INFORMATION AND COMMUNICATION TECHNOLOGY ADOPTION BY HEALTHCARE PROFESSIONALS: AN OVERVIEW OF THEORETICAL MODELS AND THEIR APPLICATION

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ABSTRACT
It has long been advocated that Information and Communication Technology (ICT) offers a huge potential to answer many of the challenges that the healthcare sector is facing. ICT applications promise efficient tools to collect, store, process and communicate health-related data and information. In that respect, it is believed that ICT could improve safety, quality, and cost-efficiency of healthcare services. Benefits for patients, health care professionals, organizations and the public in general are thus expected. Therefore, the integration of ICT into the health system constitutes a priority for many countries. However, ICT adoption among healthcare providers remains an important issue. This paper reviews some of the theoretical models that have been applied to the study of ICT adoption in the specific sector of healthcare, presents a synthesis of actual knowledge on factors involved in ICT adoption among healthcare professionals, and identifies key issues that need to be addressed in order to promote the integration of ICT in the daily practice of healthcare professionals.

KEYWORDS
Information and Communication Technology, Healthcare, Adoption, Diffusion, Theoretical Models, Review.

1. INTRODUCTION
Over the past decades, adoption of information and communication technology (ICT) in the healthcare sector has been the focus of many studies. The rationale for studying ICT adoption is that many ICT projects have failed because of the lack of integration into practices and organizations (Ash & Bates, 2005; Lorenzi et al., 1997). While it is important to look at systemic, organizational and professional factors that shape the integration of ICT in health care systems, studying adoption at the individual level is particularly relevant since the ultimate decision to use a new technology is often that of the individual (Hu et al., 2001; Igbaria et al., 1997).

The aim of this paper is twofold: first, it presents an overview and a critique of some of the theoretical models that are most relevant to study ICT adoption among healthcare professionals. Second, it discusses some important findings from the literature on ICT adoption by healthcare professionals and proposes avenues for promoting an optimal use of these technologies. These findings are particularly relevant for the advancement of ICT integration in healthcare. Nevertheless, many of these considerations are likely to be transferable to a variety of ICT applications and this work is thus relevant for any researchers and decision-makers in the field of applied computing.

2. THEORETICAL MODELS OF ICT ADOPTION
Several theoretical models can be adapted and applied to the study of ICT adoption in healthcare. Most of them consist of frameworks developed in other scientific fields, such as social psychology. The theoretical
models described below have been empirically applied to understand ICT adoption behaviours among healthcare professionals at the individual level. Other theories and frameworks that are adapted from these models exist, but the focus is on the following since they have been more extensively tested in the field of healthcare.

2.1 Diffusion of Innovation Theory

One of the models that have received much attention for the study of ICT adoption in healthcare is the Diffusion of Innovation (DOI) (Rogers, 1995). This model suggests that there are three main sources influencing the adoption and diffusion of an innovation: perceptions of innovation characteristics; characteristics of the adopter; and contextual factors (Berwick, 2003). According to a review of numerous empirical studies (Rogers, 1995), perceptions of the characteristics of an innovation are the most critical factors for its diffusion. There are five perceived characteristics of innovation: 1) relative advantage is the degree to which the innovation is perceived as better compared to the status quo; 2) compatibility is the degree to which the innovation is perceived as being consistent with existing values and practices among potential adopters; 3) complexity is the degree of difficulty perceived regarding the use of the innovation; 4) triability represents the possibility for a potential adopter to experiment the innovation on a small scale; and 5) observability is the degree to which the results of the innovation are visible to potential adopters.

With respect to individual factors, the DOI proposes five categories of adopters that are based on the distribution curve of the diffusion process, which follows a relatively normal distribution. These are: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, (5) laggards. Individuals in each category present specific characteristics and personality traits that have been found to influence their adoption behavior. The DOI also suggests that contextual factors, such as organizational culture, resources and leadership, influence the rate of diffusion of innovations. However, these factors are not considered in this synthesis since the focus is on ICT adoption at the individual decision-making level.

One of the main critiques that have been expressed with regard to this model is its lack of specificity. As Chau & Tam (1997) argue, the DOI was developed to explain the diffusion of any innovation and the relationships it posits between concepts such as innovation’s characteristics and adoption behavior are not explicit.

2.2 Theories of Reasoned Action and Planned Behavior

These two models are very similar since the Theory of Planned Behavior (TPB) (Ajzen, 1985; 1991) constitutes an extension of the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975). Both models were developed in the field of social psychology in order to understand a variety of human behaviors. These models are often referred to as intention-behavior theory since they consider intention as the direct precursor of behavior.

The TRA (Fishbein & Ajzen, 1975) postulates that the realization of a given behavior (B) is predicted by the individual intention (I) to perform this behavior. In turn, the individual intention is formed by two antecedents: attitude towards the behavior (AACT) and subjective norm (SN). AACT represents the evaluation of the advantages and disadvantages associated with the performance of a given behavior, weighted by their relative importance. SN is the individual’s perception that significant others will approve or disapprove the behavior in question, weighted by individual’s motivation to comply.

However, some behaviors might not be totally under volitional control, which means that they require specific resources, skills, or opportunities for an individual in order to perform them. Therefore, the TPB (Ajzen, 1985; 1991) proposes to add the perception of behavioral control (PBC) – the person’s evaluation of the barriers related to the realization of the behavior and his or her perceived capacity to overcome them – as a direct determinant of the behavior. Furthermore, the PBC can also act as an indirect determinant of the behavior by influencing intention. According to these models, the influence of external variables, such as age, gender, and personality traits, is usually mediated through theoretical constructs.

Both the TRA and the TPB have shown good predictive validity to explain behavior and behavioral intention (Armitage & Conner, 2001). Moreover, these theories have been successful to explain different behaviors of healthcare professionals (Godin et al., 1998; Légaré et al., 2005; Levin, 1999). However, empirical evidence shows that the relationship between behavioral intention and actual behavior is not always...
strong (Armitage & Conner, 2001), indicating that other factors may intervene in the actualization of intentions (Cooke & Sheeran, 2004).

### 2.3 Theory of Interpersonal Behavior

Another model that has been used to understand acceptance behaviors with respect to ICT is the Theory of Interpersonal Behavior (TIB) (Triandis, 1980). Essentially, the TIB is similar to the other intention-behavior models in that it also proposes a set of psychosocial factors that influence the realization of a behavior. However, the TIB specifies that three direct determinants influence behavior: intention, facilitating conditions, and habit. Intention refers to the individual’s motivation regarding the performance of a given behavior. Facilitating conditions represent perceived factors in the environment that can ease or impede the realization of a given behavior. Habit constitutes the level of routinization of a given behavior, i.e. the frequency of its occurrence.

According to the TIB, the behavioral intention is formed by attitudinal normative beliefs. Attitudinal beliefs are formed by an affective (affect) and a cognitive (perceived consequences) dimension. Affect represents an emotional state that the performance of a given behavior evokes for an individual, whereas perceived consequences refer to the cognitive evaluation of the probable consequences of the behavior. The TIB also incorporates two different normative dimensions: social and personal norms. Social norms are formed by normative and role beliefs. Normative beliefs consist of the internalisation by an individual of referent people or groups’ opinion about the realisation of the behaviour, whereas role beliefs reflect the extent to which an individual thinks someone of his or her age, gender and social position should or should not behave. The personal normative construct of the TIB is formed by personal normative belief, the feeling of personal obligation regarding the performance of a given behaviour, and self-identity, the degree of congruence between the individual’s perception of self and the characteristics he or she associates with the realisation of the behaviour.

Compared to other intention-behavior models, the TIB has a wider scope since it also considers cultural, social, and moral factors. The TIB is also sensitive to cultural variations that affect the realization of behaviors within specific groups of the society, such as healthcare professionals (Facione, 1993). However, a possible critique to the TIB might be its relative complexity since it considers many independent predictors. This is why empirical studies do not usually apply this model in its integrity. Nevertheless, the comprehensiveness of the TIB constitutes its major strength.

### 2.4 Technology Acceptance Model

The Technology Acceptance Model (Davis, 1989) was developed based upon the TRA specifically for understanding user acceptance of information technology. In its original version, the TAM is similar to the TRA, considering intention as the direct determinant of behavior, while attitude and social norms being the predictors of intention (Davis, 1989). The specificity of the TAM is that it decomposes the attitudinal construct found in previous models into two distinct factors: perceived ease of use and perceived usefulness. However, the TAM has been simplified over time and the attitudinal and normative components have been dropped from the model, leaving PEU and PU as the sole predictors of intention (Venkatesh et al., 2003). Many studies have empirically tested the TAM for the prediction of adoption behaviors for various technologies (Ma & Liu, 2004) and the TAM has also been applied to understand healthcare professionals’ acceptance of ICT (Hu et al., 1999; Croteau & Vieru, 2002).

The TAM has the particularity of being ICT-specific and it proposes a set of beliefs that can be measured among various groups of users (Davis, 1989). However, some authors have criticized the applicability of the TAM to the study of healthcare professionals’ behaviors (Croteau & Vieru, 2002). Various efforts have been done to extend the TAM either by introducing variables from other theoretical models or by examining antecedents and moderators of perceived ease of use and perceived usefulness. Recently, an integrated model of information technology adoption, the Unified Theory of Acceptance and Use of Technology (UTAUT) was proposed, which incorporates most of the variables found in other theoretical models (Venkatesh et al., 2003). The UTAUT could be useful to assess healthcare professionals’ acceptance of ICT and some authors have already proposed its application ( ). However, this model has not yet been tested empirically to understand ICT adoption among healthcare professionals.
3. SYNTHESIS OF STUDIES ON ICT ADOPTION IN HEALTHCARE

A review of empirical studies that have applied theoretical frameworks to understand ICT adoption among healthcare professionals was conducted. A synthesis of the findings is presented in Table 1. The findings are reported according to broad categories of factors that are found in the theoretical models described above. These categories are: 1) perceived attributes; 2) perceived normative factors; and 3) perceived barriers and facilitators.

3.1 Perceived Attributes

This category refers to users’ perceptions towards the technology and their evaluation of the consequences of adopting it. Thus, the five characteristics of an innovation from the DOI, the attitudinal constructs found in the TRA, TPB, and TIB, as well as the concepts of perceived usefulness and perceived ease of use from the TAM are considered.

Hebert & Benbasat (1994) have analyzed factors influencing nurses’ adoption of computerized medical records. They used a combination of the DOI, TRA and TAM. Their model was fairly strong by explaining 77% of the variance in intention to use the technology. Perceived relative advantage, compatibility with usual work patterns, and result demonstrability were associated with intention. Other empirical studies using the DOI have also found support for the use of this model in order to explain physicians’ adoption of telemedicine (Spaulding et al., 2005) and the Internet (Chew et al., 2004). In all the studies based upon the DOI that were reviewed, relative advantage was the strongest predictor of ICT acceptance.

A study of telemedicine adoption among physicians in Hong Kong based upon the TPB (Hu & Chau, 1999) reported that attitude was the principal determinant of physicians’ intention to use telemedicine. A similar study applied the TAM to assess predictors of telemedicine acceptance among physicians and found that 44% of the variance was explained by perceived usefulness (Hu et al., 1999). Conversely, perceived ease of use did not influence significantly its adoption. Croteau and Vieru (2002) used an adaptation of the TAM to explore the factors affecting telemedicine adoption by two groups of physicians in Canada. Likewise, perceived usefulness was the main predictor of telemedicine adoption in both groups, while perceived ease of use was associated to adoption in only one of the groups. A modified version of the TAM was applied to explore physicians’ intention to use Internet (Chismar & Wiley-Patton, 2003). The model explained 59% of the variance in intention, with perceived usefulness being the only significant predictor of intention.

3.2 Perceived Normative Factors

Normative factors are not accounted for explicitly neither in the DOI nor the TAM, although many researchers using these models have added a social or a normative component to their framework (Chismar & Wiley-Patton, 2003; Croteau & Vieru, 2002; Hebert & Benbasat, 1994). In most of the studies on telemedicine adoption by physicians, social factors have not been significant (Croteau & Vieru, 2002; Hu & Chau, 1999; Hu et al., 1999). Similar findings have been found with respect to physicians’ adoption of the Internet where subjective norm was not a significant predictor (Chismar & Wiley-Patton, 2003). As Succi and Walter (2002) have pointed out, normative factors considered in psychosocial models might not be adapted to the study of healthcare professionals’ behaviours. Thus, these authors suggest testing the influence of other normative components, such as the perceived impact of using the technology on professional status.

In contrast, a study based upon the TIB explained a high 81% of the variance in physicians’ intention to use telemedicine exclusively with normative factors (Gagnon et al., 2003). These normative components were perceived social norm, role beliefs, and professional norm. Other studies of ICT acceptance among healthcare professionals have shown a significant influence of social factors. For instance, Hebert and Benbasat (1994) found that perceived support from the Director of Nursing significantly influenced nurses’ intention to adopt computerized health records.
3.3 Perceived Barriers and Facilitators

Many studies have explored barriers and facilitators to ICT adoption in healthcare but only a few used an explicit theory to assess them. Using the TPB as their theoretical framework, Hu & Chau (1999) found that perceived behavioral control had a small but significant effect on intention of Hong Kong physicians to adopt telemedicine. These authors used three items to assess perceived control: proper training, technology access, and in-house technology expertise. Furthermore, Chau & Hu (2002) proposed a combined model to study telemedicine acceptance in which perception of behavioral control was a significant predictor of intention. However, these findings have not been supported by other empirical studies of telemedicine adoption in which behavioral control did not influence significantly intentions (Gagnon et al., 2003; Croteau & Vieru, 2002).

With respect to the relationship between intention to use ICT and subsequent behavior, a longitudinal study has shown that, depending on the specific tasks considered, about 8 to 51% of physicians who intended to adopt information technologies in their practice actually did so in the following year (Lai et al. 2004). This study also explored factors that influenced the translation of intention to computerize into actual computerization. These factors referred to the number of tasks physicians intended to computerize, the number of tasks already computerized, and a physician’s positive attitude towards computerization.

Table 1. Synthesis of findings from theoretical studies of ICT adoption in healthcare

<table>
<thead>
<tr>
<th>Study Authors (year)</th>
<th>Professional group ICT targeted</th>
<th>Theoretical model (s)</th>
<th>Predicted variance in intention</th>
<th>Determinants of intention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hebert &amp; Benbasat (1994)</td>
<td>Nurses Computerized health record</td>
<td>Diffusion of Innovation (DOI)</td>
<td>77%</td>
<td>Relative advantage Compatibility Demonstrability Social norm</td>
</tr>
<tr>
<td>Spaulding et al. (2005)</td>
<td>Physicians + Physician assistants Telemedicine</td>
<td>DOI</td>
<td>Not applicable: <em>t</em>-tests were conducted to assess differences between ICT adopters and non-adopters</td>
<td>Significant differences between adopters and non-adopters on all 5 innovation attributes and presence of opinion leader</td>
</tr>
<tr>
<td>Chew et al. (2000)</td>
<td>Physicians Internet</td>
<td>DOI</td>
<td>31%</td>
<td>Relative advantage Trialability</td>
</tr>
<tr>
<td>Hu &amp; Chau (1999)</td>
<td>Physicians Telemedicine</td>
<td>Theory of Planned Behavior (TPB)</td>
<td>37%</td>
<td>Attitude Perceived behavioral control Previous experience</td>
</tr>
<tr>
<td>Chau &amp; Hu (2002)</td>
<td>Physicians Telemedicine</td>
<td>TPB + Technology Acceptance Model (TAM)</td>
<td>43%</td>
<td>Attitude Perceived behavioral control Perceived usefulness</td>
</tr>
<tr>
<td>Hu et al. (1999)</td>
<td>Physicians Telemedicine</td>
<td>TAM</td>
<td>44%</td>
<td>Perceived usefulness</td>
</tr>
<tr>
<td>Croteau &amp; Vieru (2002)</td>
<td>Two groups of physicians Telemedicine</td>
<td>TAM + Variables from the DOI</td>
<td>59.6% in group A 47.5% in group B</td>
<td>Group A: perceived usefulness, perceived ease of use, non-voluntariness Group B: perceived usefulness</td>
</tr>
</tbody>
</table>
4. DIRECTIONS FOR FUTURE RESEARCH ON ICT ADOPTION

This overview of theoretical frameworks applied to ICT adoption by healthcare professionals has highlighted some avenues to orient future advancements in this field of research. However, the purpose of this paper was not to provide a systematic review of studies on ICT adoption since it focused on a limited number of studies which provided examples of the application of the theoretical frameworks discussed. Thus, a logical next step would be to carry on a systematic review of the literature on the factors influencing healthcare professionals’ adoption of ICT applications. This systematic review would synthesize actual knowledge on the factors that are the most influential for different professional groups and various ICT applications. This systematic review would also assess the extent of theory utilization in studies of ICT adoption, identify other theoretical models that have been applied to this field, and provide a blueprint for future research on ICT adoption by healthcare professionals.

A second line of research that is proposed is the development of multidimensional models that combine concepts from individual-level behavioral theories with variables from group-level and organizational frameworks (Kukafka et al., 2003). Such models would provide knowledge to build multi-level interventions for an optimal integration of ICT into healthcare practices. However, in order to consider simultaneously the influence of factors at different decision-making levels, multi-level analyses would be required. Another possibility is the use of rigorous triangulation techniques combining quantitative and qualitative data (Ammenwerth et al., 2003). Similarly, the collaboration between researchers from different disciplines and backgrounds would be necessary to address at the same time the whole range of factors that influence the integration of ICT applications in healthcare practices.

Another important avenue for the advancement of research on ICT adoption in healthcare is the development and validation of comprehensive predictive tools to assess users’ perceptions with respect to the implementation of the new technology. In fact, there is a huge gap between theoretical concepts and how to assess them adequately. Models from the field of social psychology, such as the TRA and the TPB, propose relatively well developed instruments to measure theoretical concepts, but other models, such as the DOI, lack measurement tools. The development of valid and reliable predictive tools will allow identifying factors that affect ICT adoption and would provide insights of effective change management strategies (Helitzer et al., 2003).

Theoretical developments are also important in order to improve our understanding of the factors affecting ICT adoption by healthcare professionals. Using meta-analysis techniques to compare theoretical models and develop comprehensive models that integrate the most influential concepts from existing theories would strengthen the development of effective interventions to promote an optimal integration of ICT in healthcare. For instance, it would be interesting to assess the relevance of a combined theoretical model such as the UTAUT (Venkatesh et al., 2003) to the study of ICT adoption among healthcare professionals.

Finally, few studies have compared ICT adoption between various groups of healthcare professionals and between cultural groups. It would be interesting to conduct such comparisons to provide a cross-cultural validation of the theories and tools available and to explore factors that could explain variations in ICT adoption between countries and professional groups.

5. CONCLUSION

ICT adoption is a multidimensional and dynamic phenomenon that is transformed over time. Together with individual beliefs and motivations towards the adoption of ICT, it is also important to address factors that
influence how ICT applications interact with current practices at the professional, organizational, and systemic levels. More empirical evidence is needed to understand user acceptance in the specific sector of health care. This paper provided an overview of some of the most prominent theoretical models used in the study of ICT adoption at the individual level and discussed some findings related to their application. A meta-analysis of quantitative theory-based studies of ICT adoption could provide a stronger basis to orient future research on ICT adoption by healthcare professionals and develop interventions based upon a combination of change strategies. Similarly, synthesis of in-depth qualitative research is also important to continue developing insights into the complex processes of ICT integration in the healthcare system. In summary, the field of ICT adoption should move from using a single theory to study adoption at one point in time to assessing ICT adoption on a continuum based upon integrative theoretical frameworks.

REFERENCES


