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Early Investigation of New Information Technology Acceptance: A Perceived Risk - Motivation Model

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Abstract:

Early investigation of the acceptance of new information technology applications will help to improve the chances of later success. In incipient stages of product deployment, before people develop a full understanding of the aspects of a new technology, users may display particular reasons for or against its use. Accordingly, this study proposes and tests empirically, through structural equation modeling techniques, a perceived risk-motivation model for the early study of new information technology acceptance. The research framework is a Web scenario describing the possible use of wireless text messaging on cell phones to improve user adherence to healthy behavior. While the underlying personal motivation may favor adoption, perceived risks may be an obstacle. This study integrates a multi-faceted perceived risk concept with a motivational model in an unbiased measure of the initial development phase of new information technology, to estimate its acceptance.

Keywords: technology acceptance, adoption, motivation, perceived risk, resistance, human computer interaction, cell phones

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I. INTRODUCTION

Investigating the reasons and conditions for individuals to adopt a new information technology (IT) application has been a popular area of research in information systems (IS) for some time. Investigations have identified several prominent competing theories or models of technology diffusion or acceptance [Venkatesh et al. 2003]; all of these models generally investigated the influence of certain factors that are considered to affect positively the behavioral intention to use or the actual usage of the technology.

A salient topic in the investigation of new IS technology adoption is associated with the appropriate time to conduct this research [Karahanna et al. 1999]. Studies must also address user issues in the early stages of system development 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 et al. 2002]. After a system is in use, it is usually too late to see the real impact of design, with serious consequences for system acceptance and success. Venkatesh et al. stress the importance of early and short term perceptions of users regarding acceptance decisions; 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 et al. 2002].

An additional issue arises from another category of research in IS. This acknowledges that, besides factors contributing to the adoption of a new technology, there may be other factors mitigating against adoption [Featherman and Pavlou 2003]. The importance of these factors, encompassed generally under the concept of 'perceived risk' [Featherman 2001; Featherman and Fuller 2003; Featherman and Wells 2004; Pavlou 2003] or 'resistance' [Lapointe and Rivard 2005; Lapointe and Rivard 2006], became more salient due to the accelerated development of new information technologies. The numerous new technologies that are supposed to help humans perform jobs or leisure activities may sometimes intrude on and irritate their users by attempting to do too much and too often for them. Furthermore, negative perceptions are potentially more influential in the early stages of technology adoption. After users have become familiar with an already popular technology for a certain period of time, risk perception is likely to play a lesser role in the adoption equation, as seen in the perceived health risk of using cell phones [Cocosila et al. 2007].

Investigation of adoption/resistance factors early in the design and development life cycle plays an increasingly important role for new information technology acceptance and use, in addition to improving the ultimate perceived usefulness and benefit for the user. This study proposes a theoretical adoption model for such situations. The model involves an unbiased approach that includes both factors favoring and factors against adoption of a new information technology application.

The study that tested the suggested model was an evaluation of the use of wireless text messaging on cell phones to support users in maintaining a healthy behavior. An empirical investigation involving 303 respondents was conducted and the data were analyzed using Partial Least Squares (PLS) techniques. The following two sections describe the theoretical background and the model and hypotheses. Next, we present the research methodology and results. The paper ends with a discussion and conclusions.

II. THEORETICAL BACKGROUND

Although a significant body of research used the Technology Acceptance Model (TAM) to study the introduction of a new technology [Venkatesh 1999; Venkatesh et al. 2003], another possible approach is to consider the use of the Motivational Model (MM). This latter model was first introduced in IS research through the seminal study of Davis and collaborators [Davis et al. 1992] and subsequently developed through the work of Igbaria and collaborators [Igbaria et al. 1994; Igbaria et al. 1996] and Venkatesh and collaborators [Venkatesh and Speier 1999; Venkatesh et al. 2002]. MM shows that, in accordance with motivational research in psychology, and somewhat in parallel with TAM viewpoints, *behavioral intention* (BI) to use a technology is determined by two key drivers: *extrinsic motivation* (EM), and *intrinsic motivation* (IM) [Venkatesh and Speier 1999].

Extrinsic motivation is "a construct that pertains whenever an activity is done in order to attain some separable outcome" [Ryan and Dec 2000, p. 60], distinct from the respective activity, such as a monetary reward for a performance in certain activity [Moon and Kim 2001]. Due to a certain amount of parallelism of MM with TAM, there is a close similarity between EM and perceived usefulness (PU) of TAM (or, according to Igbaria et al. [1995], PU is

an example of EM). In certain 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 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]. Over time, since the introduction of the Motivational Model, researchers have come to the conclusion that PU and EM are similar. In fact, Davis measured the two constructs with the same items in his introduction to the two models [Davis 1989; Davis et al. 1992]. Therefore, there is sufficient reason to believe that the two variables represent, in fact, one single construct [Venkatesh et al. 2002]. This is usually termed as 'perceived usefulness' due to the fact that TAM has been more popular with researchers than MM.

Intrinsic motivation (IM), the other key construct of the MM, represents "doing of an activity for its inherent satisfactions rather than for some separable consequence" [Ryan and Deci 2000 p. 56]. This type of motivation surfaced through experimental studies showing that persons engage in various behaviors when driven by exploratory, curiosity, or playful reasons, even in the absence of a reinforcement or reward [Moon and Kim 2001; Ryan and Deci 2000]. Previous research associated IM with the meaning of *enjoyment* [Davis et al. 1992; Venkatesh 1999] or *perceived enjoyment* [Igbaria et al. 1994], showing positive implications of IM on behavioral intention. Higher IM indicates a willingness to spend more time with a task, a lower anxiety, and better mood regarding a task, and a facilitation of volitional behavior [Venkatesh and Speier 1999; Venkatesh et al. 2002]. According to 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 behavior 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 behavior to be driven mostly by intrinsic factors rather than external rewards [Deci 1975; Venkatesh and Speier 1999].

Following the examples of previous work, in the remainder of this paper when describing the two sides of motivation, we will use perceived usefulness as an example of extrinsic motivation and enjoyment as an example of intrinsic motivation. Igbaria et al., for instance, stated that people accept and make an effort to use an application because it is both useful and enjoyable [1995]. Hence, this points to the combined effect of the two motivations.

Taking into account the above ideas from motivational research in psychology, and following the reasoning of Davis and collaborators [1992] and Venkatesh and collaborators [2003], we consider the Motivational Model to be a suitable approach in the early investigation of new IT acceptance for the following reasons:

- It captures the main two drivers for accepting and using a new IT application (i.e., attaining some external rewards or goals and pure attraction exerted by the use of that technology, making abstraction of the rewards) at a more general level, and in a broader way compared to TAM

- It looks at the broad picture of reasons to use *in principle* an incipient technology and not at the details of the use, thereby not necessitating effective exposure to an already deployed technology (in contrast to TAM, for instance, that considers perceived ease of use as a key driver)

- It is generally applicable in research due to its parsimony, allowing a clear delimitation of the extrinsic and intrinsic reasons for accepting the new technology

Intrinsic and extrinsic motivation in the Motivational Model in particular, as well as all of the main factors identified by salient technology acceptance theories and models, show reasons more or less favoring the adoption and usage of a certain technology [Venkatesh et al. 2003]. However, research in IS also shows that there is another category of factors with an opposite influence - i.e., they do not favor the adoption of a new technology or new technology application [Featherman and Pavlou 2003; Lapointe and Rivard 2005].

A growing body of recent IS research has shown that consumer opinions, evaluations, and adoption intentions for technology vary with the perceptions of usage risks [Cunningham et al. 2004; Featherman and Fuller 2003; Featherman and Pavlou 2003; Featherman and Wells 2004; Kim and Lennon 2000; Lapointe and Rivard 2005; Ratnasingham and Pavlou 2003; Sjöberg 2002; Sjöberg and Fromm 2001]. Moreover, a solid stream of consumer behavior research acknowledges that, in order to reduce the effects of perceived risk, research must recognize and measure the effects of several types of risk. The six risks that seem to be the most popular in consumer behavior literature are [Jacoby and Kaplan 1972; Laroche et al. 2004; Lim 2003; Roselius 1971]:

- *Perceived financial risk* (or *economic risk*) associated with the possible loss of money in a purchase

- *Perceived performance risk* referring to the product/service not working as expected
- *Perceived social risk* associated with other people's opinions on the purchase, resulting in possible disapproval by family or friends
- *Perceived physical risk* (or *health risk*) expressing the individual's fear of the product/service being purchased to be harmful for health
- *Perceived psychological risk* referring to the mental anxiety associated with a purchase
- *Perceived time risk* referring to the time loss associated with a purchase

Perceived risk has become an increasingly popular construct in some IS studies, usually being associated with online shopping. Perceived risk was recognized as an issue, especially due to product intangibility and to the lack of information when making purchase decisions which are even more acute in the services market [Bebko 2000; Bielen and Semples 2004; Kim and Lennon 2000; Laroche et al. 2004]. To capture the above aspects, especially when referring to risk in the e-commerce context, IS studies have added other facets to the "classical" six dimensions of individual perceived risk from consumer behavior research. These additions include perceived privacy risk (e.g., uncertainty or fear that online businesses may use inappropriately customer personal information) [Featherman and Pavlou 2003; Shareef et al. 2008] or perceived source risk (e.g., individual apprehension of buying online from unknown businesses) [Greenberg et al. 2008; Lim 2003; Tan and Teo 2000].

Therefore, summarizing at a macro level the two opposite visions examined above, it is logical to consider that in the initial stage of adoption of a new information technology or application, when users have little knowledge of the technology, there may be *opportunity factors* motivating users to adopt the new technology, and *barrier factors* (in terms of perceptions and not necessarily actual obstacles) making users dubious about the adoption. Based on the literature review, we consider the combination of *motivation* and *perceived risk* (both seen as multi-sided constructs) the most appropriate in describing reasons for or against the adoption of a technology. Accordingly, this study proposes two *research questions*:

RQ1: What are the influences of the various dimensions of perceived risk on the motivation associated with the use of a new information technology application?

RQ2: What are the influences of motivation and perceived risk on the intention to use a new information technology application?

III. RESEARCH MODEL

The duality of motivation-demotivation that is associated with early implementation of a new information technology implies many unknowns and uncertainties. Therefore, we propose a theoretical model that would reflect the dyad pro-against the technology from the user point of view. The model integrates the multifaceted concept of perceived risk drawn from consumer behavior literature [Stone and Grønhaug 1993] with the motivational model previously used in IS literature [Venkatesh et al. 2003]. This model allows an in-depth analysis of the influence of the perceived risk-motivation link (with both elements seen as multi-faceted constructs) on user intention to adopt a new IT application, early in the development process.

As perceived risk is context based in the consumer behavior literature [Conchar et al. 2004], technology adoption research must take into account the use context. Consequently, the specific perceived risk facets utilized in the model depend on the situation. For the research presented here, we consider four dimensions of those presented in Section II above: perceived financial, social, privacy, and psychological risk. Readers will fully understand the reasons for these choices after the presentation of technology and application contexts, as explained in the next section.

The research hypotheses of this study are based on the research questions. Hypotheses are in direct relationship to the proposed theoretical model. Thus, as we described above, consumer behavior studies consistently showed the existence of several dimensions of perceived risk. However, marketing literature is controversial about the independence among the types of risk. Although early studies reported by Jacoby and Kaplan considered risk facets to be independent [Jacoby and Kaplan 1972], others often found them to be correlated when investigating the purchase of specific products. Moreover, some studies of this second category showed that all the risk dimensions are perceived through the mental process of individuals. Therefore, some researchers believe that all risk perceptions should be captured through the measure of the perceived psychological risk [Stone and Grønhaug

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1993]. This captures people's overall uncertainty about the worthiness of making a purchase or subscribing to a service. Thus, individuals may fear that their action would have unpleasant consequences because of the possible waste of money, social status before peers/friends, or control over private data. This discussion suggests the following hypotheses:

H1a: Perceived financial risk will have a positive effect on perceived psychological risk.

H1b: Perceived social risk will have a positive effect on perceived psychological risk.

H1c: Perceived privacy risk will have a positive effect on perceived psychological risk.

Perceived risk is integrated as an antecedent of the motivational factors in the MM starting from the reasoning that perception of real or virtual obstacles may exert a negative influence on the motivation to use a technology. Perceiving a risk in connection to the use of a technology would reduce both the motivation to use this technology for attaining some goals and the enjoyment associated to its use. Furthermore, Davis et al. suggested that "usefulness and enjoyment may be a common causal pathway through which many psychological and environmental factors achieve their influence" on the behavioral intention [Davis et al. 1992, p.1126]. Accordingly, the motivational model is appropriate for this research since MM is amenable to examining the antecedent effects of perceived risk on the behavioral intention through the two motivation constructs.

Perceiving a mobile service as risky for various reasons (e.g., too expensive, or stressful) is likely to decrease the extrinsic motivation associated with the use of that service together with the intent to use it. Empirical research showed that perceiving a service to be risky reduces its utilitarian value, and hence, its extrinsic motivation [Featherman and Wells 2004]. Studies addressing consumer behavior in telephone and Internet shopping found that perceived risk negatively affected not only the extrinsic motivation of such activities, but also an attitudinal aspect [Grazioli and Jarvenpaa 2000; Jarvenpaa et al. 2000] because people became inhibited about using such a service. Understandably, if customers perceive a threat to their online shopping activity on a certain Web site, the enjoyment associated with this activity is seriously affected and this may lead to people stopping the purchase and quitting that Web site. As there is a close positive link between intrinsic motivation in general and attitude [Dabholkar and Bagozzi 2002], it is expected that, since perceived risk affects attitude negatively, it would also affect intrinsic motivation in the same way. Accordingly, it is hypothesized that:

H2: Perceived psychological risk will reduce intrinsic motivation.

H3: Perceived psychological risk will reduce extrinsic motivation.

Similarly to the influence of perceived ease of use on perceived usefulness that has been consistently demonstrated by technology adoption studies, conceptual IS research and empirical evidence show there is also a causal link between intrinsic motivation and extrinsic motivation. IM 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. IM increases pleasure or enjoyment regarding the fulfillment of a task resulting in higher quality and productivity. Therefore, a higher IM deepens cognitive processing and enhances perceptions of extrinsic motivation [Venkatesh et al. 2002]. Consistent with results from prior studies which showed an influence from an IM construct on the EM construct, it is hypothesized that:

H4: Intrinsic motivation will have a positive effect on extrinsic motivation.

Almost all motivational theories showed that motivation is a multifaceted and individual-dependent phenomenon that may predict personal behavior [Deci 1975; Deci and Ryan 1985; Mitchell 1982]. Furthermore, in explaining intentions of using a technology and the actual behavior towards using it, previous research showed that "extrinsic and intrinsic motivation play an additive role" [Venkatesh et al. 2002]. Researchers have unanimously shown that extrinsic motivation is a key antecedent of the behavioral intention to use a new technology. People would not use a technology without perceiving its usefulness side. However, another category of studies insist on the non-negligible role of intrinsic motivation. Although its role was often seen as secondary or indirect, facts show that enjoyment aspects should not be underestimated, especially regarding the adoption of a technology in a non-organizational environment. An increase in enjoyability increases acceptability, "but has less of an effect on the acceptance of useless systems" [Davis et al. 1992, p. 1125].

Regarding perceived risk influence on behavioral intentions to use a technology, it is natural for consumers to adopt risk reducing strategies [Shimp and Bearden 1982]. Consumers tend to become averse to using a technology if they perceive it as risky. Perceived risk is a powerful determinant of consumer behavior [Lim 2003] because "consumers

are more often motivated to avoid mistakes than to maximize utility in purchasing" [Mitchell 1999]. In particular, for studies in the IS field, researchers found perceived risk plays an important role by adversely influencing user intent to adopt electronic services [Pavlou 2003]. For instance, if customers see a risk in using an online commerce service offered through a Web site, this would affect their intention to use that service. Risk perception plays an important role in inhibiting users' intention to adopt electronic or mobile services. Taking into account the two opposite influences on behavioral intention, it is hypothesized that:

H5a: Intrinsic motivation will have a positive effect on behavioral intention to use a new information technology application.

H5b: Extrinsic motivation will have a positive effect on behavioral intention to use a new information technology application.

H5c: Perceived psychological risk will have a negative effect on behavioral intention to use a new information technology application.

In accordance with the above hypotheses, Figure 1 depicts the theoretical perceived risk-motivation model for the acceptance of a new IT application early in its deployment. The model integrates perceived financial, social, privacy, and psychological risks into the Motivational Model.

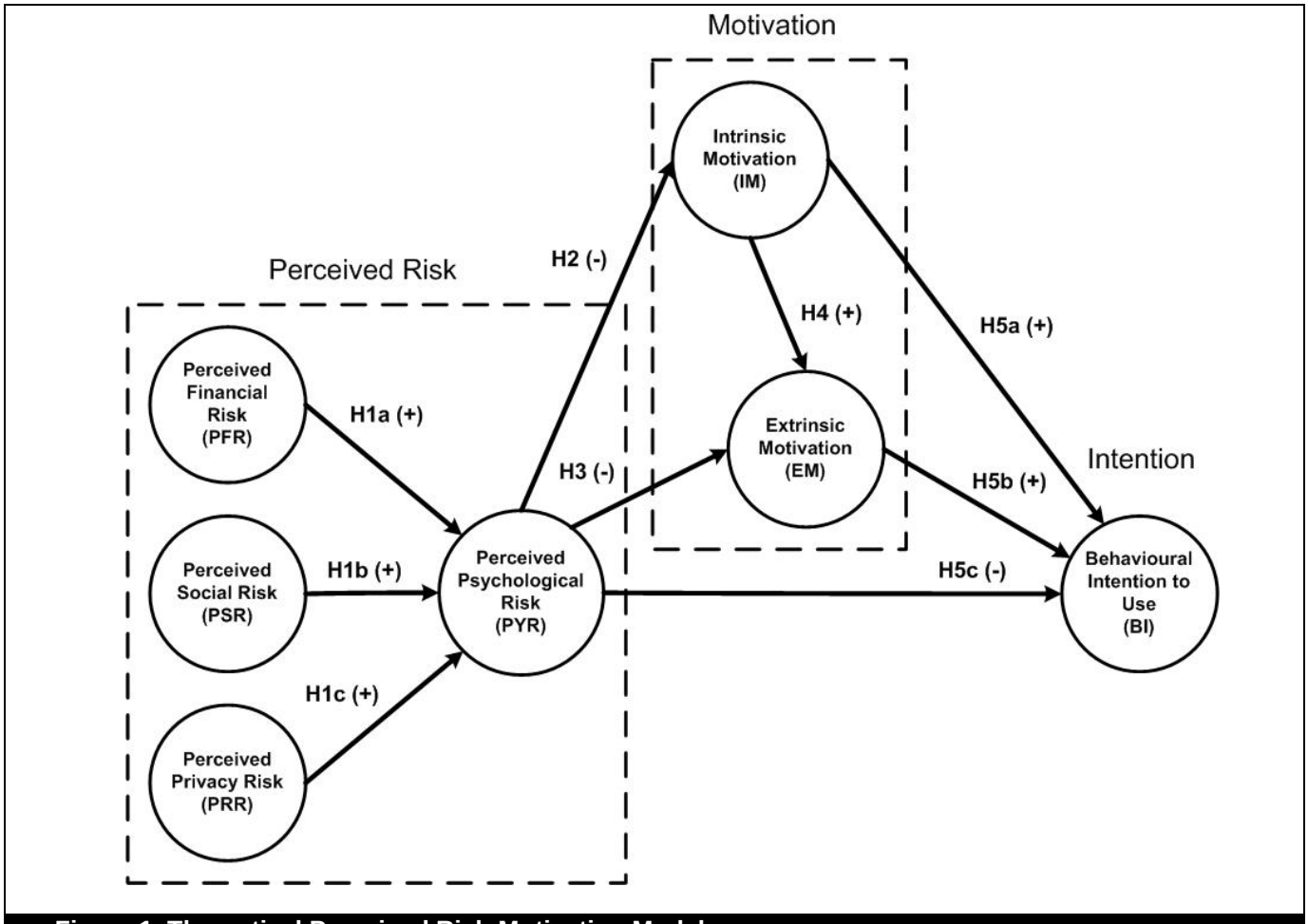

Figure 1. Theoretical Perceived Risk-Motivation Model

IV. METHODOLOGY

Instrument Development and Data Collection

Instrument development started from widely used measures from published reputable studies, to ensure strong psychometric properties. We measured perceived risk constructs with items from relevant consumer behavior research [Stone and Grønhaug 1993; Stone and Mason 1995] or IS work [Featherman and Pavlou 2003]. We drew constructs in the motivational model from previous IS studies, but with some rewording [Van der Heijden 2004;

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Venkatesh et al. 2002]. We measured all items on a 7-point Likert-type scale, having as extreme anchors *strongly agree* and *strongly disagree*. Appendix A presents survey questions.

We tested the hypotheses through a cross-sectional experiment involving a Web scenario, followed by an online survey conducted in a North American university. The topic of the scenario was the adoption of wireless text messaging to address adherence of individuals to a healthy behavior regimen. Developments in healthcare indicated that wireless text messaging, or short messaging service (SMS), is a tool that might help patients with chronic health conditions to improve their adherence to medically specified regimens while living a socially normal life. Insufficient adherence is an ubiquitous problem affecting 50 percent of patient cases on average [Haynes et al. 2002]. Innovative new solutions using SMS to address some forms of non-adherence (e.g., by sending reminders to people willing to comply but being forgetful) were already developed [Dunbar et al. 2003]. Despite the apparent attractiveness of such solutions, they may face acceptance obstacles for various reasons. A scientific perspective of the user factors favoring or disfavoring the use of SMS for this specific purpose provides an opportunity for testing the proposed perceived risk-motivation adoption model.

This research used as a framework the use of SMS to remind people participating in the experiment to take one daily vitamin C pill for health reasons (e.g., fortifying the body and preventing flu and colds). Including conditions required all participants in the study to be at least 18 years old and to be cell phone users.

In these conditions, of the six classical perceived risk components present in a large number of consumer behavior studies, only three were included in the model: financial risk (doubt about financial loss if subscribing for such a mobile IT service), social risk (doubt about social embarrassment from using a service that might be unnecessary), and psychological risk (doubt about making the right decision when subscribing for a new and untested service). As participants were cell phone users, we considered performance and time risks not to be an issue. Previous research showed that perceived health risk is not a concern for cell phone users [Cocosila et al. 2007]. However, as confidentiality is important when sending personal information wirelessly or in disclosing cell phone numbers to third parties, we also took into account perceived privacy risk as the fourth risk facet.

We recruited participants through advertising on the main university Web site and on announcement boards. The experiment had three steps. First, we presented the subjects 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. Second, we presented them a brief Web scenario regarding how they could receive daily SMS messages reminding them about taking vitamin C pills for preventive reasons. According to the scenario, subjects would receive health reminders on their cell phones as if they were coming from a virtual friend. The messages would have fresh and variable content, come at random times, and would be in a colloquial language, including jokes. The scenario specified that some of the messages would require participants to reply by one-letter SMS messages confirming that they were complying with the reminders. Third, we asked participants to complete an online survey eliciting their impressions and perceptions of the scenario.

A total of 335 participants completed the scenario-based survey. We excluded 16 questionnaires because participants did not meet a required condition of being a cell phone user. In addition, we eliminated another 16 questionnaires because these were incomplete or showed a lack of frankness in the participant's answers. The remaining 303 cases were valid.

An analysis of the demographics revealed that participants were young people with a wide range of experience with cell phones and of SMS use. Participant age ranged from 18 to 64 years (mean 23.5, median 22.0), about three quarters of the sample being less than 24 years old. Females represented 51.4 percent of the respondents. Experience with cell phones averaged 48.7 months (median 48.0) and average experience with SMS 29.8 months (median 24.0).

Model Estimation

We used the Partial Least Squares (PLS) method to analyze the data because it is more appropriate for complex models when the goal of the research is exploratory (rather than confirmatory) by explaining variance [Bontis et al. 2002]. We completed data analysis with PLS in two steps: evaluation of the measurement model, followed by the evaluation of the structural model (for explanatory and predictive power) [Jarvenpaa et al. 2004].

Measurement Model

We performed the actual analysis globally on the theoretical model using PLS Graph 3.0 with bootstrap with 200 re-samples, following closely the guidelines of Gefen and Straub [2005]. Table 1 presents relevant statistics:

Table 1. Statistics of the Measurement Model

Item	Mean	Standard deviation	Factor loading	Error	Item-total correlation	*t*-value	Internal consistency (Cronbach's alpha; AVE)
PFR1	4.52	1.76	0.900	0.027	0.834	34.28	0.929 (0.807; 0.696)
PFR2	5.58	1.58	0.757	0.076	0.831	9.67	
PFR3	4.99	1.67	0.860	0.045	0.885	18.14	
PSR1	2.75	1.77	0.850	0.028	0.872	30.21	0.962 (0.889; 0.821)
PSR2	2.67	1.68	0.936	0.011	0.931	82.33	
PSR3	2.45	1.62	0.929	0.015	0.914	60.58	
PRR1	2.97	1.68	0.898	0.017	0.882	52.70	0.953 (0.860; 0.784)
PRR2	3.35	1.81	0.913	0.013	0.909	69.44	
PRR3	3.24	1.85	0.842	0.025	0.862	33.00	
PYR1	3.05	1.83	0.888	0.017	0.893	50.21	0.969 (0.906; 0.848)
PYR2	2.59	1.62	0.956	0.006	0.954	145.48	
PYR3	2.51	1.58	0.916	0.015	0.912	58.89	
IM1	3.85	1.60	0.932	0.010	0.930	92.41	0.973 (0.922; 0.864)
IM2	3.99	1.58	0.921	0.020	0.922	45.45	
IM3	3.81	1.62	0.935	0.010	0.935	89.46	
EM1	4.68	1.70	0.907	0.018	0.913	50.64	0.973 (0.943; 0.855)
EM2	4.95	1.64	0.933	0.013	0.935	70.69	
EM3	4.90	1.64	0.948	0.010	0.950	90.52	
EM4	4.85	1.64	0.907	0.018	0.899	50.44	
BI1	4.17	1.80	0.965	0.008	0.965	127.76	0.980 (0.929; 0.934)
BI2	4.15	1.86	0.967	0.008	0.967	128.01	

Note: PFR-perceived financial risk, PSR-perceived social risk, PRR-perceived privacy risk, PYR-perceived psychological risk, IM-intrinsic motivation, EM-extrinsic motivation, BI-behavioral intention, 1…4-item numbers

From Table 1, all of the constructs have high reliability and convergent validity since Cronbach's alpha, internal consistency (calculated according to Staples and Higgins [1998]), and average variance extracted (AVE), provided by PLS, are above the recommended thresholds of 0.7, 0.7, and 0.5 respectively [Bontis et al. 2002; Jarvenpaa et al. 2004]. The high item loading on the factors (above 0.7 for all items) as well as the high *t*-values for the item loadings substantiate this conclusion. Consequently, we maintained all items in the measurement model.

The next step is 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. We built a matrix of loadings and cross-loadings following the guidelines of Gefen and Straub [2005]. Visual inspection of the resulting matrix depicted in Table 2 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 et al. 2002].

A second test for discriminant validity compares the correlations between the constructs with the square root of the average variance extracted [Turel et al. 2007]. Table 3 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 the table shows that the diagonal elements are larger than the off-diagonal (i.e., the variance shared with other constructs). Therefore, the constructs have appropriate discriminant validity [Igbaria et al. 1996; Compeau et al. 1999].

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

Table 2. Loadings and Cross-loadings							
	PFR	**PSR**	**PRR**	**PYR**	**IM**	**EM**	**BI**
PFR1	**0.926**	0.112	0.234	0.323	-0.595	-0.324	-0.585
PFR2	**0.734**	0.042	0.204	0.116	-0.329	-0.018	-0.241
PFR3	**0.831**	0.088	0.201	0.152	-0.437	-0.174	-0.323
PSR1	0.130	**0.851**	0.361	0.445	-0.138	-0.130	-0.096
PSR2	0.094	**0.936**	0.351	0.494	-0.106	-0.204	-0.121
PSR3	0.073	**0.929**	0.429	0.545	-0.081	-0.189	-0.122
PRR1	0.211	0.412	**0.898**	0.578	-0.233	-0.189	-0.306
PRR2	0.226	0.351	**0.914**	0.569	-0.258	-0.138	-0.304
PRR3	0.240	0.354	**0.842**	0.502	-0.195	-0.144	-0.213
PYR1	0.318	0.440	0.615	**0.890**	-0.353	-0.309	-0.398
PYR2	0.220	0.554	0.565	**0.956**	-0.250	-0.269	-0.323
PYR3	0.218	0.523	0.533	**0.916**	-0.279	-0.295	-0.342
IM1	-0.553	-0.135	-0.252	-0.304	**0.933**	0.392	0.666
IM2	-0.531	-0.124	-0.248	-0.292	**0.921**	0.412	0.608
IM3	-0.538	-0.068	-0.224	-0.301	**0.936**	0.389	0.654
EM1	-0.227	-0.127	-0.126	-0.225	0.397	**0.908**	0.437
EM2	-0.224	-0.197	-0.169	-0.305	0.374	**0.934**	0.416
EM3	-0.219	-0.142	-0.139	-0.269	0.380	**0.949**	0.425
EM4	-0.287	-0.241	-0.217	-0.361	0.424	**0.908**	0.482
BI1	-0.486	-0.137	-0.297	-0.361	0.663	0.458	**0.966**
BI2	-0.520	-0.106	-0.307	-0.386	0.674	0.466	**0.967**

Table 3. Correlations and Average Variance Extracted							
	PFR	**PSR**	**PRR**	**PYR**	**IM**	**EM**	**BI**
PFR	**0.834**						
PSR	0.100	**0.906**					
PRR	0.253**	0.417**	**0.885**				
PYR	0.237**	0.544**	0.621**	**0.920**			
IM	-0.539**	-0.121*	-0.258**	-0.323**	**0.929**		
EM	-0.207**	-0.188**	-0.174**	-0.313**	0.426**	**0.924**	
BI	-0.458**	-0.124*	-0.309**	-0.388**	0.691**	0.476**	**0.966**
Significance levels: * = 0.05; ** = 0.01							

Structural Model

The structural model was evaluated using PLS-Graph 3.0 with bootstrap with 200 re-samples to estimate the significance of the path coefficients [Chin 2001]. Figure 2 shows the structural model in the light of the evaluation.

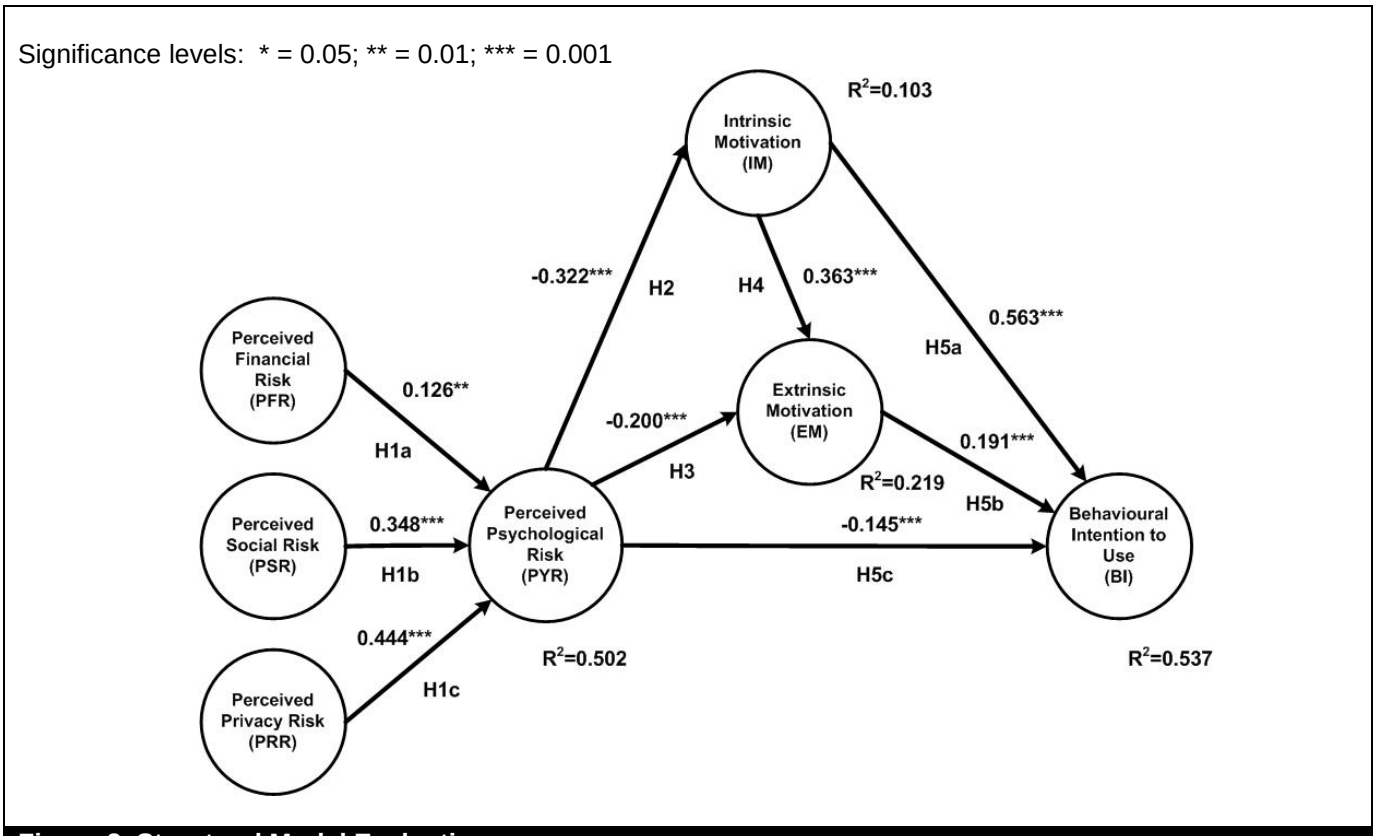

Figure 2. Structural Model Evaluation

It is evident from Figure 2 that all of the paths hypothesized in the theoretical model are supported and most of them have at least moderate coefficient values. We also found total causal effects on BI from PYR and IM to be moderately high: -0.387 and 0.632, respectively [Alwin and Robert 1975]. Furthermore, the model demonstrates moderately high explanatory power. The value of the coefficient of determination R^2 for the BI construct is 0.537; hence, the model explains over half of the variance in the behavioral intention. The value of R^2 associated with perceived psychological risk is in the same range. The R^2 for extrinsic motivation and intrinsic motivation are comparatively smaller. However behavioral studies in IS, and specifically technology adoption studies, often report even lower values for the coefficient of determination R^2 [Moon and Kim 2001].

Figure 2 shows that perceived financial, social, and privacy risk have a positive and significant effect on perceived psychological risk; hence, hypotheses H1 (a-c) are verified. We did a further analysis to test for the possible mediation of the perceived psychological risk for the other risk facets that was shown by previous consumer behavior studies. For this we applied the Baron and Kenny procedure [Baron and Kenny 1986] as follows: we first ran a model with direct links between PFR and EM, IM, and BI but no links between PFR and PYR. We repeated the procedure for PSR and PRR. In addition, we conducted a visual inspection of the factor loadings of all models as a check for the compatibility of the tested constructs. This ensures that changes in path coefficients result from structural differences and not from discrepancies in the measurement model. Table 4 depicts the results of direct links mediation tests.

Table 4. Direct Links Mediation Tests for Perceived Psychological Risk

Model tested	Path	Path coefficient	Standard error	*t*-value	Significance level
Direct links from PFR	PFR-EM	0.018	0.066	0.272	n.s.
	PFR-IM	-0.523	0.050	10.363	0.000
	PFR-BI	-0.143	0.056	2.518	0.05
Direct links from PSR	PSR-EM	-0.061	0.069	0.875	n.s.
	PSR-IM	0.083	0.073	1.125	n.s.
	PSR-BI	0.082	0.048	1.705	n.s.
Direct links from PRR	PRR-EM	0.067	0.066	1.009	n.s.
	PRR-IM	-0.099	0.071	1.385	n.s.
	PRR-BI	-0.072	0.050	1.435	n.s.

From these results it is obvious that there is no mediation for PSR and PRR. It appears that the only significant direct paths are between PFR and IM and PFR and BI. Therefore, it is reasonable only for these links to complete the Baron and Kenny procedure. Consequently only for these two paths are data regarding the path coefficients, their standard errors, and significance levels compared with corresponding data from the theoretical model as well as from a model with all the links between PFR, PYR, EM, IM, and BI. Table 5 presents these results.

Table 5. Mediation Tests for Perceived Financial Risk

Model tested	Path	Path coefficient	Standard error	*t*-value	Significance level
Theoretical model	PFR-PYR	0.126	0.043	2.882	0.01
All-links model	PFR-PYR	0.116	0.041	2.779	0.01
	PFR-EM	0.017	0.060	0.279	n.s.
	PFR-IM	-0.524	0.043	12.143	0.000
	PFR-BI	-0.145	0.058	2.477	0.05
	PYR-EM	-0.202	0.066	3.054	0.01
	PYR-IM	-0.182	0.046	3.903	0.001
	PYR-BI	-0.131	0.044	2.949	0.01

Examination of the results in Table 5 shows significant links between PFR - IM and PFR - BI even after the addition of PYR. To check for possible partial mediation of PYR [MacKinnon et al. 2002], we performed a Sobel test using the formula available online at *http://www.people.ku.edu/~preacher/sobel/sobel.htm*. The test yielded a value of 3.76 (sig. = 0.000) for PFR-IM, and 1.91 (sig. = 0.055) for PFR-BI. Table 5 and Sobel test results suggest that the mediation of PYR for PFR is significant for IM, not significant for EM, and on the boundary between non-significance and significance for BI.

Perceived psychological risk decreases intrinsic and extrinsic motivation significantly in the model results of Figure 2. Hence, hypotheses *H2* and *H3* are supported. As the model proposed in this research is exploratory and since Davis et al. [1992] called for more investigation to verify that additional factors in the Motivational Model exert their influence through the two motivational constructs, we also considered it necessary to test for partial mediation of IM and EM for the perceived psychological risk. We followed the same procedure as described above [Baron and Kenny 1986] by testing a model with a direct link between PYR and BI but no links between PYR and motivation constructs. We found a path coefficient of -0.386 (sig. =0.000) and no changes of the factor loadings for any construct compared to the theoretical the model. Since the paths PYR-EM-BI and PYR-IM-BI are all significant in the theoretical model (Figure 2), we ran the Sobel test as described above. We found a value of -2.48 (sig. = 0.05) for the path PYR-EM-BI and -5.09 (sig. = 0.000) for the path PYR-IM-BI. This shows that both sides of motivation partially mediate the effect of perceived psychological risk on behavioral intention to use the technology.

Intrinsic motivation positively influences extrinsic motivation significantly, so hypothesis *H4* is supported as well. As hypothesized (*H5, a-c*), intrinsic and extrinsic motivation have a positive influence on behavioral intention, whereas perceived psychological risk has a negative influence. We remark here that extrinsic motivation plays a lesser role in this model both in terms of interaction with the psychological risk and with behavioral intention.

Effect Size

We calculated effect size or predictive power of the independent variables on the dependent variables using the approach described by Chin [1998]: $f^2=(R^2included - R^2excluded)/(1- R^2included)$. In this formula $R^2included$ is the R^2 when the link from the independent variable is included in the analysis and $R^2excluded$ when this is neglected. Effect threshold values are 0.02 for small, 0.15 for medium, and 0.35 for large effect [Chin 1998; Cohen 1988]. Table 6 presents results for the two endogenous constructs of interest in the model, PYR and BI.

Effect size coefficients show perceived financial risk (PFR) has a small influence on perceived psychological risk (PYR), while the other risk facets have a medium influence. Intrinsic motivation (IM) has a large effect on behavioral intention to use the technology (BI), while extrinsic motivation (EM) and perceived psychological risk (PYR) have a small effect.

Table 6. Size Effects on the Endogenous Constructs				
Dependent variable		**Independent variables**		
PYR	$R^2_{included}$ = 0.502	**PFR**	**PSR**	**PRR**
	$R^2_{excluded}$	0.487	0.405	0.349
	f^2	0.03	0.19	0.31
	Effect	small	medium	medium
BI	$R^2_{included}$ = 0.537	**PYR**	**EM**	**IM**
	$R^2_{excluded}$	0.519	0.509	0.290
	f^2	0.04	0.06	0.53
	Effect	small	small	large

Influence of Control Variables

Besides the independent and dependent variables analyzed above, the research model might be influenced by control variables. In addition to the customary control variables, such as demographics or previous experience related to the technology (e.g., SMS experience in this case), we gave special attention in this research to attitude toward the activity involving the technology implementation. Technology, no matter how refined, can do next to nothing for people whose attitude is against the activity for which they manifest low interest. In order to capture subject attitudes toward taking vitamin C in this study, we used an adaptation of a widely used, questionnaire based method, for assessing beliefs about specific and general medication, the *Beliefs about Medicines Questionnaire* (BMQ) [Horne et al. 2004]. We measured attitude as a 4-item construct on a 7-point Likert-type scale, having as extreme anchors *strongly agree* and *strongly disagree* plus an *I don't know option*. Appendix A presents these questions.

We analyzed the impact of the control variables by adding separately one control variable at a time and re-running the PLS model. We then assessed influences of control variables by comparing the R^2 values for all the endogenous constructs with the corresponding values in the uncontrolled model.

Attitude toward adherence necessitated a special treatment as this is a multi item construct. An analysis of Cronbach's alpha indicated a value of 0.752. When running the PLS model with this construct included, the AVE was 0.573, so both measures of reliability were at acceptable levels. A visual inspection of the loadings and AVE values for all the constructs in the theoretical model revealed virtually no differences between the controlled and uncontrolled situation. Accordingly we can conclude that changes in R^2 came from structural changes and not from the outer model. Table 7 synthesizes the results.

Table 7. Variances Explained R^2 in the Uncontrolled and Controlled Model				
Control variables	**PYR**	**IM**	**EM**	**BI**
Uncontrolled model	*0.502*	*0.103*	*0.219*	*0.537*
Attitude toward adherence	0.502	0.103	0.230	0.546
Gender	0.502	0.103	0.220	0.537
Age	0.502	0.103	0.223	0.538
SMS experience	0.505	0.103	0.224	0.540

The effect of control variables for all endogenous constructs proved to be marginal except the influence of attitude toward adherence on EM and BI. A path analysis revealed that the path coefficient from attitude toward adherence on EM was 0.107 (sig. = 0.06) and on BI was 0.095 (sig. = 0.05). Therefore, of all the control variables only attitude toward adherence had a significant influence, and then only on behavioral intention to use the SMS application.

V. DISCUSSION AND CONCLUSIONS

This research proposed a model to investigate the acceptance of new information technology applications. In an incipient stage of usage, users may not have a sufficient grasp of the various aspects of using the technology and they may perceive reasons to adopt it (encompassed under *motivation*) and reasons to resist it (encompassed under *perceived risk*). Accordingly, we empirically tested a perceived risk-motivation model, using as a case the possible use of wireless text messaging to improve adherence to healthy behaviors.

As risk perception is context dependent [Conchar et al. 2004], for the technology context of this study we considered four facets of perceived risk: financial risk, social risk and psychological risk (adapted from consumer behavior research [Lim 2003]) and privacy risk (adapted from IS studies [Featherman and Pavlou 2003]). Similar to relevant consumer behavior research, we assumed all the risk facets exerted their influence through the mental perception of

anxiety that is associated with using the technology. This perceived anxiety is encompassed under the concept of *perceived psychological risk* [Stone and Grønhaug 1993]. Because of the channeling of all risk influences through the psychological risk, we believe that the model preserves its generality, although different risk facets acting as antecedents could be added or removed, depending on the context.

Recall the first research question (RQ1): *What are the influences of the various dimensions of perceived risk on the motivation associated with the use of a new information technology application?* Thus we found, first, that all risk facets positively affect psychological risk. Second, this risk also acted as a partial mediator for financial risk. This means that financial risk (about possibly wasting money) is an important perception that may affect directly motivation and the intention to use SMS for health reminders. This consideration is also supported by the comparatively smaller effect of the perceived financial risk on perceived psychological risk. Third, we showed perceived psychological risk to have a significant negative influence on both motivational components, but with more influence on intrinsic motivation. Therefore, if users perceive a risk in the use of the information technology service, they would also tend to see less enjoyment in using this type of service. This finding is aligned with similar reports from other studies [Jarvenpaa et al. 2000]. The negative influence of the perceived risk on extrinsic motivation is similar to that found in studies that incorporated perceived risk in the technology adoption model (TAM) [Featherman and Pavlou 2003].

Recall the second research question (RQ2): *What are the influences of motivation and perceived risk on the intention to use a new information technology application?* Results from this study prove that intrinsic and extrinsic motivation have a positive influence on intention to use the service and perceived risk has a negative influence. Therefore, the higher the enjoyment and usefulness users perceive in the service, the more likely they are to adopt it. This is in accordance with previous findings [Igbaria et al. 1995; Van der Heijden et al. 2005; Venkatesh 1999; Venkatesh et al. 1999]. Conversely, the more risk that is perceived, the less inclined users would be to adopt such a service, as found in earlier consumer behavior and IS studies [Laroche et al. 2003; Laroche et al. 2004; Mitchell and Greatorex 1993]. Results also partially confirm the beliefs of Davis and collaborators [Davis et al. 1992] that extrinsic and intrinsic motivations are the channels through which other factors exert their influence on behavioral intention to use the technology. However, a topic for future research would be to reverse the picture and investigate the possible role of perceived risk as a moderator of the motivation-behavioral intention relationship, similarly to a stream of previous work that has demonstrated risk to moderate trust-behavior relationship [Mayer et al. 1995].

Another possible direction for future research would be to examine the influence of perceived risk facets by a different conceptualization [MacKenzie et al. 2005, Petter et al. 2007] through a multidimensional second-order construct, similar to other studies [Featherman and Pavlou 2003]. Future research could also examine the possible inclusion in the model of the influence of *perceived risk of not using* the technology (e.g., users not using the SMS health reminders in this case) and contrast it with the perceived risk *of using* it.

Our study also showed that extrinsic motivation plays a lesser role than intrinsic motivation in favoring adoption. The explanation is that, since participants were mostly young people, they did not perceive the utilitarian value of a service that reminded them about a preventive healthy behavior. This indicates that subjects perceived the intrinsic motivation side of the SMS reminder service as a more important factor than the extrinsic motivation side in their intention to adopt the service [Van der Heijden 2004]. A more refined explanation of our findings involves concepts from applied psychology. Thus, while from one perspective intrinsic motivation exists within individuals, from another point of view IM is generated in individuals' interaction with activities. Thus, exploratory research in applied psychology has shown that intrinsic motivation is affected by two main factors: task characteristics and individuals' attributions about the perceived causes of their actions [Deci 1975; Hirst 1988]. Accordingly, the same individual may be more intrinsically motivated for some tasks while being less motivated by other activities [Ryan and Deci 2000]. In the case of our research, participants were all familiar with the very popular text messaging and their hypothetic SMS tasks were presumably perceived as easy and enjoyable. As the external reason of the participants' action (i.e., taking vitamins to stay healthy) was not apparent for their SMS tasks, intrinsic motivation had a larger effect compared to extrinsic motivation on the adoption intention.

Our findings are thus similar to studies that found "more immersive, hedonic aspects of new media play at least an equal role" [Childers et al. 2001, p. 527] to extrinsic motivation in the adoption equation. For instance, Igbaria et al. [1995] showed that individuals accept and use a certain technology because it is either fun (or enjoyable) or useful (and beneficial) or for both reasons. Therefore, fun's positive effect on the use of a technology should not be underestimated, although perceived usefulness remains the key driver in an abundant number of studies.

The study detected no influence from demographic characteristics (gender and age) or of a specific experience feature (months of SMS usage). Consequently, we identified no distinct features that would make any specific category of people more positive toward adopting the application. However this study detected a significant influence

of attitude toward the activity supported by the technology on behavioral intention and a slightly non-significant influence on extrinsic motivation. This means that if people are favorable toward the activity targeted by the technology, they tend to be favorable to the adoption of the technology. In addition, people might also have an extrinsic motivation to use that technology. In the light of these findings, we *should not confuse* the *attitude toward the activity* with the *attitude toward the technology* used in early technology adoption studies [Davis 1989]. Attitude toward the activity deserves further attention in future studies as it may prove to have an influential role in the adoption equation.

To summarize, the contributions of this research are that it:

- Proposes and validates a theoretical model giving equal consideration to both factors favoring adoption and factors disfavoring adoption of a new IT application at an early stage
- Embeds a multi-faceted perceived risk concept (having perceived psychological risk as a key factor), adapted from consumer behavior research, into the motivational model as an obstacle to adoption
- Opens the door for subsequent investigation on multi-faceted perceived risk use in other IS adoption studies as risk perception is context-dependent
- Shows that intrinsic motivation may play a leading role within the motivational drivers for adoption
- Shows that attitude toward the activity addressed by a new IT application plays a role that deserves future attention

As in virtually all empirical research, this study has limitations. For reasons of convenience and feasibility, and similar to a substantial body of IS research, most of the participants were young people from a university environment. Therefore the motivation of taking vitamins for preventive reasons might be low and some risk perceptions associated with the use of an SMS reminding service for this purpose might also be small. However, these subjects do not differ from the general population in terms of needing to have healthy behaviors (although they may differ in terms of education level and financial and social risk perceptions). As their needs related to the possible use of technology for health purposes will grow with age, it is important to predict future trends based on their current perceptions especially when performing an early adoption study [Lee et al. 2001]. The sample may not be fully representative for another reason: subjects are participating voluntarily [Hu and Wang 2005]. Then, there is always 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 et al. 1999].

This study is one of the first scientific attempts to look at aspects involving early adoption issues of new information technology applications, through an unbiased evaluation of the perceptions affecting its adoption. Future research is expected to deepen this study by enriching the 'pro' and 'con' factors. Subsequent research should also examine the evolution of motivation and risk perceptions in time, after the users are effectively exposed to new technologies.

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APPENDIX A

MEASUREMENT SCALES

Perceived Financial Risk

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.

Perceived Social Risk

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.

Perceived Privacy Risk

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.

Perceived Psychological Risk

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.

Extrinsic Motivation

Using TMT would help me to take the daily vitamin C pill at proper time.

Using TMT would help me to not forget about the daily vitamin C.

Using TMT would help me to take the vitamin C every day.

I find TMT to be useful in reminding me to take my vitamin C daily.

Intrinsic Motivation

I find TMT to be enjoyable.

The actual process of using TMT would be pleasant.

I would have fun using TMT.

Behavioral Intention

Assuming I had access to TMT, I intend to use it.

Given that I had access to TMT, I predict that I would use it.

Attitude Toward Adherence (or Compliance)

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.

*TMT is an abbreviation for 'Text Messaging Telehealth' and denotes a service using SMS for health reminders on cell phones

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