivery, etc.). This is not the situation here, because people do not have to make any choice from competing products. Also, there is no waste of time with learning how to use the service since it is expected that participants are familiar with cell phone SMS use, and, it will be easy for them to use a simple variant of SMS.

Perceived privacy risk is considered the only IS-specific risk that should be included in the model in addition to the risk dimensions adapted from consumer behaviour studies. This type of risk refers to the perceived loss of control over personal information that may occur during wireless text messaging or by giving another entity access to this information. Confidentiality is important when sending personal information wirelessly. For instance, an SMS application to remind patients about upcoming medical appointments did not include specific information that could link the appointment to the patient. This was done in order to avoid other individuals reading patient details if the telephone contact number might be incorrect or if other persons had access to the cell phone (Downer, Meara et al. 2005).

Although text messaging in this experimental study would not contain confidential information, storing cell phone numbers on a server in order to contact the participants raises questions about hackers (Internet criminals) obtaining cell phone numbers for illegal purposes. The issue may be even more salient for SMS applications addressing patients whose medical data would be stored on an online server and might become available to third parties by accident or crime.

3.5.3 Theoretical Model

Taking into account all the considerations exposed in this chapter so far, and based on the review of the literature, the theoretical model for this study is obtained by incorporating the perceived overall risk construct adapted from the consumer behaviour literature (Jacoby and Kaplan 1972; Kaplan, Szybillo et al. 1974; Brooker 1984; Stone and Grønhaug 1993; Stone and Mason 1995), having as antecedents financial risk, social

risk, privacy risk, and psychological risk, into the motivational model previously used in information systems studies (Davis, Bagozzi et al. 1992; Igbaria, Parasuraman et al. 1996; Venkatesh and Speier 1999; Venkatesh, Speier et al. 2002). A diagram of the model is presented in Figure 3.8.

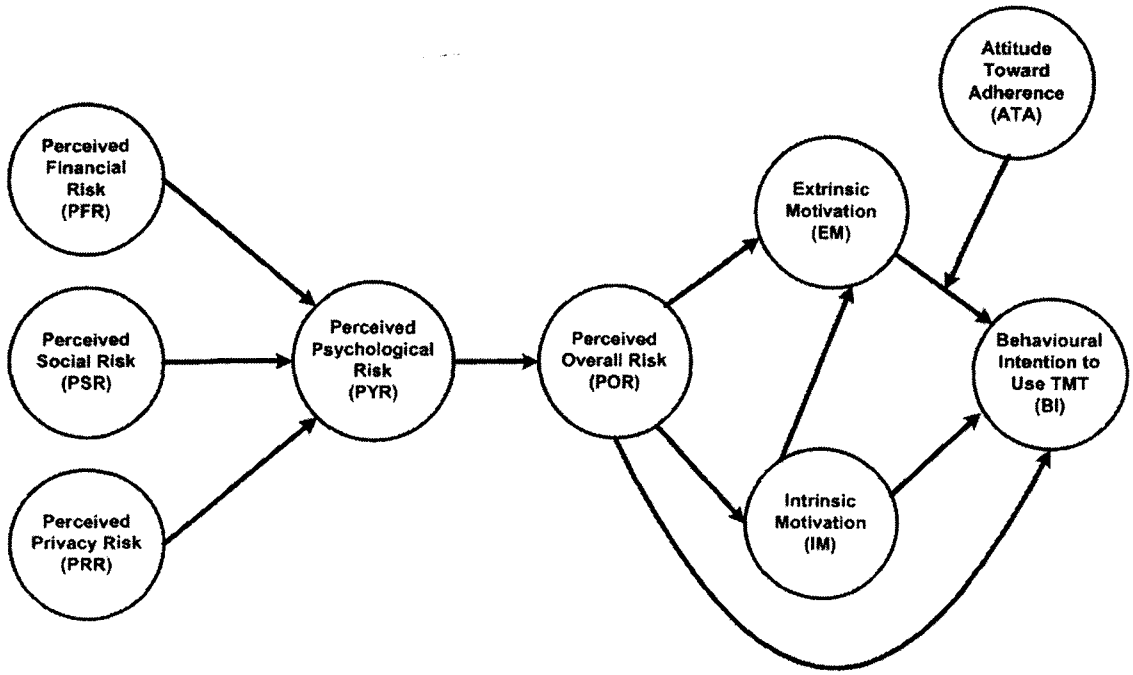


Figure 3.8 Theoretical Perceived Risk-Motivation Model of User Acceptance of Wireless Text Messaging in Telehealth

The model comprises several control variables (fully explained in Chapter 4) but one of them was included in the model diagram to clearly show its importance: attitude toward adherence. According to what was presented in Chapter 2 about adherence, patient-related factors are critical for the success of any adherence-improving intervention: little can be done for a patient who does not perceive the need for a treatment, no matter how low-risk, how useful, or how enjoyable a technology intervention may be.

Following the same logic of Chau and Hu (2001), intention to use has been utilized as the dependent variable in the model because of theoretical and practical justifications:

- The equivalence of self-reported usage and actual usage of a system is still a controversial issue in IS studies (Straub, Limayem et al. 1995; Venkatesh and Davis 2000);
- A substantial body of research shows that there is a "strong and significant causal link between behaviour intention and targeted behaviour" (Chau and Hu 2001, p. 701); and,

- Agarwal and Prasad (1999) stated that, in survey-based research it is more appropriate to measure intention than actual usage because intentions "are measured contemporaneously with beliefs", at the same point in time (p. 367).

From the practical point of view, measuring intention rather than actual use of technology is preferable in the early stages of technology introduction and before a large-scale implementation. This is the case for telemedicine in general (Hu, Chau et al. 1999), and as in the particular case of the system examined in this study. It is thus important to investigate and evaluate user acceptance of a technology before exposing it to a large number of users (Chau and Hu 2001). This is why a significant number of the models investigating user acceptance of technology have included "intention to use" technology as a common final component.

3.6 Research Hypotheses

The research hypotheses of this study are based on the research questions (presented in Chapter 2) and are in direct relationship to the proposed theoretical model.

Recall ***RQ1:*** *What are the influences of the various dimensions of perceived risk on the perceived overall risk associated with the use of wireless text messaging in telehealth?* Consumers perceive risk because of the frustration associated with the possibility of loss if the purchase is unsuccessful (Cox and Rich 1964; Lim 2003). Previous research in consumer behaviour has consistently shown perceived risk to be a multidimensional construct that expresses a subjective expectation of loss related to the purchase of a product or service (Jacoby and Kaplan 1972; Featherman and Pavlou 2003; Lim 2003).

Perceived risk is seen as a complex construct with individual risk dimensions accounting for a substantial part of the variation in the overall risk (i.e., criterion variable) (Stone and Grønhaug 1993). The contribution of various dimensions of risk may differ substantially. For instance, Jacoby and Kaplan (1972) showed that physical risk contributes only 2% to the overall risk and psychological risk contributes 1%. However, these percentages may vary between various categories of products and between products and services. Even if the relative importance of the diverse risk dimensions is not the same, their aggregate influence on the overall risk is expected to be about the same (Stone and Grønhaug 1993).

As shown in Subsection 3.3.2, the 'classical' dimensions of perceived risk explain a significant part of the variance of the overall risk. Consistent with Subsection 3.5.2 above, the components of perceived risk that are considered meaningful for this study are psychological risk, financial risk, social risk, and privacy risk. Taking into account the risk components relevant for this research, as described above, it is hypothesized that:

H1: ***Perceived overall risk will be explained by perceived psychological, financial, social, and privacy risk.***

There is controversy in the marketing literature about independence among the types of risk. Although Jacoby and Kaplan (1972) considered them to be independent, other researchers often found these facets of risk to be correlated when investigating specific products (Stone and Grønhaug 1993; Kim and Lennon 2000).

In contrast to what Jacoby and Kaplan (1972) affirmed initially, the risk dimensions need not be necessarily unrelated since all of them capture some aspects of the same overall risk. Early marketing research has shown the performance risk to be the most important risk component. However this research was investigating real products. It is believed that the situation will be different for services, especially in connection with an online or wireless channel of delivery. All the risk dimensions are perceived through the mental process of an individual, and, therefore, it is believed that they should be captured through measures of the perceived psychological risk. The hypothesis was first introduced by Stone Grønhaug (1993) who, extrapolating from Bauer's thoughts that some consequences of the individual's choice are "at least likely to be unpleasant" (Bauer 1960, p. 30), inferred that all facets of risk should be perceived through the psychological view. As indicated in Table 3.3, perceived psychological risk displayed a fairly high correlation with other components of risk in previous marketing studies, even if they were referring to products and not services.

As explained in Subsection 3.5.2 above, the situation should be more obvious for a service (which, compared to a product, is relatively intangible) especially when the service is new (hence, there is no information or feedback upon its perceived value). Featherman and Wells (2004) speak even of a *"mental intangibility"* (p. 9) that is more important than *"physical intangibility"* in driving risk perceptions in situations such as e-services adoption. Because individual perceptions have a central role in a purchasing process, it is reasonable to say, as Stone and Grønhaug (1993) posited, that perceived psychological risk that expresses the whole perception regarding uncertainty over a right or wrong decision (about subscribing for the text messaging service for telehealth in this case) is the most important dimension of the overall risk and it mediates the influences of the other dimensions. Consequently, it is suggested that:

H2: ***Perceived psychological risk will be correlated with perceived financial, social, and privacy risk.***

H3: ***Perceived financial, social, and privacy risk will be mediated through perceived psychological risk to influence perceived overall risk.***

Recall ***RQ2:*** *What is the influence of perceived overall risk on the motivation associated with the use of wireless text messaging in telehealth?* The perceived overall risk is integrated in the motivational model, similarly to the work of Featherman and Pavlou (2003) who integrated a perceived risk multidimensional construct into the technology acceptance model. As shown in Subsection 3.4.1, the technology acceptance model has some similarities with the motivational model in terms of general layout and parallelism between the main constructs. Extrinsic motivation and perceived usefulness represent, in fact, one single construct (Venkatesh, Speier et al. 2002) which captures the *performance expectancy* of an activity. Featherman and Pavlou's work (2003) studying

perceived risk associated with e-services adoption found that "consumer concerns for the perceived risk of e-service adoption inhibited both" perceived usefulness and behavioural intention (p. 466). Similarly, Van der Heijden, Ogertschnig et al. (2005), Pavlou (2003), Featherman and Wells (2004), or Kanungo and Jain (2004) showed empirically that perceiving a service as riskier reduces its utilitarian value. Consequently, perceiving a mobile service as risky for various reasons (e.g., too expensive, or stressful) is likely to decrease the perceived usefulness of that service.

Studies addressing consumer behaviour in telephone and, more recently, Internet shopping found that perceived risk negatively affects not only the utilitarian side of such activities but also an attitudinal side. Thus, a study investigating consumer trust in an Internet store found that a high perception of risk negatively influences the attitudinal orientation of the consumers toward the store with a path of -0.37, significant at 0.05, between the two constructs (Jarvenpaa, Tractinsky et al. 2000). A similar type of relationship is reported by Grazioli and Jarvenpaa (2000) in a study regarding the implications of the Internet fraud on consumer intentions to use the online shopping channel. Thus, the study identified a negative influence of perceived risk on attitude (coefficient = -0.388, significant at 0.001). Due to the close positive link between enjoyment, or intrinsic motivation in general, and attitude (Dabholkar and Bagozzi 2002), it is expected that perceived risk affecting negatively attitude would also affect the same way the intrinsic motivation associated with using the technology. Accordingly, it is hypothesized that:

H4: ***Perceived overall risk will reduce intrinsic motivation.***

H5: ***Perceived overall risk will decrease extrinsic motivation.***

There are two opinions, sometimes contradictory (Dermer 1975), regarding the relationship between the two types of motivation: one states that the intrinsic motivation (IM) and extrinsic motivation (EM) combine into an overall one, and the other considers that extrinsic rewards might interfere with intrinsic motivation (Shapira, Kantor et al. 2001). The latter opinion seems to be more popular in published motivation studies.

Similarly to the influence of perceived ease of use on perceived usefulness that has been consistently demonstrated by technology adoption model (TAM) studies, conceptual studies and empirical evidence show there is also a relationship between IM and EM. Traditional motivational research has shown a negative interaction between EM and IM (Ryan and Deci 2000), because when a task is associated with achieving some goals, "the perceived locus of causality shifts from the individual to the external reward" (Hirst 1988, p. 96) thus decreasing the intrinsic motivation. Davis, Bagozzi et al. (1992) also noticed a positive effect interaction between PU and enjoyment. The combined effect of the two forms of motivation had a strength (beta effect) of 0.16 ($p<0.001$) in one study and of 0.58 ($p<0.05$) in another study (Davis, Bagozzi et al. 1992).

An empirical study reported by Van der Heijden, Ogertschnig et al. (2005) investigating the user acceptance of mobile services showed a strong correlation between the *utilitarian value* (i.e., extrinsic motivation) and *hedonic value* (i.e., intrinsic

motivation). Intrinsic motivation is higher when individuals perceive tasks as being done for themselves because they tend to associate the fulfilling of these tasks with satisfying their self-determined needs. Venkatesh and collaborators (Venkatesh, Speier et al. 2002) suggest that there is *a causal link from intrinsic motivation to perceived usefulness*. The reason is that previous research showed intrinsic motivation to increase pleasure or enjoyment regarding the fulfillment of a task resulting in higher quality and productivity. A higher intrinsic motivation deepens cognitive processing and enhances perceptions of extrinsic motivation. Therefore, consistent with results from prior studies which showed an influence from an IM (e.g., enjoyment) construct to the EM construct (e.g., usefulness), as presented in Subsection 3.4.1, it is hypothesized that:

H6: ***Intrinsic motivation will have a positive effect on extrinsic motivation.***

Recall ***RQ3:*** *What are the influences of motivation and perceived risk on the intention to use wireless text messaging in telehealth?* Empirical research suggests motivation is an important factor influencing perception and behaviour regarding an activity (Venkatesh 1999). Almost all motivational theories have shown that motivation is a multifaceted and individual-dependent phenomenon that may predict personal behaviour (Mitchell 1982).

In particular, motivational influence has been demonstrated in technology adoption studies, including the abundant number of studies indicating the influence of only one side of motivation (i.e., perceived usefulness) on adoption intention. Thus, previous studies in technology acceptance have established that perceived usefulness is the key determinant of the behavioural intention (BI) to use a technology while perceived ease of use and enjoyment are secondary antecedents (Igbaria 1993; Venkatesh 1999; Childers, Carr et al. 2001; Liaw 2002). However, as some studies report, the "more immersive, hedonic aspects of new media play at least an equal role" (Childers, Carr et al. 2001, p. 527). For instance, Igbaria and his collaborators (1995) added that individuals accept and use a certain technology because it is either fun (or enjoyable) or useful (and beneficial) or for both reasons and, therefore, fun's positive effect on the use of a technology (e.g., computer technology) should not be underestimated.

Van der Heijden, Ogertschnig et al. (2005) found in a scenario-based experiment that both EM and IM have a positive impact on BI to use mobile phone services, with utilitarian value having a significantly larger effect than the hedonic value. Higher enjoyment leads to higher acceptance (even for unproductive systems), but enjoyment has been seen to have an increased effect on acceptance for systems that are also high in perceived usefulness. An increase in enjoyability increases acceptability "but has less of an effect on the acceptance of useless systems" (Davis, Bagozzi et al. 1992, p. 1125).

Prior research initiated by Deci (1975) shows that "extrinsic and intrinsic motivation play an additive role" (Venkatesh, Speier et al. 2002, p. 303) in explaining intentions of using technology and behaviour towards using it. This was also confirmed by the findings of Davis, Bagozzi et al. (1992). Somewhat in discordance with other results, Venkatesh, Speier et al. (2002) found that intrinsic motivation has no direct effect on behavioural intention, but they concluded that intrinsic motivation is "an important

catalyst for both perceived usefulness and perceived ease of use" (p. 310) having an indirect role in user intention to adopt.

Regarding perceived risk influence on behavioural intentions to use a technology, in general it is natural for consumers to adopt risk-reducing strategies, such as relying on some product quality and performance features before making a decision to purchase (Shimp and Bearden 1982). Starting with the early studies, consumer behaviour research has shown that consumers tend to become more risk averse, as they perceive a higher level of risk (Bettman 1973). Perceived risk is a powerful determinant of consumer behaviour (Lim 2003) because "consumers are more often motivated to avoid mistakes than to maximize utility in purchasing" (Mitchell 1999). For instance, studies in marketing showed perceived risk to be important for consumer adoption of e-mail-order shopping and telephone shopping (Lim 2003).

Empirical consumer behaviour research has shown perceived risk to lower purchase intention for products or services (Mitchell and Greatorex 1993). When perceived risk falls below an individual's acceptance value, it is essentially ignored, whereas a very high level of perceived risk can cause a postponement or avoidance of a purchase altogether (Cunningham, Gerlach et al. 2004).

In particular, for studies in the IS field, perceived risk has been found to play an important role by adversely influencing users' intent to adopt electronic services (Pavlou 2003; Featherman and Wells 2004). For instance, perceived risk of e-commerce and trust in electronic channels were found to be major determinants in adoption behaviour regarding e-banking (Kim and Prabhakar 2000). Also, a survey of about 700 New Zealand Internet users found perceived risk and perceived benefits of Internet shopping to be linked with the purchases (in terms of amount and frequency) (Doolin, Dillon et al. 2005). Two empirical studies (a high-low risk level manipulation with control group plus a control group replication) showed perceived risk to be a significant inhibitor of perceived usefulness and adoption intention of e-services, especially for the individuals in the groups subjected to manipulation (Featherman and Fuller 2003). Consequently, it is hypothesized that:

H7a: ***Intrinsic motivation will have a positive direct effect on behavioural intention.***

H7b: ***Extrinsic motivation will have a positive direct effect on behavioural intention.***

H7c: ***Perceived overall risk will have a negative direct effect on behavioural intention.***

Recall ***RQ4:*** *How appropriate is the proposed risk-motivation theoretical model in explaining the intention to use wireless text messaging in telehealth?* No hypothesis is formulated for the fourth research question. This will be answered by estimating the total variance in the behavioural intention to adopt the technology that is explained by the theoretical model, and by comparing it with values from similar research in the literature. Testing the model appropriateness would also answer a challenging question launched by the initiatiors of the motivational model in IS. Davis, Bagozzi et al. (1992) found that PU and enjoyment mediated fully the effects on usage intentions of other constructs (perceived output quality and PEOU for their studies) in the motivational model. Also,

they showed that PU and enjoyment may be a common pathway through which other "psychological and environmental factors may achieve their influence" (p. 1126). Accordingly, it is also reasonable to test whether and how much perceived risk influences usage intentions, partially through this path and partially in a direct manner, as seen from consumer behaviour studies.

Recall ***RQ5:*** *What are the characteristics of the user population who are positive towards the use of wireless text messaging in telehealth?* No hypothesis is formulated for this research question. The answer to this question will be formulated after collecting user demographics and characteristics (e.g., age, gender, SMS usage) and relating them to the behavioural intention to use the technology.

Recall ***RQ6:*** *What are the main opportunities and barriers, from the users' viewpoint, regarding the intention to use wireless text messaging in telehealth?* The answer to this question will be obtained by integrating the results from a quantitative study with the results from a qualitative study, in an effort to obtain a more comprehensive model of the reasons that would make the users accept or not accept such a system. No research hypothesis can be presented at this stage.

Recall ***RQ7:*** *How much would users agree to pay and for how long would they stay in a program using wireless text messaging telehealth as a support in improving adherence to a healthy behaviour regimen, if usage is not free?* Answering this question involves collecting qualitative information from users. There are no prior studies upon which to base an hypothesis at this time.

Recall ***RQ8:*** *Would a wireless text messaging telehealth service that reinforces adherence to a healthy behaviour improve this adherence over time?* No a priori hypotheses can be formulated for the eighth research question either. This question will be answered only after comparing pre-study and post-study data as well as data collected among the study participants in the intervention and the control group of a randomized controlled trial (details are given in Chapter 4).

3.7 Summary

This chapter has conducted a literature review and critique in the domains of motivation, perceived risk, and technology acceptance that are related to the research topic. This approach has been necessary in order to anchor scientifically an original theoretical model and the research hypotheses into the existing knowledge.

First, intrinsic and extrinsic motivations have been discussed starting from recognized motivation theories. It was thus shown that while intrinsic motivation is linked to performing an activity for only its inherent satisfactions, extrinsic motivation is related to external goals associated with doing the activity. Also, previous research has shown that a link or, even, interdependency exists between the two sides of motivation.

Second, perceived risk associated with the purchase of an object or a service was extensively examined. The discussion started from consumer behaviour research which considered perceived risk as expressing subjectively potential negative outcomes of a purchase and having six 'classical' facets (i.e., financial, performance, social, physical, psychological, and time) that influence an overall risk perception. Only relatively recent studies have taken into account risk in IS research and associated it with either a general or a specific (e.g., privacy-related) perception of potential loss encountered especially in online purchases.

Third, this chapter has discussed and criticized the most popular technology acceptance models in IS studies, according to recent research categorizing (Venkatesh, Morris et al. 2003): Theory of Reasoned Action, Technology Acceptance Model, Theory of Planned Behaviour, Decomposed Theory of Planned Behaviour, and Motivational Model. Extant level of technology acceptance in telehealth has been discussed with a special stress on the absence of research investigating scientifically patient perceptions regarding technology in general and IT in particular. The immaturity of technology acceptance research in mobile information systems was also pointed out.

In justifying the building of the original theoretical model, this chapter has also discussed previous studies integrating motivation and perceived risk into technology acceptance models. It was thus shown that, especially in terms of using perceived risk construct with several risk antecedents in IS research, there are only a handful of studies with outcomes far from being conclusive, and these studies call for more research to be done.

Using the above foundation, this chapter has presented an original theoretical model to investigate the user acceptance of SMS for supporting the adherence of well people toward a healthy preventive behavior. This model resulted from incorporating several perceived risk dimensions (appropriate for this study) into the motivational model introduced in IS studies by Davis and collaborators (Davis, Bagozzi et al. 1992) and validated by reputable subsequent research (Igbaria, Parasuraman et al. 1996; Venkatesh and Speier 1999; Venkatesh, Speier et al. 2002). The original theoretical model is followed by the hypotheses to be tested in this study. Seven hypotheses are thus formulated based on the first three research questions introduced in Chapter 2 and supported by literature arguments. No hypotheses could be formulated for the remaining five research questions, as answering these questions would not be based on the theoretical socio-behavioural model introduced in this chapter. The remainder of this work presents the methodology undertaken to test the research hypotheses and answer the research questions, the results obtained, and their interpretation.

Chapter 4: Methodology

4.1 Introduction

This chapter presents the methodology for collecting and analyzing the data necessary to test the research hypotheses and answer the research questions proposed earlier in this study. The research questions are answered by testing in a real-life context an original system proposed by this work, Text Messaging Telehealth (TMT), which is based on wireless text messaging (or SMS). Recall that this study includes research questions based on three fields: information systems, business models, and healthcare, with a considerable weight on the IS part. This chapter, after presenting the layout of the experimental design and the principles of TMT in Section 4.2, deals successively with the study participant characteristics in Section 4.3, methods of data collection in Section 4.4, and of data analysis in Section 4.5 for the three types of research questions.

4.2 Experimental Design

This research involves a one-month longitudinal experiment in the form of a randomized controlled trial (RCT) with two categories of subjects: an intervention group, and a control group. This design is necessary in order to be able to answer the types of research questions that originate from the three fields: information systems, business models, and healthcare questions. The component of the study answering the healthcare research question is *longitudinal* (during one month) whereas the part answering the information systems and business model research questions is done *at a single point in time*, at the end of the one-month field experiment, being based at least partially on the experience that participants gained throughout the experiment.

4.2.1 Text Messaging Telehealth

According to the healthcare literature on adherence, there are several types of strategies to increase compliance: "combinations of instruction and instructional materials, simplifying the regimen (e.g., less frequent dosing, controlled release dosage forms), counseling about the regimen, support group sessions, reminders (manual and computer) for medications and appointments, cuing medications to daily events, reinforcement and rewards (e.g., explicitly acknowledging the patient's efforts to adhere), self-monitoring with regular physician review and reinforcement, involving family members and significant others" (Haynes, McDonald et al. 2002, p. 2881). Starting from these, this study proposes a system called *Text Messaging Telehealth (TMT)* which utilizes SMS technology to perform a *combination of educational and behavioural interventions* to improve adherence toward a healthy behaviour. The basic layout of TMT is shown in Figure 4.1:

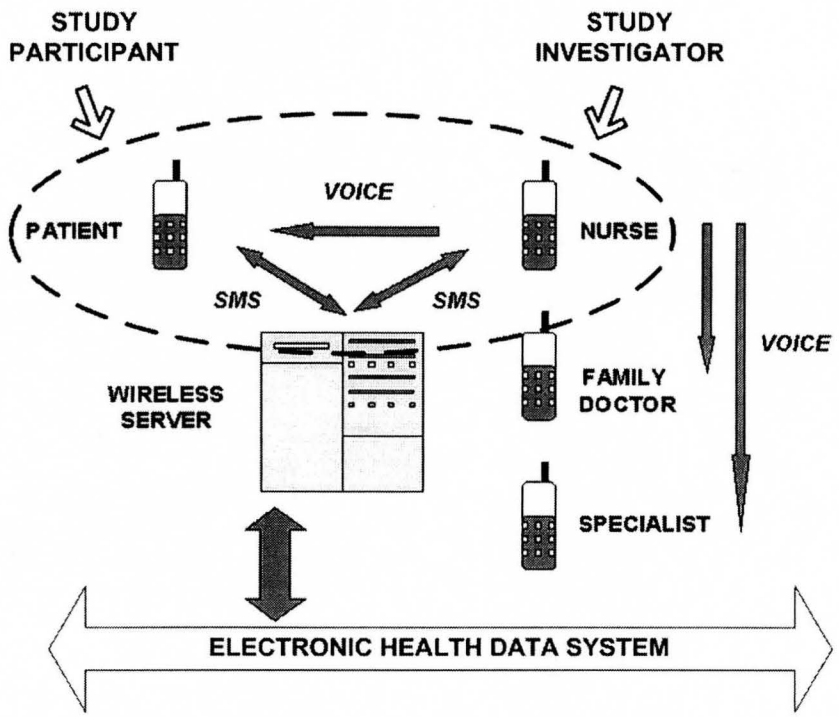


Figure 4.1 Text Messaging Telehealth (TMT) Layout (The dotted-line oval represents the domain reached by this study)

TMT is a communication and data exchange system that uses SMS to address outpatient adherence. The system is composed of a secure wireless server that stores a database of limited information about the patients using the system, and of patient and nurse cell phone numbers. The server sends and receives SMS messages, when appropriate, to/from patients and sends SMS messages to responsible nurses. When necessary, nurses may call patients as well as their physicians (e.g., family doctors or specialists). The wireless server may also be integrated with the currently expanding electronic data health systems, such as those of the *CCACs (Community Care Access Centers)* in the Canadian province of Ontario. Consistent with the healthcare literature and with recommendations regarding adherence-improving initiatives, as described in Section 2.3, TMT may implement the two most popular initiatives of adherence enhancement (*reminding* and *monitoring*) and facilitates another two (*consulting* and *educating*), as explained below:

- **Reminding.** Receiving reminders for adherence is "useful when the problem is a failure of the [expected] behaviour to occur" (Dunbar, Marshall et al. 1979, p. 176). Thus, the server sends personalized brief reminders about taking medication, or performing self-tests, e.g., "***Hello, Alex. It's time to take ALPHA***" 30 minutes before the due time for medication ALPHA. The patient confirms by

sending a single-letter SMS ("***A***" - 'Acknowledge') after taking the pill. If Alex is complying well with his regimen, he will receive from time to time a feedback message such as "***Well done, Alex! Your glucose level has dropped 3 units this month***", and possibly encouraging calls from his homecare nurse. As shown in the medical literature, reinforcement "increases the probability of the behaviour being repeated" (Dunbar, Marshall et al. 1979, p. 185). If a patient has not responded after a number of reminders, he/she may be called by the responsible nurse for details.

- **Monitoring.** This is based on "observing and recording one's own behaviour" (Dunbar, Marshall et al. 1979, p. 184). The patient sends a codified multi-character message, as instructed by the responsible nurse, e.g., "***G123***" (to indicate a 'Glucose' test reading of 123), or "***B123***" (to indicate a 'Blood pressure' reading of 123), soon after performing a self-test. If the patient is complying well with the regimen, a feedback message may be sent from time to time, e.g., "***Good, Julia! Your blood pressure is improving***". Sometimes the homecare nurse may call to discuss the results with the patient. If the patient does not send a test result regularly, he/she is reminded automatically to do so. If test results are not sent for some time, or if results are outside allowable limits, the patient is contacted by the responsible nurse for details.
- **Consulting.** If the patient wants to speak with a nurse, a one-letter message, "***N***" - for 'Nurse', is sent and a nurse calls as soon as available. Thus, voice calls are initiated only from the provider's side to avoid overwork due to possible excessive calls from patients.
- **Educating.** Any intervention such as this requires an initial educational program to ensure that the patient understands his/her disease or condition and the importance of adherence to the regimen and continuing self-management (Haynes, McDonald et al. 2002). The combined actions of monitoring, reminding, and consulting would also enhance patient education toward a more adherent attitude. Some key issues include ensuring patient participative and conscious role in monitoring and reminding (in contrast to the 'intelligent devices' approach which excludes patients from the action loop (Cocosila and Archer 2005a)), thus providing feedback and encouragement for improving adherence and fostering patient dialogue with healthcare providers.

TMT could have the following significant advantages:

Technology: Uses basic SMS messaging that is available on all modern mobile phones. Cell phone usage is experiencing a sharp rise worldwide, as the figures in Section 2.3 have shown. Patients and nurses using cell phones are an advantage for the end users (e.g., patients would be able to use their portable devices for their usual business, personal, or entertainment needs, and not just as 'medical' devices) and for the industry (e.g., there is no need to design devices specifically for adherence-improving applications).

Patients: Using the TMT system would be relatively easy. There are no special skills required to send short 1 to 4 digit SMS messages. Having patients send acknowledgements and enter their own monitoring test results would probably help them to develop a responsible and proactive attitude toward adherence. In contrast to an entirely automated device that could perform the tests and send the results without patient intervention, patients using the TMT system would be obliged to participate directly in the process, thus developing a conscious, proactive attitude (Cocosila and Archer 2005a). This would be further enhanced by feedback, encouragement, and reinforcement.

Healthcare providers: The TMT system would not seek to alter patient relationships with their healthcare providers since previous research has shown this to be a sensitive issue. Physicians and nurses are reluctant to accept patient-initiated communications for various reasons (e.g., overwork, fear of communication overflow, liability and lack of reimbursement) (Shactman 2000; Cheah 2001; Harris Interactive 2001; Chin 2002; Forkner-Dunn 2003). Family doctors or specialists would be involved in the picture only if nurses decide it is necessary. Also, in order to avoid nurse overwork, voice communications with outpatients could be asked by patients through text messaging but initiated only by the nursing support staff, and when possible. Consequently, TMT would only affect the relationships between patients and supporting care nurses and physicians, potentially relieving healthcare providers of boring low-level repetitive tasks (Cocosila, Coursaris et al. 2004). For instance, experimental research with 31 patients with type 1 diabetes did prove that telecare modem transmission of glucometer data brought an enhanced adherence to self-monitoring. In this case a major benefit was in the reduction of health professional time spent: nurses had more time for feedback and this led to more frequent treatment adjustments for the remote patients (Montori, Helgemoe et al. 2004).

4.2.2 Text Messaging Telehealth Application for This Study

As this study is the first step in utilizing a TMT system and since this is done in a specific situation (targeting the adherence of well people to healthy behaviour), several distinctive features have been adopted (Table 4.1):

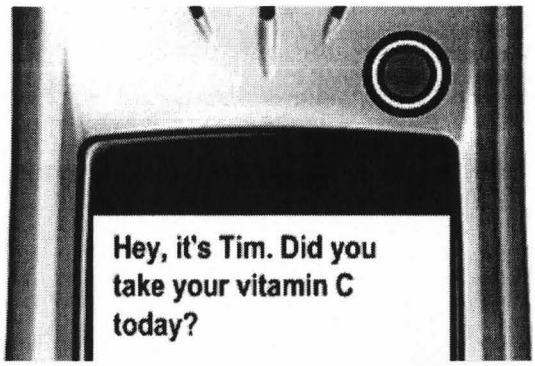
- the system is restricted to ***study participants*** (instead of patients), ***study investigator*** (instead of nurse), and ***wireless server*** (i.e., the dotted ellipse in Figure 4.1);
- the system implements only ***several types of reminding*** about taking one vitamin C pill daily (the reasons for this intervention are explained in detail in the remainder of this section), along with a form of ***consulting*** and, through a combination of reminding and consulting, ***educating***; and,
- in an attempt to maximize the study's success, since improving adherence to a prophylactic behaviour is the most problematic intervention by its very nature (Anna, Jose-Maria et al. 2004), the system is as simple as possible, and reduces required actions and interference with regular participant activities to a minimum.

There is significant evidence from the technology acceptance body of research that inducing enjoyment tends to increase the chances for a system to be accepted by users. Conversely, "insufficient satisfaction and enjoyment can undermine the adoption of otherwise productive computer systems" (Davis, Bagozzi et al. 1992, p. 1128). Consistent with the work of Deci (1975), who showed that environment is one of the elements that can stimulate intrinsic motivation and, consequently, direct behaviour towards reaching a goal, IS research has shown the beneficial influence of enjoyment (or playfulness) for technology adoption. Venkatesh and Speier (1999) attempted to manipulate intrinsic motivation by inducing a state of playfulness in the users and Venkatesh (1999) used a game-based training approach to enhance the intrinsic motivation of users. Therefore, for further increasing participant acceptance, the TMT interventions are ***enjoyable*** and ***interesting***, based on the experience of early implementations as described in Section 2.3.4: all reminders have ***variable content***, coming at ***random times*** (Franklin, Waller et al. 2003), from a ***virtual friend*** called 'Tim' (Neville, Greene et al. 2002), some of them containing ***fresh jokes*** (Rodgers, Corbett et al. 2005) and ***ending with a 'smiley'*** (Franklin, Waller et al. 2003).

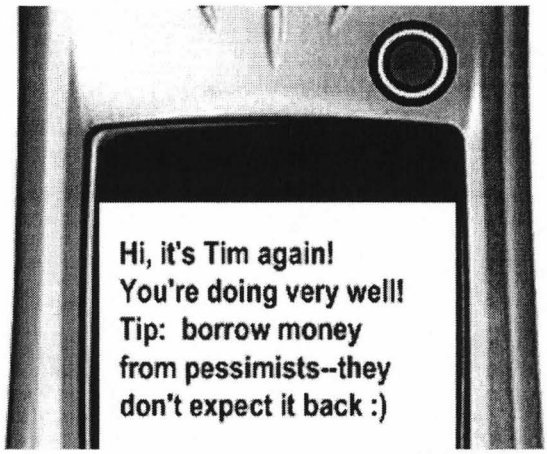
Table 4.1 Text Messaging Telehealth Features for This Study

TMT intervention	System actions	Study participant actions
Reminding-basic	Send daily, sometime in the afternoon, a message reminding about taking vitamin C (Figure 4.2).	Send a one-letter SMS: "**A**" ('Acknowledge'), after taking the vitamin but no later than the midnight of the same day (i.e., there are at least 5-6 hours to reply).
Reminding-reinforcing (for participants who have replied as expected to the basic reminders)	Send more rarely (every 2-3 days) feedback encouraging messages with fresh jokes, brief information reminding why it is important to take vitamin C, and ending with a 'smiley' (Figure 4.2).	No action required.
Reminding-correcting (for participants who have not replied as expected to the basic reminders)	Send more rarely feedback with no enjoyment and no 'smiley', but with brief information about the importance of taking the vitamin (Figure 4.2).	No action required.
Consulting (for some non-urgent questions, concerns, or suggestions regarding the study and not healthcare issues)		If they want to speak with the investigator for various reasons, participants may send a one-letter SMS: "**C**" ('Call me') to the TMT system number and the investigator will call as early as possible.

Reminding-basic



Reminding-reinforcing



Reminding-correcting

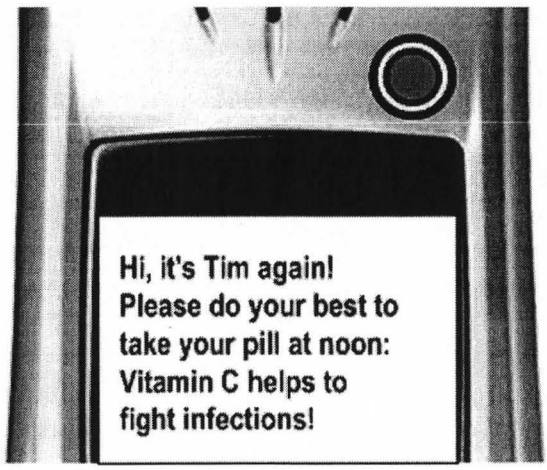


Figure 4.2 Examples of Reminders in the TMT Study

4.2.3 Why a Randomized Controlled Trial?

This type of experiment was developed in order to give the participants an opportunity to actually use an SMS-based intervention that promotes adherence to

healthy behaviour for well people. Using the system for a period of time gives the participants a better image of how the system actually works and allows them to develop some perceptions in a real-life context. Thus, participants, while working with the application, are able to build more realistic reasons for adopting such an intervention (e.g., it is useful, it is enjoyable) or reasons not to accept it (e.g., it is worthless, disturbing, embarrassing, etc). This helps participants develop enough experience to be able to respond to a survey which addresses relevant research questions (e.g., reasons to adopt or not adopt such an application, how much would users agree to pay for using such a service, and for how long would they stay in a program like this one).

The RCT is essential to answer the healthcare research question. Although secondary to this study, the healthcare research question, as presented in Chapter 2, is not at all of secondary importance, especially for healthcare and IS practice. In fact, no study investigating scientifically user perceptions and behavioural intentions regarding the use of such a mobile IT intervention could be identified in the existing literature. *The one-month duration of the trial was imposed by scientific medical reasons.* Literature indicates that, for short-term regimens (less than two weeks long) the best way to improve adherence is through giving clear instructions (Haynes, McDonald et al. 2002). Nonetheless, the two-week limit must be regarded with caution as not a threshold, but strongly dependent upon the type of illness and treatment. However, the real issue is with long-term adherence that necessitates complex interventions (e.g., informing, reminding, counseling, offering rewards and social support, etc.). This, despite a number of relevant studies, is still an unsolved problem (Haynes 1979a; Haynes, McDonald et al. 2002).

4.2.4 Framework of the Trial

For important methodological, practical, and ethical issues, this study could not investigate the outcome of a mobile IT intervention to measure adherence in the treatment of real patients. In an effort to find the "best balance between idea and feasibility" (Haynes, Sackett et al. 2005, p. 7), the study utilizes a surrogate intervention: investigating mobile IT influence on the adherence of well people to healthy behaviour. However, adherence in preventive situations such as this one is the most difficult to ensure because it is harder to convince people that they really need the intervention. Thus, any small positive results revealed by the trial are important.

In documenting the framework for this trial, systematic searches of the literature were performed in MEDLINE and The Cochrane Library databases as well as in healthcare journals such as Journal of the American Medical Association and British Medical Journal. Several possible healthy behaviours could have been chosen as a framework for this study: drinking a certain quantity of water or walking a certain distance daily, or taking a herbal product (such as Echinacea) or a vitamin C tablet for prophylactic reasons (e.g., fortifying the body to prevent cold and flu). After studying the literature, it was found that drinking water or walking should be highly personalized because each individual differs in terms of the daily needs of these healthy activities (Sawka, Cheuvront et al. 2005). Also, after searching systematic medical reviews published after 2000 and some other randomized controlled studies, it was found that

there was no unanimously agreed solid evidence that either Echinacea or vitamin C would prevent colds or reduce cold symptoms (e.g., preventing flu and cold). A popular conclusion was that "probably" the two products are helpful for these, but further research is necessary. On the other hand, Echinacea was found to be a more complex product associated in some studies with possible rare and non-serious side-effects such as allergy or anaphylaxis (Del Mar and Glasziou 2002; Ernst 2002; Barrett 2003; Turner, Bauer et al. 2005).

Consequently, after a careful balance between the idea and feasibility, and taking into account what can be afforded and what the circumstances permit (Haynes, Sackett et al. 2005), vitamin C taken as a preventive measure was deemed as a suitable study to test the outcomes of a mobile IT intervention for adherence. While the effects of vitamin C in the prophylaxis of flu and cold were termed as "probably" useful (Del Mar and Glasziou 2002), there are other several advantages to using vitamin C for this study:

- vitamin C dosages are more precise, studies suggesting usual dosages of some 250-500 mg, up to 1-2 g per day (Del Mar and Glasziou 2002; Douglas, Hemilä et al. 2004; Sasazuki, Sasaki et al. 2005);
- systematic reviews report virtually no side effects for dosages below 1g per day (Del Mar and Glasziou 2002; Hemilä 2004; Hathcock, Azzi et al. 2005);
- vitamin C is a popular product and so it is possible that some study participants have already been taking it, thus making adherence judgments easier;
- because of its comparative popularity, vitamin C is more acceptable as a harmless intervention; and,
- vitamin C is comparatively inexpensive.

The approach embraced in this study would obviously have a limited external validity from the medical research point of view but it may be considered as "a step forward in testing an idea at a reasonable price" (Haynes, Sackett et al. 2005, p. 8)

4.2.5 Layout of the Trial

The trial comprised four stages. The layout of the trial is depicted in Figure 4.3 and Table 4.2.

Stage I. The objectives of this stage were to inform potential participants on the layout of the randomized controlled trial and to collect baseline data. First, subjects visited a Web site describing the *purpose* of the project (i.e., eliciting their impressions on the possible use of SMS for keeping them healthy) and two *preliminary conditions* for participating (i.e., being at least 18 years old and being cell phone users). Second, if accepting to participate, they were presented *brief information* from a recognized source (*The British Broadcasting Corporation (BBC)* Web site (Young 2005)) on the benefits of taking vitamin C daily for preventing flu and colds. Third, they were asked to complete a *survey* regarding their experience with cell phones and SMS, possible existing patterns of vitamin C consumption, attitude regarding vitamin C use, as well as their perceptions on

a scenario showing how mobile IT could help them remember to take vitamin C daily. Finally, they were offered the *possibility of participating* in a one-month field experiment taking place exactly as described in the scenario. If willing to do so, they had to enter their e-mail address at the end of the survey, so they could be contacted by the investigator.

The scenario approach was motivated by the following:

- all participants learned about the actual development of the RCT, thus ensuring equal treatment at baseline;
- knowing about the experiment helps recruitment for the actual RCT part because this develops participant interest for a novel application needing their contribution (Lankton and Louis 2005); and,
- building upon the scenario they might remember and the health intervention experience (because they have taken the vitamins for one month), participants eventually allocated to the control group would be able to offer some feedback after the RCT on the possible use of SMS in the field experiment thus potentially enriching the results gained from the study.

"A scenario describes a possible set of events that might reasonably take place" (Jarke 1999, p. 47). According to the same author, a scenario stimulates and documents reasoning about current problems and possible occurrences of events, circumstances of these occurrences, actions and risks involved. The scenario-based approach has a tradition and popularity in sciences such as applied psychology (Ross and Wieland 1996; De Cremer and van Knippenberg 2002; Stern, Mullenix et al. 2002; Tenbrunsel and Diekmann 2002; Humphrey, Ellis et al. 2004; De Cremer, van Knippenberg et al. 2005) and consumer behaviour (Stone and Grønhaug 1993; Stone and Mason 1995; Featherman and Fuller 2003).

Scenario-based research has been used in the last 25 years in human-computer interaction studies related mostly to software development. Some authors consider scenarios a 'success story' that have been little understood, explained, and applied in the IT and management area (Jarke 1998; Hertzum 2003). This type of research has also been utilized in a few IS studies. For instance, Cenfetelli (2004), studying inhibitors of technology use, employed a fictious scenario to investigate an airline and hotel itinerary for a friend's visit by examining one of 36 travel Web sites, randomly allocated to the participants. The research was conducted entirely online and, at the end of the scenario completion, participants were asked to provide details of the results and to respond to a survey regarding their perceptions and evaluations. The purpose of the study was to elicit user insights regarding the inhibitors of technology usage.

Another study of this type investigated the effect of context and perceived risk on user acceptance of mobile information systems (Van der Heijden, Ogertschnig et al. 2005). One hundred and twenty three participants recruited from Dutch Internet forums were randomly allocated into two groups and presented two online "vignettes" (i.e., hypothetical situations): a high-context relevance and a low-context relevance scenario

regarding the use of mobile services as a location helper for a traveler in a foreign country. Then the participants filled in an online survey eliciting their perceptions and intention to use a mobile service. The authors did not report methodological problems with this approach and their results were consistent with previous similar research. The total explained variance of the model outcome was 38.3%.

A study that, following the recommendations of Wilson and Lankton (2004a), was situated at the boundary between healthcare and information systems, used paper-based scenarios to examine diabetics' opinions on interactive health communication systems (Lankton and Louis 2005). The authors reported useful returns from the use of the scenario method, besides the expected advantages indicated by earlier research (simplicity, time and financial savings, easy changes and rearrangements) (Van Schaik 1999), such as more time for enriching conversations with subjects, and being able to develop participant interest for active involvement in the development of the final system (Lankton and Louis 2005). This is consistent with the practice of involving users in participatory design of IT projects, enunciated by Damodaran (1996). However, Lankton and Louis (2005) reported a low explained variance in the outcome of the theoretical model (13%). They suggested that paper-based scenarios may have contributed to the low explanatory value due to causes such as: inappropriate match of the information offered in the scenario with participant knowledge levels, and the lack of a dynamic scenario.

The current research took into account the experience gained through the above studies. This research is believed to offer higher scenario realism because, when reading the imaginary situation depicted, all participants are assumed to be familiar with cell phones and SMS activities. Furthermore, it is believed that any young person had some prophylactic activity at one point in time, at least.

Stage II. This stage took place soon after Stage I (a few hours or days later). The objectives of this stage were to inform potential participants of the one-month RCT and randomize them into the two groups: intervention and control. Participants who took the scenario-based survey and expressed their willingness to learn more on the field study were sent an e-mail inviting them to visit an information page. This gave details of the actual RCT and stated the *mandatory conditions* for participation: being at least 18 years old, having their own cell phone with text messaging capabilities for at least the next 30 days, not being allergic or intolerant to vitamin C, and, if female, not being pregnant or likely to become pregnant during the study. The last mandatory condition came from studies showing concerns about possible adverse effects of vitamin C during pregnancy (Rumbold and Crowther 2005).

If accepting to participate, subjects were *randomly directed to either the intervention or the control group*. This was done from a Web page using a script that distributes participants alternatively to the two groups following a "random without replacement procedure" (Van der Heijden, Ogertschnig et al. 2005) commonly utilized in laboratory experiments with an "open door procedure". The Web page was accessed by potentially interested participants at diverse times and locations and this preserved the randomness of the distribution process while still ensuring a virtually equal number of

subjects for both groups of this relatively small-sample experiment. As neither participants nor the investigator had any knowledge of the distribution process until it was fully completed, the allocation can be termed 'double-blind'.

After being directed to the appropriate groups, participants received group-specific information about the one-month experimental procedure. Lastly, they were required to complete a brief survey asking them to confirm meeting the mandatory conditions for participation (just as a double check for ethical purposes), as mentioned above, and to indicate their cell phone number and e-mail address. The Web presentation ended by indicating to participants how they could pick up their containers of vitamins for the field experiment. The vitamin pills were provided by the investigators in sealed containers, of a commercially available brand, and furnished by a pharmacy. Providing free vitamin tablets could raise a question about the influence on adherence of free medication. However, previous research does not offer conclusive evidence on the relationship between free medication and adherence improvement (Haynes 1979b).

Stage III. All participants were supposed to take one 500-mg vitamin C pill from the containers provided by the investigators, every day, in early afternoon when it was assumed to be most effective for the human body, for one month. Participants in the two groups differed only in terms of the information they exchanged with a central server and/or investigators, as described below. At the end of the one-month experiment, subjects in both groups were invited by e-mail to fill out a final survey that collected their impressions and perceptions from the experiment (one for the intervention group and a different one for the control group).

Stage IV. After filling out the last survey, which was different for the two groups, as explained below, participants were informed how to contact the investigators in order to receive compensation for participating in the experiment and debriefing information.

4.2.6 Intervention Group Treatment

During the first two weeks of the one-month experiment, participants in the intervention group were sent at random times within a two-hour time interval one *reminding-basic* text message daily and, depending on their reply (i.e., acknowledgement as expected after taking the pill or not), a *reminding-reinforcing* or a *reminding-correcting* message every two days. In the last two weeks the frequency of reminders and, consequently, of the participants' required actions was decreased. Thus participants received one *reminding-basic* text message every other day, and either a *reminding-reinforcing* or a *reminding-correcting* message every three days (as shown in Table 4.2). This has a twofold purpose:

- reducing interference with the normal daily routine of participants; and,
- progressively educating participants to do by themselves what is healthy to do.

Reducing the frequency of telecare interventions in time is consistent with outcomes of previous studies showing that this is what patients would expect. For instance, a 6-month randomized controlled trial reported by Montori, Helgemoe et al.

(2004) and targeting telecare interventions for type 1 diabetes patients with inadequate glycemic control, showed that both the intervention group and the control group decreased the frequency of modem transmission of their glucose level in time. The patients in the intervention group (who were sending their glucose levels and were receiving feedback within 24 hours) decreased the frequency of their responses from a median of 6 times per week in the first 2 months to 5 in the last 2 months. The control group patients (who were sending their glucose readings without receiving feedback) decreased the frequency of their responses from a median of 5 per week in the first 2 months to a median of 4 times per week in the last 2 months (Montori, Helgemoe et al. 2004).

Participants in the intervention group received in Stage II of the experiment information regarding the conduct of the experiment. In Stage IV they were expected to fill out a healthcare-related, business study, and technology acceptance survey based on their overall impressions of the experiment (Figure 4.3 and Table 4.2).

4.2.7 Control Group Treatment

Participants in the control group received only one e-mail message inviting them to fill out the final online survey. For them, this survey was much shorter, asking feedback on taking vitamin C tablets and possible health outcomes of this activity, and their opinion on the possible usefulness of an SMS-based application for their vitamin-taking activity (Figure 4.3 and Table 4.2). A layout of the trial, the list of SMS messages, and the Web scenario and survey pages are indicated in Appendices B to F.

Table 4.2 Trial Group Treatments

Stage	Duration	Intervention group	Control group
I	20 minutes	Read initial participation information, and, if consenting to participate, a scenario-based intervention, and fill in a baseline survey	
II	5 minutes	Read participation information for the RCT and, if consenting to participate in the field experiment, be allocated to one of the two groups	
	A few days	Receive group-specific participation information and a bottle of vitamins	Receive group-specific participation information and a bottle of vitamins
III	2 weeks	Receive one *reminding-basic* text message daily; Receive a *reminding-reinforcing* ***or*** a *reminding-correcting* message every two days	No SMS treatment
	2 weeks	Receive one *reminding-basic* text every two days; Receive a *reminding-reinforcing* ***or*** a *reminding-correcting* message every three days; Receive an invitation for final survey	No SMS treatment; Receive an invitation for final survey
IV	20 minutes	Fill in the final survey for the intervention group; Receive debriefing	Fill in the final survey for the control group; Receive debriefing

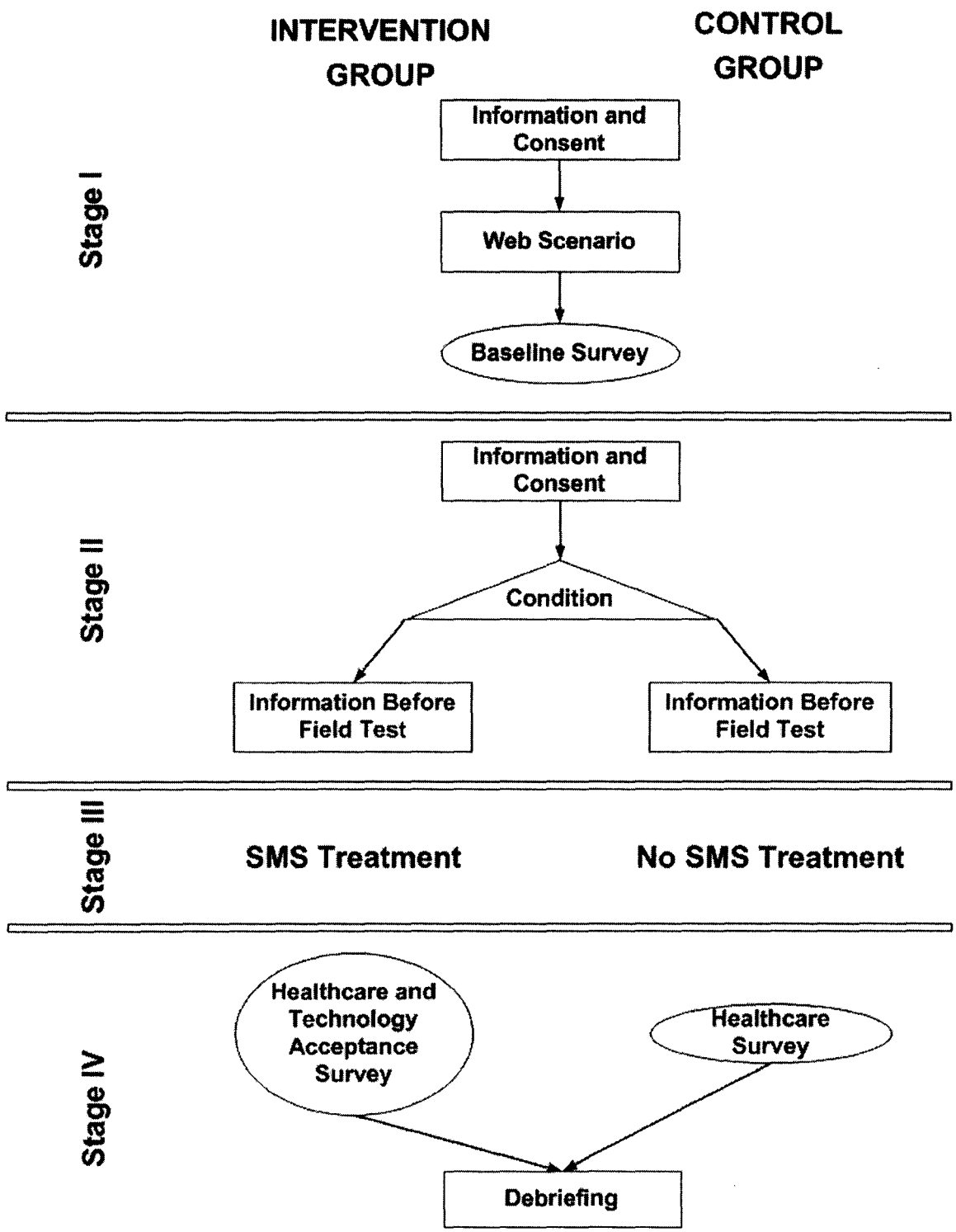


Figure 4.3 Layout of the Randomized Controlled Trial

4.3 Study Participants

4.3.1 Recruitment and Selection

There is a debate in the IS literature regarding the appropriateness of using students as participants in research. For this study it was considered that students are a suitable population for subject selection since they meet all the mandatory participation conditions:

- They are at least 18 years old;
- They have access to a cell phone with text messaging capabilities for the next 30 days after signing up for the study;
- They do not have known allergies or intolerance to vitamin C;
- If female, they are not pregnant or likely to become pregnant during the study; and,
- They agree to take one 500 mg vitamin C pill for prophylactic reasons (i.e., preventing flu and cold), every day for one month.

Questions about the representativeness of the students for the entire population may be raised (because young people may have a better general health state than the entire population, they may care less about health issues, or they may be more knowledgeable and familiar with mobile devices), but these limitations will be addressed in the final chapter of this work.

Accordingly, this study was comprised of roughly 100 participants, both male and female, most of whom were graduate and undergraduate students at McMaster University. Conducting a field study within one organization has the advantage of reducing the variability of some factors and allows detecting some micro-level effects (Karahanna, Straub et al. 1999) but with the disadvantage of decreased generalizability. Participants were recruited by advertising at McMaster University, in graduate and undergraduate classes, and online. There was minimal social presure to participate, and no power relationships among investigators and participants.

Recruiting participants this way raises the question of contamination (Haynes, Sackett et al. 2005). Although participant allocation to either the intervention or the control group is randomized through a computer program, the *unit of allocation is the individual* and this may raise problems because friends or colleagues may register together and fall into different groups as a result. Interactions between such individuals during the experiment may lead to under-estimation of the effects on adherence, because participants in the control group may use knowledge gained from the participants in the intervention group (Haynes, Sackett et al. 2005). An alternate approach would have been, following Haynes and collaborators (2005), to use *cluster randomization* (e.g., by selecting participants in the intervention group from a faculty and participants in the control group from another faculty at McMaster University). However, this type of study

would have raised questions on possible group differences, feasibility, and data analysis. Furthermore, as stressed in Chapter 2, the *PICOT* research question on the effectiveness of the SMS intervention, although extremely important for healthcare, is considered secondary for this IS study, so it should not become a financial and methodological burden for the whole study.

4.3.2 Response Rate

In the particular situation of this study there is a twofold concern about the response rate: increase the *response rate* of potential participants, and the *retention rate* for the entire study. Having these concerns in mind, several measures were taken, to increase perceived benefit/risk ratio regarding participation in this study as well as to follow some principles of ethical research. As a conservative measure, this study followed holistically the 7 key principles of ethical clinical research: i.e., enhance knowledge, have scientific validity, use a fair subject selection, have a favourable benefit/risk ratio, use independent review, use participant informed consent, and manifest respect for enrolled subjects (Emanuel, Wendler et al. 2000; Haynes, Sackett et al. 2005). These principles, together with the concern for maximizing the participant response and retention rates, led to several measures, as explained below.

Online surveys. Taking into account the particular conditions of this study (i.e., four stages spreading over one month), and the method of selecting the participants, the use of the Web survey approach was considered a necessary condition. Web surveys have many advantages, well-documented in the literature, that have made them popular in recent years (Simsek and Veiga 2001):

- lower cost;
- faster data collection; and,
- media richness (e.g., allowing incorporation of additional information, illustrative pictures, etc.).

Of course, there are also some disadvantages of Web surveys, such as the possibility of the same person filling in the survey multiple times, but this type of problem is minimized because, as explained below, participants responding to the surveys are monitored through their cell phone numbers.

All surveys used Web Surveyor™ software hosted on a secure server in the DeGroote School of Business at McMaster University. Once completed, the answers were stored on the server and only the investigators have password access to the data.

Dealing with contingencies. Since this study involved several stages, the *contingency* problem was taken into account as recommended by Haynes, Sackett et al. (2005). Following their recommendations, the entire study process was closely monitored, especially during recruitment and final data collection. Also, in order to avoid contingencies that would alter the study results, an initial recruitment of roughly 150 participants was attempted in order to have at least 100 participants completing the surveys, as required by the quantitative data analysis procedures (explained in Section 4.5

below). The anticipated high drop-off rate was based on the literature: "Of those [patients] who enter the medical care system, more than a third may drop out, especially during the first few months" (Haynes, McDonald et al. 2002, p. 2880). The potentially high drop-out rate was taken into account when adopting an *intention to treat analysis* (i.e., considering all the participants registering for the experiment, and not just those completing it) (Haynes, Sackett et al. 2005) for the healthcare study.

Studies with cohorts of patients are the most challenging, because patients may drop entirely from the treatment program and their withdrawal from a study is *the highest form of non-compliance* (Sackett and Snow 1979). Furthermore, in this study, withdrawal could have been because of IT interventions or because of healthcare interventions. The study conditions were designed to be as positive as possible, by making it informative, interesting, and enjoyable, to help prevent drop-outs. All subjects were permitted to stop taking the vitamin C at any time, and subjects in the intervention group could also stop the SMS intervention if they wished. Subjects interrupting their participation in any way were still permitted (and encouraged by compensation paid at the end) to fill in the final survey because the information they provided (including the causes which made them interrupt the study) was still useful.

Attractiveness. Another way to increase the response rate is to make the study instruments interesting and easy to handle by the participants. It was believed that the study, by its novelty, would be attractive to potential participants. Additional measures to increase its attractiveness were:

- show participants that their contribution to the study is important;
- give clear and simple information about the development of the study;
- keep participant actions simple and at a minimum level during the experiment;
- make the experiment enjoyable;
- tailor research questions to participant level of knowledge by simple and direct language;
- explain the necessity of collecting some sensitive information (such as cell phone numbers);
- start with simple questions and ask demographic questions (i.e., about age and gender at the end); and,
- keep the data collection instrument short and simple (Edwards, Roberts et al. 2002).

Compensation. In an effort to deal with contingencies and to reward study activities, all participants were offered *in-kind* and *financial compensation* because "increasing mail survey response using monetary incentives is a proven, but not always cost-effective, method in every population" (Jobber, Saunders et al. 2004, p. 21). According to the cited study, a monetary incentive increases the response rate 15%, with the size of the incentive having an additional effect at the rate of 2% per U.S. dollar.

Other studies even show a doubling of the response rate when using monetary incentives (Edwards, Roberts et al. 2002). Thus, after signing-up for the study, all participants received a sealed vitamin C container of pills (worth about $5) of a commercially available brand. Even if they chose to withdraw from the study, participants could keep the in-kind compensation (i.e., vitamin C container). All (and only) subjects filling in the final survey (i.e., no matter if they completed or interrupted the taking of vitamins and/or the SMS treatment in Stage III of the study) were entitled to full financial compensation as follows:

- participants in the *control group* received compensation of $15 which covered their activities (i.e., to fill in the surveys before and after the one-month experiment, and to pick up their containers of vitamins);
- participants in the *intervention group* received compensation of $30 to cover their time to fill in the baseline and endpoint surveys, the time to pick up their containers of vitamins, the time spent with SMS receiving and sending, as well as the text messaging costs (i.e., about $2-$2.50) during the one-month experiment.

Participation risks. Participants were expected to take daily one vitamin C pill for prophylactic reasons (i.e., preventing flu and colds). As an overwhelming body of relevant scientific medical literature demonstrates, taking one pill of vitamin C per day poses no health risk if the dosage does not exceed 1 or 2 grams (Audera, Patulny et al. 2001; Del Mar and Glasziou 2002; Douglas, Hemilä et al. 2004; Hemilä 2004; Hathcock, Azzi et al. 2005; Sasazuki, Sasaki et al. 2005). As there are inconclusive data regarding the side effects of vitamin C taking upon pregnant women (Rumbold and Crowther 2005), this category of potential participants was discouraged from enrolling in the study. Participants were offered sealed containers with medium dosage pills (500 mg) of a commercially available brand and purchased from a pharmacy. Therefore, it was expected that the research did not involve greater risks in terms of probability and magnitude *more than those encountered in everyday life* and this was a reasonable balance between decreasing the risk for participation and capturing some aspects of perecived risk.

On the other hand, some of the research hypotheses aim at investigating exactly the participants' perceived risks associated with the use of text messaging in telecare. Thus some participants in the intervention group could have felt bothered or embarrassed by receiving daily text messages. If this happened, participants might have asked not to be sent any more text messages (as shown in the consent form) at some point in time during the experiment. However, they could still participate in the final survey and reveal their perceptions which were still important to the investigators. They were also entitled to full compensation. Participants could also skip parts of the surveys if they did not wish to answer certain questions.

Another type of participation risk refers to participants not being told upfront that they were in an intervention group or a control group. As this was not possible because this would have compromised the healthcare part of the study, their role was revealed to them only through the debriefing after they filled in the final survey. They were told that

no matter what role they played, their contribution to the research was equally important, and that they did not face more risk nor receive less financial benefit compared to the effort than participants in the other group.

Insufficient confidentiality and anonymity could be another source of participation risk. Subjects were advised upfront that it was necessary for the investigators to know their cell phone numbers during the one-month experiment, for sending/receiving text messages, or calling them if asked, as well as for identifying the participants when handing them the vitamin C containers and the compensation. However, only the cell phone numbers were known and not individual identities. Furthermore, participants were told that their cell phone numbers were used by the investigators only and during the experiment only. After the experiment was over, the cell phone numbers were stored together with the survey data on a secure server in the School of Business at McMaster University and no third party can access that data. The study poses no higher than the usual risk encountered in everyday life. If, however, participants had concerns about possible risks and inconveniences, they could contact the investigator at any time by sending a cell phone text message (the intervention group) or an e-mail (the control group), and the investigator would contact them as soon as possible.

Overall, this research approach appears to be the most harmless way possible to give participants a real-life perception of using SMS as a support application for improving adherence to healthy behaviour. However, if participants chose to totally withdraw from the study at a certain point in time, without participating in the final survey, they were still entitled to keep the in-kind compensation and receive a fraction of the financial compensation (i.e., $5 for the intervention group and $2.50 for the control group).

4.4 Data Collection

This study included a quantitative part and a qualitative part. Following the approach of Moon and Kim (2001), several steps were taken in the development of data collection scales:

- development of measures from the literature;
- initial pre-test; and,
- pilot testing of the measures.

Item development started from widely used measures from reputable studies, to ensure strong psychometric properties. Measures were modified as little as possible so as to be relevant for the specific usage context, while preserving proven psychometric features.

Similarly to the procedure described by Wu and Wang (2005), an iterative interview process involving faculty and graduate students was used to refine the measurement instrument. This pre-testing was conducted to validate the instrument with the help of selected users: five faculty and PhD candidates from the IS field and experts in IS research. Respondents were asked to identify problems with the length of the instrument, question ambiguity, scale formatting, as well as additional factors considered important (Karahanna, Straub et al.1999) (1999). This provided testing for reliability, item consistency, and ease of understanding (Liaw 2002).

Consistent with the recommendations of Karahanna, Straub et al. (1999), feedback was used for correcting, enhancing, and refining the instrument. Respondents were asked to suggest any factors not in the survey questionnaire they considered important, and, if necessary, alternative terminology. This contributed to the assessment of the content validity of the instrument. Some terms were changed because their initial semantics, although conforming to instruments in the literature, was not relevant for the system studied and the targeted population. Feedback referred to the format of the scales, construct validity, and ambiguity in the questions. Consequently, several questions were refined or modified before pilot testing.

4.4.1 Quantitative IS Study

The goal of this study is to collect, analyze, and interpret the data necessary to test the research hypotheses. Operationalization of the constructs was achieved by adapting from other published studies with minor rewording to improve suitability for this work (Chau and Hu 2001). Any research must use rigorously developed and validated psychometric questionnaires (Ammenwerth, Kaiser et al. 2003) and one way to do this is to use previously validated and widely used questionnaires with minimal modifications.

The final instrument consisted of 28 items measuring 9 latent variables. The latent variables were categorized, according to the theoretical model presented in Figure 3.8, as perceived risk variables and motivational model variables. Besides these, the data analysis required additional control variables. These variables are important and were chosen with care because they help to eliminate alternative interpretations of the phenomenon under observation (Jarvenpaa, Dickson et al. 1985; Jarvenpaa, Shaw et al. 2004).

4.4.1.1 Perceived Risk Model Variables

Two approaches have been most popular for perceived risk measurement: (a) asking participants to assess directly the amount of risk of a statement or situation or (b) using measures of probabilities and consequences (Conchar, Zinkhan et al. 2004). It is unlikely that perceived risk is identical to actual risk. However, it seems plausible that the more consumers express their opinions about risk, the more these perceptions will mirror the real risk (Garbarinoa and Strahilevitzb 2004).

Up to the early 1970s there was little effort dedicated to measuring risk and building a formal model of risk and its components, and many studies have been developing arbitrary measures with little standardization (Bettman 1973). Since then

various attempts have appeared in marketing research to operationalize perceived risk either by comparing several categories of products or by measuring the impact of specific product features on perceived consumer risk within one product category (Havlena and DeSarbo 1991). Although most consumer behaviour studies claim to follow the widely-cited work of Jacoby and Kaplan (Jacoby and Kaplan 1972; Kaplan, Szybillo et al. 1974) and Roselius (Roselius 1971) of the early 1970s, there is much inconsistency. For instance McLain (1995) used a self-reported measure of perceived risk with participants estimating risk on a scale ranging from 0 to 100, while other researchers used 7 or 9-point Likert scales (Laroche, Bergeron et al. 2003).

The issue of the psychometric properties of risk scales is equally worrisome. Although Grewal, Gotlieb et al. (1994), for instance, used 3 item 7-point Likert scales for perceived financial risk (alpha = 0.77) and performance risk (alpha = 0.90), based on Shimp and Bearden's work (1982), their study is not specific about testing the scales. The same observation can be made about the study of Kim and Lennon (2000) who did not elaborate on the development of a 26-item scale to address the six types of perceived risk and the overall risk.

Stone and collaborators claim to have developed multiple measures for the dimensions of risk for the first time, starting from expert opinions. Thus, Stone and Grønhaug noticed in 1993 that "multiple measures of these constructs are virtually non-existent in the marketing literature". Many studies before them used single-item scales to capture a dimension of the perceived risk (Bielen and Semples 2004). Usually, each of the perceived risk components was evaluated by asking the same question repeatedly for several products. For instance, to capture perceived performance risk, Brooker (1984) used the question: "What is the likelihood that there will be something wrong with an unfamiliar brand of ... or that it will not work properly?" with responses captured on 9-point Likert scales. Even more recent studies, using 7-point Likert type scales, utilized only one statement for each of the 'classical' risk components. For instance, Ko, Jung et al. (2004) used a 7-point scale ranging from 1 (strongly disagree, i.e., lowest perceived risk) to 7 (strongly agree, i.e., highest perceived risk) to measure the six risk components in a hypothetical purchase situation.

After examining the literature it appears that perceived risk measures operationalizing the facets of perceived risk were introduced by Stone and Grønhaug (1993) and validated by Stone and Mason (1995). These measures were formulated as "pre-choice behaviour with loss arising from engaging in the behaviour" (Stone and Mason 1995, p. 142). In a cross-sectional research design investigating the hypothetical purchase of a personal computer with 177 executive MBA alumni of a major university Stone and Grønhaug (1993) used 3 items for each of the 6 classical dimensions of perceived risk and the same for the overall risk. They used 7-point Likert scales ranging from 'extremely agree' to 'extremely disagree'. The alpha coefficient for the measures ranged between 0.59 and 0.81. Finally, one of the indicators of the social risk was dropped because it was found to be unrelated to the dimension (Stone and Grønhaug 1993).

Taking into account the above and following examples of recent research in marketing studies (Laroche, Bergeron et al. 2003; Laroche, McDougall et al. 2004), perceived overall risk and three of the four risk dimensions (financial, social, and psychological) were measured using a modified version of Stone and collaborators' multi-item Likert scale (Stone and Grønhaug 1993; Stone and Mason 1995). This scale has demonstrated good reliability and validity in re-tests (Laroche, Bergeron et al. 2003; Laroche, McDougall et al. 2004). Modifications for the proposed study were based upon a pre-test of the scale adapted from a study exploring the use of the Internet as a distinct mode of shopping (Pope, Brown et al. 1999). Privacy risk, introduced by IS studies and non-existent in consumer behaviour studies, was adapted from the work of Featherman and Pavlou (2003). Table 4.3 presents the measures used for risk facets expected to be significant for this study and for the overall risk for the intervention group. Questions for the scenario-based survey before the experiment were similar. All items are measured on a 7-point Likert type scale having as anchors *strongly agree* and *strongly disagree*.

Table 4.3 Perceived Risk Construct Items

Instructions: Based on your overall impressions from the experiment, please check one response which corresponds most closely to your desired answer for each of the following statements, where TMT is an abbreviation for Text Messaging Telehealth and denotes the system you tested: *(1 - Strongly Disagree ... 7 - Strongly Agree)*		
Perceived risk type	**Item code**	**Question**
Financial	PFR1	Signing up for TMT would be a poor way to spend my money.
	PFR2	I would be concerned about how much I would pay if I subscribed to TMT.
	PFR3	If I subscribed to TMT, I would be concerned that I would not get my money's worth.
Social	PSR1	If I subscribed to TMT, I think I would be held in higher esteem by my colleagues.
	PSR2	The thought of subscribing to TMT causes me concern that some friends would think I was just showing off.
	PSR3	Some of the people whose opinion I value would think I was foolish if I signed up for TMT.
Privacy	PRR1	My use of TMT would cause me to lose control over the privacy of my information.
	PRR2	Signing up for and using TMT would lead to a loss of privacy for me because my personal information could be used without my knowledge.
	PRR3	Internet hackers (criminals) might take control of my information if I used TMT.
Psycholo-gical	PYR1	The thought of signing up for TMT makes me feel uncomfortable.
	PYR2	The thought of signing up for TMT gives me an unwanted feeling of anxiety.
	PYR3	The thought of signing up for TMT causes me to experience unnecessary tension.
Overall	POR1	Overall, the thought of signing up for TMT causes me to be concerned that I might experience some kind of disadvantage.
	POR2	All things considered, I think I would be making a mistake if I signed up for TMT.
	POR3	Overall, I really feel that signing up for TMT poses problems for me that I just don't need.

4.4.1.2 Motivational Model Variables

Recall that the motivational model was adapted and employed in IS for the first time by Davis and collaborators (1992). In their seminal work as well as in most of the research that followed, *extrinsic motivation* (no matter what it was called as a construct e.g., *utilitarian value*, *usefulness*, etc., as shown in Table 3.7) was measured using the scales of *perceived usefulness* initially introduced by Davis in 1989 (Davis 1989; Davis, Bagozzi et al. 1989; Igbaria, Iivari et al. 1995; Atkinson and Kydd 1997; Venkatesh and Speier 1999; Childers, Carr et al. 2001; Venkatesh, Speier et al. 2002). In their 2002

study Venkatesh, Speier et al. even called this construct *perceived usefulness* since it is used in TAM which is one of the most popular models in the contemporary IS literature. Using the four-item perceived usefulness construct from TAM for this study would lead to statements like:

- "Using TMT improved my performance in taking the daily vitamin C pill";
- "Using TMT to remind to take my vitamin C increased my efficiency";
- "Using TMT enhanced my effectiveness in taking vitamins daily";
- "I found TMT to be useful in helping me to remember to take my vitamin C".

As face validity testing with PhD students and faculty professors in the IS field showed, this type of statements would not exactly fit the context of this research. Furthermore, Van der Heijden (2004) showed that, for systems judged as having a higher degree of hedonic value for the user, the mechanical adaptation of perceived usefulness from the widely-popular TAM is problematic from the construct validity point of view. In dealing with this issue some researchers have developed multi-item scales specific for their studies (Pedersen 2002; Pedersen, Nysveen et al. 2002; Van der Heijden 2004; Lee, Cheung et al. 2005) but there is no clear indication of the validity of these scales.

The approach in this research was to use the 4-item perceived usefulness construct utilized in validated technology adoption research in IS but adapting the questions used to the context of this study and keeping *extrinsic motivation* as the construct name for consistency reasons. Terms were developed using definitions from Webster's unabridged dictionary (Webster's Dictionary 2002) and items are shown in Table 4.4:

- Effective: "capable of bringing about an effect; capable of being used to a purpose; valid, operative, effectual, efficient, efficacious";
- Efficacy: "the power to produce an effect; effectiveness";
- Efficiency: "the capacity to produce desired results with a minimum expenditure of energy, time, money, or materials"; and,
- Productivity: "abundance or richness in output; the effectiveness in utilizing labor or equipment".

Intrinsic motivation has been measured in several studies (Table 3.7) as *enjoyment* (Atkinson and Kydd 1997; Liaw 2002), *perceived enjoyment* (Van der Heijden 2004; Lee, Cheung et al. 2005), *perceived playfulness* (Moon and Kim 2001), or *hedonic value* (Van der Heijden, Ogertschnig et al. 2005). The seminal work of Davis and collaborators (1992) also used the term *enjoyment* and measured it with a 3-item 7-point Likert-type scale for which a high reliability was found (Cronbach's $\alpha = 0.81$). Igbaria, Iivari et al. (1995) measured *perceived enjoyment* to describe perceptions of individual on the use of computer technology in major companies in Finland. Using the construct of perceived enjoyment, they elicited individual perceptions about the use of a computer for their jobs on a dyadic scale: fun-frustrating, pleasant-unpleasant, negative-positive, pleasurable-painful, exciting-dull, foolish-wise, and enjoyable-unenjoyable.

For the current study it was considered more appropriate to measure *intrinsic motivation* at a more general level since the main driver of a healthcare application is not expected to be related to pure enjoyment. This follows the path of a significant number of studies that have used and validated the classical term of *intrinsic motivation* (Venkatesh and Speier 1999; Venkatesh, Speier et al. 2002; Venkatesh, Morris et al. 2003; Wilson and Lankton 2004b). As most of the latter works belong to the recognized body of quality literature in IS and as they used approximately the same construct that has good psychometric properties (Cronbach alpha reliability coefficient of 0.91) (Venkatesh, Speier et al. 2002), this construct was also adopted for this study, with the necessary rewording (Table 4.4).

Similarly to perceived usefulness measures, constructs for *behavioural intention* to use a system have been used in a wide variety of studies (Davis, Bagozzi et al. 1992; Taylor and Todd 1995a; Szajna 1996; Venkatesh 1999; Venkatesh and Speier 1999). For this study measures for the behavioural intention to use the system were based on the construct used by Venkatesh and Davis (2000) which was shown to give high Cronbach alpha coefficients (0.82 to 0.97). Although this construct was measured with only 2 items by these researchers, if its reliability and factor validity are high, there should not be any concerns (Venkatesh and Davis 2000). This construct is presented in Table 4.4. Questions for the scenario-based survey are similar. All items were measured on a 7-point Likert-type scale having as anchors *strongly agree* and *strongly disagree*.

Table 4.4 Motivational Model Construct Items

Instructions: Based on your overall impressions from the experiment, please check one response which corresponds most closely to your desired answer for each of the following statements, where TMT is an abbreviation for Text Messaging Telehealth and denotes the system you tested: *(1 - Strongly Disagree ... 7 - Strongly Agree)*		
Construct	**Item Code**	**Question**
Extrinsic Motivation	EM1	Using TMT helped me to take the daily vitamin C pill at proper time.
	EM2	Using TMT helped me to not forget about the daily vitamin C.
	EM3	Using TMT helped me to take the vitamin C every day.
	EM4	I found TMT to be useful in reminding me to take my vitamin C daily.
Intrinsic Motivation	IM1	I found TMT to be enjoyable.
	IM2	The actual process of using TMT was pleasant.
	IM3	I had fun using TMT.
Behavioural Intention	BI1	Assuming I had access to TMT, I intend to use it.
	BI2	Given that I had access to TMT, I predict that I would use it.

4.4.1.3 Comments on Data Collection

There are two distinct approaches regarding item ordering in a questionnaire: some studies advocate the randomization of item order to counteract the possible contamination of responses due to item adjacency effects (Wilson and Lankton 2004b), while other studies indicate that there is no such need. Following the example of some well-recognized IS studies (Venkatesh and Davis 2000; Venkatesh, Morris et al. 2003), items were grouped in the questionnaire starting with the independent variables (i.e., components of perceived risk) and ending with the outcome variable (behavioural intention to use TMT).

The grouped item ordering takes into account recent similar studies as well as the recommendations of Podsakoff and Organ (1986). The latter study draws attention to the *common method variance*. This is one of the three types of variance attributable to the measurement of a construct (trait, error, and method) by self-reported measurement (Spector 1994). Whereas trait variance depends on the construct and error depends on the random errors associated with the measurement, common method variance (also termed *common method bias*) is linked to the data collection method. This type of error may appear when both independent and dependent variables are collected with the same survey instrument from the same source (i.e., same individual) through self-reports, when an attempt is made to interpret relationships between these variables (Podsakoff and Organ 1986; Podsakoff, MacKenzie et al. 2003). Some methods are recommended in the literature to deal with this possible problem (more is explained in Sub-section 4.5 below). Among the procedural methods recommended by Podsakoff and Organ (1986), one of the simplest is *scale reordering* (although "little research exists to evaluate [the benefits of this] strategy": "reorder the items on the questionnaires such that the dependent or criterion variable follows, rather than precedes, the independent variable" (p. 540).

Also recall that the study involves an intervention group being subjected to a real SMS treatment and a full sample group subjected to a scenario-based treatment only. As both groups answer the same technology acceptance survey, similarly to the approach described by Karahanna, Straub et al. (1999), identical questions will appear in both questionnaires, with only the wording modified. Thus the tense of the sentences should be in accordance with the time of the measurement: *future and conditional* after reading a scenario (Karahanna, Straub et al. 1999; Venkatesh, Morris et al. 2003) and *present and past* after actually using the system.

4.4.1.4 Control Variables

Besides the independent (i.e., having no antecedents) and dependent (i.e., being influenced by antecedents) variables explained above, the research model is expected to be influenced by *control variables*. As shown in Chapter 2 and in previously published work, patient factors are decisive for any adherence-improvement intervention (Cocosila and Archer 2005a). Accordingly, technology, no matter how refined, can do next to nothing for people whose attitude is against the activity for which they manifest low adherence. Therefore it was considered that attitude toward adherence is the most

important control variable and, to show its importance, it was included in the diagram of the theoretical model (Figure 3.8).

Finding the right construct for this attitude is not an easy task. For instance, motivation was often considered a rationale for adoption and maintaining health behaviours. However, a systematic review of nursing literature done on 41 studies with well persons (i.e., people without physical illness or pregnancy as motivators) cited in the Cumulative Index of Nursing and Allied Health Literature (CINAHL) database from January 1982 to November 2001 reached puzzling conclusions. The authors reported that motivation did not appear as a significant predictor of health behaviours for over one third of the studies. This happened because "either motivation is not being effectively measured because of a lack of conceptual clarity or that motivation is not an essential determinant of health behaviours" (Carter and Kulbok 2002, p. 316). Consequently, the apparently common sense percept according to which adoption of health behaviours would be determined by motivation needs further research, starting with a clearer definition and measurement of motivation in healthcare (Carter and Kulbok 2002).

In order to express subject attitudes toward taking vitamin C, this study uses an adaptation of a widely used questionnaire-based method for assessing beliefs about specific and general medication, the *Beliefs about Medicines Questionnaire (BMQ)* developed by Horne, Weinman et al. (1999) and improved by Horne, Graupnera et al. (2004). From this construct with 3 sections of 4 items each (*General-Harm*, assessing the individuals' beliefs about the medicines perceived as harmful, *General-Overuse,* assessing the beliefs that doctors over-prescribe medicines, and *General-Benefit* assessing the beliefs about the potential benefits of medicines), only the last section was deemed appropriate for this study. This is justified because the study addresses possible prophylactic needs (to take a harmless vitamin C) of well people. The developers of the scale reported marginal reliability values for the three sections (0.62, 0.72, and 0.62, respectively) (Horne, Graupnera et al. 2004) and care was taken in refining and adapting the instrument to the present study. Therefore, the attitude toward adherence was measured with a 4-item construct (adapted from the *General-Benefit* scale which initially was "*Without medicines doctors would be less able to cure people*, *Medicines help many people to live better lives*, *Medicines help many people to live longer*", and "*In most cases the benefits of medicines outweigh the risks*" (Horne, Graupnera et al. 2004, p. 1309). Table 4.5 presents the adaptation for the current study.

Table 4.5 Attitude Toward Adherence Construct Items

Instructions: Please check one response which corresponds most closely to your desired answer for the following statements: *(1 - Strongly Disagree ... 7 - Strongly Agree,* plus *I don't know* option*)*		
Construct	**Item code**	**Question**
Attitude Toward Adherence	ATA1	Without vitamin C doctors would be less able to cure people for colds and flu.
	ATA2	Taking vitamin C helps many people to be healthy.
	ATA3	Taking vitamin C helps many people to prevent or recover faster from colds and flu.
	ATA4	The benefits of taking vitamin C outweigh the risks.

Experience with text messaging is considered a second control variable. This is consistent with IS research where experience with using the technology investigated is being constantly taken into account. For instance, Davis, Bagozzi et al. (1992) measured usage with Likert-type scales of the self-assessment of being a (frequent/infrequent) user of a system and also reporting the use of a system "not at all, less than once a week, about once a week, 2 or 3 times a week, 4 to 6 times a week, about once a day, several times a day".

This type of scale can not be used for the current study because there is no consistent data from previous studies about SMS usage and, furthermore, the figures on mobile phone usage are extremely dynamic. As there is no reliable information about the text messaging activity of the target population (students of a Canadian university), their experience was captured with a question asked upfront, in the first stage of the study: *"For how long have you been using SMS?"* (in months). Thus, the answer was not biased by text messaging that occurred during the study. To develop a better picture of the subjects' previous SMS activities, the average number of messages received and sent per week was also collected.

Regarding the classical demographic measures, respondent age was collected (i.e., *"Please indicate your age"*), but not considered a control variable since most of the participants were in about the same age category. However, gender (i.e., *"Please indicate your gender"*) was considered a control variable because, according to previous studies, there are reasons to believe that the two genders have different attitudes toward technology, especially if risk is taken into account. For instance, a study reported by Kanungo and Jain (2004) found that "that relationship between perceived risk and intention to purchase is moderated by interaction of gender and product category". Also, results from a 260-subject paper-and-pencil survey showed that "even when controlling for differences in Internet usage, women perceive a higher level of risk in online purchasing than do men" (Garbarino and Strahilevitz 2004), and receiving a recommendation from a friend may somewhat alleviate the risk perception. Therefore gender was the third control variable, and coded as a 0/1 dummy variable following the example of Venkatesh (Venkatesh, Morris et al. 2003; Venkatesh, Ramesh et al. 2003).

4.4.2 Qualitative IS Study

In the last decade there has been a call from the IS research community for more emphasis on qualitative research (Hunter 2004). Accordingly, employing a qualitative research method is a current trend in many IS studies. Qualitative methods have increased in popularity gradually, as the focus of research shifts from technological to managerial and organizational issues (Myers 1997). The *positivist approach* (employed in quantitative studies) tells ***that*** people are doing something. However, it can not tell ***why*** and ***how*** people are doing something. The *interpretive lens* and *qualitative analysis* are able to bring out this information (Trauth 2001). Moreover, "qualitative research is an interpretive approach to investigate subjects in their natural surroundings" (Hunter 2004, p. 292).

A recent tendency in qualitative research in IS is to perform *triangulation* that employs its results to cross-verify quantitative research results. This helps researchers to be more confident in their results, brings different viewpoints in analyzing the same phenomenon, and helps in the synthesis or integration of theories (Jick 1979). According to Jick's work, the term "triangulation" comes from navigation and military strategy and is a metaphor to indicate the use of multiple viewpoints to improve accuracy of a studied phenomenon. In a more refined analysis, it appears that two meanings have emerged for triangulation: a process of *cumulative validation* (that increases the precision of the perspective of a phenomenon observed through several methods) or a process of *complementarity* (that gives more depth of the existing perspective of a phenomenon) (Udo 2001).

Therefore triangulation has either a purpose of "mutual confirmation among ... various approaches", or a purpose of "completeness", or both of them (Shih 1998, p. 633). Following this view, the qualitative analysis in this research implies asking open-ended questions about *major reasons for using or not using* the system, recommendations for system designers, and other suggestions, concerns, and recommendations. The data collected serves ultimately for triangulation (between the quantitative and qualitative study). The purpose of the triangulation here is to obtain both *cumulative* (or *mutual*) *validation* (i.e., convergence with the quantitative IS study) and *complementarity* (i.e., deepen the findings of the quantitative approach which attempts to explain only '***How?***' through the qualitative approach which attempts to explain '***Why?***'). The overall target is to better answer the *RQ6* research question of this study (i.e., *What are the main opportunities and barriers, from the users' viewpoint, regarding the intention to use wireless text messaging in telehealth?*) by building a more comprehensive model of motivators and demotivators of user intention to adopt wireless text messaging in telehealth for healthy behaviours.

4.4.2.1 Reasons For/Against Use

As shown in Chapter 2, previous research has identified both opportunities and barriers from the patients' viewpoint regarding the use of mobile IT in adherence-improving initiatives. The theoretical model presented in Chapter 3 attempts to take these into consideration, based on the literature support. However it would be impossible for such a model to claim exhaustivity in explaining all the variance in the behavioural intentions of subjects to accept the technology. Therefore it is reasonable to ask some open-ended questions, as in Table 4.6, with the purpose of deepening an understanding of the motivators and demotivators regarding the use of TMT in this study.

Table 4.6 Reasons For/Against Use of TMT

No.	Question
1	Indicate as many as three reasons why you would like to use TMT
2	Indicate as many as three reasons why you would NOT like to use TMT

4.4.2.2 Recommendations For Designers

Respondents were also asked through open-ended questions to provide recommendations for future development of such a system, as well as to express other thoughts, beyond those asked through specific questions. This feedback was hoped to be of use for researchers, developers, and experimenters in healthcare. The specific questions are described in Table 4.7.

Table 4.7 Insight Questions For Developers

No.	Question
1	Based on your experience with taking vitamin C and this study, please provide recommendations for the designers of a system like TMT
2	Please indicate other thoughts, concerns, and recommendations about TMT

In order to enrich the information provided by the study participants with a possible 'out-of-the-box' view on the usefulness of a system like TMT, participants in the control group were asked to answer in the endpoint survey the following question: "*If you had received about one SMS per day reminding you in an enjoyable manner, from a virtual friend called Tim, to take your vitamin C pills (e.g., Tim here: Took Ur vitamin C 2day?), do you think such messages would have helped or bothered you? Why?*". Asking them this question was justified by the fact that, according to the including conditions, these participants have cell phone and SMS experience and they, supposedly, took vitamins for one month. By combining these two elements and, possibly, remembering

the scenario they were presented at baseline, participants in the control group might be able to provide supplementary insights but from a different perspective, without being influenced by the actual use of TMT.

4.4.2.3 Feedback on the Questionnaire

Another set of open-ended questions asked participants about any difficulties with understanding the survey questions. This is also a means to verify indirectly that the subjects have enough knowledge to answer the questionnaire. Although these questions refer to the whole survey, they are mentioned in this sub-section because the IS part of the questionnaire is by far the largest. Questions are depicted in Table 4.8.

Table 4.8 Feedback Questions on the Questionnaire

No.	Question
1	Did you experience any difficulties in understanding the information for this survey? Additional comments:
2	Did you experience difficulties in understanding any of the questions in this survey? Additional comments:
3	Do you have any comments regarding the content, design, or administration of this survey? Additional comments:

4.4.3 Business Case Study

Recall the research question ***RQ7***: *How much would users agree to pay and for how long would they stay in a program using wireless text messaging telehealth as a support in improving adherence to a healthy behaviour regimen, if usage is not free?* As shown in Chapter 2, answering this research question could offer some insight for the business model of mobile IT in addressing outpatient adherence.

Traditional research in the area of patient support in some healthcare services estimated the cost aspect by performing evaluations of the technologies and care activities from the system point of view, but ignored patient preferences and quality of life issues. An alternative method in detecting the value of healthcare is to use the willingness to pay (WTP) indicator in order to elicit patient preferences. This approach is called "contingent evaluation, because the respondent is being asked to value a contingent market" (Barner, Mason et al. 1999, p. 879). Previous studies evaluating WTP were usually in environmental services (e.g., pollution, water quality, etc.). Studies eliciting customer WTP dollar amounts in healthcare are relatively new (Barner, Mason et al. 1999).

In a similar study described by Barner, Mason et al. (1999) patients were presented a scenario describing a hypothetical market for a health education program in asthma. Patients were given a description of the product to be valued, along with benefits and payment method. After eliciting patient perceptions on how much they perceive the

program to be of use for them, patients were read a list of fees and asked to stop when the interviewer reached the upper limit of their willingness to pay for participating in such a program. Patients were also given the hypothetical situation of a 50% improvement in their asthma condition. In order to detect the willingness to give time (WTGT), i.e., how much time they would like to devote to the program, they were also read a list of time commitments (Barner, Mason et al. 1999).

The referred study involves a mail survey that received responses from 166 participants. It also went one step further in an attempt to investigate the independent factors affecting WTP and WTGT for the asthma patients if they were enrolled in a self-management program. Various general and specific factors were found to influence positively WTP: low levels of positive behaviours during an asthma attack, more access to health resources, less educational information from health providers, previous participation in such an educational program, and expressed intention to participate. The mean patient WTP was $29.50 for an 8-week program. The WTGT was higher for patients having more emergency department visits, or who had expressed interest in participating in such a program, or who had a higher number of comorbidities. Also, younger people were willing to spend more time in the program than older patients. The WTGT mean value was 5.8 hours per week in an 8-week asthma self-management program.

The approach described in the Barner, Mason et al. (1999) work could not be applied in the current study because the business case for this study was purely exploratory. Furthermore, the problem of the starting level for fees is controversial: some studies suggest that providing a starting point or offering the respondents some information may induce bias in the WTP and WTGT levels (Barner, Mason et al. 1999; Detlor, Sproule et al. 2003). Thus, if a bid starts at a higher level it may induce participants to provide a WTP level higher than if they were given a bid starting at a lower level. Therefore this study used a direct approach of finding a WTP by asking participants the dollar amount reasonable to be paid for the service. Although this types of question is more difficult to answer since they "pertain to a task [subjects] do not face in real life" (Bala, Wood et al. 1998), such a question was preferred because users have, nonetheless, cell phone and SMS experience and the service offered is of an SMS type.

As in the Barner, Mason et al. (1999) study, a problem is that respondents are from about the same income category. However eliciting information about their WTP and WTGT might offer some insight for future healthcare and marketing research. The questions extracting this information are presented in Table 4.9.

Table 4.9 Questions on Business Case Issues

No.	Question
1	For how long would you expect to continue using TMT if it did not cost you anything?
2	For how long would you expect to continue using TMT if it were not free?
3	How much would you think it would be reasonable to pay for a service like TMT if the usage were not free?

4.4.4 Healthcare Study

This study measures adherence to taking vitamin C pills by questioning participants, which is "the most widely applicable method of measuring compliance" (Stephenson, Rowe et al. 1993, p. 2870). However, it must be noted that measuring adherence through self-reports presents a great deal of approximation because of the tendency of over-estimation. This may happen when practitioners report adherence of their patients (WHO 2003) and is a usual phenomenon when patients self-report their adherence (Stephenson, Rowe et al. 1993; Haynes, McDonald et al. 2002). Therefore, as compliance definition is "intended to be non-judgmental" (Haynes 1979a, p. 2), i.e., implying no patient fault (or other healthcare stakeholder's fault either), a recommended approach is to ask patients to report their adherence in a neutral way, indicating no blame for low adherence (Stephenson, Rowe et al. 1993). Thus a *validated question* has an introductory statement indicating that some people may have difficulties in taking the medication and then asks a question like: "Have you missed any pills in the past week?" (Haynes, McDonald et al. 2002, p. 2880). This approach was used in the post-trial questionnaire, after the period of time when participants were supposed to be taking the vitamin C pills.

In the pre-trial questionnaire, since it was not known whether participants currently took vitamin C pills, a question adapted from the *Brief Medication Questionnaire (BMQ)* was used. BMQ is a tool introduced and validated by Svarstad and collaborators in several studies to measure adherence and obstacles to adherence (Svarstad, Chewning et al. 1999; Bultman and Svarstad 2002).

Both the 'before' and the 'after' questionnaires contain several questions meant to elicit participant opinions about taking vitamin C and the health outcomes of this, as recommended by BMQ and other relevant literature (Stephenson, Rowe et al. 1993; Haynes, McDonald et al. 2002) (Table 4.10). Thus, because there is a "need for coupling compliance to the achievement of treatment goals" (Sackett and Snow 1979, p. 22), the final questionnaire linked the vitamin C question with a question about cold and flu symptoms.

Table 4.10 Questions on Healthcare Issues

No.	Question
Before the trial	
1	Have you ever taken vitamin C tablets for health? Additional comments:
2	About how many vitamin C pills have you taken during the last 7 days?
3	Do you have any further comments about taking vitamin C?
After the trial	
1	People often have difficulty taking a vitamin C tablet daily for one reason or another. Have you missed any vitamin C pills in the past week? If yes, how many?
2	How well does vitamin C work for you? (i.e., are you free from cold or flu symptoms?) OK, Not OK, I don't know. Additional comments:
4	Did you have any side effects symptoms while taking vitamin C?
3	Do you have any further comments about taking vitamin C?

Besides adherence self-reporting, the approach described in this work has the advantage of measuring adherence with increased accuracy, directly and continuously in time, somewhat similar to the *Medication Event Monitoring System (MEMS)* (Stephenson, Rowe et al. 1993; Svarstad, Chewning et al. 1999; Floerkemeier and Siegemund 2003). Thus the system that sent SMS reminders to participants, time stamped the messages sent and acknowledged messages received, together with the cell phone numbers of the participants. Accordingly, it was possible to see if participants acknowledged their daily vitamin taking, and how late after the prescribed intake time this was done. However, a noticeably difference to MEMS is that this latter usually does not involve active reminding. Assuming that participants behave honestly (as this is a condition for all sytems addressing outpatient adherence), TMT has the potential to become a system that reports promptly observed adherence to medication or behavioural change patterns of participants. This corresponds to the recommendations of the medical literature, asking for more objective measures of adherence (McDonald, Garg et al. 2002).

4.4.5 User Background

The SMS experience of the users was captured through the question *"For how long have you been using SMS?"* (in months), which serves as a control variable, as explained in Sub-section 4.4.1.3 above. Other elements of user background were captured in order to have a more comprehensive user profile. Thus, users were asked up-front about their cell phone experience and SMS usage, as described in Table 4.11 below. The use of this type of question was necessary because, as explained in 4.4.1.3, the existing literature indicates a wide spread of these figures and the values tend to change weekly.

Table 4.11 Questions on User Background

No.	Question
1	For how long have you been using a cell phone? (months)
2	About how many SMS messages do you receive per week?
3	About how many SMS messages do you send per week?

4.5 Data Analysis Approach

Data were analyzed separately for the three categories of studies (IS, business model, and healthcare) using basic statistics, Structural Equation Modeling (SEM) techniques (Partial Least Squares software, more specifically), and classical content analysis.

4.5.1 Quantitative IS Study

4.5.1.1 Initial Data Assessment

"The relevancy or validity of any instrument must be assured before relationships between measures of independent and dependent variables can be assessed" (Jarvenpaa, Dickson et al. 1985, p. 143). Accordingly, the first step in data analysis of the quantitative IS study is Cronbach's alpha measure of *reliability* of the multi-item scales (Bontis, Keow et al. 2000). This assesses the quality of the instrument (Bontis 1998). Since SEM techniques can assess reliability as well and the constructs have been adapted from previously validated research, Cronbach's alpha is evaluated for ***comparison purposes***, as described by Jarvenpaa, Shaw, et al. (2004). According to the classic work of Nunnally cited by almost every study, a reliability value above 0.7 is sufficient (Nunnally 1978).

The second step in data analysis is to develop a *factor analysis* with the purpose of reducing and summarizing data (Bontis 1998) and to ascertain that the theoretical model constructs are distinct (Karahanna, Straub et al. 1999; Teo, Lim et al. 1999). The result indicates clearly either an association or a lack of association between the variable and the factor (Hair, Rolph et al. 1987; Bontis 1998). Items that did not load on their expected factors at levels of at least 0.5 or greater or that cross-load on several factors were dropped from the analysis (Bontis 1998).

Developing a factor analysis is also an opportunity to deal with the third step in data analysis: possible *common method variance* "that might artificially inflate the relationships among constructs" (Cenfetelli 2004, p. 163). The first approach in dealing with common method variance was *Harman's one-factor extraction test* (Harman 1967). This consists of performing a factor analysis with all of the variables of interest. If a single factor emerges from the factor analysis or a 'general' factor accounts for the largest part of the covariance in the independent and dependent variables, common method variance is present in the measurement (Podsakoff and Organ 1986; Bontis 2004; Cenfetelli 2004). A further step for checking common method variance is to perform the

partial correlation procedure reported in Podsakoff and Organ's work. This is applied after Harman's factor test and consists of partialling out the first unrotated factor ("assumed to be a general factor on which all variables load" (p. 537)), and testing again possible meaningful correlation between remaining independent and dependent variables.

Since this study dealt with two groups of subjects, it was important to see if there were significant differences between them at the baseline. Similar to other studies in technology acceptance, this was done by an analysis of variance (ANOVA) (Venkatesh 1999; Venkatesh and Speier 1999) and the Multiple Analysis of Variance (MANOVA) technique (Tabachnik and Fidell 2001).

4.5.1.2 Partial Least Squares (PLS) Method

This research used Structural Equation Modeling (SEM) for quantitative data analysis because of its popularity in various management research fields such as knowledge management (Shook, Ketchen et al. 2004) or information systems (Gefen, Straub et al. 2000), including technology adoption studies (Igbaria, Parasuraman et al. 1996; Karahanna, Straub et al. 1999; Venkatesh 2000; Venkatesh, Morris et al. 2003). The increasing use of SEM is justified by major advantages over the classical quantitative data analysis techniques that are detailed below.

Structural Equation Modeling. SEM uses a set of equations to express a phenomenon under study "in terms of cause and effect variables and various causal effects" (Jöreskog 1982, p. 81) An important advantage of SEM is that it analyzes the measurement and the entire structural model simultaneously, in contrast to the traditional techniques that require successive testing of the hypotheses. The model fit thus depends at the same time on the data integrity and theory soundness (Bontis 1998).

In contrast to the *first-generation techniques* of data analysis (e.g., principal components analysis, factor analysis, or multiple regression), SEM techniques (which are also termed *second-generation techniques*) have the advantage of greater flexibility for the interaction of theory with data (Chin 1998; Chin and Newsted 1999). Overall, SEM provides a more rigorous analysis of the research model and is a better methodological assessment tool (Gefen, Straub et al. 2000). Because of its advantages, SEM has gained increasing popularity in IS studies. A review done by Gefen, Straub et al. (2000) revealed SEM to be used in 18% of the studies involving validation of instruments and/or testing of linkages between constructs, and published in the top three IS research journals in the period 1994 to 1997.

Features of PLS. It is generally acknowledged that there are two types of SEM techniques: covariance-based (of which the most popular is LISREL - i.e., Linear Structural Relations) and PLS (Gefen, Straub et al. 2000). This latter technique is similar to covariance-based techniques like LISREL or the newer AMOS or EQS in that it combines data and theory and can concurrently estimate construct loadings and paths (Gefen, Straub et al. 2000; Bontis, Crossan et al. 2002). Loadings of measures of each construct in PLS can be seen as loading in principal components factor analysis and paths can be seen as standardized beta weights in regression analysis (Karahanna, Straub et al.

1999). PLS gives researchers the opportunity to analyze the constructs in an overall theoretical context based on the fact that constructs derive their meaning from two sources: their own underlying measures and the antecedence/consequence relationship with other constructs (Bontis 1998).

In contrast to covariance-based techniques which study the structure of the observable items as reflected in their covariance matrix, PLS aims to predict the indicators (Jöreskog and Wold 1982). Nonetheless, PLS can be used for both theory confirmation and "to suggest propositions for testing later" (Chin 1998, p. 295).

A distinct characteristic of PLS is that it works well with relatively small samples in contrast to covariance-based techniques which require larger samples (Chin and Newsted 1999; Karahanna, Straub et al. 1999). Furthermore, PLS makes no assumptions about the distribution of the sample data (Jöreskog and Wold 1982; Karahanna, Straub et al. 1999; Vlachos and Vrehopoulos 2005). Also, PLS is more appropriate for complex models and when the goal of the research is exploratory (rather than confirmatory) by explaining variance (Bontis, Crossan et al. 2002; Vlachos and Vrehopoulos 2005). All these characteristics are met by the current study which included, for the first time, perceived risk constructs adapted from marketing research into the motivational model employed in IS. In addition, due to methodological and feasibility reasons, the current study could not use a large sample.

Data analysis with PLS is done in two steps: evaluation of the measurement model, followed by the evaluation of the structural model (as explanatory and predictive power) (Bontis 1998; Jarvenpaa, Shaw et al. 2004).

Measurement Model. The *measurement model* (called also the *outer model* or *outer relations* (Chin 1998)) aims at specifying the construct-to-measurement relationships. Any such model has two categories of constructs: exogenous (i.e., independent variables or antecedents) and endogenous (i.e., dependent variables or consequents) (Bontis 1998).

The theoretical model in this research used reflective indicators. In contrast to formative indicators which are 'causing' (or 'forming') the latent constructs, reflective indicators are the 'effects' (or 'manifestations') of these variables (Bontis 1998; Chin and Newsted 1999; Vlachos and Vrehopoulos 2005). While formative indicators should not be correlated, reflective indicators are expected to display a high degree of correlation (Chin 1995; Vlachos and Vrehopoulos 2005). The decision on which types of construct-to-measure relationship to specify is based on theoretical support (Bontis 1998; Karahanna, Straub et al. 1999). For this work, as previously explained, all measures were adapted from previously tested and validated measures in consumer behaviour and IS research, and all of these are reflective.

The indicators are partitioned into nonoverlapping blocks described by different relationships for reflective or formative indicators (Chin 1998). Thus, for reflective indicators the relationships are:

$$x = \Lambda_x \xi + \varepsilon_x \tag{4.1}$$

$$y = \Lambda_y \eta + \varepsilon_y \tag{4.2}$$

where x and y are the indicators for the exogenous and endogenous latent variables ξ and η respectively, Λ_x and Λ_y are the loadings matrices (i.e., representing simple regression coefficients connecting latent variables, or constructs, and their measures) and ε_x and ε_y are residuals of the measurement (i.e., measurement errors or noise) (Chin 1998). The elements above are depicted in the block-diagram of a PLS model with reflective indicators depicted in Figure 4.4. In this figure *a*, *b*, *c*, *d*, *e*, and *f* signify the loadings, *p* the path coefficient between the two latent variables (ξ and η) and ζ the variance.

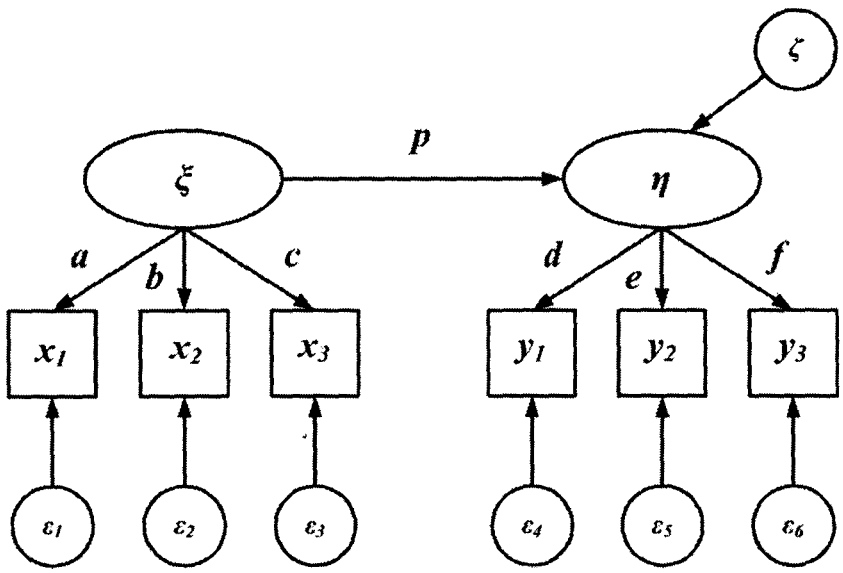


Figure 4.4 A Two-Block Model Diagram with Reflective Indicators (adapted from (Chin 1998))

For formative indicators the relationships, according to the same seminal work of Chin, are:

$$\xi = \Pi_\xi x + \delta_\xi \tag{4.3}$$

$$\eta = \Pi_\eta y + \delta_\eta \tag{4.4}$$

where ξ, η, x, and y have the same meaning as in equations (4.1) and (4.2), Π_x and Π_y represent the multiple regression coefficients for the latent variables on their block of indicators, and δ_x and δ_y are the residuals from the regressions.

Structural Model. The *structural model* (called also the *inner model* or *inner relations* (Chin 1998)) describes the relationship among the model variables based on a substantive theory:

$$\eta = \beta_0 + \beta\eta + \Gamma\xi + \zeta \tag{4.5}$$

where η is the vector of endogenous (or dependent) latent variable, ξ the vector of exogenous latent variable, ζ is the vector of residual variables (i.e., unexplained variance), and β and β_0 are the path coefficients. Thus the structural model describes the paths between the latent variables and is linked with the theoretical model (and, hence, hypotheses) proposed for the study.

Weight Relations. The weight relations complete the PLS estimation algorithm. Thus, the latent variables estimates of the model are a linear aggregation of their indicators whose weights result from the PLS estimation procedure (Chin 1998).

Outcomes of PLS. PLS, as other SEM techniques, allows the concurrent analysis of the measurement model and structural model (Bontis 1998). Assessment of the measurement model in PLS includes first the tests for item reliability, internal consistency, and validity (Igbaria, Parasuraman et al. 1996; Bontis 1998; Jarvenpaa, Shaw et al. 2004). An acceptable *reliability* for an individual item means an item loading (or measure of correlation with the expected construct) of at least 0.7. This implies that there is more variance shared between the construct and its items than the error variance (Bontis 1998; Bontis, Keow et al. 2000). According to the same work, verification of the condition for individual item reliability implies the verification of the condition for *internal consistency* for each construct in the theoretical model (which should be higher than the 0.7 threshold recommended by Nunnally (1978)) (Venkatesh, Morris et al. 2003; Jarvenpaa, Shaw et al. 2004). For this, the internal consistency formula of Fornell and Larcker (1981) is used. Internal consistency is considered a more appropriate measure of reliability when using SEM than Cronbach's alpha (Bontis 2004) because this latter assumes that all items contribute equally to reliability (Shook, Ketchen et al. 2004).

Average variance extracted (AVE) reported by PLS is used to assess convergent and discriminant validity. AVE accounts for "the variance captured by a latent construct, that is, the explained variance" (Gefen and Straub 2005, p. 94). "Established thresholds do not yet exist for loadings to establish convergent and discriminant validity" (Gefen and Straub 2005, p. 93). However, there are some values many papers mention consistently. Thus an appropriate *convergent validity* means the constructs have an AVE above the threshold of 0.5 recommended by Fornell and Larcker (1981) and used by many works such as Bontis, Crossan et al (2002), Shook, Ketchen et al. (2004), and Gewald and Dibbern (2005). An acceptable *discriminant validity* implies that the loading of any item with its associated construct is significantly higher in comparison with cross-loadings in a matrix of loadings and cross-loadings (Igbaria, Parasuraman et al. 1996; Bontis 1998; Bontis, Crossan et al. 2002; Jarvenpaa, Shaw et al. 2004; Gewald and Dibbern 2005). An alternative approach (and more popular according to some authors (Shook, Ketchen et al. 2004)), is to follow the method proposed by Fornell and Larcker

(1981) and test that the shared variance between any two constructs in the model is less than the AVE by either of the two constructs (Bontis, Crossan et al. 2002). Thus for adequate discriminant validity, the square root of the AVE values should be larger (or much larger (Gefen and Straub 2005)) than the correlation between the latent variables (Jarvenpaa, Shaw et al. 2004) and should be at least 0.50 (Fornell and Larcker 1981).

Following the example of Jarvenpaa, Shaw, et al. (2004), assessment of the structural model was done in two steps: first the hypothesized relationships between the constructs were analyzed to test hypotheses, and second the predictive power of the model was analyzed by calculating R^2 values on the endogenous variables. R^2 (or R-square) is the *coefficient of determination* and represents the proportion of the variance of the dependent variable about its mean explained by the independent variables (Gefen, Straub et al. 2000). It is commonly known as *variance explained.*

In the first step path coefficients are calculated. These coefficients represent the effect of exogenous variables on endogenous variables and they are assessed in terms of statistical significance by using a non-parametric test of significance: *jackknifing* or *bootstrap* analysis (Igbaria, Parasuraman et al. 1996). In contrast to the traditional *t*-tests, this procedure allows the testing of significance for estimates from data which are not necessarily multivariate normal (Bontis 1998; Bontis, Keow et al. 2000). Calculating path coefficients helps in accepting or rejecting the research hypotheses.

The second step consists of the evaluation of R^2. In contrast to the path loading which shows the causal links between constructs, R^2 for a construct shows the prediction in that construct explained by its antecedents (Bontis 1998; Bontis, Keow et al. 2000; Gewald and Dibbern 2005). Therefore, regarding the structural model PLS has as its objective the maximization of the explained variance. A *high* R^2 (i.e., *variance explained*) and a *significant relationship* between the constructs indicate a good model (Bontis 1998; Bontis, Keow et al. 2000).

4.5.1.3 Sample Size

One of the significant benefits of PLS is that it may work with a small sample size. According to recommendations in the literature, the sample size should be at least ten times the larger of the two indicators below (Bontis 1998; Chin 1998; Jarvenpaa, Shaw et al. 2004) :

- the number of indicators of the most complex formative construct; or,
- the number of paths leading to the endogenous construct with the largest number of antecedents.

For the model in the current research all constructs are specified as having reflective indicators. The construct with the largest number of paths leading into it (namely four) is the behavioural intention to use TMT (Figure 3.7). Accordingly, the sample size for running PLS with this model is 10 * 4 = 40 participants.

The initial enrolment sought for the study was about 150 participants (i.e., 75 each: intervention group or control group). As explained above, numerous measures were

taken to address possible contingency problems caused by withdrawal and interruption. Therefore it was hoped that the number of subjects completing the study was at least 100 (i.e., 50 per group). Thus, it would meet the recommendations of Venkatesh and Davis (2000) who noticed that a smaller sample size (e.g., below 50 participants) could diminish the power of the significance tests.

4.5.2 Qualitative IS Study

Data collected through open-ended questions must be analyzed with appropriate tools. There are several possibilities, but the choice of a research method should be made in relation to the research questions and research objectives (Hunter 2004). Overall, there are five factors which influence the choice of a certain qualitative method in IS research (Trauth 2001):

- the research problem (i.e., what one wants to learn determines how: e.g., field studies, document analysis);
- the researcher's theoretical lens (i.e., *positivist* studies are primarily done to test theory, *interpretive* studies intend to increase the understanding of a phenomenon and ***most frequently influence the choice of a qualitative method***, and *critical* studies do a critique of the structural contradictions of the status quo);
- the degree of uncertainty surrounding the phenomenon (because from a positivist viewpoint, the less known about a phenomenon the more difficult it is to measure);
- the researcher's skills (e.g., individual knowledge of methods and the institutional influence); and,
- academic politics (that depend on norms and values of the IS field).

Hunter points out that there are many qualitative research methods, "too numerous to even attempt to list" (2004, p. 300). According to the same study, some popular qualitative research methods are:

- Action research: suitable when investigating impact of change associated with IT (Baskerville 1999);
- Case study: investigating phenomena in their environment, especially when the relationship between the two is not clear (Yin 1994);
- Ethnography: recommended for conducting long-term primary observations (Myers 1999);
- Grounded theory: building a theory without (or with minimal) a priori research framework (Urquhart 2001); and,
- Narrative inquiry: analysis of individual relevant stories about the personal experiences (Clandinin and Connelly 2000).

Referring to the specific domain of utilization and acceptance of IT in healthcare "to date there have been relatively few qualitative studies of the social processes surrounding the use of healthcare information systems" (Murphy, Dingwall et al. 1998, p. 201). The same authors classify the research methods associated with the use of IS in healthcare into two broad categories: *interactionist* (that focus on how people ***see*** things) and, *ethno-methodological* (that focus on how people ***do*** things). Interactionist studies of computer use in healthcare help to understand healthcare professional perceptions relative to how computers affect and are affected by organizational context, and the causal processes in these organizations (Murphy, Dingwall et al. 1998). On the other hand, studies about patient interactions with IT are remarkably absent.

In choosing a certain method for data analysis of the qualitative IS study, more importance should be attached, not to whether a method is intrinsically better than another, but which combination of methods is best to meet the objectives of a particular study (Downe-Wamboldt 1992). The weight of this IS study was on the quantitative side and the qualitative questions were relatively precise and meant to offer an additional perspective on the phenomenon for the required triangulation. Thus, as explained in Sub-section 4.4.2, it was judged that content analysis was a suitable technique for these purposes.

4.5.2.1 Content Analysis

Content analysis is a popular technique for text interpretation used in many qualitative studies in consumer research (Jones 1999; Kim and Lennon 2000), healthcare and mass media (Mayring 2000; Roznowski 2003), human resources (Insch, Moore et al. 1997), including IS research (Detlor, Sproule et al. 2003; Chung and Tan 2004). The roots of content analysis are derived from conscious use of symbols and language. Content analysis methodology offers the opportunity to combine what are often thought of as antagonist approaches of data analysis (Downe-Wamboldt 1992).

The purpose of content analysis is to lead to meaningful and valid deductions starting from text expressions (Bauer, 2000). Of many approaches of content analysis still not clearly delimited in the literature, *classical content analysis* "comprises techniques for reducing texts to a unit-by-variable matrix and analyzing that matrix quantitatively to test hypotheses" (Ryan and Bernard 2000, p.785). According to the same work, matrix analysis is based on codes previously established by the researcher. The most elementary type of data analysis in classical content analysis is to count the frequencies of occurrence of text units based on the assumption that there is an association between frequency of content and meaning of this content (Kohlbacher, 2005).

Content analysis is an unobtrusive research method that provides "systematic and objective means to make valid inferences from verbal, visual, or written data in order to describe and quantify specific phenomena" (Downe-Wamboldt 1992, p. 314). Although there is not a single set of rules in content analysis, since they "vary with the theoretical and substantive interest of the investigator" (Weber 1985, p. 9), a comprehensive practical approach is presented in Downe-Wamboldt's work. According to this, the main steps in a content analysis study are:

Designing the sampling method and selecting the unit of analysis. Sampling must be representative for the phenomenon of interest (for this study it was extensively explained in Section 4.3 above). The unit of analysis (i.e., that may be word, sentence, phrase, paragraph, book, theme, etc.) should be guided by the research question.

Creating and defining the category system. Category schemes should be based on the research question, unit of analysis, relevant theories, previous research, literature, and data. Categories should be mutually exclusive to facilitate statistical analysis and for conceptual clarity.

Pre-testing the category definitions and rules. This should be done with a small sample test to see if the classification rules are clear. It may indicate that some other categories are necessary. This step also allows iterative refining and validating of the category scheme by going back and forth between coding and data.

Assessing reliability. A challenging task is to find the best combination which does not sacrifice reliability for meaning or vice versa. This is always a difficult choice: to deepen the level of understanding and repeatability or to increase reliability. Reliability is of two types:

- Stability (also called *intra-rater* reliability): results of content classification are consistent over time (assessed with Cohen's kappa for nominal data); and,
- Agreement reliability (or *inter-rater* reliability): between two coders at the same moment in time (done with Cohen's kappa or percentage agreement).

The coding rule must be revised if the reliability is low (0.8-0.9 is the desired level and 0.7 is the minimum standard). If several coders are used, reliability of the coding process and disputes among coders must be resolved first before advancing with the data analysis process. After the revisions, more pretests of the coding scheme need to be completed until an acceptable level of reliability is achieved.

Assessing validity. There are several approaches to assess validity. For instance, one is to take the results to the participants to validate the interpretations, while another is to obtain inter-rater subjective agreement. Validity may be also be confirmed or denied by returning to the original text to find examples of categories and by relating relevant theory to text. In general, content analysis relies heavily on face or content validity that can only be derived by the judgments of experts in the area (or by relevant research and literature).

Besides the above mandatory steps, the work of Downe-Wamboldt (1992) mentions some additional steps that may appear in some studies: *revising the coding rules if necessary, pre-testing the revisited category scheme, coding all the data,* and *re-assessing reliability and validity.*

Hunter (2004) expressed several general concerns for qualitative research that are, hence, applicable for content analysis research:

- Verification (the best mean to validate conclusions is replication);

- Researcher bias (when a researcher becomes involved with the research situations or participants); and,
- Reliability (difficult to measure).

It is believed that this research addresses appropriately all of these concerns. Thus *reliability* is ensured by the use of three independent coders that use the same code book. This was based on previous consumer behaviour studies and motivation studies used in IS. The coding results were compared by calculating an agreement coefficient following the method described by Krippendorff (1980). Discrepancies were resolved as suggested by Downe-Wamboldt (1992) and described above. It was believed that *researcher bias* was not an issue for this research. The investigator was not involved with the research situations of the participants, as Hunter (2004) feared, the open-ended questions are clear and asked upfront, before the study, and not adjusted during interviews. Furthermore, *objectivity* was enhanced by the use of two additional coders, besides the investigator.

Validity or *verification* was done by using the *cumulative validation* part of the process of triangulation, as described in Sub-section 4.4.2, as well as by comparisons with the findings of other studies investigating the integration of perceived risk into a technology acceptance model. For instance, it was expected that perceived risk decreases the behavioural intention to use the technology and motivation increases this intention, so the qualitative study should yield the same type of logical results.

The actual data coding can be done by developing code books or by the use of specialized software. A recommendation for beginning researchers doing small-scale studies is to use a manual approach to analyzing data in order to gain an insight of the phenomena (Webb 1999). Furthermore, it is also recommended to explain the analysis process in order to share experience and "disseminate the research findings" (p. 329).

In conclusion, content analysis is a useful qualitative data analysis method that allows theoretical useful generalizations with minimal loss of information from the original data. Some disadvantages refer to the limitation to recorded communications of text, the time consumed in coding, and the application of statistical procedures. Special care must be given to the reliability and validity issues (Downe-Wamboldt 1992).

4.5.2.2 Business Case Study

The data in the business case study was analyzed using descriptive statistics. Mean and standard deviation scores were analyzed similarly to Barner, Mason et al. (1999). In addition, correlation of willingness to pay (WTP) and willingness to give time (WTGT) with the constructs of the theoretical IS model were analyzed, similarly to other studies which studied correlations of variables external to the model with variables in the model (Igbaria, Iivari et al. 1995; Teo, Lim et al. 1999). The correlation results gave an indication on how perceived risk, motivation, and behavioural intention to use TMT were linked with WTP and WTGT.

4.5.2.3 Healthcare Study

One remark of a scientific review investigating interventions to enhance patient adherence to medication is that many of the studies did not have a sufficient sample size to achieve a satisfactory level of power (McDonald, Garg et al. 2002). This review recommends that future studies should use at least 60 patients per study group. Beginning by seeking 150 participants, and hoping to have at least 100 subjects (i.e., 50 per group) completing the entire experiment, this study was at about the level recommended in the cited work.

A more rigorous determination of the sample size could follow recommendations regarding the calculation of the sample size for clinical trials, depending on the effect size of difference expected between the intervention group and the control group (Taylor, Sackett et al. 1984; Haynes, Kris-Etherton et al. 1999; Devane, Begley et al. 2004; Haynes, Sackett et al. 2005; Scales and Rubenfeld 2005). There is no information available in the literature regarding the effect size to be expected in the type of prophylactic intervention undertaken by this study and the healthcare research question was secondary for this study as explained earlier. Therefore *the sample size derived from the requirements of the IS part of the study was considered acceptable for the healthcare part as well.*

The baseline difference between the intervention group and the control group was evaluated by applying a MANOVA test. To test the effect of the SMS intervention on adherence, a paired *t*-test measuring for the change of the average adherence rate was applied to each of the two groups (to detect changes within groups between baseline and endpoint). More importantly, an ANOVA test for the difference of average adherence rate between the two groups at the end of the experiment was performed, following data analysis recommendations (Tabachnik and Fidell 2001) and the example of similar studies (Haynes, Kris-Etherton et al. 1999; Metz, Stern et al. 2000). In controlled trials, the differences between groups are far more important than the changes within groups (Akobeng 2005; Haynes, Sackett et al. 2005).

TMT may function like a *Medication Event Monitoring System* by measuring adherence directly, based on participant acknowledgements about taking the vitamins as explained in Sub-section 4.4.4. Assuming that these responses were honest, a further comparison was done between participant self-reported number of pills taken and the data reported by the system.

4.6 Summary

This chapter has discussed the methodology adopted to collect and analyze the data necessary to answer the research questions of the study. Data collection was performed by testing in real-life conditions an original system proposed by this work, called Text Messaging Telehealth (TMT). This system consists of exchanging SMS

messages between a wireless server and the research participants. Participants were sent reminders about taking daily a vitamin C pill for prophylactic reasons. Subjects were asked to comply and acknowledge the vitamin C taking as early as possible by one-letter text messages. The system also sent the participants more rare and enjoyable messages of encouragement and reinforcement (if they responded as expected) or correction (if they failed to respond as scheduled). The investigator could intervene in the text messaging dialogue only if asked by a participant.

In order to give the participants a real-life experience which was important for conducting this multi-sided study, a randomized controlled trial approach was adopted. Participants were randomly allocated to two groups of equal size: an intervention group receiving the text messaging treatment and a control group receiving no SMS treatment. For full comparability, participants in both groups had cell phone and SMS familiarity. The framework of the controlled trial was the daily taking of one vitamin C pill of 500 mg by well people for prophylactic reasons (e.g., to prevent flu and cold). One hundred and fifty individuals were expected to join the experiment and various measures were considered to encourage participation and reduce the possible dropouts during the one-month experiment.

Data were collected in four stages as follows:

- Participants answered a baseline survey after being presented a scenario and were offered the possibility of participating in a one-month field experiment;
- Interested participants were randomly allocated to an intervention and a control group and started a one-month RCT after indicating their cell phone numbers and e-mail addresses;
- During the field experiment data regarding the SMS exchange with participants in the intervention group were appropriately recorded (e.g., message content and time stamp); and,
- At the end of the field experiment all participants filled in an online survey regarding their vitamin C taking experience. Participants in the intervention group also answered to a technology acceptance survey regarding their perceptions on the actual use of TMT.

Data collection and analysis was organized upon the three fields of research comprising the study: information systems (quantitative and qualitative), business model, and healthcare. The quantitative data collection in the IS study used multi-item scales adapted from previously validated measures in information systems research to capture participant perceptions about intrinsic and extrinsic motivation and behavioural intention to use TMT. The perceived risk constructs were measured through multi-item scales adapted from behavioural research. Other questions captured demographic information and SMS experience and usage. Qualitative data collection in the IS study was done through open-ended questions aiming ultimately at both confirming and completing the quantitative study in a triangulation approach. Data analysis for the quantitative IS study was done through the most appropriate Structural Equation Modeling technique for the

conditions of this study, namely PLS. Data analysis for the qualitative IS study was done through content analysis.

While the core of the study was IS, business and healthcare issues were also examined. Data for the business case study were acquired by questions adapted from similar studies, eliciting participant willingness to pay for and willingness to give time to such a program. The analysis was done by basic statistics, and study of correlations with possible constructs of interest in the theoretical IS model.

Data for the healthcare study were gathered by questions validated in the healthcare literature, asking participants to self-report their pill-taking pattern and to provide their impressions regarding this activity and its outcomes. Data were analyzed by comparing the two groups (i.e., intervention and control) at the baseline and at the end of the trial, as well as the intra-group changes during the one-month period. As TMT is able to measure timely the actual vitamin taking (provided the participants report honestly their actions), a last comparison performed in the healthcare part of the study was between the system-recorded adherence during the last week of the trial and the self-reported adherence at the end of the trial.

In conclusion, the study collected and analyzed various data necessary to answer the research questions asked in Chapter 2, with a considerable weight to the quantitative side of the technology acceptance research. The study, the data analysis, and the results obtained are presented in the following chapter.

Chapter 5: Data Analysis and Results

5.1 Introduction

This chapter presents the data collection process, followed by the data analysis and results. The major part of this chapter is dedicated to the data analysis and results of the IS study, especially the quantitative part. The business case study and the healthcare study analysis and results are presented separately at the end.

The pilot study and its results are presented in Section 5.2, and the experimental process and the related data collection are presented in detail in Section 5.3. The next section presents the data treatment that was applied before the actual data analysis. Section 5.5 presents the demographics analysis. Section 5.6 describes the data analysis and results for the quantitative IS study and Section 5.7 deals with the qualitative IS study. The last two sections are dedicated separately to the business case and to the healthcare study respectively.

5.2 Pilot Study

A pilot study was conducted in the period January-February 2006. The purpose of the pilot study was to receive feedback on the design of the experiment in general and of the survey instruments in particular. Of special interest was participant understanding of all the instructions and questions, and whether the Web information pages and online questionnaires functioned properly.

The target population was similar to the sample that was used in the main study-participants were to be at least 18 years old and have a cell phone. Invitations to participate in the pilot study were e-mailed to a set of 28 people known to the experimenter, who met these conditions. A supplementary stipulation for the pilot was that, to be in accordance with the main study sample, only responses coming from participants younger than 39 years were accepted.

Twenty five participants answered the pilot survey. Only 15 participants provided answers to all questions and met all the conditions. The sample mean was 33.4 years, ranging from 24 to 39 years. Experience with SMS use averaged 14.2 months with a range between 6 months and 6 years.

The experimental methodology for the pilot study group followed the baseline scenario-based approach shown in Subsection 4.2. Some valuable conclusions were drawn regarding the design of the experiment itself. The experiment comprised four items: (1) an information Web page followed by (2) the preliminary survey regarding SMS and vitamin C consumption background, then by (3) the Web scenario, and finally,

(4) the main survey pertaining to the research model. Because of an imperfection in the software utilized (Web Surveyor), after submitting a survey there is a time lag of about 5-10 seconds (during which a banner is displayed) before subjects are redirected to the next Web page. Thus, although the Web pages contained clear instructions on the whole process, some participants very likely closed the Internet browser after the preliminary survey (i.e., step 2), without waiting for the Web scenario to load. This caused a discrepancy between the number of answers collected through the first survey (25) and the second survey (21). Consequently, appropriate measures were taken for the main study, which was modified to present both questionnaires in sequence, with no break between them.

Another issue not considered in the initial design was that some participants were currently taking multivitamins, but not vitamin C. To avoid any possible medical questions, the participating conditions for the main study were relaxed further. Thus, participants already taking a multivitamin (besides those taking specifically vitamin C) were accepted as well, by being allowed to continue taking their usual pills.

Regarding the actual wording and instructions, 100% of the participants said they had no difficulties in understanding the information in the survey. This demonstrates that the layout, including the scenario design, was appropriate. One participant even said:

"like it (info is easy to understand)"

Fourteen participants (of the total of 15) did not report difficulties in understanding any of the questions in the survey (one participant complained about an excessive number of questions), and 13 participants did not have any suggestions for improvement. Just two participants offered suggestions:

"be creative"

"do not split 1st and 2nd survey as two different surveys - it should be one survey with two pages"

This last suggestion was, indeed, important and was taken into account when aggregating the two questionnaires into one. After this adjustment, the layout, information, and questions were considered appropriate. As the survey for the intervention group was almost identical, it was considered that the layout of the data collection instrument was adequate. A more refined analysis of the pilot study regarded the quantitative and qualitative data collecting tools, as follows.

A necessary step in analyzing data collected during the pilot study was to calculate the reliability coefficients for all the multi-item scales and to compare them with the thresholds recommended in the literature. Results are shown in Table 5.1.

Table 5.1 Reliability Values of the Scales in the Model

Scale	Cronbach's alpha obtained	Cronbach's alpha in reference papers
Perceived financial risk	0.737	0.762 (Stone and Grønhaug 1993; Stone and Mason 1995)
Perceived social risk	0.481	0.715 (Stone and Grønhaug 1993; Stone and Mason 1995)
Perceived privacy risk	0.933	0.857 (Featherman and Pavlou 2003)
Perceived psychological risk	0.991	0.810 (Stone and Grønhaug 1993; Stone and Mason 1995)
Perceived overall risk	0.885	0.686 (Stone and Grønhaug 1993; Stone and Mason 1995)
Intrinsic motivation	0.913	0.910 (Venkatesh, Speier et al. 2002)
Extrinsic motivation	0.926	0.870-0.980 (Venkatesh and Davis 2000)
Behavioural intention	0.971	0.820-0.970 (Venkatesh and Davis 2000)
Attitude toward adherence	0.740	0.620 (Horne, Graupnera et al. 2004)

The large majority of the values obtained was comparable with those in other publications and above the threshold value of 0.7 recommended by Nunnally (1978). Of special interest here is the attitude toward adherence which is higher than in the paper by Horne, Graupnera et al. (2004) where it was below the recommended threshold.

The only situation contrasting with the above values is the case of the perceived social risk for which a very low and unacceptable value was obtained. Four explanations can be offered for this:

- a low perception of the social risk in a cross-sectional survey (possibly, after a one-month experiment where people would effectively use the service in various social contexts, they would develop some other perspective of the social risk);
- being reminded about taking a common vitamin preventively may not pose a significant social risk (which would, probably, not be the case when taking a pill for a chronic disease);
- the very small sample (but this is, however, the case for the other constructs too); and,
- insufficient clarity of the construct's items.

The pilot study used for perceived social risk an adaptation of the original scale developed and validated by Stone and Grønhaug (1993). However, other studies that used adaptations of the same original scale obtained much higher values (e.g., 0.92 on a 2-item scale (Laroche, McDougall et al. 2004), or 0.85 on a 3-item scale (Dholakia 2001)). Assuming that the last two causes of the list above were the reason for the unsatisfactory

Cronbach alpha, in an effort to address this scale problem, and similar to the IS research where later validations of scales are sometimes more popular than the original scales, the main study used an adaptation of the scale tested by Dholakia (2001). This had the advantage of using three items and eliminating the reverse coding of one item that may have created additional problems in the initial scale. Therefore the scale used in the main study contained the items:

- "My friends and colleagues' opinions about my signing up for TMT would cause me to feel concern";
- "If signing up for TMT, I would be concerned about what people whose opinion is of value for me would think of me, if I made a bad choice"; and,
- "My subscribing to TMT would cause me concern about what my friends would think of me, if I made a bad choice".

The other measures were considered to be appropriate and were used without changes in the main study.

An inspection of the quantitative and qualitative data collected through the pilot study showed that, overall, there was a reasonable variability in the answers, expressing different participant opinions with respect to the theoretical model and reasons to use or not TMT. In addition, some correlations in the expected direction were noticed (e.g., perceived overall risk was negatively correlated with the intention to use the technology and extrinsic and intrinsic motivation were positively correlated with intention) but further analysis was not carried on due to the small sample. In conclusion, some confidence could be expressed that the instrument for data collection was designed appropriately for capturing the data necessary to build a general picture of the motivators and demotivators of user intention to adopt wireless messaging in telehealth for healthy behaviour.

5.3 Experiment Administration and Data Collection

The study was run in two stages: in March-May (Spring) 2006 and in September-November (Fall) 2006. The subjects were recruited in several ways:

- by advertising three times (once in March 2006 and twice in September and October of 2006) through the main McMaster University Web site;
- by advertising through an e-mail addressed to all undergraduate and graduate students in McMaster University DeGroote School of Business in September 2006;
- by running advertisements on the TV displays situated in the lobby of McMaster University DeGroote School of Business in April 2006;

- by posting advertisements on the advertising boards in McMaster University in March-April and September-October 2006;
- by going to classes in the DeGroote School of Business of McMaster University in April 2006, briefly presenting the research and distributing fliers with the URL where potentially interested participants could read information about the study and register, if they wished to do so;
- by going to classes in the DeGroote School of Business of McMaster University in March and September 2006, presenting the research study, and leaving paper information forms and baseline surveys to be completed by students interested in participating, in a stress-free manner at their convenience; and,
- by presenting information about the study in March-April and September-October 2006, when requested by e-mail or verbally, in casual conversations, with people who heard about the study through various channels.

The study involved data collection in three stages: at the baseline (beginning of the experiment), during the one-month field experiment, and at the end of the field experiment.

5.3.1 Data Collection at Baseline

Data collection at baseline was done through the initial survey, preceded by an information form specific to this survey. In addition, participants were presented a brief message regarding the positive consequences of taking vitamin C on a regular basis, according to trusted sources (i.e., the BBC Web site) and a *scenario* on how SMS on their cell phones could help to remind them to take their daily vitamin C pill, if they decided so. After that they were asked to complete a brief feedback survey eliciting participant usage patterns of cell phones and SMS, and possible existing patterns of vitamin C taking as well as their attitude regarding vitamin C use. Finally, based on the scenario they were presented, participants completed a survey regarding their perceptions, comments, and suggestions of the possible use of SMS on their cell phones for this specific purpose. Table 5.2 summarizes numerical data regarding this stage of data collection.

At the end of the baseline survey participants were presented with the possibility, in a stress-free manner, to learn about potential participation in a field study identical to that described in the scenario, if they wished to do so. Interested participants were directed to a Web page describing the information specific for the field study. If they indicated a willingness to participate in this study, they were randomly allocated to one of the two groups (intervention or control).

A total of 335 participants completed the scenario-based survey. Eight questionnaires (6 online and 2 on paper) were mostly incomplete and were discarded. Also, 16 questionnaires (2 online and 14 on paper) were excluded because participants did not meet one of the required conditions: being cell phone users. Numerical data regarding the participant recruitment for the field study are summarized in Table 5.2.

Table 5.2 Participants Involved in the Experiment

Category of participants	Number of participants		
	Spring 2006	Fall 2006	Total
Completed the baseline scenario-based survey	43 (online) 47 (on paper)	118 (online) 103 (on paper)	311
Willing to receive information about the field experiment	37	115	152
Registered for the field experiment	13 (intervention) 12 (control)	39 (intervention) 38 (control)	52 (intervention) 50 (control)
Completed the field experiment	12 (intervention) 10 (control)	39 (intervention) 38 (control)	51 (intervention) 48 (control)

Of the 311 remaining questionnaires, 152 showed that participants were willing to receive more information about the field study and indicated their e-mail addresses for this purpose. Each of these participants was sent an individual e-mail directing them to an online information form. This form offered details about the field experiment, stating the mandatory conditions to be accepted for such a study, as shown in Section 4.3. When they clicked the 'Accept' button on the online information form, participants were randomly distributed into one of the two groups (intervention or control) by an automated script. The next page the participants saw was specific information for their task during the experiment, and their compensation. Finally, participants in each group indicated through a brief survey their e-mail addresses and cell phone numbers. Overall, 52 participants registered for the intervention group and 50 for the control group.

Participants who registered for the field experiment met with the investigator individually to receive a bottle of vitamin C pills. Each bottle was purchased from a pharmacy, and contained 100 pills of 500 mg each. Thirty one participants (eleven in the intervention group) indicated that they would be using their own vitamin C pills or multivitamins for the experiment. Nonetheless, to be fair, these participants were offered the bottle of vitamin C pills along with their financial compensation at the end of the experiment.

Participants were aware of the existence of the two groups. Besides the information about the experiment they received when registering, they were also given indications and provided answers to their questions during the individual meetings with the investigator and through e-mails, if they asked, at the beginning of the experiment.

5.3.2 Data Collection During the Field Experiment

During the field experiment all participants were supposed to take one vitamin C pill (or their multivitamins) every day. While participants in the intervention group received reminders by SMS (basic, reinforcement, or correcting, as described in Chapter 4), subjects in the control group had no such SMS activity. Data collection during the

field study was performed mainly with the help of a software application developed by Allegro Wireless Inc. Mississauga, Ontario. This software application sent SMS reminders exactly as described in Subsection 4.2 and Appendices C and D, and collected participant SMS response content and time stamped each response. Six participants in the spring and 14 in the fall started the study up to one week after the main batch of participants. The software application was programmed to run just once, and exactly for one month. In order to ensure every person participated for the required one-month period, late participants were sent the necessary additional SMS messages from a regular cell phone, after the software application completed the main cycle. Similarly, late participant responses were received on the same cell phone and recorded manually.

5.3.3 Data Collection at the End of the Field Experiment

Data collection at the end of the field study was conducted exclusively online, when participants were sent individual e-mails directing them to an online survey that depended on the group they participated in (intervention or control). The last question of this survey asked participants to provide their cell phone numbers. This made it possible to match their baseline and final survey responses. After completing the final questionnaire, participants were given the promised financial compensation through individual meetings. This amounted to $30 for the participants in the intervention group (they were involved in more activities and text messaging would cost them a small amount) and $15 for participants in the control group. During these meetings participants were also debriefed about the full layout and the aims of this research.

The number of participants who completed the final survey is presented in Table 5.2. Two participants in the control group and one in the intervention group did not complete the final survey. During the experiment one participant indicated that he/she did not want to receive SMS any more. However he/she completed the final survey so was considered as having interrupted the study and not withdrawn. Overall, 51 participants in the intervention group and 48 in the control group completed the study. This was very close to the number of 100 participants in the original study plan. Figure 5.1 presents a flow diagram of participant involvement in the study.

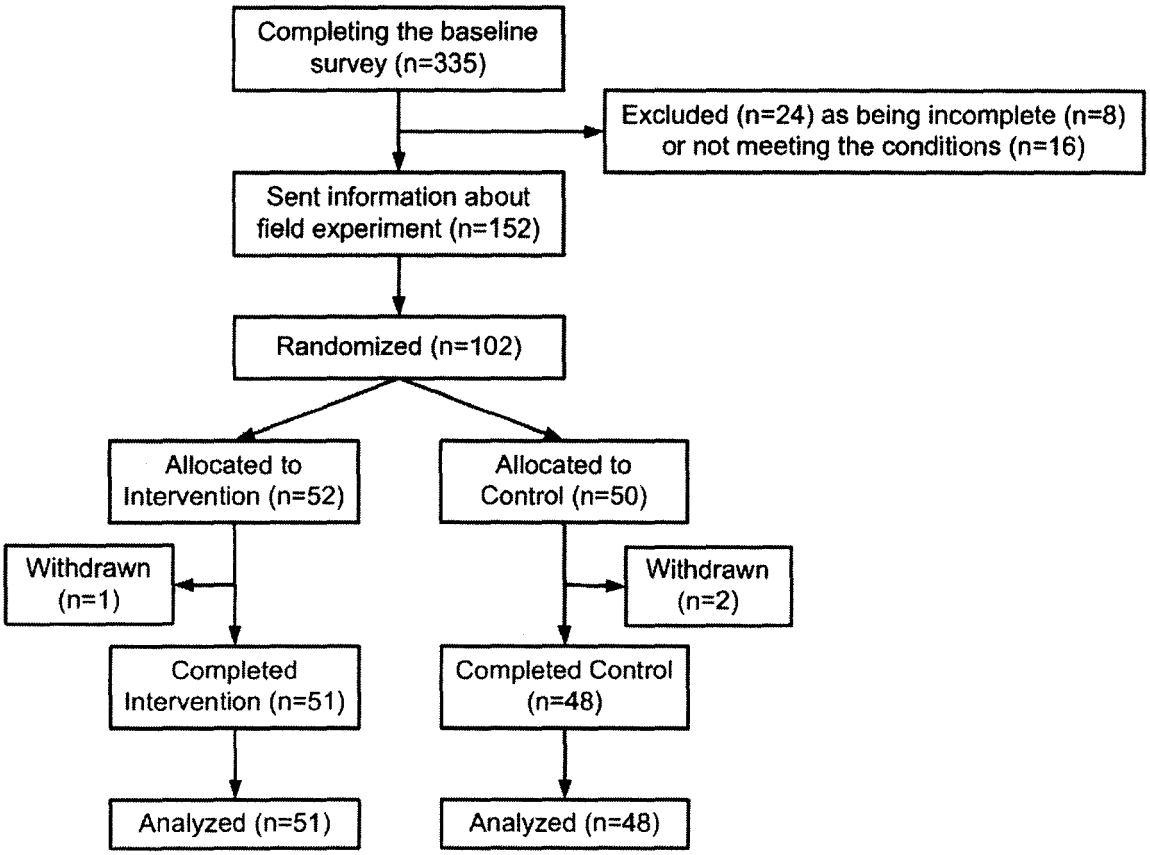


Figure 5.1 Flow Diagram of Participant Involvement in the Study

5.4 Data Treatment

Since participants joined this research at two times (spring or fall 2006), a mandatory step in the data analysis was to test for statistical differences in responses to the surveys from the temporal point of view for each of the two groups completing the experiment (i.e., intervention and control). The test for statistical differences in the responses used the Multiple Analysis of Variance (MANOVA) technique (Tabachnik and Fidell 2001).

A first analysis was to test for differences in the *intervention group* (i.e., 51 participants) in terms of the time of the experiment (spring or fall). Two MANOVA analyses were separately conducted in this case: one for the *behavioural data* (regarding the means of the constructs in the research model including the attitude toward taking vitamin C) and the other one for *self-reported factual data* (regarding the pattern of cell phone and SMS use as well as taking vitamin C). The Multivariate General Linear Model available with SPSS 14.0 software was used. The analyses did not reveal significant differences in either of the two data categories, i.e., for the means of the items in the

theoretical model (Wilk's Lambda = 0.907, significance level = 0.888) or for the factual data (Wilk's Lambda = 0.723, significance level = 0.069). The higher the values for the Wilk's Lambda coefficient (ranging between 0 and 1) and the higher the significance level, the more similar the groups are.

Tests for differences in the *control group* (48 participants) were also conducted. As the ANOVA test for the only behavioural data compared here (attitude toward adherence) did not reveal any difference between the spring-fall sub-groups (significance level = 0.965) and the MANOVA test for the factual data did not indicate significant differences either (Wilk's Lambda = 0.892, significance level = 0.780), it was concluded that there was no temporal bias for the results from either the intervention or the control group.

5.5 Participant Demographics

Results regarding participant demographics and relevant background are presented in this section. Data examined concern age, gender, as well as cell phone and SMS experience and activity for the scenario-based, intervention, and control group respectively.

5.5.1 Gender

An analysis by gender revealed that 51.4% of the respondents in the scenario-based survey, 56.9% in the intervention group and 56.3% in the control group (at endpoint for the latter two) were female. While 23 people in the scenario-based survey did not reveal their gender, there were no missing data for the field experiment groups. A binomial nonparametric test (i.e., not making assumptions on the data distribution) was conducted to test whether the proportion of females differed significantly from the theoretical 50%. The Z approximation revealed no statistical significance of the proportion of females (and, implicitly of males) from the theoretical 50-50 distribution: p=.680 for the scenario sample, p=.401 for the intervention group, and p=.471 for the control group.

5.5.2. Age

Respondents indicated their age on a continuous scale. Participant age ranged from 18 to 64 years for the scenario-based survey (mean 23.5, median 22.0). Twenty participants in the scenario-based sample did not indicate their age. In the intervention group age ranged between 18 and 51 years (mean of 23.9 and median 21.0) while in the control group the range was 18 to 48 years (mean 24.0 and median 21.5), both at the experiment's endpoint. Figure 5.2 presents detailed age demographics. About three quarters of the sample were less than 24 years old.

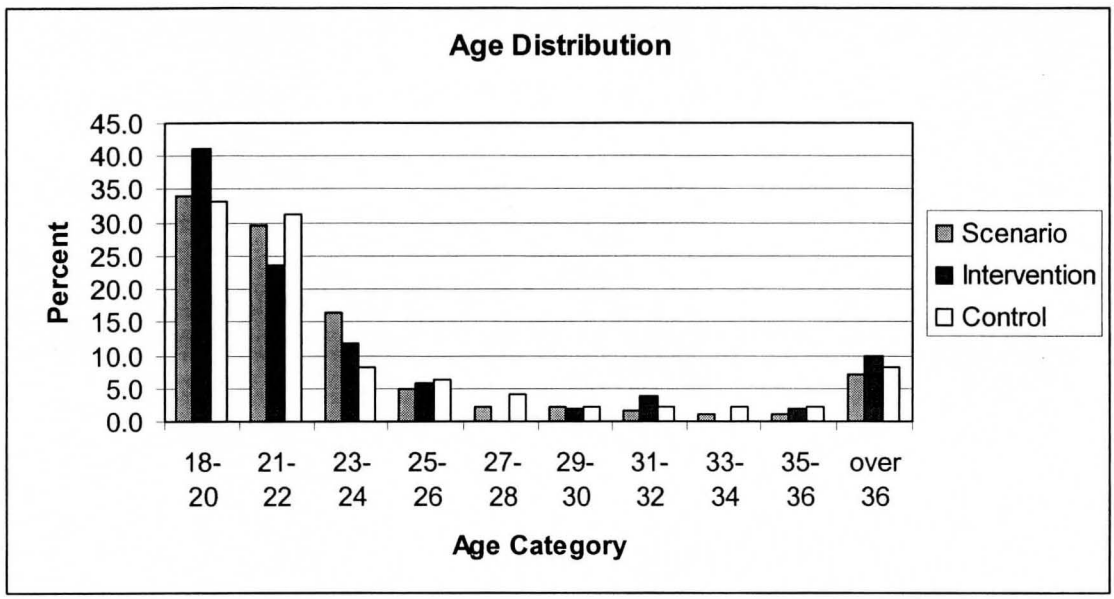


Figure 5.2 Age Distribution of the Participants

5.5.3 Cell Phone and SMS Experience and Activity

According to participant self-reports of cell phone usage, experience with cell phones ranged from 1 month to 10 years for the scenario-based survey (mean 48.7 months and median 48.0), from 9 months to 10 years for the intervention group (mean 49.5 months and median 48.0), and from 2 months to 10 years for the control group (mean 38.2 months and median 36.0). One participant in the control group was not specific on cell phone experience ("*few years*"), two participants in the intervention group were less precise (e.g., "*more than 72* [months]"), and five participants in the scenario group were vague (e.g., "*forever*", or "*ages*").

Participant SMS experience tended to be less than cell phone experience in years. Participants in the scenario sample indicated a range from zero months to 10 years for the scenario-based survey (mean 29.8 months and median 24.0), those in the intervention group from zero months to 10 years (mean 31.8 months and median 30.0), and those in the control group from zero months to 9.5 years (mean 25.6 months and median 24.0). About the same participants as in the case of cell phone usage were not sure about their SMS usage and made similar non-precise comments.

According to participant self-reported figures, the range in the number of SMS messages received was from zero to 460 per week for the scenario-based survey (mean 16.3 and median 7.2), from zero to 150 for those in the intervention group (mean 14.4 and median 7.0), and from zero to 460 for those in the control group (mean 24.5 and median 5.0). In terms of SMS messages sent, participants reported from zero to over 330 per week for the scenario-based survey (mean 15.3 and median 5.0), from zero to 60 for those in the intervention group (mean 12.2 and median 5.0), and from zero to 334 for

those in the control group (mean 23.0 and median 4.0). A few participants were not specific in their responses (e.g., "*sometimes > 40*", "*50-60*", "*less than 10*", "*around 8*") and some mentioned very high numbers (above 300 or 400 SMS received/sent per week). Nonetheless, the analysis shows that the vast majority of the participants reported SMS activities below 10 messages per week with smaller figures for the SMS sent compared to those received. Table 5.3 synthesizes key figures on cell phone and SMS experience and activity.

Table 5.3 Cell Phone and SMS Experience and Activity

Cell phone and SMS demographics	Group	Range	Mean	Median
Cell phone experience	Scenario-based group	1 month to 10 years	48.7 months	48.0 months
	Intervention group	9 months to 10 years	49.5 months	48.0 months
	Control group	2 months to 10 years	38.2 months	36.0 months
SMS experience	Scenario-based group	0 months to 10 years	29.8 months	24.0 months
	Intervention group	0 months to 10 years	31.8 months	30.0 months
	Control group	0 months to 9.5 years	25.6 months	24.0 months
SMS messages received per week	Scenario-based group	0 to 460	16.3	7.2
	Intervention group	0 to 150	14.4	7.0
	Control group	0 to 460	24.5	5.0
SMS messages sent per week	Scenario-based group	0 to 334	15.3	5.0
	Intervention group	0 to 60	12.2	5.0
	Control group	0 to 334	23.0	4.0

Overall, the analysis of the participant demographics shows that participants were young people with a wide range of experience with cell phones and a wide range of SMS message activity.

5.6 Quantitative IS Study

The main objective of the IS quantitative research was to answer research questions one to four, as presented in Subsection 2.4, by examining the theoretical research model presented in Subsection 3.5. This involved several steps, as follows.

5.6.1 Preliminary Steps

Preliminary steps for the quantitative data analysis regarded the specification of the sample examined and appropriate data treatment. Based on the philosophy that participants who have actually used the proposed TMT application are in the best position to express their perceptions about the system, the testing of the theoretical model was done using the sample of 51 participants in the intervention group. According to the sample size specifications presented in Subsection 4.5 (Bontis 1998; Chin 1998; Jarvenpaa, Shaw et al. 2004), this sample is larger than the minimum of 40 required for this research by the PLS technique that was used to analyze the experimental data.

Of the 51 responses, one case was deleted because a visual inspection identified a lack of frankness in the participant's answers. The remaining 50 cases were considered valid. In terms of demographics, this 50-case sample consisted of 56.0% females and the average age was 24 years, with a range of 18 to 51 and a standard deviation of 7.4.

One preliminary step was to test for statistical differences between the cases with no missing data and those where the participants failed to answer one or several questions, according to the recommendations of Moore (2000). Only one response was missing in one case of the *self-reported factual data* (specifically about taking vitamins, and not directly related to the theoretical model), so no analysis was done in this case. Seven cases in the theoretical model had at least one missing *behavioural answer*. The differences between the complete cases and those with missing data were analyzed using two MANOVA tests: one for the items in the theoretical model and another for selected items referring only to extrinsic motivation, intrinsic motivation, and behavioural intention. The results (Wilk's Lambda = 0.990, significance level = 0.517 in the first analysis and Wilk's Lambda = 0.917, significance level = 0.946 in the second analysis) confirmed that there was no difference in item scores between fully completed and partially completed questionnaires.

A further preliminary step in data analysis was to test for common method bias, using Harman's one-method test (Bart, Bontis et al. 2001). This method consists of entering all items pertaining to the theoretical model into an exploratory factor analysis. The unrotated solution produced six factors with eigenvalues greater than one, the smallest eigenvalue being 1.227. The first factor accounted for 31.65% of the variance and included items pertaining mostly to the perceived psychological risk and perceived overall risk. The six factors isolated through this method accounted for 79.24% of the variance. This analysis indicated that the variables do not load on a single factor. Thus the variance recorded in the measurements of the items is not due to a presumably common method.

The last preliminary step in the data analysis was to test for the normality of the frequency distributions of items in the data model constructs. Based on other papers in the field, a non-parametric Kolmogorov-Smirnov test was applied (Bontis 1998). All the constructs in the model showed normality of the distributions at a significance level of 0.05 with the perceived psychological risk being the closest to this limit. In terms of individual items, almost 50% (i.e., 11 out of 24) did not show normality at a significance

level of 0.05. However, this was not considered an impediment for subsequent analysis, since PLS features tolerance for non-normal data (Bontis 1998; Thomas, Lu et al. 2005).

5.6.2 Measurement Model

Before actually testing the measurement model produced by PLS, a recommended step is to calculate the Cronbach alpha reliability coefficients for all multi-item scales. All the coefficients calculated through SPSS 14.0 were above the 0.7 level considered acceptable for further data analysis (Cronbach 1951). The values of these coefficients are presented in Table 5.4.

The actual analysis was performed globally on the theoretical model using PLS Graph 3.0 with bootstrap, following closely the guidelines of Gefen and Straub (2005). The first step was to assess the *reliability* and *convergent validity* of the measurement model. The loadings of the items on the constructs they were supposed to load on were examined before going further. The first run of the program revealed acceptable loads for all items of the constructs in the theoretical model except the second item for perceived financial risk (PFR2) which displayed a loading of only 0.0058 and a *t*-value of 0.02. This item was then removed from further analysis and PLS was rerun. The corresponding Cronbach's alpha for the remaining two items was re-evaluated. The values now revealed that virtually all factor loadings and Cronbach's alphas were above the value of 0.7 and the item-total correlations were above 0.35. The average variance extracted (AVE) can be calculated with the formula (Gefen and Straub 2005):

$$AVE = \frac{\sum \lambda_i^2}{\sum \lambda_i^2 + \sum (1 - \lambda_i^2)} \tag{5.1}$$

where λ_i is the loading of each measurement item on its corresponding construct. AVE produced by PLS was greater than the recommended value of 0.5 and the internal consistency measure, calculated with the formula introduced by Fornell and Larcker (1981), was higher than 0.7 for all constructs, consistent with recommended levels (Bontis 1998; Bontis, Crossan et al. 2002; Jarvenpaa, Shaw et al. 2004).

The statistics for all the items pertaining to the constructs in the theoretical model are presented in Table 5.4. A special mention is necessary for the PFR construct. Cronbach's alpha with three items is 0.710 but after dropping the second item, as suggested by the PLS analysis, it became 0.679. However, the AVE is 0.723 and the internal consistency 0.817. Therefore, this two-item scale was considered acceptable from the reliability point of view.

Table 5.4 Statistics of the Measurement Model

Item	Mean	Standard deviation	Factor loading	Error	Item-total correlation	*t*-value	Internal consistency (Cronbach's alpha; AVE)
PFR1	3.59	1.49	0.969	0.298	0.517	3.25	0.817
PFR3	4.21	1.64	0.711	0.252	0.517	2.82	(0.679; 0.723)
PSR1	2.55	1.66	0.735	0.105	0.529	6.97	0.972
PSR2	2.13	1.17	0.932	0.047	0.773	19.73	(0.790; 0.754)
PSR3	2.04	1.01	0.924	0.037	0.708	25.20	
PRR1	2.38	1.36	0.924	0.019	0.768	49.79	0.984
PRR2	2.87	1.68	0.876	0.054	0.753	16.16	(0.867; 0.794)
PRR3	2.94	1.62	0.872	0.042	0.739	20.82	
PYR1	1.98	0.94	0.887	0.033	0.730	26.98	0.988
PYR2	1.85	1.03	0.924	0.026	0.836	34.85	(0.891; 0.823)
PYR3	1.66	0.86	0.911	0.032	0.808	28.73	
POR1	1.85	0.94	0.724	0.088	0.437	8.26	0.968
POR2	2.63	1.39	0.778	0.065	0.535	11.97	(0.714; 0.643)
POR3	2.39	1.24	0.893	0.036	0.674	25.11	
IM1	4.53	1.41	0.949	0.027	0.885	34.90	0.991
IM2	4.64	1.50	0.941	0.017	0.857	53.90	(0.936; 0.888)
IM3	4.49	1.43	0.936	0.027	0.865	34.41	
EM1	4.77	1.72	0.827	0.110	0.721	7.53	0.983
EM2	5.27	1.42	0.929	0.049	0.849	18.85	(0.923; 0.821)
EM3	5.02	1.62	0.973	0.009	0.936	102.69	
EM4	5.15	1.54	0.888	0.054	0.807	16.42	
BI1	5.61	1.31	0.986	0.006	0.944	170.82	0.997
BI2	5.90	1.40	0.985	0.006	0.944	176.23	(0.971; 0.972)

Note: PFR – perceived financial risk, PSR – perceived social risk, PRR – perceived privacy risk, PYR – perceived psychological risk, POR – perceived overall risk, IM – intrinsic motivation, EM – extrinsic motivation, BI – behavioural intention to use, 1…4 – scale items

From the table above, all the constructs have high reliability and convergent validity since Cronbach's alpha, internal consistency, AVE, and item-total correlations are above the recommended thresholds. This conclusion is substantiated by the high item loading as well as by the *t*-values for the item loadings that indicated significance at the 0.01 level for PFR3, at the 0.005 level for PFR1, and at 0.000 for the other items.

The next step was to evaluate the *discriminant validity* of the constructs. A first test for this is to compare the item loadings on their associated constructs to the cross-loadings with other constructs. A matrix of loadings and cross-loadings was built following the guidelines of Gefen and Straub (2005). Visual inspection of the resulting matrix depicted in Table 5.5 shows that items load higher on the constructs they are supposed to load on (figures shown in bold) compared to the other constructs (seen on the rows of this matrix). This is an indication of adequate discriminant validity (Bontis, Crossan et al. 2002).

Table 5.5 Loadings and Cross-loadings

	PFR	PSR	PRR	PYR	POR	IM	EM	BI
PFR1	**0.969**	0.084	0.193	0.271	0.474	-0.329	-0.193	-0.551
PFR3	**0.711**	0.083	0.059	0.095	0.292	-0.377	-0.432	-0.508
PSR1	0.015	**0.735**	0.125	0.353	0.318	-0.302	-0.244	-0.001
PSR2	0.080	**0.932**	0.145	0.359	0.329	-0.155	0.016	-0.014
PSR3	0.125	**0.924**	0.196	0.527	0.317	-0.111	-0.110	-0.027
PRR1	0.239	0.203	**0.924**	0.655	0.672	-0.122	-0.103	-0.166
PRR2	-0.001	0.052	**0.876**	0.451	0.373	-0.044	-0.062	0.022
PRR3	0.193	0.221	**0.872**	0.471	0.433	0.150	0.102	-0.067
PYR1	0.330	0.395	0.668	**0.887**	0.636	-0.092	-0.211	-0.215
PYR2	0.178	0.447	0.439	**0.924**	0.614	-0.118	-0.119	-0.138
PYR3	0.158	0.500	0.523	**0.911**	0.599	-0.183	-0.178	-0.184
POR1	0.061	0.573	0.570	0.696	**0.724**	-0.139	-0.166	-0.177
POR2	0.565	-0.007	0.379	0.360	**0.778**	-0.338	-0.256	-0.481
POR3	0.484	0.323	0.451	0.585	**0.893**	-0.393	-0.382	-0.428
IM1	-0.329	-0.143	-0.001	-0.077	-0.304	**0.949**	0.462	0.645
IM2	-0.392	-0.274	-0.077	-0.190	-0.430	**0.941**	0.551	0.575
IM3	-0.345	-0.152	0.025	-0.134	-0.309	**0.936**	0.552	0.477
EM1	-0.253	-0.093	-0.106	-0.076	-0.236	0.445	**0.827**	0.304
EM2	-0.246	-0.098	-0.011	-0.147	-0.334	0.554	**0.929**	0.441
EM3	-0.285	-0.094	-0.033	-0.214	-0.360	0.565	**0.973**	0.435
EM4	-0.240	-0.194	0.022	-0.247	-0.302	0.416	**0.888**	0.316
BI1	-0.552	-0.019	-0.058	-0.183	-0.412	0.447	0.622	**0.986**
BI2	-0.627	-0.016	-0.125	-0.211	-0.490	0.382	0.565	**0.985**

A second test for *discriminant validity* is to compare the correlations between the constructs with the square root of the average variance extracted (Turel, Serenko et al. 2007). Table 5.6 synthesizes these data: on the diagonal are the square roots of the AVE values for all constructs in the model, while in the off-diagonal are the correlations between the constructs obtained through the procedure described by Gefen and Straub (2005). Visual inspection of that table shows that the diagonal elements are larger than the off-diagonal (i.e., the variance shared with other constructs). Therefore one can affirm that there is appropriate discriminant validity of the constructs (Igbaria, Parasuraman et al. 1996; Compeau, Higgins et al. 1999).

Table 5.6 Correlations and Average Variance Extracted

	PFR	PSR	PRR	PYR	POR	IM	EM	BI
PFR	**0.850**							
PSR	0.092	**0.868**						
PRR	0.175	0.185	**0.891**					
PYR	0.249	0.492**	0.606**	**0.907**				
POR	0.473**	0.368**	0.576**	0.681**	**0.802**			
IM	-0.283*	-0.128	-0.034	-0.189	-0.345*	**0.942**		
EM	-0.378**	-0.204	-0.021	-0.143	-0.372**	0.554**	**0.906**	
BI	-0.598**	-0.018	-0.092	-0.200	-0.457**	0.421**	0.602**	**0.986**

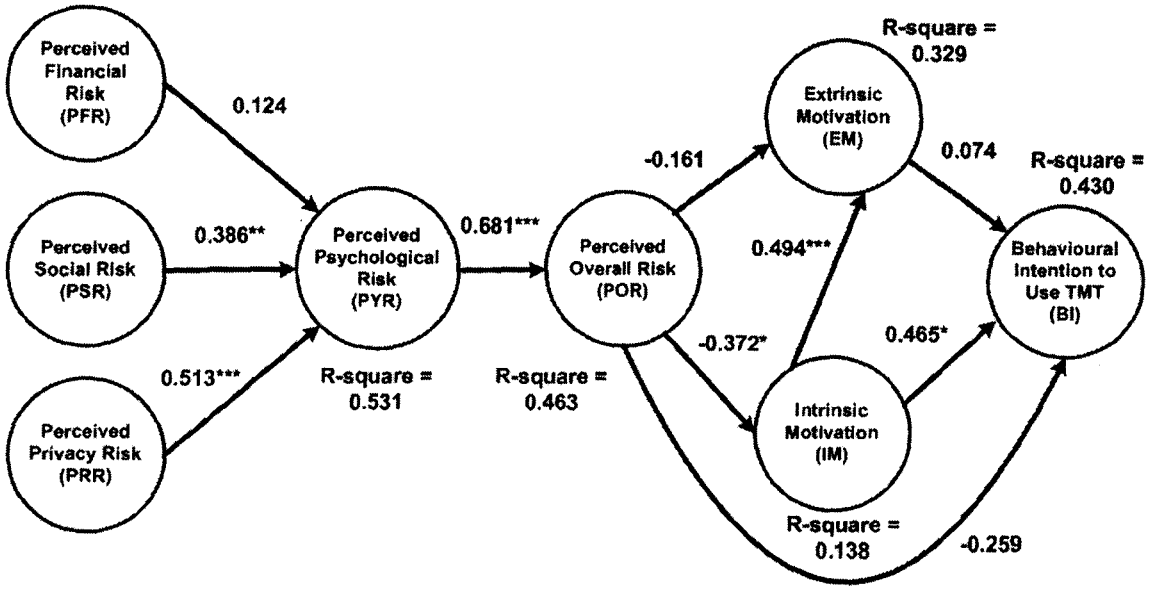
Significance levels: * = 0.05; ** = 0.01

Note: PFR – perceived financial risk, PSR – perceived social risk, PRR – perceived privacy risk, PYR – perceived psychological risk, POR – perceived overall risk, IM – intrinsic motivation, EM – extrinsic motivation, BI – behavioural intention to use

According to the reliability and construct validity analysis, it can be concluded there is some confidence that the model constructs proved to have adequate reliability as well as convergent and discriminant validity.

5.6.3 Structural Model

The structural model was evaluated using PLS-Graph 3.0 with jackknife to estimate the significance of the path coefficients. Figure 5.3 shows the structural model and Table 5.7 the hypothesized path significance testing in the light of the structural model evaluation.



Significance levels: * = 0.05; ** = 0.01; *** = 0.001

Figure 5.3 The Structural Model Evaluation

Table 5.7 Path Significance Tests

Path	Path coefficient	Standard error	*t*-value	Significance level	Test result
PFR-PYR	0.124	0.129	1.010	0.317	rejected
PSR-PYR	0.386	0.121	3.235	0.002	supported
PRR-PYR	0.513	0.101	5.128	0.000	supported
PYR-POR	0.681	0.101	7.047	0.000	supported
POR-IM	-0.372	0.142	2.521	0.015	supported
POR-EM	-0.161	0.139	1.035	0.306	rejected
POR-BI	-0.259	0.150	1.900	0.063	rejected
IM-EM	0.494	0.120	4.258	0.000	supported
IM-BI	0.465	0.175	2.601	0.012	supported
EM-BI	0.074	0.171	0.438	0.663	rejected

According to the results of the evaluation, most of the paths hypothesized in the theoretical model are supported. The model demonstrated that the overall risk perception (POR) is strongly influenced by the perceived psychological risk (PYR) and this, in turn, has perceived social risk (PSR) and perceived privacy risk (PRR) as antecedents. Also, as expected, the overall risk perception diminishes intrinsic motivation (IM) and this latter has a strong effect on extrinsic motivation (EM): if people perceive the enjoyment side of

using a technology for a specific purpose, they also tend to see usefulness in that technology.

The evaluation of the structural model did not support the hypothesized linkages between the perceived financial risk (PFR) and the overall risk perception, or between the extrinsic motivation and overall risk and extrinsic motivation and behavioural intention. This means that the perceived financial risk is not an antecedent of the overall risk in the use of SMS technology for improving adherence to a preventive healthcare activity. Furthermore, extrinsic motivation does not play a role in the adoption picture: adoption intention is positively related to the enjoyment of the activity. Also note that perceived overall risk has a negative effect on the subjects' behavioural intention (BI) to adopt SMS for this activity, although this path is not quite significant.

It is evident from Figure 5.3 that the model demonstrated moderately-high explanatory power. The *R-square* value for the BI construct was 0.430, a level relatively common in many IS studies (Moon and Kim 2001). The values of *R-square* associated with perceived psychological risk, perceived overall risk, and extrinsic motivation were in the same range. The *R-square* for intrinsic motivation is comparatively smaller, but behavioral studies in IS and specifically technology adoption studies often report even lower values for *R-square*, according to the Moon and Kim study.

5.6.4 Saturated Model

The theoretical model proposed by this work was intended for application in explaining the possible adoption of a relatively new technology in a totally new area. The model is at the intersection of consumer behaviour studies and technology adoption studies, where an imperfect theoretical foundation exists, especially in terms of the influence of perceived risk on adoption intention. It is therefore fully justified to test a saturated model so as to explore in depth all the possible links between the model constructs. In the fully saturated model there are an additional 18 paths between constructs. All the paths (initial and additional) were simultaneously evaluated through the PLS program and the results are presented in Tables 5.8 and 5.9.

Table 5.8 Significance Tests in the Saturated Model for Paths in the Initial Model

Path	Initial Model			Saturated Model			Absolute change of path coefficient
	Path coefficient	*t*-value	Test result	Path coefficient	*t*-value	Test result	
PFR-PYR	0.124	1.010	rejected	0.095	0.985	rejected	0.029
PSR-PYR	0.386	3.235	supported	0.377	3.214	supported	0.009
PRR-PYR	0.513	5.128	supported	0.526	4.974	supported	0.013
PYR-POR	*0.681*	*7.047*	supported	*0.397*	*2.202*	supported	*0.284*
POR-IM	-0.372	2.521	*supported*	-0.415	1.636	*rejected*	0.043
POR-EM	-0.161	1.035	rejected	-0.155	0.981	rejected	0.006
POR-BI	-0.259	1.900	rejected	-0.234	1.542	rejected	0.025
IM-EM	0.494	4.258	supported	0.452	2.432	supported	0.042
IM-BI	0.465	2.601	supported	0.401	2.142	supported	0.064
EM-BI	0.074	0.438	rejected	0.008	0.047	rejected	0.066

Examination of the data in Table 5.8 shows that, in the saturated model compared to the initial model, the paths tended to maintain about the same values for the coefficients and levels of significance. However, there are a few remarkable differences:

- the PYR-POR coefficient link, while remaining significant, dramatically decreased from 0.681 to 0.397 and its *t*-value from 7.047 to 2.202; and,
- without suffering much change in the coefficient value, the path POR-IM lost its significance.

These changes can be better understood by examining Table 5.9. In that table, notice the appearance in the saturated model of two strong links with moderately high coefficients (above 0.3), both significant at the 0.05 level. This means that the saturated model showed a direct and relatively strong influence of the perceived financial risk over perceived overall risk and even over behavioural intention. Since a part of the influence of PFR is exercised directly on POR and another part on BI, the PYR-POR link lost its strength and significance. The change in significance of the path POR-IM (not so important when examining the associated *t*-value) can be explained mostly by the way PLS analyzes data. Thus, PLS attempts to optimize the variance explained by all the constructs in the model. This causes a redistribution of the path coefficients when new paths are added to the model, as in the case of the saturated model.

Table 5.9 Significance Tests for New Paths in the Saturated Model

Path	Path coefficient	*t*-value	Significance level	Test result
PFR-PSR	0.096	0.484	0.631	rejected
PFR-PRR	0.141	0.710	0.481	rejected
PFR-POR	0.322	2.063	0.044	*supported*
PFR-IM	-0.261	1.490	0.143	rejected
PFR-EM	-0.103	0.553	0.583	rejected
PFR-BI	-0.358	2.236	0.030	*supported*
PSR-PRR	0.175	0.846	0.402	rejected
PSR-POR	0.078	0.395	0.695	rejected
PSR-IM	-0.154	0.525	0.602	rejected
PSR-EM	0.053	0.194	0.847	rejected
PSR-BI	0.205	1.251	0.217	rejected
PRR-POR	0.268	1.530	0.132	rejected
PRR-IM	0.198	1.195	0.238	rejected
PRR-EM	0.144	0.620	0.538	rejected
PRR-BI	0.108	0.776	0.441	rejected
PYR-IM	0.143	0.150	0.881	rejected
PYR-EM	-0.115	0.085	0.993	rejected
PYR-BI	-0.073	0.327	0.745	rejected

In terms of *R-square* values the saturated model generated the changes captured in Table 5.10 below. The saturated model had an increase in variance explained for the perceived overall risk and for the final construct, the behavioural intention to adopt the technology.

Table 5.10 Variance Explained Values in the Initial Model and Saturated Model

	PYR	POR	IM	EM	BI
Initial model	0.531	0.463	0.138	0.329	0.430
Saturated model	0.526	0.595	0.271	0.349	0.572

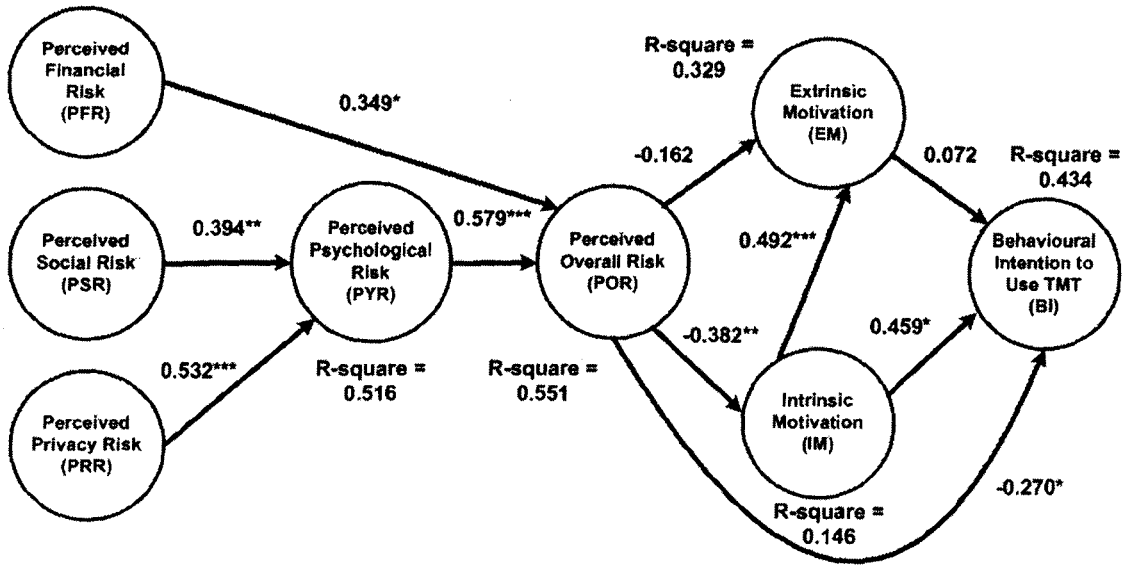
From the data above it appears that the new direct paths PFR-POR and PFR-BI have a significant influence on the theoretical model. In their seminal paper that

introduced multi-item constructs for the facets of perceived risk, Stone and Grønhaug (1993) report indeed that during several trials they found a strong direct path between financial risk and overall risk. They called for future research to explore this possible link since it does not match their theoretical model, where PYR mediates the influence of all the other risk facets.

The present study may offer an explanation for such a link: in some situations the influence of the financial side is so important that it overshadows the other facets of the perceived risk. This may be the case here: as study participants are young healthy individuals for whom a prophylactic intervention using a common pill (i.e., vitamin C) would not make a big difference, aspects such as social risk or privacy risk are less of a concern. Also, as the individuals did not actually subscribe to a plan involving this type of intervention for a longer period of time, perceived psychological risk that would capture possible concerns in making a choice is again less of a concern. But since all the participants have cell phone experience and know that any cell phone activity costs money, their financial concerns are very strong. This may explain the direct influence of the perceived financial risk on the overall risk and, possibly, on behavioural intention.

5.6.5 Improved Theoretical Model

Due to the strength and significance of the new paths PFR-POR and PFR-BI, as well as to the increase of the *R-square* value for BI from 0.430 to 0.572 for the saturated model, several new models were tested, with the intent of identifying a better model that would have a maximum gain in terms of *R-square* but with a minimum of new paths added (i.e., to maintain parsimony). After several trials the best model was found to meet these two contradictory demands while maintaining the theoretical support of previous work reported by Stone and Grønhaug (1993) and Featherman and Pavlou (2003). This model was obtained by replacing the direct non-significant path between PFR and PYR with the significant and relatively strong path between PFR and POR. This is in accordance with Stone and Grønhaug (1993), so it has some theoretical support. With these changes, the improved model appears in Figure 5.4.



Significance levels: * = 0.05; ** = 0.01; *** = 0.001

Figure 5.4 Evaluation of Improved Theoretical Model

The improved model can be termed as superior to the original model because three out of five endogenous constructs (including BI) have higher *R-square* values and, further, there are more significant paths at higher significance levels. Of special attention are the new significant path between PFR and POR as well as the path POR-BI which becomes significant at the 0.05 level. This improved model corresponds to the recommendations in the literature regarding a good model: it should have significant relationships between the constructs and high *R-square values* (Bontis 1998; Bontis, Keow et al. 2000).

A visual inspection of the loadings of the outer model for the improved theoretical model revealed virtually identical loadings and levels of significance compared to the original model. Namely, the difference in loadings was below 1% for all items except those of PFR and POR, which displayed 1 to 8% higher loadings. Furthermore, AVE values for all constructs were identical to those in the original model except for PFR which AVE increased from 0.723 to 0.748. Therefore, since virtually no alterations of the outer model occurred and changes, if any, took place in a favourable direction, it was not necessary to rerun the entire structural analysis of the improved model. This improved model, which is a slightly different form of the proposed theoretical model and has also a theoretical justification in the literature, ***is the basis for the analysis that follows***.

5.6.6 Hypotheses Tests

Hypothesis *H1* states that perceived overall risk will be explained by perceived psychological, financial, social, and privacy risk. In the current model these risk facets explain about 55.1% of the variance of the overall risk, which is lower than the Stone and Grønhaug (1993) results where individual risk facets explained 88.8% of the overall risk.

The value is also smaller than those in other consumer behaviour studies. For instance, Kaplan and collaborators (1974) reported 73-74% and Brooker (1984) found 62.9% of the variance of the overall risk was explained by the risk facets. Referring to the originally tested model (Figure 5.3), *R-square* for POR was even less, at 46.3%. It is therefore concluded that *H1* can only be partially supported. Possibly some other risk facets not taken into account in the current study (such as performance or time risk) account for the unexplained variance.

Hypothesis *H2* states that perceived psychological risk will be correlated with perceived financial, social, and privacy risk. From data depicted in Table 5.6 (which remains valid for the improved model) PYR is indeed strongly correlated with PSR (correlation coefficient = 0.492 significance level = 0.05) and with PRR (correlation coefficient = 0.606 significance level = 0.05) but not with PFR (correlation coefficient = 0.249 not significant). This may have the same explanation as described above regarding the direct link between PFR and POR that was also discovered by Stone and Grønhaug (1993) in some of their studies. Therefore it is concluded that *H2* can only be partially supported (and there is no differentiation between the original and improved models).

Hypothesis *H3* states that perceived financial, social, and privacy risks will be mediated through perceived psychological risk, to influence perceived overall risk. In the initial model (where there is a non-significant path between PFR and PYR) and in the improved model (where there is no path between PFR and PYR) the psychological risk does not mediate the influence of the financial risk. The mediation effect was nonetheless tested for the two other risk facets, PSR and PRR. The procedure follows the steps described by Cocosila, Turel, Archer et al. (2006) by applying the Baron and Kenny procedure (Baron and Kenny 1986).

A model with direct links between PSR and POR as well as PRR and POR but no links between PSR and PYR and PRR and PYR was run first. Data regarding the path coefficients and their standard errors were compared with corresponding data from the improved theoretical model as well as from a model with all the links between PSR, PYR, and POR on one side and PRR, PYR, and POR on the other side. In addition, a visual inspection of the factor loadings of all models was conducted as a check for the compatibility of the tested constructs. This would ensure that changes in path coefficients would result from structural differences and not from differences in the measurement model. The results are depicted in Table 5.11.

Table 5.11 Results of Mediation Tests

Model tested	Path	Path coefficient	Standard error	*t*-value	Significance level
Direct links PSR-POR PRR-POR	PSR-POR	0.221	0.135	1.674	n.s.
	PRR-POR	0.468	0.126	3.685	0.001
Theoretical model	PSR-PYR	0.394	0.126	3.202	0.01
	PRR-PYR	0.532	0.093	5.455	0.001
All-links model	PSR-PYR	0.388	0.127	3.185	0.01
	PSR-POR	0.076	0.150	0.541	n.s.
	PYR-POR	0.389	0.177	2.068	0.05
	PRR-PYR	0.537	0.093	5.808	0.001
	PRR-POR	0.265	0.199	1.670	n.s.
	PYR-POR	0.389	0.177	2.068	0.05

An examination of Table 5.11 shows that the direct path between PSR and POR is not significant, whereas the indirect path through PYR is. Therefore PYR fully mediates the effect of the perceived social risk on the perceived overall risk. Regarding PRR, the direct path to POR is significant but when the mediator PYR is added, this path becomes non-significant. To check for possible partial mediation (Sobel 1982; MacKinnon, Lockwood et al. 2002) a Sobel test was performed, using the formula at *http://www.psych.ku.edu/preacher/sobel/sobel.htm*. The test yielded a value of 2.05, significant at the 0.05 level. This suggests that the full mediation of PYR is significant for the link between PRR and POR. Since PYR is fully mediating the links between PSR and POR as well as between PRR and POR, but does not mediate the effect of PFR hypothesis *H3* is only partially supported.

Hypotheses *H4*, stating that perceived overall risk will reduce intrinsic motivation, and *H6*, that intrinsic motivation will have a positive effect on extrinsic motivation, are supported by highly significant links in the theoretical model, as shown in Figure 5.4. Hypotheses *H7a*, according to which intrinsic motivation will have a positive direct effect on behavioural intention, and *H7c*, stating that perceived overall risk will have a negative direct effect on behavioural intention, are equally supported.

Hypothesis *H5*, that perceived overall risk will decrease extrinsic motivation, is not supported due to the non-significance of the path between POR and EM. The path linking EM and BI is also non-significant and this leads to the rejection of hypothesis *H7b*, which states that extrinsic motivation will have a positive direct effect on behavioural intention. A common interpretation of the results for hypotheses *H5* and *H7b* shows that extrinsic motivation plays a non-significant role in this model due to the fact

that the participants in the experiment were young healthy individuals who did not see an obvious usefulness of such a prophylactic intervention.

The situation might change when dealing with ill participants for whom the extrinsic motivation to use such a mobile application would be completely different. Therefore it is believed that the model maintains its generality, despite the fact that paths leading to and from EM are not significant.

Another important conclusion is that when people perceive a sufficiently high enjoyment by using a technology, this may be enough to lead to its adoption, although its usefulness is not apparent. This may lead to suggestions for educational interventions regarding new IT in healthcare where, by making things more pleasant, some behavioural changes could be induced although end-users might doubt their usefulness.

5.6.7 Effect Size

A refinement of the *R-square* analysis is to look at the individual effect of the independent variables on the dependent variables, thus having a better picture of the predictive power of the theoretical model. *Predictive power* (or the *impact*, or the *effect size*) of the independent variables on the dependent variables can be explained by a formula introduced by Chin (1998):

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}} \tag{5.2}$$

where $R^2_{included}$ is the R^2 value when the independent construct is included in the model and $R^2_{excluded}$ when this construct is not included in the model. Step values for f^2 recommended by Chin (1998) based on Cohen's (1988) work are: 0.02 for *small*, 0.15 for *medium*, and 0.35 for *large effect* of the predictor at a structural level. This analysis is useful in determining if a single independent variable has a significant influence on the predictive power of the dependent variable. Predictive power was calculated in turn for PYR, POR, and BI (i.e., all the nodes with at least two significant paths leading to them) by removing one link going into each of those nodes in turn and running the model in order to record the *R-square* values for the three constructs. The values obtained are presented in Table 5.12.

Table 5.12 Size Effects on the Endogenous Constructs

Dependent variable			Independent variables	
PYR	$R^2_{included}$	0.516	**PSR**	**PRR**
	$R^2_{excluded}$	→	0.370	0.244
	f^2	→	0.30	0.56
	Effect	→	medium	large
POR	$R^2_{included}$	0.551	**PFR**	**PYR**
	$R^2_{excluded}$	→	0.463	0.285
	f^2	→	0.19	0.59
	Effect	→	medium	large
BI	$R^2_{included}$	0.434	**POR**	**IM**
	$R^2_{excluded}$	→	0.375	0.297
	f^2	→	0.10	0.24
	Effect	→	small	medium

The calculated values for f^2 show that privacy (PRR) is most important for the psychological risk (PYR), psychological risk most important for the overall risk (POR), and intrinsic motivation (IM) most important for behavioural intention (BI) to adopt SMS in adherence improving interventions.

5.6.8 Influence of Control Variables

The impact of the control variables in the model is analyzed by adding separately one control variable into the model at a time. Their influence is then detected by comparing the *R-square* values for all the endogenous constructs with the values corresponding to the uncontrolled model.

A special discussion is needed here for attitude toward adherence, which is a four-item construct. A preliminary analysis of Cronbach's alpha indicated a value of 0.740. However, when running the PLS model with this construct included, its AVE was only 0.470, with a loading of the fourth item of only 0.290 and a *t*-value of 0.773. After dropping this item and re-running SPSS and PLS, Cronbach's alpha increased to 0.768 and the AVE to 0.592 so the measure was considered to have acceptable reliability and convergent validity. A visual inspection of the loadings and AVE values for the constructs in the theoretical model revealed virtually no changes, compared to the uncontrolled situation. Therefore it was concluded that the introduction of attitude toward adherence does not affect the measurement model and changes in *R-square* come mostly from structural changes. Table 5.13 synthesizes the results obtained in terms of *R-square* values.

Table 5.13 Variances Explained in the Uncontrolled and Controlled Model

Control variables	PYR	POR	IM	EM	BI
Uncontrolled model	0.516	0.551	0.146	0.329	0.434
Attitude toward adherence	0.520	0.558	0.159	0.399	0.489
Gender	0.512	0.576	0.210	0.360	0.437
SMS experience	0.520	0.551	0.147	0.330	0.434

The results indicate that SMS experience had virtually no influence on dependencies in the model. The influences of the other two control variables are marginal with some noticeable exceptions. Attitude toward adherence improved more substantially the *R-square* of EM and BI and gender that of IM, so a further analysis was undertaken for the path coefficients and their significance. Data for this analysis are captured in Table 5.14.

Table 5.14 Path Coefficients Between the Control Variables and the Endogenous Constructs in the Controlled Model

Control variables		PYR	POR	IM	EM	BI
Attitude toward adherence	**Path coefficient**	0.067	-0.098	0.117	0.273	0.255
	***t*-value**	0.871	1.045	0.464	2.020	2.835
	Significance	n.s.	n.s.	n.s.	0.05	0.01
Gender	**Path coefficient**	-0.025	0.155	0.264	0.189	-0.065
	***t*-value**	0.123	1.370	1.870	1.428	0.453
	Significance	n.s.	n.s.	n.s.	n.s.	n.s.
SMS experience	**Path coefficient**	-0.054	0.017	0.036	-0.034	-0.004
	***t*-value**	0.445	0.045	0.341	0.208	0.059
	Significance	n.s.	n.s.	n.s.	n.s.	n.s.

The table shows that attitude toward adherence has a positive direct influence on EM and on BI. Therefore, as people tend to see the benefits of taking vitamin C they also tend to see usefulness in a service like TMT and to adopt such a service. The path coefficient analysis confirmed that gender and SMS experience play no role in the adoption of SMS for use in adherence-improving initiatives.

Another test was for age as a possible influencer. Although age was not considered a potential control variable for this study because the participants were in a

relatively narrow age range, a test for age as a possible control variable was also performed since age is usually tested in this posture in many studies. The results showed that age had no influence on the model: the changes in *R-square* values for the endogenous constructs were below 2% and all the paths leading to these constructs were non-significant.

5.7 Qualitative IS Study

The goal of the qualitative IS study was to enrich the findings of the quantitative study by both deepening and widening the findings of the quantitative study. Participants in the intervention group were asked to answer the following questions at the end of the study:

Q1: Indicate as many as three reasons why you WOULD LIKE to use TMT;

Q2: Indicate as many as three reasons why you WOULD NOT LIKE to use TMT;

Q3: Based on your experience with taking vitamin C and this study, please provide recommendations for the designers of a system like TMT;

Q4: Please indicate other thoughts, concerns, and recommendations about TMT.

The analysis of these questions was done through content analysis, for which four separate codebooks (presented in Appendix J) were developed. Since the first two of the above questions refer to technology adoption issues, and since the aim of the qualitative study was to complement the quantitative study, the codebooks for these questions were developed starting from the theoretical model of this study and other technology adoption studies. Codebooks began with several large categories at the first level. Then these categories were discretized into level-two and these latter, in turn, into level-three categories through an iterative process that required several rounds of group splitting and merging. The general philosophy was to keep the categories aligned with concepts and constructs in the existing IS literature and previous mobile commerce studies (Miles and Huberman 1994).

The codebooks for questions Q3 and Q4 were developed with a starting point from the first two questions, having in mind the idea that respondents would very likely provide recommendations and express thoughts and concerns related to what they liked or did not like about the system. The same iterative process was conducted in several rounds so as to provide codebooks anchored both in the IS literature and in the specifics of this study.

Following the idea that the qualitative study should enrich the quantitative study, the responses from the 51 participants in the intervention group were taken into account in the content analysis. Following the principles of classical content analysis, their responses to the four questions were broken into smaller text units that still had independent meanings (many respondents included several ideas in the same responses

they gave) and were assigned only one code from the lower level of the corresponding codebook. For reliability issues, coding was performed by three independent coders and the results were evaluated with the Krippendorff's agreement coefficient (Krippendorff 1980). All discrepancies were discussed and solved by reaching agreement on classifications. For those without a clear category, 'Other' was used. The Krippendorff agreement coefficients for the four questions were found to be above the minimum standard of 0.7, around the desired level 0.8-0.9 what proves a corresponding level of reliability (Table 5.15). The codebooks developed are presented in Appendix H.

Table 5.15 Krippendorff Agreement Coefficients

	Q1	Q2	Q3	Q4
Krippendorff Agreement Coefficients	0.79	0.78	0.83	0.78

The results obtained for the four questions are presented in the following.

5.7.1 Reasons for Using TMT

Q1: Indicate as many as three reasons why you WOULD LIKE to use TMT. A total of 102 reasons to use TMT were indicated by 47 of the 51 participants in the intervention group. Figure 5.5 represents the distribution of the reasons at level 1, and Table 5.16 the reasons at coding level 3.

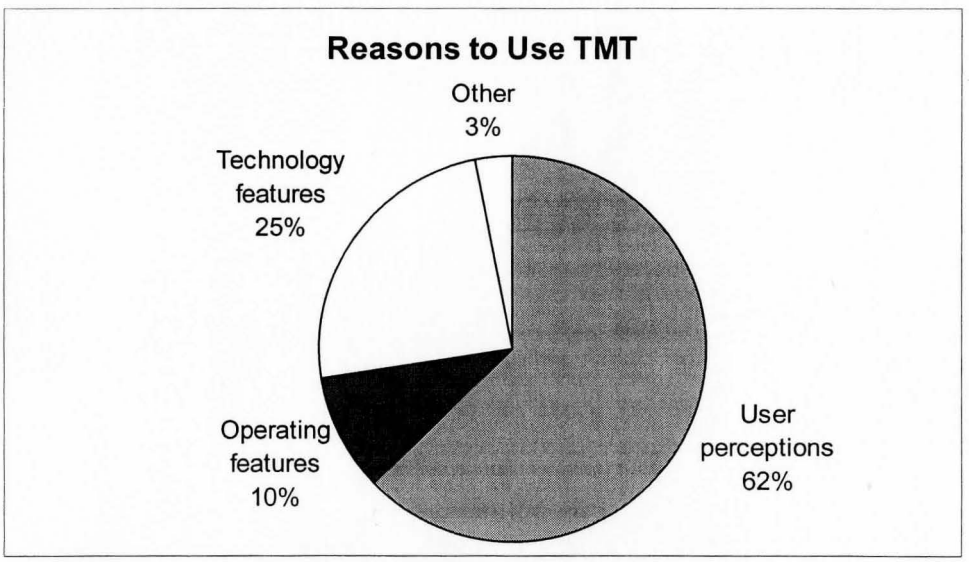


Figure 5.5 Reasons to Use TMT (First level)

Table 5.16 Reasons to Use TMT (Third level)

Reason	Percentage	Absolute number
Usefulness	40%	41
Easy to use	12%	12
Handiness	9%	9
Enjoyable	6%	6
Low cost	6%	6
Superiority to other channels	5%	5
Social interaction	4%	4
Pervasiveness	4%	4
Non-intrusiveness	3%	3
Organizing	2%	2
Attractive	2%	2
Trendy	2%	2
Operating type	1%	1
Consistence	1%	1
Confidence	1%	1
Other	3%	3
Total	**100%**	**102**

By far the most important reason participants would like to use TMT is its perceived usefulness. Forty percent of the people provided answers like (in the square brackets, *I* denotes the intervention group and the number is the number of the record):

[I 3] "to keep me healthy"

[I 9] "vit c tablets are good for me but i keep forgetting. This would help."

[I 46] "its a good reminder"

Other high frequencies in the level 1 category of user perceptions (which represents 62% of the total) were recorded for ease of use and intrinsic motivation (perceived enjoyment especially):

[I 11] "jokes were actually somewhat funny"

[I 21] "- fun messages&- easy to use"

[I 29] "- simple&- fun"

Technology features like convenience, consistence, and low cost were the second important reason of possible future use at level 1:

[I 8] "Convienient & Simple & Consistent"

[I 31] "Seems like a very cheap service."

[I 35] "- phone always around"

Of the operating features, participants appreciated more the social interaction and non-intrusiveness, seeing TMT like an SMS service:

[I 15] "can text message during any time (ie. when you or the receiver are in class or busy) and you know the other person will receive the message"

[I 31] "Is very unobtrusive, does not interupt my day to day activities."

5.7.2 Reasons for Not Using TMT

Q2: Indicate as many as three reasons why you WOULD NOT LIKE to use TMT. A total of 93 reasons to not use TMT were provided by 47 of the 51 respondents. Figure 5.6 shows the percentages of the level 1 reasons and Table 5.17 the numbers and percentages of the level 3 reasons.

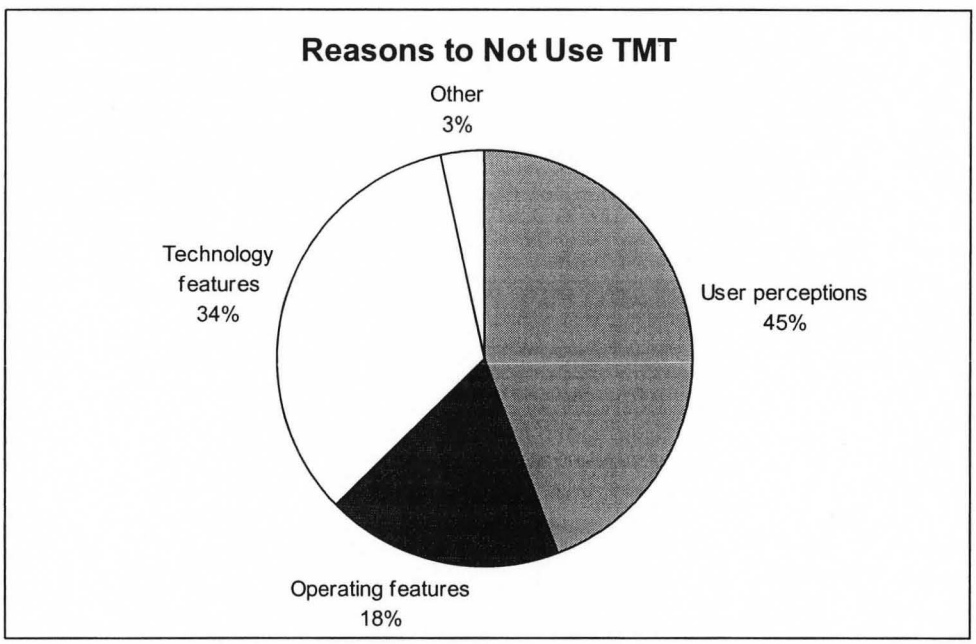


Figure 5.6 Reasons to Not Use TMT (First level)

Table 5.17 Reasons to Not Use TMT (Third level)

Reason	Percentage	Absolute number
Cost	26%	24
Annoyance	22%	20
Lack of usefulness	9%	8
Not easy to use	8%	7
Social issues	6%	6
Intrusive	5%	5
Inferiority to other channels	4%	4
Time consuming	4%	4
Lack of confidence	3%	3
Unattractiveness	2%	2
Operating type	2%	2
Not handy	2%	2
Not pervasive	2%	2
Burden	1%	1
Other	3%	3
Total	**100%**	**93**

An examination of the proportions in the above-mentioned figure and table shows that the large majority of the reasons gravitated around two topics: annoyance (or absence of enjoyment) from the user perception category, and financial issues from the technology features category. Here are some sample responses:

[I 4] "After a while it is annoying. & Cost"

[I 7] "Multiple messages a day are annoying."

[I 11] "if it costs too much"

Perceived lack of usefulness and ease of use, both belonging to the user perceptions level 1 category, come next in terms of frequency:

[I 10] "takes time to type a msg."

[I 12] "dont' feel that i would need such a service"

[I 13] "I don't take a regular pill or medication"

Other reasons mentioned with smaller frequency refer to social issues (like the lack of privacy or embarrassment), intrusiveness in people's daily schedules, and the time consumed with text messaging. Some people remarked on the imperfections of cell phone

and SMS technology like the absence of the 100% connectivity, and the lack of confirmation about the actual delivery of the SMS messages.

5.7.3 Recommendations for Designers of TMT

Q3: Based on your experience with taking vitamin C and this study, please provide recommendations for the designers of a system like TMT. Of the 51 participants in the intervention group, 33 offered recommendations for the designers of a future system like TMT. Five said they liked the system as they used it, and 13 did not have any recommendations. Sixty-two recommendations were received in total. Their frequency per level 1 category is shown in Figure 5.7 and per level 3 category in Table 5.18.

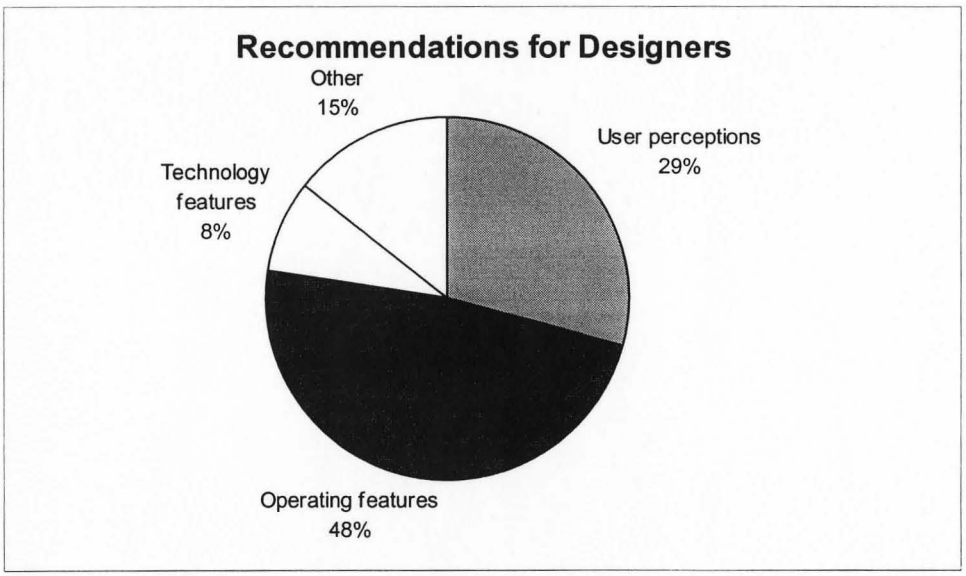


Figure 5.7 Recommendations for the Designers of a System like TMT (First level)

Table 5.18 Recommendations for the Designers of a System like TMT (Third level)

Recommendation	Percentage	Absolute number
Message flexibility	15%	9
Message timing	11%	7
Message content	10%	6
Enjoyment	10%	6
Message frequency	10%	6
Attractiveness	6%	4
One-way messaging	5%	3
Low cost	5%	3
Other social targets	5%	3
Free service	3%	2
Ease of use	3%	2
Privacy	2%	1
Feedback	2%	1
Other	15%	9
Total	**100%**	**62**

The results show that message flexibility was the most frequent recommendation. Participants felt that having the possibility to customize the reminders in terms of content or timing would be desirable:

[I 8] "Allow people to set up the time they recieve the message"

[I 22] "be able to customize the message and what time it would be sent. like with a online form or website"

The second most frequent recommendation was the timing of the messages. Although some people mentioned the possibility of choosing their own time, many of the suggestions in this category suggested a fixed daily time for messages:

[I 5] "It would be better to get the SAME message at the SAME time everyday."

[I 7] "Allow users to choose times for different pills/vitamins. Repeat at the same time daily."

This type of recommendation is somewhat surprising since randomness of the timing of messages was supposed to decrease the boredom, according to early implementations of similar systems (Franklin, Waller et al. 2003). The surprise is augmented by the next most frequent categories of recommendations: message content and enjoyment. Based on early attempts to implement similar systems and reduce

boredom, messages were designed to be enjoyable and in a non-pretentious language (Neville, Greene et al. 2002). Several participants recommended more enjoyable content in a more professional language.

[I 43] "Please make the TMT system less of a teenager and more professional."

[I 50] "the jokes could be a little better!"

In terms of message frequency the most recurrent recommendation was to send a maximum of one or two messages per day, which in fact was provided by the application tested:

[I 18] "Send just one or two messages a day"

Other recommendations regarded the attractiveness (e.g., transmitting the messages with images or voice clips), one-way messaging (not requiring participant responses), low or no cost, clearer text, increased privacy, or no feedback from the system. Although some recommendations like low cost or increased privacy are desirable features, others (like one-way messaging or no feedback) conflict with the philosophy of adherence-improving interventions. There were three recommendations to use the system for other areas, targeting ill people on medication.

5.7.4 Other Thoughts, Concerns, and Recommendations

Q4: Please indicate other thoughts, concerns, and recommendations about TMT. Twenty three of the 51 participants provided further thoughts about the system. In total 39 distinct thoughts were isolated. Their frequency per level 1 category is shown in Figure 5.8 and per level 3 category in Table 5.19.

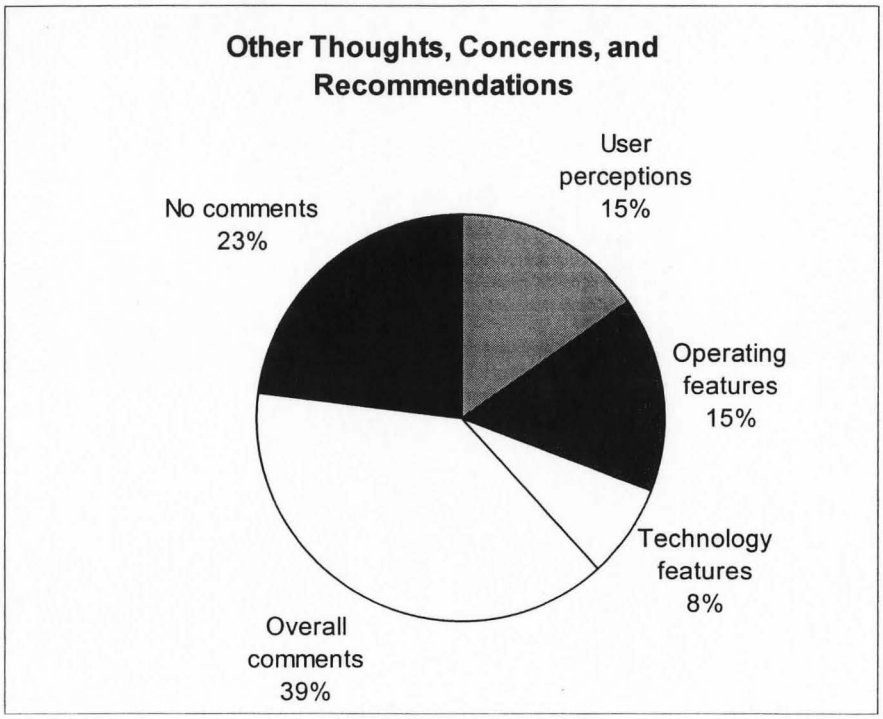


Figure 5.8 Other Thoughts, Concerns, and Recommendations About TMT (First level)

Table 5.19 Other Thoughts, Concerns, and Recommendations About TMT (Third level)

Thoughts, concerns, recommendations	Percentage	Absolute number
Appreciative	33%	13
Content	8%	3
Enjoyment	5%	2
Other social targets	5%	2
Customization	5%	2
Other approach	5%	2
Concerned	5%	2
Attractiveness	3%	1
Privacy	3%	1
Frequency	3%	1
Cost	3%	1
No comments	23%	9
Total	**100%**	**39**

The most frequent type of comments or thoughts were the appreciative ones:

[I 2] "none, it was a good experience."

[I 4] "Overall it encouraged my to take my vitamin C"

[I 13] "I enjoyed the study and see a use for TMT, but maybe not for me."

Only two comments were dubious about the system:

[I 5] "The effectiveness of the system also has to do with whether people are honest."

[I 40] "It was not very effective for me. Answering the message did not mean that I actually took vitamin C."

The last two comments showed these participants understood accurately the fundamentals of a system like TMT: it depends on peoples' honesty. However, it is presumed that people are honest in matters regarding their own health.

Other low-frequency comments were mostly suggestions regarding an increased diversity of the message content, better jokes and more attractive presentations, and customization of messaging. Two comments suggested using some alarm features on cell phones instead of messaging and two comments, as an extension of the recommendation for designers questions, saw usefulness of the system for some categories of people:

[I 37] "I think it is a viable system for people who are frequent cell phone users. It may not be suitable for the current cohort of elderly, who may use cell phones but not text message, but this is likely to change quickly"

Nine participants did not express any comments regarding the system or its use.

5.7.5 Reliability of the Findings

Besides the high inter-rater reliability found following the coding by the three coders (Table 5.15), a supplementary verification was to test if any change in the distribution of the responses into categories occurs with sample size. For that a split-half method was used. Responses from the open-ended questions were divided into two equal parts, according to the order of completing the questionnaire. Responses in the first half were coded according to the first level category and the results were compared to those similar for the entire sample. The results for the first two questions are presented in the Tables 5.20 and 5.21. Percent summations of all categories may not always lead to 100 because of the rounding.

Table 5.20 Reasons to Use TMT (Split-half comparison of first level)

Group	User perceptions	Operating features	Technology features	Other
Half-sample	62%	11%	24%	3%
Full-sample	62%	10%	25%	4%

Table 5.21 Reasons to Not Use TMT (Split-half comparison of first level)

Group	User perceptions	Operating features	Technology features	Other
Half-sample	51%	13%	31%	4%
Full-sample	45%	18%	34%	3%

The results show quite close distributions at the first level categories for half-sample and full sample. This allows to conclude that theoretical saturation was reached - i.e., the adding of new responses would not significantly change the distribution per categories, and, hence, the conclusions of the qualitative study. The method could not be applied for the responses to the last two questions because of the too small sample size, which by splitting comes to 30 statements or less.

5.7.6 Validity of the Findings

First, in order to perform a test for data validity in the qualitative IS study, responses to the four questions were visually compared. Thus it was expected that the same persons would not indicate the same reasons to use and to not use a system like TMT. Indeed this was the not case and people provided generally opposite reasons for liking or not liking the system.

Second, it was expected that there would be some correlation between the reasons individuals would not use TMT and their suggestions for designers, and even with other thoughts, concerns, and recommendations. Indeed, several individuals reiterated the same themes (e.g., usefulness, privacy, and cost) throughout two or three of their answers. These checks give some confidence in the validity of the qualitative data. A further check is concordance with quantitative data, which is discussed more extensively in Chapter 6.

5.7.7 Thoughts of the Control Group Participants

Recall that for possibly enriching the answer to the question '**Why** people would use a system like TMT', participants in the control group were asked at endpoint: "*If you had received about one SMS per day reminding you in an enjoyable manner, from a virtual friend called Tim, to take your vitamin C pills (e.g., Tim here: Took Ur vitamin C 2day?), do you think such messages would have helped or bothered you? Why?*". Of the 48 participants completing the study in the control group, 36 answered this question. The answers were overwhelmingly positive: 27 people (i.e., 75%) thought such messages

would have helped and only 2 (i.e., 5%) saw them as useless. The remainder of the respondents provided answers not related to the question.

Some thoughts of the control group participants may provide interesting feedback if judged in accordance with the philosophy of TMT (in the square brackets, *C* denotes the control group and the number is the number of the record):

> *[C 6] "It would have bothered me if I had already made a habit of taking the vit. C., but would have helped if I'd had trouble remembering."*
>
> *[C 8] "these messages would act as incentives for people to take their vit c."*
>
> *[C 11] "Yes it would have help since an SMS reminder is a non-intrusive form of reminder."*
>
> *[C 12] "maybe it'd be a good idea to have SMS for a while and when you start remembering on your own you can turn off the reminders."*
>
> *[C 16] "Such messages would have helped me at the beginning of the experiment by allowing me to create a habitual pattern. Consequently, the number of missed vitamin C pills taken per day over the course of the experiment would have been substantially smaller. However, those messages would have been intrusive towards the end if a pattern of daily pill in-take has already been established."*

Therefore participants thought reminders would have been useful, if not intruding. Thus they thought reminders would be helpful especially in the beginning of a treatment and less important after some time (i.e., when some patterns of pill consumption have been formed). Also, one participant saw TMT as a virtual link with a remote care provider:

> *[C 5] "I think it would have helped because it would be reassuring to know that someone else was making sure you took your pill."*

Overall, these thoughts increase the confidence that the design of the system and experiment were appropriate, as a starting point, at least. Indeed, the system was thought to be enjoyable and non-intrusive. To decrease the possible disturbing of the participants, the frequency of the reminders was decreased in time. Also, the use of a virtual friend gave TMT some personality, as though a remote caring person and not a rigid software application were at the other end of the communication channel.

5.7.8 Feedback on the Questionnaires

Although the data collected in feedback about the questionnaires refers to the whole study, results are presented here since the type of questions resemble those used in the qualitative IS study. Feedback about the questionnaires was requested in the baseline questionnaire. They were not repeated in the post-survey questionnaire because the latter was basically a shorter version of the baseline questionnaire for the intervention group and only a four-question survey for the control group. Furthermore, the results collected through the baseline questionnaire did not give any reasons for concern.

Of the 311 respondents to the baseline survey 15 answered "yes" to the question "*Did you experience any difficulties in understanding the information for this survey?*". Just a few reasons for answering affirmatively were provided: "*English is my second language*", "*some of the questions seemed pretty repetative in the agree disagree part*", "*why vit C, why not something more serious*", "*wordy*", "*weird questions (repetitive)*", "*poorly worded, confusing*".

Twenty participants answered "yes" to the question "*Did you experience difficulties in understanding any of the questions in this survey?*". Some of the reasons were: "*Some questions are extremely vague*", "*often survey questions are too wordy*", "*poor grammar*", "*I don't see the relevance to some questions*", "*Some were a little too repetitive*".

Finally, 17 participants answered "yes" to the question "*Do you have any comments regarding the content, design, or administration of this survey?*". Some of the explanations were: "*some questrions seem to be similar*", "*make it shorter*", "*why so many repetitive questions*", "*don't repet questions*", "*make the spaces larger*", "*some questions lead me to ask more questions*", "*too long*", "*very repetitive* ", "*refer to a drug other then vit C - it loses its relevance when the medication is unimportant*".

Besides these, there were a few appreciative comments for all of the three questions above: "*concise and easy to fill out*", "*all is good*", "*Very well designed*", "*very clear and to the point*", "*very informative*", "*well organized*", "*prett straight forward*". Taking into account all of the above, it was considered that the questionnaires were adequate. They were therefore used in the post-study survey as well, with minimal changes in terms of layout. The fact that an overwhelming proportion of the participants indicated that they did not have problems with the survey verified that they had the appropriate knowledge to answer the questions.

5.8 Time and Cost Considerations

The business study part of this work regards some cost issues with the use of SMS in adherence-improving initiatives. Cost issues were examined *exclusively from the end user point of view*: how much users would be willing to pay for such a service and how long they would continue in such a program, whether or not the usage was free. Data were collected through open-ended questions, as described in Section 4.4, in the exit survey completed by participants in the intervention group. Thus participants had one month of experience with the system on which to base their responses to these questions.

The first question was "*For how long would you expect to continue using TMT if it did not cost you anything?*". Only 13 out of 51 participants (25%) provided clear numerical answers (e.g., "*1 year*", "*1 month*", "*4 weeks*"), and 3 participants did not answer this question. The remainder of the participants provided short text answers that

were less precise. A categorization of the numerical and text answers into time categories with their weights is summarized in the list below and in Figure 5.9:

- Long (indefinite) period of time (e.g., *"forever"*; *"indefinitely"*; *"for many years"*; *"for as long as i could"*) **45%**;
- Period of time conditioned by usefulness (e.g., *"untill i felt i no longer needed it"*; *"however long it takes for me to fall into a regular habit"*; *"as longh as i needed it"*; *"during my medical treatemnet"*) **8%**;
- Limited period of time without a reason (e.g., *"1 month"*, *"a few months"*; *"12 months"*; *"1 year"*) **31%**;
- Short period of time (e.g., *"2 weeks"*; *"3 weeks"*; *"probably not long"*) **6%**;
- Would not use at all (e.g., *"would not continue"*; *"none"*) **10%**.

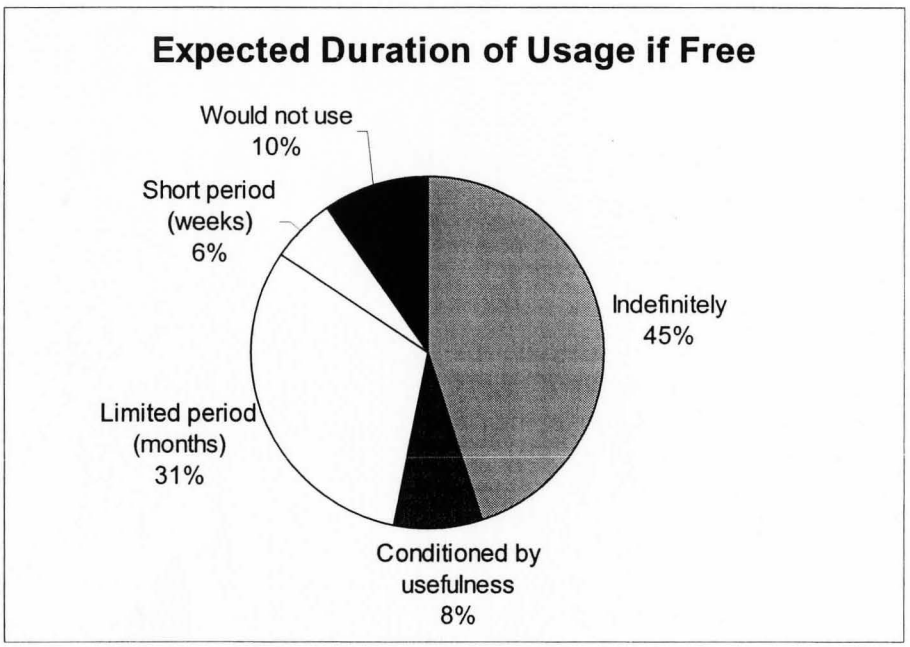


Figure 5.9 Expected Duration of TMT Use if Usage Were Free

As expected, a large proportion of the answers (45%) indicate long, indefinite periods of time if usage were free. However, a significant part of the responses fell into a limited or short period of time (37% in total). These results can be linked to the IS study results, demonstrating that participants did not perceive the usefulness of a service that would be used for the specific purpose of improving adherence to taking vitamin C. Therefore, even if the service were free, a substantial proportion of participants (47%) would use it for only a short or limited period of time or would not use it at all.

The second question was: "*For how long would you expect to continue using TMT if it were not free?*". From the 51 participants 14 (27%) offered precise numerical answers (e.g., *"6 months"; "0 days"*), two did not answer, and the remainder provided less precise text answers. A categorization of all numerical and text answers to this question with their relative proportions resulted in the list below and the plot in Figure 5.10:

- Indefinite period of time depending on usefulness (e.g., "*At least 5 more years...then I would reevaluate my use of it*"; "*forever but only when i really need to*"; "*until habit was formed*"; "*untill i felt it was not helping me*") **10%**;
- Depending primarily on the cost (e.g., "*depends on cost*"; "*probably not that long, depends how much it cost*"; "*it would depend on the price, and what I feel I am getting out of it*") **18%**;
- Limited period of time (e.g., "*a few months*"; "*4 months*"; "*1 year*"; "*couple months till i could rememer on my own*") **14%**;
- Short period of time ("*1 month*"; "*a few weeks*"; "*1 week*") **29%**;
- Would not use (e.g., "*would not continue*"; "*not at all*"; "*I would not use it if it were not free*"; "*I won't want to pay for it*") **29%**.

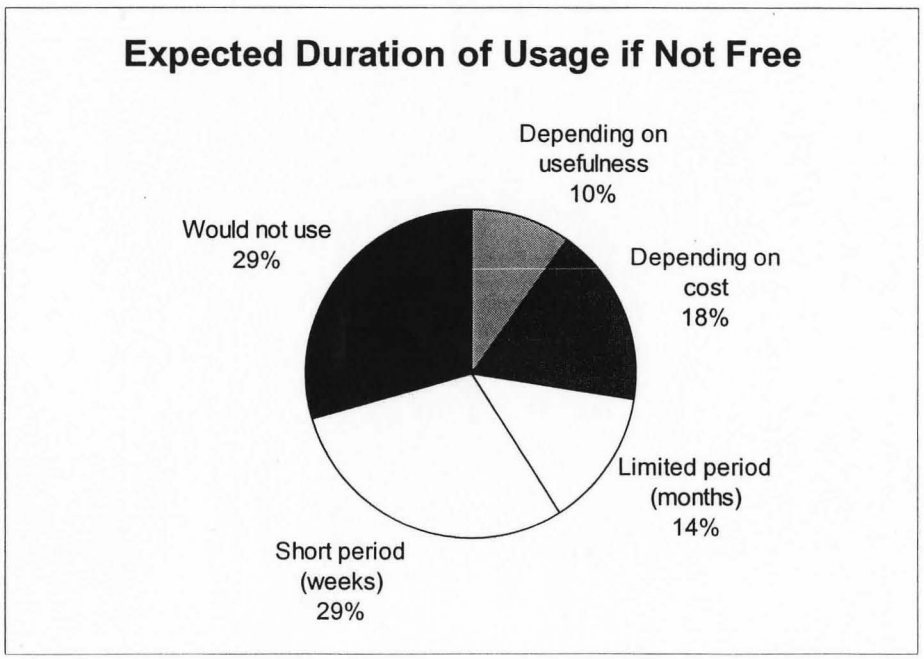


Figure 5.10 Expected Duration of TMT Use if Usage Were Not Free

As expected, a large proportion of respondents (almost two thirds) would not use the service or would use it only for a short period of time (weeks) if the service were not

free. However, 10% would consider using it, depending on its usefulness, and 18% depending on cost. Therefore, more than one quarter of the people who participated in the experiment did not reject a priori paying for such a service provided that they thought it had some usefulness and the cost were right.

The third question attempted to elicit from the participants precise numbers in terms of what they perceived as an appropriate fee for TMT service: *"How much would you think it would be reasonable to pay for a service like TMT if the usage were not free?"*. All 51 participants provided a numerical answer in terms of dollars per month. The average value indicated was $5.79 with a range from $0.5 to $30, a standard deviation of $5.59, and a median of $5.00. These were realistic results since participants were cell phone users and knew the monthly fee for cell phone service. The average value from this question represents about half the monthly cost of using a cell phone through a card, or about one quarter of the cheapest plan offered by major cell phone operators in this geographic area.

Correlations between the amount people would pay for such a service and the constructs in the theoretical IS model were also examined. This approach was justified since participants might be willing to pay more if they perceived usefulness and/or enjoyment in the service and less if they perceived risks from its use (especially financial risks). A Pearson correlation test was not significant, although some correlations of the average amount were in the expected direction and relatively close to 0.05 significance: with extrinsic motivation (correlation coefficient = 0.258, significance level = 0.070) and with perceived financial risk (correlation coefficient = -0.277, significance level = 0.051).

Therefore it can be concluded that the business study offered some useful results to build upon in further, larger studies. Probably the most remarkable of these are associated with the willingness to give time (WTGT) and willingness to pay (WTP) according to the usefulness people perceive in the service: if people do not see a reason for using the service they will not want to use it, even if it is free, and conversely, if they perceive that it is useful they would be willing to pay a moderate fee. Note that these parameters might change if dealing with chronically ill people participating in long term interventions: they would see a more clear usefulness of the service and the intervention would be of a definitely longer term.

5.9 Impact on Adherence

The healthcare part of this research had the objective of comparing the self-reported figures on taking daily vitamin C between the intervention group and the control group. The study was designed as a randomized controlled trial with double blinding of allocation (ensured by an automated software program). The purpose of the randomization was to have two groups of people with similar characteristics in demographics, existing vitamin C consumption patterns, and familiarity with cell phones and SMS.

As previously noted, participants were accepted for this study only if meeting mandatory conditions regarding age, cell phone use, no known intolerance to vitamin C, no likelihood of pregnancy (if females), and only if they agreed to take one 500 mg vitamin C pill (or multivitamin) each day for one month. A total of 102 participants who met the conditions registered for this study and were randomly allocated into the intervention group (52) and control group (50). Only 98 finished the study (51 in the intervention group and 48 in the control group), as shown in Figure 5.1. The data analysis in the healthcare component of this study follows the recommended *intention to treat* approach, based on the starting sample of 102 participants (Metz, Stern et al. 2000; Akobeng 2005; Haynes, Sackett et al. 2005).

5.9.1 Baseline Data

The sample of 102 participants was extracted from the larger sample that completed the initial scenario-based survey. Accordingly, baseline data were obtained from that survey. Participant age, gender, self-reported vitamin C consumption, attitude regarding vitamin C, and cell phone and SMS experience were used for this study. Data at baseline are presented in Table 5.22.

Table 5.22 Baseline Features of the Experimental Groups

Features	Intervention group (n=52)	Control group (n=50)
Mean (±SD) age (years)	23.8 ± 7.3	23.9 ± 7.0
Female participants (number and percent)	29 (55.7%)	27 (54.0%)
Mean of vitamin C (multivitamin) consumption in the last 7 days (±SD)	1.3 ± 2.1	1.6 ± 2.3
Mean attitude regarding adherence to vitamin C consumption (1 to 7 four-item Likert scale) (±SD)	5.3 ± 1.7 (Cronbach alpha = 0.756)	5.1 ± 1.7 (Cronbach alpha = 0.838)
Mean experience (±SD) with cell phones (months)	48.7 ± 29.2	38.6 ± 27.9
Mean experience (±SD) with SMS (months)	31.3 ± 23.5	26.5 ± 24.6

All participants showed generally positive opinions regarding the effects of vitamin C and the necessity of taking this vitamin. This impression was captured through their attitude toward adherence to taking vitamin C (mean scores of 5.3 and 5.1 on a 1 to 7 scale for the two groups at baseline, respectively). Responses to open-ended question generally confirmed this attitude: 78.8% of the people in the intervention group and 74% in the control group had taken vitamin C at some time. Some supportive comments:

> *[I 2] "I think that people need to get the required does of vitamin C daily, and this will help prevent diseases from occurring. many people take vitamin C once they*

are sick however by then, it is too late. They need to take it daily in order for it to be beneficial."

[C 7] "it definitely helps!"

[C 25] "vitamin C is vital to the health of an individual."

Forty-two percent of the participants in each group reported taking at least one vitamin C or multivitamin during the 7 days prior to baseline. Despite this, there were many comments showing that participants believed that the daily intake of vitamin C should be from food and drinks rather than pills:

[I 2] "I usually try to get my daily dose from my daily diet"

[I 42] "I usually drink orange juice or eat an orange"

[C 14] "usually drink orange juice to get my vitamin C when im sick"

5.9.2 SMS Intervention

The intervention consisted of sending participants in the intervention group SMS reminders about taking their daily vitamin C pill. The layout of this intervention was presented in Chapter 4 and Appendices B and C. That is participants were sent basic reminders daily in the first two weeks and every other day in the last two weeks. Reminders were sent randomly in a 2-hour interval and participants were expected to reply by a one-letter SMS message (i.e., '*A*', from '*acknowledge*') as early as possible after complying. In addition to these interactions, participants in the intervention group were sent SMS reinforcers or correctors every other day in the first two weeks and every third day in the last two weeks. Reinforcers were messages of positive feedback and encouragement that included brief jokes, while correctors were messages (with no jokes) urging the participants to take their vitamins and stressing the importance of these vitamins, as discussed in Chapter 4. Reinforcers and correctors did not require SMS replies from participants.

5.9.3 Outcome Measurements

At the end of the study participants in both groups were informed that the experiment had ended and were directed separately to two online exit surveys. The most important quantitative piece of information for the healthcare study collected at this point regarded the number of vitamin C daily pills that were *missed during the past week.* In addition, SMS responses of the participants in the intervention group were recorded throughout the field study. As mentioned, one participant in the intervention group and two participants in the control group withdrew from the study. Another participant in the intervention group elected to suspend receiving SMS messages, but completed the final survey. This participant was considered to have interrupted the study but to have completed it. Data of interest from the exit surveys are presented in Table 5.23.

Table 5.23 Endpoint Features of the Experimental Groups

Features	Intervention group (n=51)	Control group (n=48)
Mean of vitamin C (multivitamin) missed in the last week (±SD)	2.5 ± 1.5	3.3 ± 2.2
Increase of vitamin C consumption compared to baseline	From 1.3 to 4.5 (246%)	From 1.6 to 3.7 (131%)
Proportion of participants reporting increased adherence	94%	67%
Mean of SMS replies during the experiment (out of maximum 21) (±SD) and percent	9.2 ± 7.4 (43.8 %)	---

Participants in the intervention group reported fewer missed vitamins. This is confirmed by most of the responses to open-ended questions, where participants in the control group mentioned more about omitting their vitamin pills, compared to the intervention group:

[C 29] "I missed about 1 pill every other day."

[C 30] "more than a dozen"

[C 31] "Almost everyday (I only took it 3 times)"

[C 35] "all"

[I 12] [missed] "once when i didnt have phone with me"

[I 25] "Worked well, small bottle - portable"

[I 26] "not sure how many"

5.9.4 Analyses and Results

The first step in the data analysis is to establish the similarities of the two groups involved at baseline. Table 5.20 shows quite close values in terms of the means of the baseline features, the most notable differences being for cell phone and SMS experience. A rigorous analysis was done using the MANOVA omnibus test. The result (Wilk's Lambda = 0.960, sig. 0.681) showed no statistically significant difference between the two groups for the participants at baseline.

One way to report study results is to compare the change in adherence in the two groups (Haynes, Sackett et al. 2005). Thus, participants in the *intervention group* reported *missing* 2.5 vitamins on average in the last week. Since the experiment referred to taking one vitamin per day, this indicates that they took an average of 4.5 daily pills during that week. Compared to the baseline where they reported an average of 1.3 vitamin pills per week, this indicates an increase in compliance by 246%. A similar analysis of *control group* data shows that reported adherence increased from 1.6 initially to 3.7 at endpoint, resulting in compliance increase by 131%. The difference between the increases in the two groups was significant in an ANOVA analysis at the level 0.001. Another way of

reporting the change (Haynes, Sackett et al. 2005) is through the proportion of participants who reported increased adherence: 48 out of 51 (94%) in the intervention group, compared to 32 out of 48 (67%) in the control group (Table 5.23). The increase in adherence is confirmed by the paired *t*-tests performed for each of the groups. These showed significant differences between the baseline and endpoint values in terms of the number of pills taken: $t = -19.827$, significance level =.0.000 for the intervention group and $t = -8.297$, significance level = 0.000 for the control group.

The most important information from a randomized controlled trial is the comparison between groups at endpoint in terms of the targeted features (Haynes, Sackett et al. 2005). In this study the only feature scrutinized was the number of vitamin C pills reported to have been missed in the last week by the participants. Examination of the endpoint data showed that participants in the intervention group missed on average 2.5 vitamins compared to the participants in the control group who missed more (3.3 on average). The 0.8 difference in means seems quite important. However, an ANOVA analysis between the two groups is not significant (significance level = 0.134).

One important feature of this study was to record participant responses through SMS during the one-month experiment. One approach is to compare the self-reported data recorded almost daily through SMS with the data at endpoint. Other possible associations and correlations involving all the features at baseline and endpoint were calculated for both groups. These Pearson correlations are depicted in Table 5.24.

Table 5.24 Correlations of the Features in Intervention and Control Groups

	Cell Phone Usage	SMS Usage	Vit C Taken (base)	Vit C Missed (end)	Attitude toward Vit C	SMS Replies	Age	Gender
Cell Phone Usage	I: 1 C: 1							
SMS Usage	I: .605** C: .780**	I: 1 C: 1						
Vit C Taken (base)	I: -.243 C: -.337*	I: -.135 C: -.280*	I: 1 C: 1					
Vit C Missed (end)	I: -.067 C: .262	I: -.021 C: .270	I: .090 C: .133	I: 1 C: 1				
Attitude toward Vit C	I: -.265 C: -.115	I: -.091 C: -.227	I:-.053 C: .122	I: -.247 C: -.014	I: 1 C: 1			
SMS Replies	I: .016 C: N/A	I: -.108 C: N/A	I: -.021 C: N/A	I: -.352** C: N/A	I: .155 C: N/A	I: 1 C: N/A		
Age	I: .349* C: .109	I: .026 C: .053	I: -082 C: .017	I: .032 C: -.159	I: -.213 C: .137	I: -.027 C: N/A	I: 1 C: 1	
Gender	I: .045 C: .169	I: -.008 C: .193	I: .117 C: .100	I: -.087 C: -.032	I: .144 C: -.134	I: .093 C: N/A	I:-.006 C: -.108	I: 1 C: 1

I: intervention group; C: control group

Significance levels: * = 0.05 (2-tailed); ** = 0.01 (2-tailed)

The correlation table reveals some expected highly significant correlation coefficients such as between cell phone and SMS usage, and cell phone experience and age. There are a couple of correlations for which there is no theoretical or logical support, such as between the number of vitamins taken and cell phone and SMS usage, and these can only be explained by pure random chance. However, the most interesting correlation is significant and in the direction expected: namely for the intervention group there is a negative and moderately high correlation (coefficient = -0.352, significance level = 0.01) between the number of vitamin C missed and the number of SMS messages through which the participants replied.

5.9.5 Discussion

Compared to baseline, the figures regarding vitamin C consumption appeared to have increased dramatically for both groups at end point: by 246% for the intervention group and by 131% for the control group. Although the differences between baseline and endpoint were statistically significant, these figures must be treated with caution. In fact, taking one more pill in that week (e.g., an increase from 2 to 3 per week) would result in a 50% increase in adherence. It is also of importance that participants were young healthy individuals who were expecting to receive compensation for being involved in this

experiment. The well-known tendency of patients to overestimate their adherence to treatment in post-hoc reports (Stephenson, Rowe et al. 1993; Haynes, McDonald et al. 2002) may have been even more important in this case, especially since participant state of health was not at immediate risk. However, the moderately high correlation between SMS recorded during the experiment and vitamin C consumption self-reports for the intervention group at the end of the experiment offers some confidence that the system may have performed like a *MEMS*, allowing virtually continuous monitoring of participant adherence behaviour.

The experiment detected a difference in the mean numbers of pills reported as missed by the two groups in the expected direction (2.5 in the intervention group compared to 3.3 in the control group). This difference was not significant because the experiment did not have enough power to detect such a variation. Following the procedure recommended by Haynes, Sackett and collaborators (2005, p. 139), sample size or power were calculated using the online script available at *http://stat.ubc.ca/~rollin/stats/ssize/index.html*. Thus, when comparing the means of the two independent samples (i.e., 2.5 and 3.3) having a common standard deviation of 1.94 for a 2-sided test (i.e., not knowing the direction of the change, better or worse, after the experiment) for the usual values of alpha = 0.05 and power = 0.80, the sample size necessary for one group would have been 93. Even for a one-sided test (checking only for the change in the expected direction) the necessary sample size would have been 73 (i.e., about 50% larger than it was in the experiment). However, the sample size for this experiment was determined from IS model considerations. As it was assumed from the very beginning that the healthcare research question would be secondary and would not affect the feasibility of the whole experiment, consistent with the recommendations of Haynes, Sackett and collaborators (2005), it was considered acceptable to run an underpowered experiment. Using the same calculation script for a 2-sided experiment with the existing sample size (the "patients I can get" (Haynes, Sackett et al. 2005, p. 141)) the power of this RCT was 0.54.

If, according to the literature, it is accepted that participants overestimated their pill taking figures by about 19-20%, it means that they missed more pills than reported at endpoint. After the necessary rounding to 0.5 values (since it is unlikely for people to report missing "1.29 pills" but is more plausible to report missing "about 1-2 pills", as the experiment proved), the new figures at endpoint are as in the table below:

Table 5.25 Experimental Groups Data with/without Overestimation

Data	Intervention group (n=51)	Control group (n=48)
Mean of vitamin C (multivitamin) missed in the last week (±SD) as reported	2.5 ± 1.5	3.3 ± 2.2
Mean of vitamin C (multivitamin) missed in the last week (±SD) without overestimation	3.1 ± 1.9	4.0 ± 2.7

Neither group shows excessive skewdness or kurtosis (values are between +1 and -1). Furthermore, a non-parametric Kolmogorov-Smirnov test showed no departure from normality for the distributions of the reports in both groups (sig. = 0.336 for the intervention group and 0.638 for the control group). Therefore, it is justified to consider the mean values in the adherence and sample calculations.

A calculation of the sample size for the mean values without overestimation shows that when comparing the means of two samples (i.e., 3.1 and 4.0) having a common standard deviation of 2.40, the necessary sample size is 112. Hence, this is an increase from the value of 93 calculated when the overestimation process was neglected. This can be explained by the fact that, when neglecting the overestimation, the trial is assumed to detect a difference of 0.8 pills for an average value of 2.8 pills (if both groups considered), hence a ratio of 0.28. If the overestimation is considered, the trial should detect a difference of 0.9 pills for an average value of 3.55 pills (if both groups considered), hence a ratio of 0.25. Detecting a smaller relative difference requires a larger sample.

Regarding participant impressions on the outcome of taking the vitamins collected through open-ended questions after the experiment, these were mixed. Very few participants noticed a worsening of their health state (in terms of getting a cold during the experiment), while some participants mentioned that they felt protected from illness, but a large majority of participants did not mention any change. Here are some sample responses:

[C 12] "I have felt perfect since taking them"

[C 13] "I didn't get sick in the past month"

[C 15] "can not tell the difference"

[I 5] "i have a bit of a cold now"

[I 20] "other people are getting sick, but i have been healthy"

[I 43] "Don't feel any better or worse"

Participants' overall comments regarding vitamin C consumption during the experiment were generally of the same tenor. Participants acknowledged the importance of vitamin C but many of them stressed that the main source of vitamins should be daily intake from food and drinks and not from pills:

[C 27] "Vitamin C is normally intake efficiently our daily diet. The pills are just for those who do not get enough in their diet."

[C32] "I find it hard to take it when I don't see results from it/don't get sick very much as it is."

[I 39] "I find vitamin C supplements to be effective in the combat of common colds, and often some in tablets which are quite tasty."

Two types of comments were encouraging towards the potential of the TMT system:

[I 12] "probably wouldnt take it [vitamin C] on a regular basis after study is over"

[C 30] "It would have been really helpful if I had gotten the reminder. I think it is a very good idea!"

The results of the healthcare study were therefore in the expected direction and represent a positive step in pursuing similar research with patients who have chronic illnesses. Furthermore, an appropriate sample size to improve the statistical power of a future study would be necessary in detecting the impact of SMS reminders on medication adherence.

5.10 Summary

This chapter has described the process of conducting the experiment, data collection, and analysis of the results. First, the results of a pilot study conducted before the actual experiment were presented. The results of that study were encouraging and led to minor adjustments (i.e., the improvement of a three-item scale and an adjustment to the appearance of the online questionnaire) before launching the main experiment.

The principal experiment of the study was conducted as a randomized controlled trial in two stages during the Spring and Fall of 2006. A comparison of the results showed no significant time dependent differences between the groups who participated in the experiment during these times. Demographics analysis showed that the vast majority of the participants were relatively young people (below 24 years old), with experience in terms of cell phone and text messaging use.

The quantitative IS study used SPSS 14.0 and PLS 3.0 and followed the customary steps pursued in the majority of IS studies: data treatment, analysis of the measurement model and then of the structural model. The survey completed by the intervention group at the end of the experiment revealed adequate properties of the measurement model in terms of reliability and factor validity, and a relatively good structural model (in terms of significant paths and high *R-square* values, as the literature recommends (Bontis 1998)). The study then proposed and tested a slightly improved model, still having theoretical support that was better in terms of number of significant

paths and *R-square* values. This improved model was the basis for further analysis in terms of hypothesis tests. Of the seven hypotheses proposed by the study two were supported, two rejected, and the reminder three partially supported.

The qualitative IS study used the responses to four open-ended questions to enrich the findings of the quantitative IS study. These responses were analyzed through classical content analysis that developed a better understanding of why participants would or would not use a system like TMT, and any recommendations and other thoughts and concerns they might have. The analysis was based on the responses provided by the intervention group in the exit survey.

Information from the intervention group was used in the business case analysis. This revealed participant willingness to use such a system for a period of time, whether free or not, and the amount they would be willing to pay for such a service. This analysis showed that participants were concerned about usefulness features, even when asked about financial aspects (i.e., being offered a free service).

Lastly, this chapter dealt with healthcare related issues. This analysis followed the recommended approach of an RCT by performing an *intention to treat analysis*. Data collected at baseline showed no significant difference between the intervention and control groups in terms of their attitude about vitamin C as well as their existing patterns of taking vitamin C. Data collected at endpoint revealed significant increases in adherence in both groups, with a higher change in the expected direction of increased adherence for the intervention group. However, the difference between groups was not statistically significant at endpoint. This means that the study can be termed as having indeterminate results (Haynes, Sackett et al. 2005). Another finding of the healthcare study was the correlation between participants' SMS activities and self-reports on taking vitamin C taking. This allows the conclusion that this system could be termed somewhat as a medication event monitoring system (MEMS).

Chapter 6: Discussion and Conclusions

6.1 Introduction

This chapter discusses the following issues: answers to the research questions, research contributions (theoretical and practical), strength and importance of the research, limitations of the research, and directions for future research. The discussion is based on the fundamentals presented in Chapters 1 to 4 as well as on the data analysis and results presented in Chapter 5. The layout of this final chapter is as follows: Section 6.2 presents the answers to the research questions, Section 6.3 the contribution of this research, Section 6.4 major strengths and limitations of the study, and Section 6.5 directions for future research.

6.2 Answers to Research Questions

RQ1: What are the influences of the various dimensions of perceived risk on the perceived overall risk associated with the use of wireless text messaging in telehealth?

The hypothesized influence of the perceived risk dimensions indicated that the risk components taken into account in this study (perceived financial risk, perceived social risk, and perceived privacy risk) would have a strong influence on the overall risk, through the mediation of psychological risk. These hypotheses were confirmed only partially. Indeed, perceived social risk and perceived overall risk have a strong influence on the perceived psychological risk (path coefficient = 0.394, sig. 0.01, and path coefficient = 0.532, sig. 0.001). Psychological risk is a mediator between these two risk facets and the overall risk, which is linked by a path coefficient of 0.579 (sig. 0.001). However, the perceived financial risk has no significant path to the psychological risk but, instead, directly to the overall risk (coefficient = 0.349, sig. 0.05). This type of influence was also found by Stone and Grønhaug in their seminal study about multi-faceted perceived risk, as measured through multi-item constructs (Stone and Grønhaug 1993).

The direct influence of the financial risk on the overall risk can be explained in this study by the fact that the study participants were healthy cell phone users who were using a prophylactic measure that had unclear healthcare outcomes, but at the same time they were familiar with the financial aspects of using cell phones. Therefore, the financial risk is a strong and direct determinant of the overall risk in this case. The situation might be quite different when dealing with ill people subscribing to a real service, when other risk facets, especially the psychological one, may become prominent as found by other studies on perceived risk theory (Stone and Grønhaug 1993; Jia, Dyer et al. 1999).

RQ2: What is the influence of perceived overall risk on the motivation associated with the use of wireless text messaging in telehealth?

Perceived overall risk was statistically shown to have a significant negative influence on the intrinsic motivation (path coefficient = -0.382, sig. 0.001). Therefore, if users perceive a risk in the use of TMT, they would also tend to see less enjoyment in using this type of service and this is aligned with relatively similar reports from other studies (Grazioli and Jarvenpaa 2000; Jarvenpaa, Tractinsky et al. 2000).

The influence of the perceived risk on usefulness was not significant for this study and this contrasts to findings of recent studies incorporating perceived risk in technology adoption models (Featherman and Fuller 2003; Featherman and Pavlou 2003). An explanation for this fact could be the lesser role of usefulness that participants perceived when using TMT for improving their adherence to taking vitamin C pills. If we were dealing with ill people whose health state is at risk if they do not take their medication, the situation regarding the perceived usefulness of such a service would likely be different. Therefore, some significant influence from the risk they perceived might exist on the possible usefulness of such a system.

RQ3: What are the influences of motivation and perceived risk on the intention to use wireless text messaging in telehealth?

The quantitative IS study proved intrinsic motivation to have a positive influence on intention to use the service (path coefficient = 0.459, sig. 0.05) and perceived overall risk a negative one (path coefficient = -0.270, sig. 0.05). Therefore, the higher the enjoyment users perceive in the service, the more prone they would be to adopt it and this is in accordance with earlier findings (Igbaria, Iivari et al. 1995; Van der Heijden, Ogertschnig et al. 2005).

Conversely, the more risk that is perceived, the less inclined they would be to adopt such a service as found previously by consumer behaviour and IS studies (Mitchell and Greatorex 1993; Kim and Prabhakar 2000). The analysis showed extrinsic motivation did not play a statistically significant role in this picture. The explanation is, again, that participants would be more inclined to see the service's enjoyment than its usefulness. In this case the service would be a more hedonic than utilitarian system (Van der Heijden 2004). Nonetheless, the study shows that enjoyment is sufficient in motivating user intention to adopt such a system. An important conclusion can be drawn: that motivating people to adopt a technology without obvious utilitarian value for their health state could be done through enjoyment associated with using the technology.

RQ4: How appropriate is the proposed risk-motivation theoretical model in explaining the intention to use wireless text messaging in telehealth?

As described extensively in Chapter 5, the proposed theoretical model was replaced with a slightly improved theoretical model. This latter model has theoretical support in the consumer behaviour literature. This improved model has more significant paths with higher path coefficients and medium to high values of variance explained for typical IS studies. This is especially true in terms of the final construct, i.e., the intention to adopt

the service (*R-square* = 0.434) (Moon and Kim 2001; Sun and Zhang 2006). Thus, according to the literature, the model can be termed as appropriate in explaining the influence of the dyad risk-motivation in adopting the technology (Bontis 1998). Although the model relieved a non-significant role for extrinsic motivation in adoption, it is believed the situation would change if dealing with ill people, since they would be more likely to perceive the usefulness of this approach to improving their medical adherence. Therefore, by retaining extrinsic motivation as a model component, the theoretical model might have a far greater degree of generality.

RQ5: What are the characteristics of the user population who are positive towards the use of wireless text messaging in telehealth?

The analysis revealed that the participants of this study were in general young individuals with lots of experience in the use of cell phones, but less experience in text messaging. Their intent to adopt the tested service was largely influenced by the intrinsic motivation they saw in the service, and less by the risk they perceived in using it, with the usefulness playing no role in their intentions. Analyses of the control variables demonstrated that participant attitudes regarding the usefulness of taking vitamin C had a significant influence on the extrinsic motivation and intention to adopt the proposed technology. Therefore, the more inclined to see vitamin C as useful, the more likely to see the reason for using the technology to improve their adherence and to adopt this technology.

The study detected no influence of the demographic characteristics (gender and age) or of a specific experience feature (months of SMS usage). Therefore, no distinct features were identified that would make any specific category of people more positive toward adopting wireless text messaging in telehealth based on their demographic or technology experience characteristics.

RQ6: What are the main opportunities and barriers, from the users' viewpoint, regarding the intention to use wireless text messaging in telecare?

By combining the analysis of the quantitative and qualitative IS study, it appears that users perceived in this case enjoyment as the unique factor that would lead to the adoption of wireless text messaging in telehealth. However, from the various reasons that would make users willing to use such a service, it is to be understood that they were thinking about the usefulness aspects as a main factor (mentioned in 40% of the responses). Therefore the main opportunities for using such a service reside in the interplay of the two motivation types: predominantly intrinsic motivation for applications with less apparent usefulness for the users and, possibly, significant extrinsic motivation where users perceive the usefulness of the intervention.

The main obstacle in adopting such a service proved to be, for this prophylactic intervention, the perceived overall risk, with significant and strong influence from both the psychological and financial risks. Financial risk was a dominant theme in the reasons users gave about not wanting to use the service, followed by lack of enjoyment and lack of usefulness. However, the situation might change if the service were being used by ill people who would be more likely to care less about money than about their health.

RQ7: How much would users agree to pay for and for how long would they stay in a program using wireless text messaging telehealth as a support in improving adherence to a healthy behaviour regimen, if usage is not free?

Data to answer this research question were collected from participants in the intervention group, who were engaged in SMS activities for one month. They were able to see the financial side of these activities clearly. Furthermore, these participants were, of course, previously users of cell phones.

The analysis of these data revealed essentially that there was a link between motivation (especially extrinsic) to use the service and willingness to use such a service and to pay for it, if necessary. Thus, if usage were free, only 45% of the participants would stay a long, indefinite, period of time. The remaining part would use the service a shorter period of time (months or weeks) or not use it at all since, very likely, they did not see the usefulness of the service. On the other hand, if the usage were for a fee, a large number (29%) would use the service just a few weeks. Nonetheless, 28% of the participants would still consider using the service an indefinite period of time if they could see its usefulness and if the cost were reasonable.

The average amount indicated by the participants as a reasonable monthly fee for such a service was $5.79, with a median of $5 and a relatively high standard deviation ($5.59). This amount represents about half of the minimum monthly cost to use a cell phone, in the geographical area where the research was conducted.

RQ8: Would a wireless text messaging telehealth service that reinforces adherence to healthy behaviour improve this adherence over time?

This one-month trial brought out some numerical results in the expected direction. Thus, an increase in the average number of vitamins reported being taken per week by both groups was detected: from 1.3 taken at baseline to 2.5 (out of 7) missed at endpoint in the intervention group, compared to 1.6 taken at baseline and 3.3 (out of 7) missed at endpoint for the control group. Furthermore, the self-reported increase in compliance of 246% was more prominent for the intervention group (compared to 131% in the control group) or by 94% in terms of the proportion of participants who reported increased adherence (compared to 67% in the control group). The healthcare study also revealed a significant correlation (coefficient = -0.352, sig. 0.01) between the average number of SMS replies sent by the intervention group participants and the number of pills reported missed near the end of the study. Therefore, people who replied with more SMS confirmations of taking the vitamins during the experiment also reported a lower number of vitamins missed near its endpoint.

Despite these promising findings, the experiment did not show a significant difference between the two groups at the end of the experiment, in terms of vitamin C pills taken. This was because of insufficient power in the study or possibly the lack of effect of the intervention. Thus, from the total sample of 99 people at endpoint (51 in the intervention group and 48 in the control one), it was able to detect a 0.8 average pill difference between the numbers of pills reported as missing in the two groups (2.5 and

3.3) with a power of only 0.54, but this is below the usually adopted minimum popular power level of 0.8. According to the recommendations of Haynes, Sackett et al (2005, p. 136), these results can not be termed as showing no difference but rather as "inconclusive" or "indeterminate".

6.3 Research Contributions

This study is one of the first scientific attempts at an unbiased evaluation of perceptions of using mobile information technology to support improved medical adherence. Its aim is to develop an understanding of user-perceived risk and motivation influence on intention to use wireless text messaging for a specific prophylactic application. This can help academics in understanding the mechanisms of newer technology adoption, and mobile technology practitioners in delivering products better suited to user needs. Last but not least, this study may offer a starting point for future healthcare-led research on outpatient views regarding the employment of mobile information technology for addressing the problems that result from poor medical adherence.

Previous exploratory work has shown that patients would have reasons both to accept and to reject mobile applications that help them to adhere to the recommendations of health providers (Cocosila and Archer 2005a; Cocosila and Archer 2005b). This research uses the **fundamental support of the theories and models of technology acceptance, of perceived risk, and of motivation** to investigate empirically the key factors that may influence the acceptance of a wireless mobile solution as a support in improving outpatient adherence. This study makes contributions both to the theoretical knowledge and applied knowledge in information systems, consumer behaviour, and healthcare.

6.3.1 Contributions to Information Systems and Mobile Technology Knowledge

6.3.1.1 Contributions to Theoretical Knowledge

This research advances knowledge derived from **theoretical research in information systems** for several reasons, as indicated below.

- Previous IS research discussing the integration of perceived risk into technology adoption models has used the TAM model exclusively (Featherman and Fuller 2003; Featherman and Pavlou 2003; Featherman and Wells 2004). Although TAM is a popular model in technology adoption research, it takes into account only the classical constructs of perceived usefulness and perceived ease of use, and is more suited to the use of concrete and well-established technologies. This research adopts a broader view by taking into account extrinsic and intrinsic motivation, and examines outcomes from an innovative intervention rather than using an established system.

- It is difficult to identify a clear stream of research on perceived risk influence in IS to date. Although in recent years quite a few studies have included perceived risk constructs that claim to draw from consumer behaviour research of the early 1970s, the constructs used tend to differ significantly from one study to another. This research attempts to enrich knowledge by following a scientific path. Thus, it draws from a research stream in consumer behaviour that introduced validated multi-item perceived risk constructs (Stone and Grønhaug 1993; Stone and Mason 1995; Laroche, McDougall et al. 2004).
- Very few studies in IT acceptance research have included the dimensions of perceived risk adapted from marketing research. The risk constructs that have been proposed and used by other researchers have a considerable lack of consistency. Although they claim common ascendancy in the Jacoby, Kaplan, and Roselius work of the 1970s (Roselius 1971; Jacoby and Kaplan 1972; Kaplan, Szybillo et al. 1974), they look very different and are not validated. In contrast, this study builds on the validated work of Stone and his collaborators (Stone and Grønhaug 1993; Stone and Mason 1995). Accordingly, this study includes a construct (i.e., perceived risk) that has seen little application in previous IS studies until recently. When this is inserted, with its different facets, into the motivational model, it is possible to derive an explanation of individual reasons for or against accepting a mobile service.
- As Davis, Bagozzi et al. (1992, p. 1126) put it, "usefulness and enjoyment may be a common causal pathway through which many psychological and environmental factors achieve their influence", but more investigation is necessary to verify the validity of this statement. The current study attempts to build on this suggestion by integrating perceived risk into the motivational model. Indeed, this study found that intrinsic motivation is a pathway through which perceived overall risk achieves partially its influence on the behavioural intention to adopt the technology.
- Preceding research has shown contradictory results regarding the interaction between extrinsic and intrinsic motivation in motivational models. While traditional research in applied psychology has postulated that an increase in EM is counterproductive for IM, empirical work by Davis, Bagozzi et al. (1992) found that IM increased together with EM. Without giving a final verdict, these authors suggested "more research is necessary to delineate the conditions governing the occurrence of independent, mutually reinforcing, or countervailing effects of extrinsic and intrinsic incentives" (p. 1125). This study attempts to answer that suggestion and its findings suggest that intrinsic motivation is an antecedent of extrinsic motivation when applying the model to the adoption of a technology: the more enjoyable the technology appears to users, the more useful it is likely to be perceived.

6.3.1.2 Contributions to Applied Knowledge

Besides contributions for IS theory, this work is also novel in terms of **applied research knowledge**.

- It applies a validated model in a new context that is different from previous studies. "If TAM or other adoption models are to be successfully applied in contexts other than originally envisioned (the employee adoption of company owned software) it is imperative to understand how new contexts conditionalize longstanding theorized relationships" (Featherman and Fuller 2003). This research helps in this understanding by applying the adoption model in an individualized and domain-specific context.
- This study is an early investigation of user acceptance of wireless text messaging for a specific purpose, which is separate from the usual communication or leisure utilization. For this reason, the study has adopted a broader perspective by balancing user reasons *for* or *against* adopting the specific technology in a specific context.
- Few studies have investigated technology acceptance of telemedicine in general (and exclusively from the provider's side). Most technology acceptance in healthcare has been limited to health care practitioners (Schaper and Pervan 2004). In contrast, this work adopts a virtual outpatient viewpoint which rhymes with the contemporary concept of patient centered medicine.
- There has been a scarcity of research about acceptance of mobile IT in healthcare, mostly taking a provider-side approach. This study brings new information to the general picture, from a consumer-side view.
- There is a lack of research about patient acceptance of any technology in general. This contrasts, surprisingly, with the patient-centric view of today's healthcare. It is always important to remember that "not the software but the human side of the implementation cycle ... will block progress in seeing that the delivered systems are used effectively" (Keen 1991, p. 220). This study helps to fill this gap.
- This study is also important because proving how and why a simple but solid application may work might also encourage the use of mobile technology by other stakeholders in healthcare (e.g., home care nurses, primary care physicians, etc.).
- This study has been consistent with other research in showing that enjoyment plays an important role in the adoption of a novel service (Dabholkar and Bagozzi 2002). Therefore marketers should address the enjoyment of a new service when targeting a new market. Moreover, if using the service for adherence improving-initiatives, as in this study, marketers together with health providers must segment first people according to their pre-existing attitude toward the adherence intervention to be implemented, as was the case with attitude toward vitamin C

for this study. Addressing people with favourable views regarding the targeted intervention considerably increases its chances of success.

- Besides the insights for markets, the study offers insights for the designers of a future system like TMT. Based on participant recommendations and perceptions, valuable suggestions regarding especially message flexibility, timing, content, or enjoyment have been gathered.

6.3.2 Contributions to Consumer Behaviour Knowledge

Risk perception is a relatively young field of research. The risk literature still involves many confusing, albeit interesting and unanswered questions (Sjöberg 2002). For instance, a salient problem in the measurement of perceived risk is that sometimes it is difficult to say whether uncertainty or its consequences are measured (Stone and Grønhaug 1993; Lim 2003).

IS research involving the perceived risk construct, besides being recent and scarce, is also inconsistent, especially when discussing the dimensions of perceived risk. For instance, some studies consider perceived risk as being formed of several types of risk (e.g., financial, psychological, etc.), in accordance with the classical marketing research of the 1960s and 1970s (Featherman and Wells 2004). This construct would be formed from the traditional facets of risk plus an overall risk which would capture all the risk effects. Other recent research from the same field sees perceived risk as a second-order construct (Featherman and Pavlou 2003). This inconsistency proves that there are still unknowns in the area and new research contribution to be made. This study attempts to bring such a contribution by drawing from a solid stream in perceived risk research (Stone and Grønhaug 1993; Stone and Mason 1995).

It is "self-evident [that] the importance of the various risk dimensions will vary according to the purchase situation confronted [because] the risk perceived in purchases varies across people and products" (Stone and Grønhaug 1993). Consequently, it is worthwhile to try to examine empirically the risk construct for different products or services and categories of users, especially related to today's mobile services that are expanding so rapidly. Also, it is important to investigate the validity of the relationship between risk facets, with psychological risk mediating the effect of the other risk facets, as initially suggested by Stone and Grønhaug (1993), especially when adding a new risk dimension of privacy. The problem is even more acute when investigating a potential service with a high degree of intangibility and many unknowns. This study brings a contribution to knowledge by taking into account an application of the widely popular SMS, when used in a specific, non-leisure, context.

6.3.3 Contributions to Healthcare Knowledge

Results from this research are also important for healthcare knowledge:

- it tests patient perceptions early, before the expense of deploying mobile healthcare systems with complex human and technical consequences (Cocosila and Archer 2005b);

- it is an initial small step that offers solid ground for future healthcare-led research on medical outcomes of mobile IT interventions that target actual outpatient adherence;
- it opens the way for building future mobile healthcare interventions that target real patient perceptions;
- it underscores the importance of cost-effectiveness analysis of mobile healthcare interventions for outpatient adherence, as it is well-known that business model issues are the ultimate condition for the success of any IS application (Yuan and Zhang 2003);
- it tests the effectiveness of an adherence improving strategy to a prophylactic healthy behaviour, based on accepted recommendations from the literature (Haynes, McDonald et al. 2002);
- it detects both adherence to healthy behaviour and adherence to IT that encourages that behaviour (through the intention to use the technology); and,
- it compares popular self-reported measures for adherence to an objective measure somewhat similar to the Medication Event Monitoring System (MEMS) (Svarstad, Chewning et al. 1999).

6.4 Strengths and Limitations

6.4.1 Strengths

A major strength of this study is the blending of information systems research with consumer behaviour and healthcare research in testing a model drawn from knowledge in these three distinct areas. In fact, *no scientific study investigating user perceptions and behavioural intentions regarding the use of a mobile IT intervention to address healthcare adherence could be identified in the existing literature.* Performing a one-month randomized controlled trial, following a rigorous experiment layout facilitated by automated software, with data being collected at baseline, during the trial, and at endpoint, offered a rich data source. Eliciting participant impressions and perceptions after participating in such a trial added more realism to the opinions they expressed.

A second strength of the research was to combine a quantitative and qualitative IS study. This contributed not only to increased validity of the findings through a triangulation process but also to the deepening of the findings. This latter aspect was of importance since the study was restricted to addressing the possible application of mobile technology to a prophylactic measure for well people. However, the study opens the way for future investigations in healthcare applications and, therefore, collecting broader impressions and recommendations for real situations was essential.

Overall, this was a small randomized controlled trial with encouraging results. Although it can be termed statistically "inconclusive" or "indeterminate" (Haynes, Sackett et al. 2005, p. 136), to the author's knowledge this is one of the first *randomized controlled trials to test the effectiveness of a mobile IT solution to improve adherence to a prophylactic behaviour*. According to the categorization in the same work, this experiment was a "small trial" (p. 236), but small trials such as this can be useful in building a basis for larger and more powerful experiments.

6.4.2 Limitations

A first limitation of the study is related to the *sample* of participants. Size was, of course, the first issue. The main cause of sample limitation came from budgetary and time constraints (i.e., the limited availability of the software application for sending/receiving SMS). Although sample size was sufficient for the IS study, according to the requirements of PLS (Bontis 1998; Chin 1998), it led to an underpowered study of the healthcare outcomes.

For reasons of convenience and feasibility, and similarly to a substantial body of IS research, most of the participants were undergraduate and graduate students. Using students as subjects in the experiment may introduce a sampling bias (because of the external validity problem). Respondents are young people who are well educated, techno-savvy, accustomed to cell phones, and, hence, they are not likely to be representative of the general population (Ahn, Park et al. 2001; Ko, Jung et al. 2004). However, they do not differ from the general population in terms of needing to adhere to healthy behaviours (although they may differ in terms of education and some financial and social perceptions). Since this need will grow with age, it is important to predict future trends based on current perceptions (Ahn, Park et al. 2001). Furthermore, conducting research with students in a specific academic organization is acceptable for the purpose of theory development because it offers the opportunity of better replicability (Laroche, McDougall et al. 2004).

The sample may not be fully representative for another reason: subjects are participating voluntarily (Hu and Wang 2005). According to Adaptive Structuration Theory, there is always an interplay between technology and the social process of technology usage. Consequently, various users of the same technology would use it in different forms by appropriating and reinventing it (Karahanna, Straub et al. 1999).

Caution should be manifested regarding the generalizability of the results of the business study. Measuring the willingness to pay is a controversial issue by itself due to some inherent problems: this is a hypothetical exercise that does not require the actual sacrifice of money, willingness to pay is determined by the ability to pay, and, further, some individuals may object to the very idea because they consider that access to healthcare should not be conditioned by pay issues (Birch, Gafni et al. 1999). In this context, the generalizability of the results is limited since the sample was drawn from a relatively young population, linked to a university, hence with fairly narrow income levels, as in the Barner, Mason et al. (1999) study.

Because of feasibility and ethical constraints, this study could not deal with ill people taking medication for a chronic disease. It is expected that ill people would behave differently in terms of extrinsic motivation to adopt the technology as well as in the risk they perceive in using this technology. There would be a difference in using this technology compared to healthy people taking vitamin C for preventive reason. Very likely, people would care less about risks, on the financial side in particular, if they believed that the technology would help them to adhere to prescribed regimens. Because of feasibility and ethical constraints, participants were allowed to take their own vitamin C pills (or multivitamins) if they wished to do so, possibly influencing the results of the adherence part of the study. However, the entire philosophy of the study relied on participant honesty in doing what was good for their health.

Having the participants for the randomized controlled trial extracted from a student population of the same university may have led to some contamination of the results of the healthcare study, as colleagues and friends may have fallen separately into the two (intervention or control) groups. However, this was considered less of a danger than drawing the groups from completely different populations.

Another question arises about the representativeness of the sample, from a cultural perspective, because popular motivation theories are culture bound. A search of papers on motivational research in IS indicates that almost all empirical research has been done in North America (Igbaria, Iivari et al. 1995). However, some authors believe that for relatively younger ages and more highly educated people the cultural differences between subjects may be small (Ko, Jung et al. 2004).

Overall, there are no reasons to believe that the two groups of people under scrutiny in this RCT behave differently from any other cell phone users in North America who are taking vitamins in order to stay healthy, although young people may have a better general health state than the entire population, they may care less about health issues, or they may be more knowledgeable and familiar with mobile devices. The fact that the study dealt with young people is indicative of the importance of future users. This should be the case as well for a prophylactic intervention in healthcare, where the main target is education for prevention rather than treatment after people become ill due to unhealthy behaviour.

The study involves some *methodological limitations* as well. Self-reported measures can always induce bias (Hu and Wang 2005) and common method variance (Igbaria, Iivari et al. 1995). Although some steps recommended by the literature to detect common method bias have been taken, a degree of uncertainty always persists unless several methods to collect the same data are used. The one-month duration of the experiment is a further complication. Respondents may not recollect well all the facts from the experiment, due to limited memory capacity (Lee, Park et al. 2001).

Operationalization of constructs close to relevant prior research has the undeniable advantage of using previously validated measures, and is essential for comparability and replication. However, this may lead to lower reliability of some scales in comparison with prior studies, so this may raise the question of the applicability of

such instruments in the telehealth context (Chau and Hu 2001). A special issue regards the capture of the behavioural intention to use the technology, which was measured with only a two-item scale. However, the measure was adapted from reputable research (Venkatesh and Davis 2000) which demonstrated high Cronbach alpha, and it has been used in numerous other papers (Venkatesh 2000; Van der Heijden 2004).

Similarly to a study reported by Childers, Carr et al. (2001), who studied motivation to engage in retail Web shopping, this research has focused only on a limited set of possible determinants of the behavioural intention to use a technology. A relatively low value of explained variance of the model outcome compared to current research may suggest that the model is missing some other factors (Chau and Hu 2001). However, the *R-square* of the final construct had a value common in many IS studies (Sun and Zhang 2006). Furthermore, the purpose of the research is to investigate only the role of the dyad *perceived risk-motivation* on the behavioural intention to adopt SMS for a specific use.

Of course, beliefs, attitudes, and perceptions are dynamic, not static (Karahanna, Straub et al. 1999). Therefore such a study cannot capture the complexity and periodicity of adoption and usage, and must be seen more as preliminary evidence regarding the adoption of a technology, according to the same authors. Besides these, because of feasibility reasons, the study was conducted within one organization and with a particular type of technological innovation, a common situation in IS research (Karahanna, Straub et al. 1999).

Representativeness of the task setting may be another limitation, as mentioned by Hirst (1988). Tasks that are too simple or too difficult may decrease the intrinsic motivation associated with fulfilling those tasks, and alter the motivational model.

Lack of blinding (i.e., by the possibility of linking the answers to the cell phone numbers) may have influenced responses to the healthcare questions. However, the whole philosophy of using the technology to help people stay healthy depends on participants' honesty.

Other inherent limitations derive from the *domain* of the problem examined:

- technology acceptance of telemedicine is a relative new field to IS research (Chau and Hu 2001);
- extending the findings from a single study that examines a particular technology and targets a specific user group, to other technologies and user groups must be done with caution (Chau and Hu 2001);
- mobile commerce (of which mobile health care is a related field) is considered to be in its infancy and not well understood (Hu and Wang 2005);
- there is inconsistency in the consumer behaviour literature in the validity of perceived risk measures, especially since they depend much on the product or service under investigation (Laroche, McDougall et al. 2004);

- "typical adherence rates are about 50% for medications and are much lower for lifestyle prescriptions and other more behaviorally demanding regimens" (Haynes, McDonald et al. 2002, p. 2880);
- although longer than what is considered in the literature as a short-term intervention for adherence (e.g., two weeks) (Haynes, McDonald et al. 2002), this study has from the *healthcare point of view* a relatively short duration, and it performs measurements at only two points in time; and,
- "noncompliance is more frequent in preventive treatments due to their very nature" (Anna, Jose-Maria et al. 2004, p. 504)

Overall, it is believed that the IS side of the study did not have more limitations than those usually reported in relevant IS literature. Also, keeping in mind the elements of *PICOT* (*Patients*, *Intervention*, *Comparison group*, *Outcomes*, and *Time)* considered when asking the healthcare research question to avoid overgeneralization of the results (Haynes, Sackett et al. 2005), the approach embraced in this study would obviously have a limited external validity from the healthcare research point of view. However it may be considered "a step forward in testing an idea at a reasonable price" (Haynes, Sackett et al. 2005, p. 8).

6.5 Directions for Future Research

Future research can be thought of as a gradual progression in the three research streams this study comprised: information systems, consumer behaviour, and healthcare, either jointly or separately.

A first step in future information systems research might be to test the same research questions and theoretical model on other populations that are older and less technologically savvy, and for other types of prophylactic interventions. This may offer further insights, thus allowing a refinement of the theory (Featherman and Fuller 2003). One major objective of such research would be to confirm that, indeed, extrinsic motivation plays no significant role in the intention to adopt wireless text messaging for improving adherence, as this study found. This would also allow the development of recommendations regarding the adoption of systems which potential users do not perceive as being particularly useful (e.g., by stressing the intrinsic motivational aspects and decreasing the sources of perceived risk).

Another focus of future information systems research might be the possible enrichment of the theoretical model by including constructs suggested by the findings of this study. Special attention should be given to the attitude toward adherence that, for this study, was considered to be a control variable. Since it proved to have a significant influence on extrinsic motivation and intention to adopt, future research might seek theoretical support for including attitude towards adherence in the research model. This approach may be also justified from the perspective of the medical literature, showing

that interventions to improve adherence can do very little for people who are not interested in the treatment regimen that is prescribed.

Other enrichments to the theoretical model can arise from the findings of the qualitative information study, such as the antecedents of extrinsic and intrinsic motivation. For instance, opinions could be elicited on the usefulness of interventions. This could be studied in association with attitude toward adherence and healthcare risks that are perceived in not using the technology (i.e., the possible resulting deterioration in their health). Research in the antecedents of intrinsic motivation could also look at some of the contradictory opinions expressed in the qualitative study such as: embedding the messages in enjoyable content or not, using more formal or more colloquial language, using a fixed or flexible layout of messaging, etc.

Another possible direction of future research might be to investigate how other constructs not included in the research model (such as perceived ease of use of the technology, or subjective norm reflecting the influence of significant persons such as health providers or family) may influence the adoption of the technology. This could consider the context; for instance, perceived ease of use might play an important role for older and less technological savvy people. For such population categories it might also be justified to consider the influence of other risk components (such as performance risk, which is associated with beliefs about the capability of using the technology) on the behavioural intention to adopt the technology.

The business case model could be developed further through a separate investigation of the antecedents of user willingness to pay and willingness to give time for a mobile information technology intervention that addresses limited adherence. These cost considerations should be closely associated with the type of intervention and its context. For example, mature people suffering from diseases might show financial concerns about paying for technology to support healthcare interventions that differ from younger people subjected to a prophylactic intervention. Further investigations are also necessary to determine possible links between participant willingness to pay for such a service, willingness to take the time to use it, and other factors in the theoretical model of technology acceptance. Such studies should be compared to recent work examining the perceived value of mobile services such as SMS (Turel, Serenko et al. 2007).

Future research on healthcare issues should be encompassed in, and adapted to, research by healthcare practitioners who are investigating the role of information technology in improving adherence to specific clinical intervention. This research should be led by medical researchers, who can study carefully the effectiveness issues of prophylactic interventions in terms of medical outcomes, as a necessary step beyond self-reported adherence figures. Obviously, medical research should ultimately look at samples of chronically ill outpatients who might benefit from such innovative technological approaches. This type of research would join the increasing trend of using mobile technology as a channel to improve medical adherence, through basic interventions such as reminders (Dyer 2003; Leong, Chen et al. 2006).

6.6 Messages to Remember

"***Effective ways to help people follow medical treatments could have far larger effects on health than any treatment itself***" (Haynes, Yao et al. 2005, p. 16).

"***It is time that additional efforts be directed towards developing and testing innovative approaches to assist patients to follow treatment prescriptions***" (Haynes, McKibbon et al. 1996, p. 383).

This study is a small step in the right direction, as suggested by the literature and the problems of everyday life.

References

Agarwal, R. and J. Prasad (1999). "Are individual differences germane to the acceptance of new information technologies?" Decision Sciences **30**(2): 361-391.

Ahn, J., J. Park and D. Lee (2001). "Risk-focused e-commerce adoption model - A cross-country study", Working Paper, Information and Decision Sciences Department Carlson School of Management, University of Minnesota.

Ajzen, I. (1991). "The theory of planned behavior." Organizational Behavior and Human Decision Processes **50**(2): 179-211.

Ajzen, I. and M. Fishbein (1980). "Understanding attitudes and predicting social behavior". Englewoods Cliffs, NJ, Prentice-Hall.

Akobeng, A. K. (2005). "Understanding randomised controlled trials." Archives of Disease in Childhood **90**: 840-844.

Al-Gahtani, S. S. and M. King (1999). "Attitudes, satisfaction and usage: Factors contributing to each in the acceptance of information technology." Behaviour & Information Technology **18**(4): 277-297.

AMA (2004). "The patient's role in improving adherence", American Medical Association, Available at http://www.ama-assn.org/ama/pub/article/4197-8427.html, Accessed March 16, 2004.

Ammenwerth, E., F. Kaiser, I. Wilhelmy and S. Höfer (2003). "Evaluation of user acceptance of information systems in health care - the value of questionnaires". Medical Informatics Europe (MIE 2003), St. Malo, France, IOS Press.

Anna, V., B. Jose-Maria, D. Maria-Teresa, G. Caterina, D. Consolacion, S. Dulcis, M. Amparo and C. Javier (2004). "The role of mobile phones in improving vaccination rates in travelers." Preventive Medicine **38**: 503–509.

Associated Press (2005). "2B? Nt2b? Shakespeare gets texting treatment", Associated Press, Available at http://www.msnbc.msn.com/id/10084329/, Accessed December 10, 2005.

Atkinson, M. and C. Kydd (1997). "Individual characteristics associated with World-Wide-Web use: An empirical study of playfulness and motivation." The DATA BASE for Advances in Information Systems **28**(2): 53-62.

Audera, C., R. V. Patulny, B. H. Sander and R. M. Douglas (2001). "Mega-dose vitamin C in treatment of the common cold: A randomised controlled trial." Medical Journal of Australia **175**: 359-362.

Bala, M. V., L. L. Wood, G. A. Zarkin, E. Norton, C. A. Gafni and B. O'Brien (1998)."Valuing outcomes in health care: A comparison of willingness to pay and quality-adjusted life-years." Journal of Clinical Epidemiology **51**(8): 667-676.

Balas, E. and I. Iakovidis (1999). "Distance technologies for patient monitoring." British Medical Journal **319**: 1309-1309.

Ball, M. and J. Lillis (2001). "E-health: Transforming the physician/patient relationship." International Journal of Medical Informatics **61**: 1-10.

Bandura, A. (1977). "Social learning theory". Englewood Cliffs, NJ, Prentice-Hall.

Bandura, A. (1986). "Social foundations of thought and action: A social cognitive theory". Englewood Cliffs, NJ, Prentice-Hall.

Banning, M. (2004). "Enhancing concordance with prescribed medication in older people." Nursing Older People **16**(1): 14-17.

Barner, J. C., H. L. Mason and M. D. Murray (1999). "Assessment of asthma patients' willingness to pay for and give time to an asthma self-management program." Clinical Therapeutics **21**(5): 878-894.

Baron, R. M. and D. A. Kenny (1986). "The moderator mediator variable distinction in social psychological-research - Conceptual, strategic, and statistical considerations." Journal of Personality and Social Psychology **51**(6): 1173-1182.

Barrett, B. (2003). "Medicinal properties of Echinacea: A critical review." Phytomedicine **10**: 66–86.

Bart, C. K., N. Bontis and S. Taggar (2001). "A model of the impact of mission statements on firm performance." Management Decision **39**(1): 19-35.

Bashshur, R. (1995). "On the definition and evaluation of telemedicine." Telemedicine Journal **2**(1): 19-30.

Bashshur, R., G. Shannon and H. Sapci (2005). "Telemedicine evaluation." Telemedicine and e-Health **11**(3): 296-316.

Baskerville, R. L. (1999). "Investigating information systems with action research." Communications of the Association for Information Systems **2**(3, Article No. 4).

Bauer, M. (2000). "Classical content analysis: A review". Qualitative Researching with Text, Image and Sound. M. Bauer and G. Gaskell, Thousand Oaks, CA, Sage: 131-151

Bauer, R. A. (1960). "Consumer behavior as risk taking". Risk Taking and Information Handling in Consumer Behavior. D. F. Cox, Boston, MA, Harvard Business Press: 23–33.

Bauer, S., R. Percevic, E. Okon, R. Meermann and H. Kordy (2003). "Use of text messaging in the aftercare of patients with bulimia nervosa." European Eating Disorders Review **11**: 279–290.

Bayliss, E., M. Park, J. Westfall and M. Zamorski (2001). "How can I improve patient adherence to prescribed medication?" Journal of Family Practice, April, 2001, Available at http://www.findarticles.com/cf_dls/m0689/4_50/74292248/p1/article.jhtml, Accessed March 16, 2004.

BBC (2005a). "What is SMS?" The British Broadcasting Corporation, Available at http://www.bbc.co.uk/webwise/askbruce/articles/mobiles/sms_1.shtml, Accessed December 9, 2005.

BBC (2005b). "Mobile phone safety.", The British Broadcasting Corporation, Available at http://www.bbc.co.uk/science/hottopics/mobilephones/, Accessed December 15, 2005.

Bebko, C. P. (2000). "Service intangibility and its impact on consumer expectations of service quality." Journal of Services Marketing **14**(1): 9-26.

Benabou, R. and J. Tirole (2003). "Intrinsic and extrinsic motivation." Review of Economic Studies **70**: 489-520.

Bettman, J. R. (1973). "Perceived risk and its components: A model and empirical test." Journal of Marketing Research **10**(2): 184-190.

Bielen, F. and C. Semples (2004). "Impact of the two dimensions of intangibility on the global perceived risk: A segmented approach.", Working Paper 106/04, IAG, Universite Catholique de Louvain, Belgium, Available at http://www.isys.ucl.ac.be/working_papers/documents/WP106Sempels.pdf, Accessed December 5, 2005.

Biermann, E., W. Dietrich, J. Rihl and E. Standl (2002). "Are there time and cost savings by using telemanagement for patients on intensified insulin therapy?" Computer Methods and Programs in Biomedicine **69**.

Birch, S., C. A. Gafni and B. O'Brien (1999). "Willingness to pay and the valuation of programmes for the prevention and control of influenza." Pharmacoeconomics **16**(1): 55-61.

Bludau, H.-B. (2003). "European contribution to mobile computing in medicine.", Available at http://www.bbriefings.com/pdf/13/hosp031_r_bludau.PDF, Accessed November 4, 2004.

Bodenheimer, T., K. Lorig, H. Holman and K. Grumbach (2002). "Patient self-management of chronic disease in primary care." Journal of the American Medical Association **288**(19): 2469-2475.

Bontis, N. (1998). "Intellectual capital: An exploratory study that develops measures and models." Management Decision **36**(2): 63-76.

Bontis, N. (2004). "National intellectual capital index: A United Nations initiative for the Arab region." Journal of Intellectual Capital **5**(1): 13-39.

Bontis, N., M. M. Crossan and J. Hulland (2002). "Managing an organizational learning system by aligning stocks and flows." Journal of Management Studies **39**(4): 437-469.

Bontis, N., W. C. C. Keow and S. Richardson (2000). "Intellectual capital and business performance in Malaysian industries." Journal of Intellectual Capital **1**(1): 85-100.

Bos, A., J. Hoogstraten and B. Prahl-Andersen (2005). "Failed appointments in an orthodontic clinic." American Journal of Orthodontics and Dentofacial Orthopedics **127**(3): 355-357.

Brooker, G. (1984). "An assessement of an expanded measure of perceived risk." Advances in Consumer Research **11**: 439-441.

Bultman, D. C. and B. L. Svarstad (2002). "Effects of pharmacist monitoring on patient satisfaction with antidepresant medication therapy." Journal of the American Pharmaceutical Association **42**(1): 36-43.

Burge, M. (2001). "Lack of compliance with home blood glucose monitoring predicts hospitalization in diabetes." Diabetes Care **24**(8): 1502.

Butler, J. C., J. S. Dyer and J. Jia (2005). "An empirical investigation of the assumptions of risk-value models." The Journal of Risk and Uncertainty **30**(2): 133–156.

Carter, K. F. and P. A. Kulbok (2002). "Motivation for health behaviours: A systematic review of the nursing literature." Journal of Advanced Nursing **40**(3): 316-330.

Celler, B., N. Lovell and J. Basilakis (2003). "The healthcare system. Using information technology to improve the management of chronic disease." Medical Journal of Australia **179**(5): 242-246.

Cenfetelli, R. T. (2004). "An empirical study of the inhibitors of technology usage". Twenty-Fifth International Conference on Information Systems, Washington, D.C., USA, December 12-15th, 2004.

Chan, S.-C. and M. Lu (2004). "Understanding Internet banking adoption and user behavior: A Hong Kong perspective." Journal of Global Information Management **12**(3): 21-43.

Chau, P. Y. K. and P. J. H. Hu (2002). "Investigating healthcare professionals' decisions to accept telemedicine technology: An empirical test of competing theories." Information and Management **39**(4): 297–311.

Chau, P. Y. K. and P. J.-H. Hu (2001). "Information technology acceptance by individual professionals: A model comparison approach." Decision Sciences **32**(4): 699-719.

Cheah, J. (2001). "Chronic disease management: A Singapore perspective." British Medical Journal **323**(27 October): 990-993.

Chen, T.-y. and H.-S. Chang (2005). "Reducing consumers' perceived risk through banking service quality cues in Taiwan." Journal of Business and Psychology **19**(4).

Childers, T. L., C. L. Carr, J. Peck and S. Carson (2001). "Hedonic and utilitarian motivations for online retail shopping behavior." Journal of Retailing **77**: 511–535.

Chin, T. (2002). "Remote control: The growth of home monitoring.", AMNews, Available at http://www.ama-assn.org/amednews/2002/11/18/bisa1118.htm. Accessed 17 August 2004.

Chin, W. W. (1995). "Partial Least Squares is to LISREL as principal components analysis is to common factor anlaysis." Technology Studies **2**: 315-319.

Chin, W. W. (1998). "The Partial Least Squares approach for structural equation modeling". Modern Methods for Business Research. A. Marcoulides, Mahwa, NJ, Lawrence Erlbaum Associates: 295-336.

Chin, W. W. and P. R. Newsted (1999). "Structural equation modeling analysis with small samples using partial least squares". Statistical Strategies for Small Sample Research. R. H. Hoyle, Thousand Oaks, CA, Sage Publications: 307-337.

Chung, J. and F. B. Tan (2004). "Antecedents of perceived playfulness: An exploratory study on user acceptance of general information-searching websites." Information & Management **41**: 869–881.

Clandinin, D. J. and F. M. Connelly (2000). "Narrative inquiry: Experience and story in qualitative research". San Francisco, CA, Jossey-Bass.

Cleemput, I. and K. Kesteloot (2002) Economic implications of non-compliance in health care. The Lancet. **359**(9324): 2129-2130.

Cleemput, I., K. Kesteloot and S. DeGeest (2002). "A review of the literature on the economics of noncompliance. Room for methodological improvement." Health Policy **59**(2002): 65-94.

Cocosila, M. and N. Archer (2004). "M-healthcare approaches for improving outpatient adherence in self-management of chronic diseases", Working Paper No. 8, McMaster University eBusiness Research Centre (MeRC), Hamilton, Ontario.

Cocosila, M. and N. Archer (2005a). "A framework for mobile healthcare answers to chronically ill outpatient non-adherence." Informatics in Primary Care **13**(2): 145-152.

Cocosila, M. and N. Archer (2005b). "Mobile healthcare initiatives for improving outpatient adherence: Opportunities and barriers." International Journal of Electronic Business **3**(6): 512-533.

Cocosila, M., N. Archer and Y. Yuan (2006). "Mobile healthcare for adherence: Business considerations". Mednet, Toronto, Canada, October 13-20, 2006, Available at http://www.mednetcongress.org/fullpapers/MEDNET-476_CocosilaMihailA1_e.pdf., Accessed January 5, 2007.

Cocosila, M., C. Coursaris and Y. Yuan (2004). "M-healthcare for patient self-management: A case for diabetics." International Journal of Electronic Healthcare **1**(2): 221–241.

Cocosila, M., O. Turel, N. Archer and Y. Yuan (2006). "Perceived health risk effects on the adoption of 3G cell phones". AMCIS, Acapulco, Mexico, August 4-6, 2006.

Cocosila, M., O. Turel, N. Archer and Y. Yuan (forthcoming). "Perceived health risk of 3G cell phones: Do users care?" Communications of the ACM.

Cohen, J. (1988). "Statistical power analysis for the behavioral sciences", 2nd ed. Hillsdale, NJ, Lawrence Erlbaum Associates.

Cohen, S. (1979). "New directions in patient compliance". Lexington Massachusetts, Toronto, Canada, Lexington Books.

Compeau, D. and C. Higgins (1995a). "Computer self-efficacy: Development of a measure and initial test." MIS Quarterly **19**(2): 189-211.

Compeau, D. and C. Higgins (1995b). "Application of social cognitive theory to training for computer skills." Information Systems Research **6**(2): 118-143.

Compeau, D., C. Higgins and S. Huff (1999). "Social cognitive theory and individual reactions to computing technology: A longitudinal study." MIS Quarterly **23**(2): 145-158.

Conchar, M. P., G. M. Zinkhan, C. Peters and S. Olavarrieta (2004). "An integrated framework for the conceptualization of consumers' perceived-risk processing." Journal of the Academy of Marketing Science. **32**(4): 418-436.

Conlin, R. (2000). "Survey prescribes more net use for doctors.", CRM Daily Website, Available at http://www.newsfactor.com/perl/story/5707.html, Accessed January 5, 2007.

Coulter, A., V. Entwistle and D. Gilbert (1999). "Sharing decisions with patients: Is the information good enough?" British Medical Journal **318**: 318-322.

Coursaris, C. (2003). "m-Health: exploring the impact of wireless devices in health care". McMaster World Congress, 3rd World Congress on the Management of Electronic Business, Hamilton, Ontario, Canada.

Cox, D. F. and S. U. Rich (1964). "Perceived risk and consumer decision making - The case of telephone shopping." Journal of Marketing Research **1**(4): 32–39.

CPC (2002). "Factors affecting patient compliance.", CPC Healthcare Communications, Available at http://www.cpchealthcare.com/admincpc/Uploads/WP/Factors_Affecting.pdf, Accessed January 11, 2006.

Cronbach, L. J. (1951). "Coefficient alpha and the internal structure of tests." Psychometrika **16**(3): 297-334.

Cunningham, L. F., J. Gerlach and M. D. Harper (2004). "Assessing perceived risk of consumers in internet airline reservations services." Journal of Air Transportation **9**(1): 21-35.

Dabholkar, P. A. and R. P. Bagozzi (2002). "An attitudinal model of technology-based self-service: Moderating effects of consumer traits and situational factors." Journal of the Academy of Marketing Science. **30**(3): 184-201.

Damodaran, L. (1996). "User involvement in the systems design process - A practical guide for users." Behaviour & Information Technology **15**(6): 363-377.

Darley, W. K. and R. E. Smith (1995). "Gender differences in information processing strategies: An empirical test of the selectivity model in advertising response." Journal of Advertising **24**(1): 41-56.

Davis, F. (1989). "Perceived usefulness, perceived ease of use, and user acceptance of information technology." MIS Quarterly **13**(3): 319-340.

Davis, F., R. Bagozzi and P. Warshaw (1989). "User acceptance of computer technology: A comparison of two theoretical models." Management Science **35**(8): 982-1003.

Davis, F., R. Bagozzi and P. Warshaw (1992). "Extrinsic and intrinsic motivation to use computers in the workplace." Journal of Applied Social Psychology **22**(14): 1111-1132.

DCMR (2003). "Prescription solutions develops predictive modeling technique to improve medication compliance.", Drug Cost Management Report, Available at http://www.findarticles.com/cf_dls/m0NKV/8_4/106060094/p1/article.jhtml?term=, Accessed March 16, 2004.

De Cremer, D., B. van Knippenberg, D. van Knippenberg and D. Mullenders (2005). "Rewarding leadership and fair procedures as determinantes of self-esteem." Journal of Applied Psychology **90**(1): 3-12.

De Cremer, D. and D. van Knippenberg (2002). "How do leaders promote cooperation? The effects of charisma and procedural fairness." Journal of Apllied Psychology **87**(5): 858-866.

Deci, E. L. (1975). "Intrinsic motivation". New York, NY, Plenum Press.

Deci, E. L. and R. M. Ryan (1985). "Intrinsic motivation and self-determination in human behavior". New York, NY, Plenum Press.

Del Mar, C. and P. Glasziou (2002). "Upper respiratory tract infection." Clinical Evidence **7**: 1391–1399.

Dermer, J. (1975). "The interrelationship of intrinsic and extrinsic motivation." Academy of Management Journal **18**(000001): 125-129.

Detlor, B., S. Sproule and C. Gupta (2003). "Pre-purchase online information seeking: Search versus browse." Journal of Electronic Commerce Research **4**(2): 72-84.

Devane, D., C. Begley and M. Clarke (2004). "How many do I need? Basic principles of sample size estimation." Journal of Advanced Nursing **47**(3): 297–302.

Dezii, C. (2000). "Medication noncompliance: What is the problem?" Managed care/Supplement **9**(9): 7-12.

Dholakia, U. M. (2001). "A motivational process model of product involvement and consumer risk perception." European Journal of Marketing **35**(11/12): 1340-1360.

Diehl, A. K. (1985). "Medication compliance in non-insulin-dependent diabetes: A randomized comparison of chlorpropamide and insulin." Diabetes Care **8**(3): 219-223.

Dillon, A. and M. Morris (1996). "User acceptance of information technology: Theories and models." Journal of the American Society for Information Science **31**: 3–32.

Doolin, B., S. Dillon, F. Thompson and J. L. Corner (2005). "Perceived risk, the Internet shopping experience and online purchasing behavior: A New Zealand perspective." Journal of Global Information Management **13**(2): 66-88.

Douglas, R. M., H. Hemilä, E. Chalker, R. R. D. D'Souza and B. Treacy (2004). "Vitamin C for preventing and treating the common cold." The Cochrane Database of Systematic Reviews(4): CD000980.pub2. DOI: 10.1002/14651858.CD000980.pub2.

Downer, S. R., J. G. Meara and A. C. Da Costa (2005). "Use of SMS text messaging to improve outpatient attendance." Medical Journal of Australia **183**(7): 366-368.

Downe-Wamboldt, B. (1992). "Content analysis: Method, applications, and issues." Health Care for Women International **13**(3): 313-321.

Duan, M. (2003). "Healthcare on the wireless frontier.", WirelessInnovator Web site, Available at http://cooltown.hp.com/mpulse/1201-healthcare.asp, Accessed January 5, 2007.

Dunbar, J. M., G. D. Marshall and M. F. Hovell (1979). "Behavioral strategies for improving compliance". Compliance in Health Care. R. B. Haynes, D. L. Sackett and D. W. Taylor. Baltimore, MD, Johns Hopkins University Press: 174-192.

Dunbar, P., D. Madigan, L. Grohskopf, D. Revere, J. Woodward, J. Minstrell, P. Frick, J. Simoni and T. Hooto (2003). "A two-way messaging system to enhance antiretroviral adherence." Journal of the American Medical Informatics Association **10**(1): 11-15.

Dyer, O. (2003). "Patients will be reminded of appointments by text messages." British Medical Journal **326**(14 June): 1281.

Edwards, J. (2002). "Hands-off medicine promises healthy payoffs.", Information Week, Available at http://www.informationweek.com/story/IWK20020314S0023, WebCite: http://www.webcitation.org/5FkrGOtqa, Accessed May 9, 2006.

Edwards, P., I. Roberts, M. Clarke, C. DiGuiseppi, S. Pratap, R. Wentz and I. Kwan (2002). "Increasing response rates to postal questionnaires: Systematic review." British Medical Journal **324**: 1183–1191.

Emanuel, E., D. Wendler and C. Grady (2000). "What makes clinical research ethical?" Journal of American Medical Association **283**(20): 2701–2711.

Ende, J., L. Kazis, A. Ash and M. Moskowitz (1989). "Measuring patients' desire for autonomy: Decision making and information-seeking preferences among medical patients." Journal of General Internal Medicine **4**(1): 23-30.

Engel, J. F., R. D. Blackwell and P. W. Miniard (1995). "Consumer behavior", Harcourt Broce Joranovich College Publishers, New York, NY, The Dryden Press.

Erickson, S., F. Ascione, D. Kirking and C. Johnson (1998). "Use of a paging system to improve medication self-management in patients with asthma." Journal of the American Pharmaceutical Association **38**(6): 767–769.

Ernst, E. (2002). "The risk–benefit profile of commonly used herbal therapies: Ginkgo, St. John's Wort, Ginseng, Echinacea, Saw Palmetto, and Kava." Annals of Internal Medicine **136**: 42-53.

Featherman, M. and M. Fuller (2003). "Applying TAM to e-services adoption: The moderating role of perceived risk". Proceedings of the 36th Hawaii International Conference on System Sciences - 2003.

Featherman, M. and P. Pavlou (2003). "Predicting e-services adoption: A perceived risk facets perspective." International Journal of Human Computer Studies **59**(1): 451-474.

Featherman, M. and J. Wells (2004). "The Intangibility of e-services: Effects on artificiality, perceived risk, and adoption". Proceedings of the 37th Hawaii International Conference on System Sciences.

Featherman, M. S. (2001). "Extending the technology acceptance model by inclusion of perceived risk". Proceedings of the Seventh Americas Conference on Information Systems, Boston, MA, USA.

Ferner, R. (2003). "Is concordance the primrose path to health?" British Medical Journal, (International edition) **327**(7419): 821.

Ferrer-Roca, O., A. Cardenas, A. Diaz-Cardama and P. Pulido (2004). "Mobile phone text messaging in the management of diabetes." Journal of Telemedicine and Telecare **10**(5): 282-285.

Fishbein, M. and I. Ajzen (1975). "Belief, attitude, intention and behavior: An introduction to theory and research". Reading, MA, Addison-Wesley.

Floerkemeier, C. and F. Siegemund (2003). "Improving the effectiveness of medical treatment with pervasive computing technologies", Workshop on Ubiquitous Computing for Pervasive Healthcare Applications at Ubicomp 2003, October 2003, Available at http://www.vs.inf.ethz.ch/publ/papers/SmartBlisterPack.pdf, Accessed December 24, 2005.

Forkner-Dunn, J. (2003). "Internet-based patient self-care: The next generation of health care delivery." Journal of Medical Internet Research **5**(2): e8.

Fornell, C. and D. F. Larcker (1981). "Evaluating structural equation models with unobservable variables and measurement error." Journal of Marketing Research **18**(1): 39-50.

Fram, E. H. and D. B. Grady (1997). "Internet shoppers: Is there a surfer gender gap?" Direct Market **59**(9): 46–50.

Franklin, V., A. Waller, C. Pagliari and S. Greene (2003). ""Sweet Talk": Text messaging support for intensive insulin therapy for young people with diabetes." Diabetes Technology & Therapeutics **5**(6): 991-996.

Frick, P., L. Lavreys, K. Mandaliya and J. Kreiss (2001). "Impact of an alarm device on medication compliance in women in Mombasa, Kenya." International Journal of STD & AIDS **12**(5): 329-333.

Friedman, R., J. Stollerman, D. Mahoney and L. Rozenblyum (1997). "The virtual visit. Using telecommunications technology to take care of patients." Journal of American Medical Informatics Association **4**(6): 413-425.

Gammon, D., E. Arsand, O. A. Walseth, N. Andersson, M. Jenssen and T. Taylor (2005). "Parent-child interaction using a mobile and wireless system for blood glucose monitoring." Journal of Medical Internet Research **7**(5): e57.

Garbarino, E. and M. Strahilevitz (2004). "Gender differences in the perceived risk of buying online and the effects of receiving a site recommendation." Journal of Business Research **57**: 768– 775.

Gawande, A. (2004). "The bell curve". The New Yorker, December 6, 2004: 82-91.

Gefen, D. and D. Straub (2005). "A practical guide to factorial validity using PLS-Graph: Tutorial and annotated example." Communications of the Association for Information Systems **16**: 91-109.

Gefen, D., D. Straub and M.-C. Boudreau (2000). "Structural equation modeling and regression: Guidelines for research practice." Communications of the Association for Information Systems **4**(7): 1-77.

Gemunden, H. G. (1985). "Perceived risk and information search. A meta-analysis of the empirical evidence." International Journal of Research in Marketing **2**: 79–100.

Gerber, K. E. (1986). "Compliance in the chronically ill: An introduction to the problem". Compliance. The Dilemma of the chronically ill. K. E. Gerber and A. M. Nehemkis, New York, NY, Springer Publishing Company: 12-23.

German, D. (2000). "Noncompliance and its effect on raising health-care costs." Canadian Pharmaceutical Journal **133**(3).

Gewald, H. and J. Dibbern (2005). "The influential role of perceived risks versus perceived benefits in the acceptance of business process outsourcing: Empirical evidence from the German banking industry", University of Frankfurt, Institute of Information Systems, E-Finance Lab Working Paper Nr. 2005-9.

Grazioli, S. and S. L. Jarvenpaa (2000). "Perils of Internet fraud: An empirical investigation of deception and trust with experienced Internet consumers." IEEE Transactions On Systems, Man, And Cybernetics - Part A: Systems And Humans **30**(4): 395-410.

Grewal, D., J. Gotlieb and H. Marmorstein (1994). "The moderating effects of message framing and source credibility on the price-perceived risk relationship." The Journal of Consumer Research **21**(1): 145-153.

Grimson, J. and W. Grimson (2002). "Health care in the information society: Evolution or revolution?" International Journal of Medical Informatics **66**(1-3): 25-29.

Grinter, R. E. and M. Eldridge (2003). "Wan2tlk?: Everyday text messaging". CHI 2003, ACM Conference on Human Factors in Computing Systems, Ft. Lauderdale, Florida, USA.

Hair, J., A. Rolph and R. Tatham (1987). "Multivariate data analysis", 2nd edition. New York, NY, Macmillan.

Harman, H. H. (1967). "Modern factor analysis". Chicago, IL, University of Chicago Press.

Harris Interactive (2001). "New data show Internet, Website and email usage by physicians all increasing", Harris Interactive Website, Vol. 1(8), Available at http://www.harrisinteractive.com/news/newsletters/healthnews/HI_HealthCareNews2001Vol1_iss8.pdf., Accessed January 12, 2006.

Hathcock, J., A. Azzi, J. Blumberg, T. Bray, A. Dickinson, B. Frei, I. Jialal, C. Johnston, F. Kelly, K. Kraemer, L. Packer, S. Parthasarathy, H. Sies and M. Traber (2005). "Vitamins E and C are safe across a broad range of intakes." The American Journal of Clinical Nutrition **81**(4): 736-745.

Haung, Y.-R. and J.-M. Ho (2005). "Overload control for short message transfer in GPRS/UMTS networks." Information Sciences **170**(2-4): 235-249.

Havlena, W. J. and W. S. DeSarbo (1991). "On the measurement of perceived consumer risk." Decision Sciences **22**(4): 927-939.

Haynes, R., D. Sackett, G. Guyatt and P. Tugwell (2005). "Clinical epidemiology: How to do clinical practice research". Philadelphia, PA, Lippincott, Williams, Wilkins.

Haynes, R., X. Yao, A. Degani, S. Kripalani, A. Garg and H. McDonald (2005). "Interventions to enhance medication adherence." The Cochrane Database of Systematic Reviews(4): CD000011.

Haynes, R. B. (1979a). "Introduction". Compliance in health care. D. W. Taylor, Baltimore, MD, Johns Hopkins University Press: 1-7.

Haynes, R. B. (1979b). "Strategies to improve compliance with referrals, appointments, and prescribed medical regimens". Compliance in health care. D. W. Taylor, Baltimore, MD, Johns Hopkins University Press: 121-143.

Haynes, R. B., P. Kris-Etherton, D. McCarron, S. Oparil, A. Chait, L. Resnick, C. Morris, S. Clark, D. Hatton, J. Metz, M. McMahon, S. Holcomb, G. Snyder, F. Pi-Sunyer and J. Stern (1999). "Nutritionally complete prepared meal plan to reduce cardiovascular risk factors: A randomized clinical trial." Journal of the American Dietetic Association **99**(9): 1077-1083.

Haynes, R. B., H. McDonald, A. X. Garg and P. Montague (2004). "Interventions for helping patients to follow prescriptions for medications (Cochrane Review)." The Cochrane Library.

Haynes, R. B., H. P. McDonald and A. X. Garg (2002). "Helping patients follow prescribed treatment: Clinical applications." Journal of the American Medical Association **288**: 2880-2883.

Haynes, R. B., K. McKibbon and R. Kanani (1996). "Systematic review of randomized trials of interventions to assist patients to follow prescriptions for medications." Lancet **348**(9024): 383-386.

Hemilä, H. (2004). "Vitamin C supplementation and respiratory infections: A systematic review." Military Medicine **169**(11): 920-925.

Hepke, K., M. Martus, and D. Share (2004) "Costs and utilization associated with pharmaceutical adherence in a diabetic population." American Journal of Managed Care, 2004. **10**(2 Pt 2): 144-151.

Hertzum, M. (2003). "Making use of scenarios: A field study of conceptual design." International Journal of Human-Computer Studies **58**: 215–239.

Hirschman, E. C. and M. B. Holbrook (1982). "Hedonic consumption: Emerging concepts, methods and propositions." Journal of Marketing **46**(3): 92–101.

Hirst, M. K. (1988). "Intrinsic motivation as influenced by task interdependence and goal setting." Journal of Applied Psychology **73**(1): 96-101.

Hoise (1999). "The newly emerging concept of next generation wireless and mobile telemedicine systems", The Hoise Website, Available at http://www.hoise.com/vmw/99/articles/vmw/LV-VM-05-99-16.html, Accessed November 2, 2004.

Holman, H. and K. Lorig (2000). "Patients as partners in managing chronic disease." British Medical Journal **320**(26 February): 526-527.

Horne, R., L. Graupnera, S. Frosta, J. Weinmanb, S. M. Wright and M. Hankins (2004). "Medicine in a multi-cultural society: The effect of cultural background on beliefs about medications." Social Science & Medicine **59**(6): 1307-1313.

Horne, R., J. Weinman and M. Hankins (1999). "The Beliefs about Medicines Questionnaire: The development and evaluation of a new method for assessing the cognitive representation of medication." Psychology & Health **14**(1): 1-24.

Hu, J.-H. and S.-C. Wang (2005). "What drives mobile commerce? An empirical evaluation of the revised technology acceptance model." Information & Management **42**: 719-729.

Hu, P. J. H., P. Y. K. Chau, O. R. L. Sheng and K.-Y. Tam (1999). "Examining the technology acceptance model using physician acceptance of telemedicine technology." Journal of Management Information Systems **16**(2): 91-112.

Hu, P. J.-H., O. R. L. Sheng, P. Y. Chau, K.-Y. Tam and H. Fung (1999). "Investigating physician acceptance of telemedicine technology: A survey study in Hong Kong". The 32nd Hawaii International Conference on System Sciences.

Humphrey, S. E., A. P. J. Ellis, D. E. Conlon and C. H. Tinsley (2004). "Understanding customer reactions to brokered ultimatums: Applying negotiation and justice theory." Journal of Applied Psychology **89**(3): 466-482.

Hung, S., C. Ku and C. Chang (2003). "Critical factors of WAP services adoption: An empirical study." Electronic Commerce Research Applications **3**: 42-60.

Hunter, M. G. (2004). "Qualitative research in information systems: An exploration of methods". The handbook of information systems research. M. E. Whitman and A. B. Wosczynski. Hershey, PA, Idea Group Inc.: 291-304.

Husemann, D. (2004). "Remote monitoring of health conditions", ERCIM News No. 56, January 2004, Available at http://www.ercim.org/publication/Ercim_News/enw56/husemann.html, Accessed April 1, 2004.

Igbaria, M. (1993). "User acceptance of microcomputer technology: An empirical test." OMEGA: International Journal of Management Science **21**(1): 73–90.

Igbaria, M., J. Iivari and H. Maragahh (1995). "Why do individuals use computer technology? A Finnish case study." Information & Management **29**(5): 227-238.

Igbaria, M., S. Parasuraman and J. J. Baroudi (1996). "A motivational model of microcomputer usage." Journal of Management Information Systems **13**(1): 127-143.

Igbaria, M., S. J. Schiffman and T. S. Wieckowshi (1994). "The respective roles of perceived usefulness and perceived fun in the acceptance of microcomputer technology." Behaviour and Information Technology **13**(6): 349-361.

Insch, G. S., J. E. Moore and L. D. Murply (1997). "Content analysis in leadership research: Examples, procedures, and suggestions for future use." Leadership Quarterly **8**(1): 1-25.

Jacoby, J. and L. B. Kaplan (1972). "The components of perceived risk", Proceedings of the 3rd Annual Conference of the Association for Consumer Research.

Jarke, M. (1998). "Guest editorial: Interdisciplinary uses of scenarios." Requirements Engineering **3**: 153-154.

Jarke, M. (1999). "Scenarios for modeling." Communications of the ACM **42**(1): 47 - 48.

Jarvenpaa, S. L., G. W. Dickson and G. DeSanctis (1985). "Methodological issues in experimental IS research: Experiences and recommendations." MIS Quarterly **9**(2): 141–156.

Jarvenpaa, S. L., T. R. Shaw and D. S. Staples (2004). "Toward contextualized theories of trust: The role of trust in global virtual teams." Information Systems Research **15**(3): 250–267.

Jarvenpaa, S. L. and P. A. Todd (1996). "Consumer reactions to electronic shopping on the World Wide Web." International Journal of Electronic Commerce **1**(2): 59–88.

Jarvenpaa, S. L., N. Tractinsky and M. Vitale (2000). "Consumer trust in an Internet store." Information Technology and Management **1**: 45–71.

Jia, J. M. and J. S. Dyer (1996). "A standard measure of risk and risk-value models." Management Science **42**(12): 1691-1705.

Jia, J. M., J. S. Dyer and J. C. Butler (1999). "Measures of perceived risk." Management Science **45**(4): 519–532.

Jick, T. D. (1979). "Mixing qualitative and quantitative methods: Triangulation in action." Administrative Science Quarterly **24**(4): 602-611.

Jih, W.-J., S.-Y. Wong and T.-B. Chang (2005). "Effects of perceived risks on adoption of internet banking services: An empirical investigation in Taiwan." International Journal of E-Business Research **1**(1): 70-88.

Jobber, D., J. Saunders and V.-W. Mitchell (2004). "Prepaid monetary incentive effects on mail survey response." Journal of Business Research **57**(1): 21-25.

Jones, M. A. (1999). "Entertaining shopping experiences: An exploratory investigation." Journal of Retailing and Consumer Services **6**(3): 129-139.

Jöreskog, K. G. (1982). The LISREL approach to causal-model building in the social sciences. Systems Under Indirect Observation, H. Wold. Amsterdam, New York, Oxford, North-Holland Publishing Company: 81-99.

Jöreskog, K. G. and H. Wold (1982). The ML and PLS techniques for modeling with latent varaibles. Systems under indirect observation. H. Wold. Amsterdam, New york, Oxford, North-Holland Publishing Company: 263-270.

Junglas, I. and R. Watson (2003). "U-commerce: An experimental investigation of ubiquity and uniqueness". Twenty Fourth Annual International Conference on Information Systems, 14-17, December 2003, Seattle, Washington, USA.

Kahn, M. E. (1999). "Diabetic risk taking: The role of information, education and medication." Journal of Risk and Uncertainty **18**(2): 147-164.

Kanungo, S. and V. Jain (2004). "Relationship between risk and intention to purchase in an online context: Role of gender and product category". Twelfth European Conference on Information Systems, Turku School of Economics and Business Administration, Turku, Finland.

Kaplan, L., G. Szybillo and J. Jacoby (1974). "Components of perceived risk in product purchase: A cross-validation." Journal of Applied Psychology **59**(3): 287–291.

Kaplan, S., S. Greenfield and J. J. Ware (1989). "Assessing the effects of physician-patient interactions on the outcomes of chronic disease." Medical Care **27**(3 Suppl): S110-127.

Karahanna, E., D. Straub and N. Chervany (1999). "Information technology adoption across time: A cross-sectional comparison of pre-adoption and post-adoption beliefs." MIS Quarterly **23**(2): 183–223.

Keen, P. (1991). "Shaping the future: Business design through information technology". Boston, MA, Harvard Business School Press.

Kim, K. and B. Prabhakar (2000). "Initial trust, perceived risk, and the adoption of Internet banking". Twenty first international conference on information systems, Brisbane, Queensland, Australia.

Kim, M. and S. J. Lennon (2000). "Television shopping for apparel in the United States: Effects of perceived amount of information on perceived risks and purchase intentions." Family and Consumer Sciences Research Journal **28**(3): 301-330.

Kivimaki, A. and V. Fomin (2001). "What makes a killer application for the cellular telephony services?" Standardization and Innovation in Information Technology, 2001 2nd IEEE Conference, Boulder, CO, USA.

Ko, H., J. Jung, J. Kim and S. W. Shim (2004). "Cross-cultural differences in perceived risk of online shopping." Journal of Interactive Advertising **4**(2).

Kohlbacher, F. (2005). "The use of qualitative content analysis in case study research." Forum Qualitative Sozialforschung / Forum: Qualitative Social Research [On-line Journal] **7**(1), Art. 21. Available at: http://www.qualitative-research.net/fqstexte/1-06/06-1-21-e.htm, Accessed April 10, 2007.

Korgaonkar, P. K. (1982). "Non-store retailing and perceived product risk". An Assessment of Marketing Thought and Practice, B. J. Walker et al., Chicago, IL, American Marketing Association: 204–207.

Krippendorff, K. (1980). "Content analysis: An introduction to its methodology". Beverly Hills, CA, Sage Publications Inc.

Kuo, Y. (2003). "Inconsistent use of diabetes medications, diabetes complications, and mortality in older Mexican Americans over a 7-year period." Diabetes Care **26**(11): 3054-3060.

Lankton, N. K. and R. D. S. Louis (2005). "Using paper-based scenarios to examine perceptions of interactive health communication systems." Communications of the Association for Information Systems **16**: 687-704.

Laroche, M., J. Bergeron and C. Goutaland (2003). "How intangibility affects perceived risk: The moderating role of knowledge and involvement." Journal of Services Marketing **17**(2): 122-140.

Laroche, M., G. H. G. McDougall, J. Bergeron and Z. Yang (2004). "Exploring how intangibility affects perceived risk." Journal of Service Research **6**(4): 373-389.

Laster, S., J. Maring and J. Fleming (1996). "The effect of a medication alarm device on patient compliance with topical pilocarpine." Journal of the American Optometric Association. **67**(11): 654–658.

Lee, D., J. Park and J. Ahn (2001). "On the explanation of factors affecting e-commerce adoption". Twenty-Second International Conference on Information Systems.

Lee, J. E. C., L. Lemyre, P. Mercier, L. Bouchard and D. Krewski (2005). "Acceptance of Internet-based learning medium: The role of extrinsic and intrinsic motivation." Information & Management **42**: 1095-1104.

Leong, K. C., W. S. Chen, K. W. Leong, I. Mastura, O. Mimi, M. A. Sheikh, A. H. Zailinawati, C. J. Ng, K. L. Phua and C. L. Teng (2006). "The use of text messaging to improve attendance in primary care: A randomized controlled trial." Family Practice **23**: 699–705.

Liao, S., Y. Shao, H. Wang and A. Chen (1999). "The adoption of virtual banking: An empirical study." International Journal of Information Management **19**(1): 63–74.

Liaw, S.-S. (2002). "Understanding user perceptions of World-Wide Web environments." Journal of Computer Assisted Learning **18**(2): 137-148.

Lim, N. (2003). "Consumers' perceived risk: Sources versus consequences." Electronic Commerce Research and Applications **2**: 216–228.

Lowes, R. (1998). "Patient-centered care for better patient adherence", American Academy of Family Physicians Website. Available at http://www.aafp.org/fpm/980300fm/patient.html. Accessed January 12, 2006.

Lu, J., C.-S. Yu, C. Liu and J. Yao (2003). "Technology acceptance model for wireless Internet." Internet Research: Electronic Networking Applications and Policy **13**(3): 206-222.

Lutfey, K. and W. Wishner (1999). "Beyond "compliance" is "adherence": Improving the prospect of diabetes care." Diabetes Care **22**(4): 635-639.

Lutz, R. J. and P. J. Reilly (1974). "An exploration of the effects of perceived social and performance risk on consumer information acquisition." Advances in Consumer Research **1**: 393–405.

MacKinnon, D. P., C. M. Lockwood, J. M. Hoffman, S. G. West and V. Sheets (2002). "A comparison of methods to test mediation and other intervening variable effects." Psychological Methods **7**(1): 83-104.

Madell, D. and S. Muncer (2004). "Back from the beach but hanging on the telephone? English adolescents' attitudes and experiences of mobile phones and the Internet." CyberPsychology & Behavior **7**(3): 359-367.

Maglaveras, N., V. Koutkias, I. Chouvarda, D. G. Goulis, A. Avramides, D. Adamidis, G. Louridas and E. A. Balas (2002). "Home care delivery through the mobile telecommunications platform: The Citizen Health System (CHS) perspective." International Journal of Medical Informatics **68**(1-3): 99-111.

Magrabi, F., N. H. Lovell, K. Huynh and B. G. Celler (2001). "Home telecare: System architecture to support chronic disease management". Engineering in Medicine and Biology Society, Proceedings of the 23rd Annual International Conference of the IEEE.

Mallion, J. and D. Schmitt (2001). "Patient compliance in the treatment of arterial hypertension", European Society of Hypertension Scientific Newsletter: Update on Hypertension Management 2001, Vol. 2, No.7, Available at http://www.eshonline.org/newsletter/2001/esh_2001_2_No07.pdf, Accessed March 11, 2004.

Mayring, P. (2000). "Qualitative content analysis." Forum Qualitative Sozialforschung / Forum: Qualitative Social Research [On-line Journal] **1**(2): Available at: http://www.qualitative-research.net/fqs-texte/2-00/2-00mayring-e.htm, Accessed December 24, 2005.

Mazzi, C. and M. Kidd (2002). "A framework for the evaluation of Internet-based diabetes management." Journal of Medical Internet Research **4**(1): e1.

McCorkle, D. E. (1990). "The role of perceived risk in mail order catalog shopping." Journal of Direct Marketing **4**: 26–35.

McDonald, H. P., A. X. Garg and R. B. Haynes (2002). "Interventions to enhance patient adherence to medication prescriptions. Scientific review." Journal of the American Medical Association **288**: 2868-2879.

McLain, D. L. (1995). "Responses to health and safety risk in the work environment." The Academy of Management Journal **38**(6): 1726-1743.

McLaren, P. (2003). "Telemedicine and telecare: What can it offer mental health services?" Advances in Psychiatric Treatment **9**: 54-61.

MDNetGuide (2004). "Patient adherence - Communicating sensitively", Available at http://www.mdnetguide.com/specialty_editions/africanamer/v1n3/cover.php?issID=00000000118, Accessed March 16, 2004.

Medtronic (2004). "Medtronic CareLink Network", Medtronic Website, Available at http://www.medtronic.com/carelink/patient/works.html, Accessed December 1, 2005.

Meichenbaum, D. and D. Turk (1987). "Facilitating treatment adherence. A practitioner's guide", New York, NY and London, U.K., Plenum Press.

Mennecke, B. and T. Strader (2003). "Mobile commerce. Technology, theory and applications", Hershey, PA, London, UK, Idea Group Publishing.

Metz, J., J. Stern, P. Kris-Etherton, M. Reusser, C. Morris, D. Hatton, S. Oparil, R. B. Haynes, L. Resnick, F. Pi-Sunyer, S. Clark, L. Chester, M. McMahon, G. Snyder and D. McCarron (2000). "A randomized trial of improved weight loss with a prepared meal plan in overweight and obese patients: Impact on cardiovascular risk reduction." Archives of Internal Medicine **160**(14): 2150-2158.

Miles, M. B. and A. M. Huberman (1994). "Qualitative data analysis: An expanded sourcebook". Thousand Oaks, Sage Publications.

Mitchell, T. R. (1982). "Motivation: New directions for theory, research, and practice." Academy of Management. The Academy of Management Review **7**(1): 80-88.

Mitchell, V. W. (1999). "Consumer perceived risk: Conceptualisations and models." European Journal of Marketing **33**(1/2): 163–195.

Mitchell, V. W. and M. Greatorex (1993). "Risk perception and reduction in the purchase of consumer services." The Service Industries Journal **13**(4): 179-200.

Montori, V. M., P. K. Helgemoe, G. H. Guyatt and D. S. Dean (2004). "Telecare for patients with type 1 diabetes and inadequate glycemic control." Diabetes Care **27**(5): 1088-1094.

Moon, J.-W. and Y.-G. Kim (2001). "Extending the TAM for a World-Wide-Web context." Information and Management **38**(4): 217-230.

Moore, G. C. and I. Benbasat (1991). "Development of an instrument to measure the perceptions of adopting an information technology innovation." Information Systems Research **2**(3): 192-222.

Moore, G. C. and I. Benbasat (1996). "Integrating diffusion of innovations an theory of reasoned acction models to predict utilization of information technology by end-users". Diffusion and Adoption of Information Technology, K. Kautz and J. Pries-Hege. London, U.K., Chapman and Hall: 132-146.

Moore, J. E. (2000). "One road to turnover: An examination of work exhaustion in technology professionals." MIS Quarterly **24**(1): 141-168.

Moyer, C., D. Stern, S. Katz and A. Fendrick (1999). ""We got mail": Electronic communication between physicians and patients." American Journal of Managed Care **5**(12): 1513-1522.

MSH (2004). "Patient adherence", Management Sciences for Health Website, Available at http://erc.msh.org/mainpage.cfm?file=4.4.0.htm&module=provider&language=English, Accessed January 12, 2006.

Murphy, E., R. Dingwall, D. Greatbatch, S. Parker and P. Watson (1998). "Qualitative research methods in health technology assessment: A review of the literature." Health Technology Assessment **2**(16).

Murphy, P. E. and B. M. Enis (1986). "Classifying products strategically." Journal of Marketing **50**(3): 24-42.

Myers, M. (1999). "Investigating information systems with ethnographic research." Communications of the Association for Information Systems **2**(4, Article No. 1).

Myers, M. D. (1997). "Qualitative research in information systems." MIS Quarterly **21**(2): 241-242.

Neville, R., A. Greene, J. McLeod, A. Tracy and J. Surie (2002). "Mobile phone text messaging can help young people manage asthma." British Medical Journal **325**(7364): 600.

Nokia (2005). "Press release", Nokia Canada, Available at http://www.nokia.ca/english/media/pr/smsrelease.asp, Accessed December 9, 2005.

Nunnally, J. C. (1978). "Psychometric theory", 2nd edition, New York, NY, McGraw-Hill.

Nurse Week (2004). "Chapter seven - Adherence in patient education", Nurse Week, Available at http://nurse.cyberchalk.com/nurse/courses/nurseweek/nw0650/c7/, Accessed January 12, 2006.

Nyshadham, E. A. (2000). "Privacy policies of air travel web sites: A survey and analysis." Journal of Air Transport Management **6**: 143–152.

O'Cass, A. and D. Griffin (2004). "Consumers' future considerations: An assessment of risk and involvement in social issues". Australian and New Zealand Marketing Academy Conference, Victoria University, Wellington, New Zealand.

Osborne, H. (2002). "Partnering with patients to improve health outcomes", Gaithersburg, MD, An Aspen Publication.

Paes, A. H. (1997). "Impact of dosage frequency on patient compliance." Diabetes Care **20**(10): 1512-1517.

Pagani, M. and D. Schipani (2004). "Motivations and barriers to the adoption of 3G mobile multimedia services: An end user perspective in the Italian market". Innovations of Knowledge Management, B. Montano, Hershey, PA, Idea Group Inc.: 80-95.

Pavlou, P. A. (2003). "Consumer acceptance of electronic commerce -Integrating trust and risk with the Technology Acceptance Model." International Journal of Electronic Commerce **7**(2).

Pedersen, P. E. (2002). "The adoption of messaging services among Norwegian teens: Development and test of an extended adoption model", SNF-Report 23/02, Institute for Research in Economics and Business Report, Bergen, Norway.

Pedersen, P. E., H. Nysveen and H. Thorbjørnsen (2002). "The adoption of mobile services: A cross service study", SNF-Report 31/02, Institute for Research in Economics and Business Report, Bergen, Norway.

Pedersen, P. E., H. Nysveen and H. Thorbjørnsen (2003). "Identity expression in the adoption of mobile services: The case of multimedia messaging services", SNF-project no. 6500 "Mobile and Channel Integrating Electronic Commerce", SNF Working Paper No. 26/03, Bergen, Norway.

Pennings, J. M. E. and A. Smidts (2000). "Assessing the construct validity of risk attitude." Management Science **46**(10): 1337-1348.

Peter, J. P. and M. J. Ryan (1976). "An investigation of perceived risk at the brand level." Journal of Marketing Research **13**(May): 184-188.

Pfizer (1996). "What's so important about taking all of your antibiotic?" Pfizer Inc., Available at http://www.pfizerforwomen.com/pdf/infections_br02.pdf, Accessed March 11, 2004.

Podsakoff, P. M., S. B. MacKenzie, J.-Y. Lee and N. P. Podsakoff (2003). "Common method biases in behavioral research: A critical review of the literature and recommended remedies." Journal of Applied Psychology **88**(5): 879-903.

Podsakoff, P. M. and D. W. Organ (1986). "Self-reports in organizational research: Problems and prospects." Journal of Management **12**(4): 531-544.

Pope, N., M. Brown and E. Forrest (1999). "Risk, innovativeness, gender and involvement factors affecting the intention to purchase sport product online." Sport Marketing Quarterly **8**(2): 25-33.

Poropudas, T. (2001). "Arbonaut develops medical location with VMWS", Nordic WirelessWatch, Helsinki September 18, 2001, Available at http://www.mobile.commerce.net/story.php?story_id=682&s=3, Accessed January 12, 2006.

PricewaterhouseCoopers (1999). "Healthcast 2010, smaller world, bigger expectations", PricewaterhouseCoopers Ltd. Website, Available at http://healthcare.pwc.com/healthcast2010.html, Accessed January 12, 2006.

ProWellness (2004). "Diabetes quality management system", ProWellness, Available at http://www.prowellness.com/pw/english/frontpage_en.htm, Accessed February 15, 2004.

Revere, D. and P. J. Dunbar (2001). "Review of computer-generated outpatient health behavior interventions. Clinical encounters "in absentia"." Journal of American Medical Informatics Association **8**(1): 62-79.

Richards, T. (1998). "Partnership with patients." British Medical Journal **316**(10 January): 85-86.

Richards, T. (1999). "Patients' priorities. Need to be assessed properly and taken into account." British Medical Journal **318**(30 January): 277-277.

Rodgers, A., T. Corbett, D. Bramley, T. Riddell, M. Wills, R.-B. Lin and M. Jones (2005). "Do u smoke after txt? Results of a randomised trial of smoking cessation using mobile phone text messaging." Tobacco Control **14**: 255-261.

Rogers, E. (1995). "Diffusion of innovations", 4th edn. New York, NY, The Free Press.

Rohm, B. and J. Rohm (2002). "A vision of the e-healthcare era." International Journal of Healthcare Technology and Management, **4**(1/2): 87-92.

Roselius, T. (1971). "Consumer rankings of risk reduction methods." Journal of Marketing **35**: 56-61.

Ross, W. H. and C. Wieland (1996). "Effects of interpersonal trust and time pressure on managerial mediation strategy in a simulated organizational dispute." Journal of Applied Psychology **81**(3): 228-248.

Roznowski, J. L. (2003). "A content analysis of mass media stories surrounding the consumer privacy issue." Journal of Interactive Marketing **17**(2): 52-68.

Ruggiero, L. (1990). "Impact of social support and stress on compliance in women with gestational diabetes." Diabetes Care **13**(4): 441-443.

Rumbold, A. and C. Crowther (2005). "Vitamin C supplementation in pregnancy." Cochrane Database Systematic Reviews **2**: CD004072.

Ryan, G.W. and H.R. Bernard (2000). "Data management and analysis methods". Handbook of qualitative research, 2nd ed., N.K. Denzin and Y.S. Lincoln, Thousand Oaks, CA, Sage: 769-802.

Ryan, R. M. and E. L. Deci (2000). "Intrinsic and extrinsic motivations: Classic definitions and new directions." Contemporary Educational Psychology **25**(1): 54-67.

Sackett, D. L. and J. C. Snow (1979). "The magnitude of compliance and noncompliance". Compliance in Health Care, D. W. Taylor, Baltimore, MD, Johns Hopkins University Press: 11-22.

Sasazuki, S., S. Sasaki, Y. Tsubono, S. Okubo, M. Hayashi and S. Tsugane (2005). "Effect of vitamin C on common cold: Randomized controlled trial." European Journal of Clinical Nutrition: 1–9.

Sawka, M. N., S. N. Cheuvront and R.-r. Carter (2005). "Human water needs." Nutrition Reviews **63**(6 Pt 2): S30-39.

Scales, D. and G. Rubenfeld (2005). "Estimating sample size in critical care clinical trials." Journal of Critical Care **20**: 6-11.

Schaninger, C. M. (1976). "Perceived risk and personality." The Journal of Consumer Research **3**(2): 95-100.

Schaper, L. and G. Pervan (2004). "A model of information and communication technology acceptance and utilisation by occupational therapists". The IFIP TC8/WG8.3 International Conference, Prato, Italy.

Shactman, N. (2000). "Why doctors hate the Internet", Wired News 2000, April 10, Available at http://www.wired.com/news/print/0,1294,35516.00.html, Accessed April 15, 2004.

Shang, R.-A., Y.-C. Chen and L. Shen (2005). "Extrinsic versus intrinsic motivations for consumers to shop on-line." Information & Management **42**: 401-413.

Shapira, B., P. B. Kantor and B. Melamed (2001). "The effect of extrinsic motivation on user behavior in a collaborative information finding system." Journal of the American Society for Information Science and Technology **52**(11): 879-888.

Shea, S., W. DuMouchel and L. Bahamonde (1996). "A meta-analysis of 16 randomized controlled trials to evaluate computer-based clinical reminder systems for preventive care in the ambulatory setting." Journal of the American Medical Informatics Association **3**(6): 399-409.

Shih, F.-J. (1998). "Triangulation in nursing research: Issues of conceptual clarity and purpose." Journal of Advanced Nursing **28**(3): 631-641.

Shimp, T. A. and W. O. Bearden (1982). "Warranty and other extrinsic cue effects on consumers' risk perceptions." Journal of Consumer Research **9**(1): 38-47.

Shook, C. L., D. J. Ketchen, Jr., G. T. M. Hult and K. M. Kacmar (2004). "An assessment of the use of structural equation modeling in strategic management research." Strategic Management Journal **25**: 397-404.

Simpson, L. and H. B. Lakner (1993). "Perceived risk and mail order shopping for apparel." Journal of Consumer Studies and Home Economics **17**: 377–398.

Simsek, Z. and J. F. Veiga (2001). "A primer on Internet organizational surveys." Organizational Research Methods **4**(3): 218-235.

Sjöberg, L. (2002). "Perceived information technology risks and attitudes", Stockholm School of Economics, Center for Risk Research, SSE/EFI Working Paper Series in Business Administration No 2002:5.

Sjöberg, L. and J. Fromm (2001). "Information technology risks as seen by the public." Risk Analysis **21**: 427-442.

Sobel, M. E. (1982). "Asymptotic confidence intervals for indirect effects in structural equation models". Sociological Methodology, S. Leinhardt, Washington, DC, American Sociological Association: 290-312.

Sofian, N., D. Newton and J. DeClaire (2000). "e-Communications and interactive e-care: The next generation of disease management". e-Healthcare, D. E. Goldstein, Gaithersburg, MD, Aspen Publishers: 148-188.

Spector, P. E. (1994). "Using self-report questionnaires in OB research: A comment on the use of a controversial method." Journal of Organizational Behavior **15**(5): 385-392.

Stephenson, B. J., B. H. Rowe, W. M. Macharia, G. Leon and R. B. Haynes (1993). "The rational clinical examination. Is this patient taking the treatment as prescribed?" Journal of American Medical Association **269**: 2779-2781.

Stern, S. E., J. W. Mullenix and S. J. Wilson (2002). "Effects of perceived disability on persuasiveness of computer-synthesizes speech." Journal of Applied Psychology **87**(2): 411-417.

Stone, R. N. and K. Grønhaug (1993). "Perceived risk: Further considerations for the marketing discipline." European Journal of Marketing **27**(3): 39-50.

Stone, R. N. and B. J. Mason (1995). "Attitude and risk: Exploring the relationship." Psychology & Marketing **12**(2): 135-153.

Straub, D., M. Limayem, et al. (1995). "Measuring system usage: Implications for IS theory testing." Management Science **41**(8): 1328-1342.

Sulway, M. (1980). "New techniques for changing compliance in diabetes." Diabetes Care **3**(1): 108-111.

Sun, H. and P. Zhang (2006). "The role of moderating factors in user technology acceptance." International Journal of Human - Computer Studies **64**: 53-78.

Svarstad, B., B. Chewning, B. Sleath and C. Claesson (1999). "The brief medication questionnaire: A tool for screening patient adherence and barriers to adherence." Patient Education and Counseling **37**: 113-124.

Szajna, B. (1996). "Empirical evaluation of the revised Technology Acceptance Model." Management Science **42**(1): 85-92.

Tabachnik, B. G. and L. S. Fidell (2001). "Using multivariate statistics", 4th edition, Boston, MA, Allyn & Bacon.

Tan, M. and T. S. H. Teo (2000). "Factors influencing the adoption of Internet banking." Journal of the Association of Information Systems **1**(5): 1–42.

Taylor, D. W., D. L. Sackett and R. B. Haynes (1984). "Sample size for randomized trials in stroke prevention. How many patients do we need?" Stroke **15**: 968-971.

Taylor, J. W. (1974). "The role of risk in consumer behavior." Journal of Marketing **38**(2): 54-60.

Taylor, S. and P. Todd (1995a). "Understanding information technology usage: A test of competing models." Information Systems Research **6**(4): 144-176.

Taylor, S. and P. A. Todd (1995b). "Assessing IT usage: The role of prior experience." MIS Quarterly **19**(2): 561-570.

Tenbrunsel, A. E. and K. A. Diekmann (2002). "Job-decision inconsistencies involving social comparison information: The role of dominating alternatives." Journal of Applied Psychology **87**(6): 1149-1158.

Teo, T. and S. Pok (2000). "Adoption of WAP-enabled mobile phones among Internet users." Omega - The International Journal of Management Science **31**: 483-498.

Teo, T. S. H., V. K. G. Lim and R. Y. C. Lai (1999). "Intrinsic and extrinsic motivation in Internet usage." Omega - The International Journal of Management Science **27**(1): 25-37.

Thomas, R. D., I. R. R. Lu and M. Cedzynski (2005). "Partial Least Squares: A critical review and a potential alternative.", Administrative Sciences Association of Canada (ASAC), Toronto, Ontario, Canada.

Thompson, R., C. Higgins and J. Howell (1991). "Personal computing: Toward a conceptual model of utilization." MIS Quarterly **15**(1): 124-143.

Tomnay, J. E., M. K. Pitts and C. K. Fairley (2005). "New technology and partner notification - Why aren't we using them?" International Journal of STD & AIDS **16**: 19–22.

Trauth, E. M. (2001). The choice of qualitative methods in IS research. Qualitative Research in IS: Issues and trends, E. M. Trauth, Hershey, PA, Idea Group Inc.: 1-19.

Triandis, H. (1977). "Interpersonal behavior". Monterey, CA, Brooke/Cole.

Turel, O., A. Serenko and N. Bontis (2007). "User acceptance of wireless short messaging services: Deconstructing perceived value." Information & Management **44**(1): 63-73.

Turner, R. B., R. Bauer, K. Woelkart, T. C. Hulsey and J. D. Gangemi (2005). "An evaluation of Echinacea angustifolia in experimental rhinovirus infections." The New England Journal of Medicine **353**(2): 341-348.

Udo, K. (2001). "Sociological explanations between micro and macro and the integration of qualitative and quantitative methods." Forum Qualitative Sozialforschung / Forum: Qualitative Social Research **2**(1): Online journal, Available at http://qualitative-research.net/fqs-texte/1-01/1-01kelle-e.htm, Accessed December 24, 2005.

Urquhart, C. (2001). "An encounter with Grounded Theory: Tackling the practical and philosophical issues". Qualitative Research in IS: Issues and Trends, E. Trauth, Hershey, PA, Idea Group Inc.: 104-140.

Vallerand, R. J. (1997). "Toward a hierarchical model of intrinsic and extrinsic motivation." Advances in Experimental Social Psychology **29**: 271–360.

Van den Poel, D. and J. Leunis (1996). "Mail-order versus retail store buying - The role of perceived risk and risk reduction strategies." International Review of Retail, Distribution and Consumer Research **6**(4): 351–371.

Van der Heijden, H. (2004). "User acceptance of hedonic information systems." MIS Quarterly **28**(4): 695-704.

Van der Heijden, H., M. Ogertschnig and L. Van der Gaast (2005). "Effects of context relevance and perceived risk on user acceptance of mobile information services". Thirteenth European Conference on Information Systems, Regensburg, Germany.

Van Impe, M. (2001). "Wireless diagnosis funded in the U.K.", Nordic Wireless Watch, October 15, 2001. Available at http://www.nordicwirelesswatch.com/wireless/story.html?story_id=779, Accessed January 12, 2006.

Van Schaik, P. (1999). "Involving users in the specification of functionality using scenarios and model-based evaluation." Behaviour & Information Technology **18**(6): 455 - 466.

Vellido, A., P. J. G. Lisboa and K. Meehan (1999). "Segmentation of the on-line shopping market using neural networks." Expert Systems with Applications **17**(4): 303–314.

Venkatesh, V. (1999). "Creation of favorable user perceptions: Exploring the role of intrinsic motivation." MIS Quarterly **23**(2): 239-260.

Venkatesh, V. (2000). "Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the Technology Acceptance Model." Information Systems Research **11**(4): 342-363.

Venkatesh, V. and F. Davis (2000). "A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies." Management Science **46**(2): 186-204.

Venkatesh, V., M. G. Morris, G. B. Davis and F. D. Davis (2003). "User acceptance of information technology: Toward a unified view." MIS Quarterly **27**(3): 425-478.

Venkatesh, V., V. Ramesh and A. Massey (2003). "Understanding usability in mobile commerce." Communications of the ACM **46**(12): 53-56.

Venkatesh, V. and C. Speier (1999). "Computer technology training in the workplace: A longitudinal investigation of the effect of mood." Organizational Behavior and Human Decision Processes **79**(1): 1-28.

Venkatesh, V., C. Speier and M. G. Morris (2002). "User acceptance enablers in individual decision making about technology: Toward an integrated model." Decision Sciences **33**(2): 297-316.

Vlachos, P. and A. Vrehopoulos (2005). "Consumers' behavioral intentions in the mobile Internet services market". Hermes Newsletter, Issue No. 33, ELTRUN, Available at http://www.eltrun.gr., Accessed November 28, 2006.

Walker, T. (2001). "Understanding patients' needs is key to medication compliance." Managed Healthcare Executive **1**(11): 34-36.

Wantland, D. J., C. J. Portillo, W. L. Holzemer, R. Slaughter and E. M. McGhee (2004). "The Effectiveness of Web-based vs. non-Web-based interventions: A meta-analysis of behavioral change outcomes." Journal of Medical Internet Research **6**(4): e40.

Watson, R. T., F. P. Leyland, P. Berthon and G. M. Zinkhan (2002). "U-commerce: Expanding the universe of marketing." Journal of the Academy of Marketing Science. **30**(4): 333-347.

Webb, C. (1999). "Analysing qualitative data: Computerized and other approaches." Journal of Advanced Nursing **29**(2): 323–330.

Weber, R. P. (1985). "Basic content analysis". Newbury Park, CA, Sage.

Webster's Dictionary (2002). "Webster's third new international dictionary of the English language unabridged 2002". Springfield, MA, Merriam Webster Inc.

Weiner, J. (2004). "Focusing on side effects increases patient adherence to medication", Medicine and Behavior, Available at http://www.medicineandbehavior.com/mb990813.html, Accessed March 16, 2004.

Weingarten, S., J. Henning, E. Badamgarav, K. Knight, V. Hasselblad, G. JrA and J. Ofman (2002). "Interventions used in disease management programmes for patients with chronic illness-which ones work? Meta-analysis of published reports." British Medical Journal **325**(26 October): 925.

Wexler, J. (2001). "Wireless apps for the healthcare industry", Wireless.itworld.com, Available at http://wireless.itworld.com/4246/NWW00322178/pfindex.html, Accessed January 12, 2006.

WHO (2003). "Adherence to long-term therapies: Evidence for action", World Health Organization Website, Available at http://www.who.int/chronic_conditions/adherencereport/en/, Accessed January 14, 2005.

Wikipedia (2005). "Short message service", Wikipedia, the free encyclopedia, Available at http://en.wikipedia.org/wiki/Text_messaging, Accessed December 15, 2005.

Wilson, E. V. and N. K. Lankton (2004a). "Interdisciplinary research and publication opportunities in information systems and healthcare." Communications of the Associtaions for Information Systems **14**: 332-343.

Wilson, E. V. and N. K. Lankton (2004b). "Modeling patients' acceptance of provider-delivered e-health." Journal of the American Medical Informatics Association **11** (4): 241-248.

Wing, R. R. (1985). "Compliance to self-monitoring of blood glucose: A marked-item technique compared with self-report." Diabetes Care **8**(5): 456-460.

Wirelessnewsfactor (2000). "AT&T to provide wireless health support", Wirelessnewsfactor, Available at www.wirelessnewsfactor.com, Accessed October 15, 2004, .

Wolf, F., J. Guevara and C. Grum (2003). "Review: Self-management education improves outcomes in children and adolescents with asthma", Educational interventions for asthma in children, Cochrane Database Syst Rev 2003, (1): CD000326, Available at http://ebn.bmjjournals.com/cgi/content/full/6/4/106, Retrieved February 17, 2004.

Wu, J.-H. and S.-C. Wang (2005). "What drives mobile commerce? An empirical evaluation of the revised technology acceptance model." Information & Management **42**: 719–729.

Yin, R. K. (1994). "Case study research: Design and methods", 2nd ed. Thousand Oaks, CA, Sage Publications Inc.

Young, J. (2005). "Vitamins", The British Broadcasting Corporation (BBC) Website, Available at http://www.bbc.co.uk/health/healthy_living/complementary_medicine/remedies_vitamins.shtml#vitamin_c, Accessed December 22, 2005.

Yuan, Y. and J. Zhang (2003). "Towards an appropriate business model for m-commerce." International Journal of Mobile Communications **1**(1/2): 35-56.

Appendix A: Glossary of Acronyms

Acronym	Meaning
3G	3rd Generation
AVE	Average Variance Extracted
BI	Behavioural Intention
DTPB	Decomposed Theory of Planned Behaviour
E	Electronic
EM	Extrinsic Motivation
IM	Intrinsic Motivation
IS	Information Systems
IT	Information Technology
MEMS	Medication Event Monitoring System
MM	Motivational Model
PEOU	Perceived Ease of Use
PLS	Partial Least Squares
PU	Perceived Usefulness
RCT	Randomized Controlled Trial
SEM	Structural Equation Modeling
SMS	Short Messaging (or Message) Service (or System)
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
URL	Uniform Resource Locator
WAP	Wireless Application Protocol
WTP	Willingness to Pay
WTGT	Willingness to Give Time

Appendix B: Scheduling of SMS Reminding Experiment

Day	Early SMS		Late SMS	
	Time interval	SMS Sent	Time interval	SMS Sent
1	5-7 p.m.	Reminder	-	-
2	5-7 p.m.	Reminder	-	-
3	5-7 p.m.	Reminder	7-9 p.m.	Reinforcement or Corrector
4	5-7 p.m.	Reminder	-	-
5	5-7 p.m.	Reminder	7-9 p.m.	Reinforcement or Corrector
6	5-7 p.m.	Reminder	-	-
7	5-7 p.m..	Reminder	7-9 p.m.	Reinforcement or Corrector
8	5-7 p.m.	Reminder	-	-
9	5-7 p.m.	Reminder	7-9 p.m.	Reinforcement or Corrector
10	5-7 p.m.	Reminder	-	-
11	5-7 p.m.	Reminder	7-9 p.m.	Reinforcement or Corrector
12	5-7 p.m.	Reminder	-	-
13	5-7 p.m.	Reminder	7-9 p.m.	Reinforcement or Corrector
14	5-7 p.m.	Reminder	-	-
15	-	-	7-9 p.m.	Reinforcement or Corrector
16	5-7 p.m.	Reminder	-	-
17	-	-	-	-
18	5-7 p.m.	Reminder	7-9 p.m.	Reinforcement or Corrector
19	-	-	-	-
20	5-7 p.m.	Reminder	-	-
21	-	-	7-9 p.m.	Reinforcement or Corrector
22	5-7 p.m.	Reminder	-	-
23	-	-	-	-
24	5-7 p.m.	Reminder	7-9 p.m.	Reinforcement or Corrector
25	-	-	-	-
26	5-7 p.m.	Reminder	-	-
27	-	-	7-9 p.m.	Reinforcement or Corrector
28	5-7 p.m.	Reminder	7-9 p.m.	Final announcement

Notes:

- The choice between *Reinforcement* or *Corrector* is done manually the morning of the respective day.
- *Reminders* and *Reinforcements* or *Correctors* are sent to the intervention group.
- Messages for a specific person come in the time interval mentioned above but at random times.
- Final announcement is announcing the end of the experiment.

Appendix C: Message Content for the SMS Reminding Experiment

Type of Message	No.	Text of Message
Reminder	1	Hey, it's Tim: Did you take your vitamin C today?
	2	Hi, it's Tim: Any vitamin C 2day?
	3	Tim here: Took Ur vitamin C?
	4	Tim speaking: What about Ur vitamin C 2day?
	5	Yo, it's me, Tim: Remember your vitamin C?
	6	Tim texting: Any vitamin C 2day?
	7	Tim here: Took Ur vitamin C?
	8	Hey, it's Tim: Did you take your vitamin C today?
	9	Yo, it's me, Tim: Remember your vitamin C?
	10	Hi, it's Tim: Any vitamin C 2day?
	11	Tim texting: Took Ur vitamin C?
	12	Tim here: Did you take your vitamin C today?
	13	Tim speaking: Remember your vitamin C?
	14	Hey, it's Tim: What about Ur vitamin C 2day?
	15	Tim here: Did you take your vitamin C today?
	16	Yo, it's me, Tim: Remember your vitamin C?
	17	Tim texting: Took Ur vitamin C?
	18	Tim speaking: Any vitamin C 2day?
	19	Hey, it's Tim: Did you take your vitamin C today?
	20	Yo, it's me, Tim: What about Ur vitamin C 2day?
	21	Hi, it's Tim: Any vitamin C 2day?
Reinforcement	1	Hi, it's Tim again: You're doing very well! Tip: Borrow money from pessimists – they don't expect it back! ☺
	2	Still Tim: Ur doing super! U know that no 1 has ever complained of a parachute not opening? ☺
	3	Tim texting again: Ur doing well! Tip: Maths and alcohol don't mix. Don't drink and derive! ☺
	4	Again Tim: Doing very well! Vitamin C helps to fight infections! ☺
	5	Hi, it's Tim again: Ur in good shape! Tip: There's 1 thing good about being poor – it's inexpensive! ☺
	6	Yo, it's Tim again: Very good! U know what's a college professor?

		Someone who talks in other peoples' sleep! ☺
	7	Tim here again: Ur doing super! Tip: 2 steal ideas from 1 person is plagiarism; 2 steal from many is research! ☺
	8	Tim texting again: You're doing very well! Vitamin C helps to fight cold and flu! ☺
	9	Again Tim: Ur doing well! Tip: Change is inevitable, except from a vending machine! ☺
	10	Still Tim: Doing very well! Tip: You know what's the forecast for tonight? Dark! ☺
	11	Tim here again: Ur doing well! Warning: Dates in calendar are closer than they appear! ☺
Corrector	1	Hi, it's Tim again: Please do your best to take your pill at noon: Vitamin C helps to fight infections!
	2	Still Tim: U didn't quite take the vitamins!
	3	Tim texting again: Forgotten the vitamins!
	4	Again Tim: Do your best to take the vitamins: they help to fight cold and flu!
	5	Hi, it's Tim again: Remember the daily vitamin C!
	6	Yo, it's Tim again: Don't forget the vitamin C to stay healthy!
	7	Tim here again: Please do your best to take your pill at noon: Vitamin C helps to fight infections!
	8	Tim texting again: U didn't quite take the vitamins!
	9	Again Tim: Do your best to take the vitamins: they help to fight cold and flu!
	10	Still Tim: Remember the daily vitamin C!
	11	Tim here again: Don't forget the vitamin C to stay healthy!
Final announcement		Hi! The Vitamin C - SMS study is over.

Appendix D: Web Scenario

McMaster University
DEGROOTE SCHOOL OF BUSINESS

Scenario of Cell Phone Use for Health

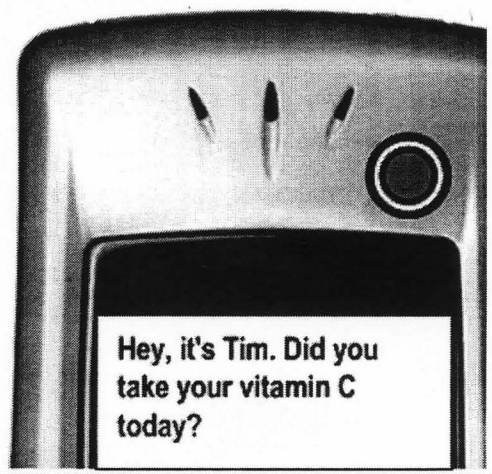
A large number of medical studies show that it is good to take a **common dosage (up to 1,000 - 2,000 mg) of vitamin C daily in order to prevent flu and colds**. You may check, for instance, useful information about vitamin C (also known as *ascorbic acid*) provided by **The British Broadcasting Corporation (BBC)** at: http://www.bbc.co.uk/health/healthy_living/complementary_medicine/remedies_vitamins.shtml#vitamin_c

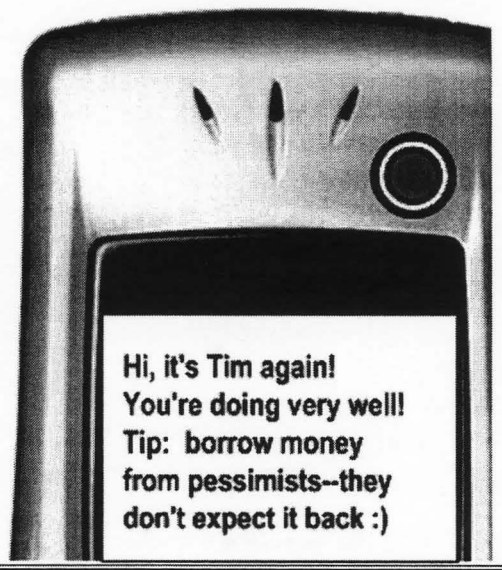
Imagine that an **SMS application** called **TMT** (i.e., *Text Messaging Telehealth*) would be designed to help you remember to take your daily vitamin C. Thus, you could receive on your cell phone reminding messages as coming from a **virtual friend** called **'Tim'**.

The messages would have a variable content looking something like in the picture on the right.

They would come at random times, usually before noon, daily in the first couple of weeks and then more rarely.

After receiving such messages and taking your vitamin C pill, you would be expected to reply by sending a one-letter SMS: **A** (from 'Acknowledge'). Your reply should be sent after taking the vitamin but no later than the midnight of the day you received the reminder



(i.e., you would usually have at least 10-12 hours to reply).	
If you replied as expected to the above messages, you would also receive additional, more rarely (every 2-3 days), feedback messages, something like in the picture on the right. So, these messages would contain brief jokes, or other variable fresh information interesting for you (trivia, sports, fashion, etc.).	

If you did not reply as expected to the reminders, the additional messages (still coming every 2-3 days) would be more corrective, like in the picture on the right. And no joke or other information for you!

If you wanted to speak with someone (e.g., a nurse or a doctor) for various reasons (e.g., about some non-urgent questions, concerns, or suggestions), you could send a one-letter SMS to the TMT system: **C** (from 'Call me') and they would call you at the earliest time possible.

What do you think about this scenario? >>

Appendix E: Baseline Survey (background questions only)

Cell Phone Use for Health

Please answer the following questions:

1) For how long have you been using a cell phone?

_____ months

2) For how long have you been using SMS?

_____ months

3) About how many SMS messages do you receive per week?

_____

4) About how many SMS messages do you send per week?

_____

5) Have you ever taken vitamin C tablets for health?

○ Yes ○ No

Additional comments:

6) About how many vitamin C pills have you taken during the last 7 days?

7) Please check one response which corresponds most closely to your desired answer for the following statements: *(1-Strongly Disagree ... 7-Strongly Agree)*,

	1-Strongly Disagree	2	3	4	5	6	7 - Strongly Agree	I don't know
Without vitamin C doctors would be less able to cure people for colds and flu.	○	○	○	○	○	○	○	○
Taking vitamin C helps many people to be healthy.	○	○	○	○	○	○	○	○
Taking vitamin C helps many people to prevent or recover faster from colds and flu.	○	○	○	○	○	○	○	○
The benefits of taking vitamin C outweigh the risks.	○	○	○	○	○	○	○	○

8) Do you have any further comments about taking vitamin C?

Appendix F: Intervention Group Endpoint Survey

SMS Study - Stage 3: Final Survey

Please answer the following questions:

1) People often have difficulty taking a vitamin C tablet daily for one reason or another. Have you missed any vitamin C pills in the past week? If yes, how many?

○ No ○ Yes

Additional comments:

2) How well does vitamin C work for you? (i.e., are you free from cold or flu symptoms?)

○ OK ○ Not OK ○ I don't know

Additional comments:

3) Did you have any side effects symptoms while taking vitamin C?

○ Yes ○ No ○ I don't know

Additional comments:

4) Do you have any further comments about taking vitamin C?

5) Based on your overall impressions, please check one response which corresponds most closely to your desired answer for each of the following statements, where TMT is an abbreviation for Text Messaging Telehealth and denotes the system you tested: *(1 - Strongly Disagree ... 7 - Strongly Agree)*,

	1-Strongly Disagree	2	3	4	5	6	7-Strongly Agree
Signing up for TMT would be a poor way to spend my money.	○	○	○	○	○	○	○
I would be concerned about how much I would pay if I subscribed to TMT.	○	○	○	○	○	○	○
If I subscribed to TMT, I would be concerned that I would not get my money's worth.	○	○	○	○	○	○	○
My friends and colleagues' opinions about my signing up for TMT would cause me to feel concern.	○	○	○	○	○	○	○
If signing up for TMT, I would be concerned about what people whose opinion is of value for me would think of me, if I made a bad choice.	○	○	○	○	○	○	○
My subscribing to TMT would cause me concern about what my friends would think of me, if I made a bad choice.	○	○	○	○	○	○	○

My use of TMT would cause me to lose control over the privacy of my information.	○	○	○	○	○	○	○
Signing up for and using TMT would lead to a loss of privacy for me because my personal information could be used without my knowledge.	○	○	○	○	○	○	○
Internet hackers (criminals) might take control of my information if I used TMT.	○	○	○	○	○	○	○
The thought of signing up for TMT makes me feel uncomfortable.	○	○	○	○	○	○	○
The thought of signing up for TMT gives me an unwanted feeling of anxiety.	○	○	○	○	○	○	○
The thought of signing up for TMT causes me to experience unnecessary tension.	○	○	○	○	○	○	○
Overall, the thought of signing up for TMT causes me to be concerned that I might experience some kind of disadvantage.	○	○	○	○	○	○	○
All things considered, I think I would be making a mistake if I signed up for TMT.	○	○	○	○	○	○	○
Overall, I really feel that signing up for TMT poses problems for me that I just don't need.	○	○	○	○	○	○	○

6) Based on your overall impressions, please check one response which corresponds most closely to your desired answer for each of the following statements, where TMT is an abbreviation for Text Messaging Telehealth and denotes the system you tested: *(1 - Strongly Disagree ... 7 - Strongly Agree)*,

1-Strongly Disagree	2	3	4	5	6	7-Strongly Agree

I found TMT to be enjoyable.	○	○	○	○	○	○	○
The actual process of using TMT was pleasant.	○	○	○	○	○	○	○
I had fun using TMT.	○	○	○	○	○	○	○
Using TMT helped me to take the daily vitamin C pill at proper time.	○	○	○	○	○	○	○
Using TMT helped me to not forget about the daily vitamin C.	○	○	○	○	○	○	○
Using TMT helped me to take the vitamin C every day.	○	○	○	○	○	○	○
I found TMT to be useful in reminding me to take my vitamin C daily.	○	○	○	○	○	○	○
My interaction with TMT was clear and understandable.	○	○	○	○	○	○	○
Interacting with TMT did not require a lot of my mental effort.	○	○	○	○	○	○	○
I found that TMT was easy to use.	○	○	○	○	○	○	○
I found it easy to get TMT to do what I wanted to do.	○	○	○	○	○	○	○
Assuming I have access to TMT, I intend to use it.	○	○	○	○	○	○	○
Given that I have access to TMT, I predict that I would use it.	○	○	○	○	○	○	○

7) For how long would you expect to continue using TMT if it did not cost you anything?

8) For how long would you expect to continue using TMT if it were not free?

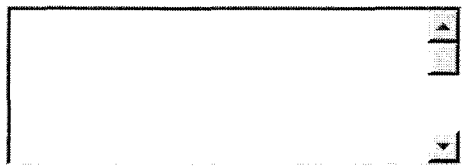
9) How much would you think it would be reasonable to pay for a service like TMT if the usage were not free?

$ per month

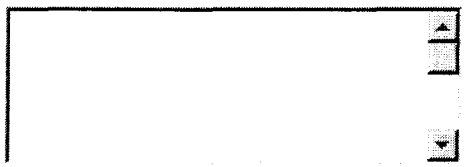
10) Indicate as many as three reasons why you WOULD LIKE to use TMT:

11) Indicate as many as three reasons why you WOULD NOT LIKE to use TMT:

12) Based on your experience with taking vitamin C and this study, please provide recommendations for the designers of a system like TMT:



13) Please indicate other thoughts, concerns, and recommendations about TMT:



Appendix G: Control Group Endpoint Survey

1) People often have difficulty taking a vitamin C tablet daily for one reason or another. Have you missed any vitamin C pills in the past week? If yes, how many?

○ No ○ Yes

Additional comments:

2) How well does vitamin C work for you? (i.e., are you free from cold or flu symptoms?)

○ OK ○ Not OK ○ I don't know

Additional comments:

3) Did you have any side effects symptoms while taking vitamin C?

○ Yes ○ No ○ I don't know

Additional comments:

4) Do you have any further comments about taking vitamin C?

5) If you had received <u>about one SMS per day</u> reminding you in an enjoyable manner, from a virtual friend called Tim, to take your vitamin C pills (e.g., Tim here: Took Ur vitamin C 2day?) , do you think such messages would have helped or bothered you? Why?

Appendix H: Codebooks Utilized in the Qualitative IS Study

Indicate as many as three reasons why you WOULD LIKE to use TMT:

Level 1 Code	Level 2 Code	Level 3 Code	Code description
1. User perceptions			The way users perceive TMT
	1.1 Functionality		Perceptions regarding the functionality of TMT for the users
		1.1.1 Usefulness	Perceived usefulness (e.g., reminds about pills, helps to comply, helps doing things at time, helps taking the vitamins, helps staying healthy, helps remembering daily, good as reminder in general, good for people who forget pills, helps remembering important things, keeps on schedule, keeps reminding what to do)
		1.1.2 Confidence	Helps feeling healthy
		1.1.3 Organizing	Helps staying organized (e.g., check the cell phone periodically, keeps the time constant)
	1.2 Intrinsic motivation		
		1.2.1 Enjoyable	Perceived enjoyment (e.g., amusing comments, funny jokes, could be fun)
		1.2.2 Attractive	Nice feeling to get messages, interesting, not boring (i.e., can read again and again)
	1.3 Ease of use	1.3.1 Easy to use	Perceived ease of use (e.g., simple, easy to use, easy)
2. Operating features			The way users perceive the process of using TMT
	2.1 Social features		Social aspects of using the service
		2.1.1 Non-intrusiveness	Does not perturb current activities (e.g., quiet, subtle, can write when busy, hassle free, unobtrusive, noninvasive)
		2.1.2 Trendy	Other people use it (e.g., friends use it, get familiar with

			technology, stay connected to what's happening)
		2.1.3 Social interaction	Helps social interaction, keep in touch with others
	2.2 Operating type	2.2.1 Operating type	Similar to messengers (e.g., catches attention instantly), good communication source
3. Technology features			Features of the service due to the specifics of the technology
	3.1 Convenience		Convenience of the service
		3.1.1 Handiness	Its use is convenient, handy for taking many pills
		3.1.2 Pervasiveness	Cell phone is always with the person, good in mobile context, immediacy of the reminders
		3.1.3 Superiority to other channels	Writing is preferred to talking (e.g., send short messages, avoid talking to people), better than answering machines, better than e-mail
	3.2 Consistence	3.2.1 Consistence	Service is consistent
	3.3 Low cost	3.3.1 Low cost	Free or cheap (e.g., to send a message anywhere, does not use long distance costs)
4. Other	4.1 Other	4.1.1 Other	Other reasons for use

Indicate as many as three reasons why you WOULD NOT LIKE to use TMT:

Level 1 Code	Level 2 Code	Level 3 Code	Code description
1. User perceptions			The way users perceive TMT
	1.1 Functionality		Perceptions regarding the functionality of TMT for the users
		1.1.1 Lack of usefulness	Low or no usefulness, not useful for medication, not worth the cost, do not need the reminder, not useful on long term
		1.1.2 Lack of confidence	Leads to lack of confidence, dependence on the system, ignoring of the reminders after some time
		1.1.3 Burden	It is a supplementary burden or commitment
	1.2 Intrinsic motivation		
		1.2.1 Annoyance	It is not enjoyable, it is a nuisance, it is annoying, not funny, boring, irritating, a hassle
		1.2.2 Unattractiveness	Texts, appearance, interface are not attractive
	1.3 Ease of use	1.3.1 Not easy to use	It is difficult to use (e.g., difficult to type, typing takes time), messages are not clear, difficult for elderly
2. Operating features			The way users perceive the process of using TMT
	2.1 Social features		Social aspects of using the service
		2.1.1 Intrusive	It is intruding, interrupting when busy, timing is not good, asks to reply when doing something
		2.1.2 Time consuming	It is time consuming
		2.1.3 Social issues	Lack of privacy, embarrassing, unwanted monitoring, legal issues
	2.2 Operating type	2.2.1 Operating type	Not flexible, not customizable, needs programming

3. Technology features			Features of the service due to the specifics of the technology
	3.1 Convenience		Convenience of the service
		3.1.1 Not handy	Cell phone is not always on, cell phone is not always with the user
		3.1.2 Not pervasive	Does not have always coverage, the messages do not go through sometimes
		3.1.3 Inferiority to other channels	Lack of confirmation of messages going through, might not receive messages sometimes, more difficult than calling, messages take space in the phone
	3.2 Cost	3.2.1 Cost	Expensive, not free, cost money
4. Other	4.1 Other	4.1.1 Other	Other reasons of not using

Based on your experience with taking vitamin C and this study, please provide recommendations for the designers of a system like TMT:

Level 1 Code	Level 2 Code	Level 3 Code	Code description
1. User perceptions			The way users perceive TMT
	1.1 Content	1.1.1 Content	Suggestions referring to the content of the text messages
	1.2 Intrinsic motivation		Recommendations about increasing the enjoyment or pleasure generated by text messaging itself
		1.2.1 Enjoyment	Perceived enjoyment (e.g., amusing comments, funny jokes)
		1.2.2 Attractiveness	Interesting, not boring messages (e.g., with images, voice clips)
	1.3 Ease of use	1.3.1 Ease of use	Increase the ease of use (e.g., clear messages)
2. Operating features			The way users perceive the process of using TMT
	2.1 Social features		Reconsider some social aspects of using the service
		2.1.1 Other social targets	Address other social targets (e.g., sick people, elderly)
		2.1.2 Privacy	Improve the privacy of the service
	2.2 Messaging features		Change some parameters of the messaging
		2.2.1 Timing	The time messages are received
		2.2.2 One-way	No responses should be necessary from users
		2.2.3 Frequency	How many messages should be sent daily
		2.2.4 Flexibility	Allow users to choose the content, time, frequency, virtual sender
		2.2.5 Feedback	No feedback from the system necessary
3. Technology features			Features of the service due to the specifics of the technology
	3.1 Cost		Cost features

		3.1.1 Free	The usage should be free
		3.1.2 Cheap	The usage should be of low cost
4. Other	4.1 Other	4.1.1 Other	Other recommendations or no suggestions (the system is good as it is now)

Please indicate other thoughts, concerns, and recommendations about TMT:

Level 1 Code	Level 2 Code	Level 3 Code	Code description
1. User perceptions			The way users perceive TMT
	1.1 Content	1.1.1 Content	Thoughts referring to the content of the text messages (e.g., text content, clarity)
	1.2 Intrinsic motivation		Recommendations about increasing the enjoyment or pleasure generated by text messaging itself
		1.2.1 Enjoyment	Perceived enjoyment (e.g., better jokes)
		1.2.2 Attractiveness	Interesting, not boring messages
2. Operating features			The way users perceive the process of using TMT
	2.1 Social features		Recommendations on some social aspects of using the service
		2.1.1 Other social targets	Address other social targets (e.g., sick people, frequent cell phone users)
		2.1.2 Privacy	Concerns on the privacy of the service
	2.2 Messaging features		Change some parameters of the messaging
		2.2.1 Customization	Allow customization of the messages
		2.2.2 Frequency	How many messages should be sent daily
3. Technology features			Features of the service due to the specifics of the technology
	3.1.1 Cost	3.1.1 Cost	The usage should be of low cost
	3.2.1 Other approach	3.2.1 Other approach	Use cell phones but with other approach (e.g., built-in alarm)
4. Overall comments			Comments on the system and/or experiment

	4.1 Comments	4.1.1 Appreciative	Positive impressions on the system and/or experiment
		4.2.1 Concerned	Concerns and doubts about the system and/or experiment
5. No comments	5.1 No comments	5.1.1 No comments	No comments expressed