



10-2013

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Abouzahra, Mohamed and Tan, Joseph, "The Role of Mobile Technology in Enhancing the Use of Personal Health" (2013).
Transactions of the International Conference on Health Information Technology Advancement. 28.
http://scholarworks.wmich.edu/ichita_transactions/28

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The Role of Mobile Technology in Enhancing the Use of Personal Health Records

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Abstract: Healthcare industry is essential for the wellbeing of society members, however this industry is characterized by high cost and by plagued by serious medical errors. Personal health records (PHR) can play an important role in solving healthcare problems by enhancing patients' involvement in their treatment, and improving patient-provider communication. Despite the potential importance of PHR systems, they suffer from low adoption rate because of several factors such as digital divide and lack of training. In this paper we propose that mobile PHR systems (MPHR) can aid in overcoming barriers to adopt PHR. We present a theoretical model based on theory of planned behavior and innovation diffusion model that attempts to explain the relationship between mobile technology and MPHR. This model helps in understanding the relationship between mobile technology and PHR, and provide insight to how to overcome PHR adoption barriers.

INTRODUCTION

Healthcare is one of the fundamental and most important services in any society. The importance of healthcare stems from its direct relation to the wellness of society and the wellbeing of its members. This importance is evident in the huge budgets governments allocate for healthcare. For example, USA spent over 6 trillion dollars (\$8300 per person) on healthcare in 2012.

Despite huge healthcare budgets, this industry is faced by many challenges. For example, healthcare is characterized by medical errors and lack of quality control(Piontek et al., 2010) leading to unwarranted deaths and cost increase. Another challenge is population aging which may increase the cost and the pressure on the healthcare industry to cope with the demand resulting from chronic diseases associated with the elderly. Finally, the growing use of information technology in everyday life and the demand of patients to be a part of their treatment add new challenges to the healthcare industry. To face these challenges, healthcare industry dependence on information and communication technologies increased leading to the development of decision support systems and electronic health records which improve the quality of care and aid in decreasing healthcare cost(Aron, Dutta, Janakiraman, & Pathak, 2011).

Personal health records (PHR) provide great potential in facing healthcare challenges. These systems, which provide individuals with the means to access, and control their health records in a safe and confidential environment, enable patients to participate in their own care, enhance communications between patients and providers, and improve quality of care(Archer, Fevrier-Thomas, Lokker, McKibbin, & Straus, 2011; Demiris et al., 2008). Despite PHR benefits and patients' positive attitude towards them (Hassol et al., 2004; Ralston et al., 2007), PHR systems suffer from a low adoption rate(Archer et al., 2011). This low adoption rate is attributed to several factors such as digital divide(Roblin, Houston II, Allison, Joski, & Becker, 2009), lack of training, and the inconclusive effectiveness of PHR systems(Archer et al., 2011).

In this paper, we argue that PHR adoption can be enhanced by utilizing mobile technology to access and use PHR systems. Mobile technology is one of the most used and most popular technologies in the world with an estimated number of mobile subscription of 6.8 billion subscriptions, and 2.1 billion mobile broadband subscriptions((ITU, 2013). The introduction of smart phones and the development of high speed mobile data communication further enhanced the role of mobile technology and made it a part of individuals' daily lives(Dery & MacCormick, 2012). In PHR context, mobile technology, especially using smart phones, provide excellent opportunity for the adoption of PHR. For example, patients are able to access their records ubiquitously. They are also able to use mobile context awareness features (e.g. mobile camera and sensors) to capture and communicate their symptoms or vital signs to

the care provider. Most importantly, the wide diffusion of mobile phones enable patients to have the skills and opportunity to use PHR systems and overcome the digital divide barrier. Finally, the use of other mobile applications, and the personalization of mobile phones create a sense of emotional attachment between users and their phones which encourages them to use their phones to access PHR systems.

Despite the potential importance of PHR and the successful use of mobile technology in different personal and professional contexts such as social networking and mobile commerce, the possible role of mobile technology in enhancing PHR adoption has seldom been studied before. Such a study would have important theoretical and practical implications. Theoretically, this study will help in understanding the relationship between mobile technology constructs and PHR adoption. Practically, it will enable PHR developers and providers to appreciate the role of mobile technology in PHR diffusion and hence, incorporate mobile technology factors in PHR system design and implementations. In this research paper, we attempt to answer two main questions: (1) Can mobile technology enhance the adoption of PHR? And (2) What factors, if any, contribute to the adoption of mobile PHR systems (MPHR)?

To answer these questions, we develop a theoretical model based on the theory of planned behavior and innovation diffusion theory that attempts to explain the relationship between mobile technology and MPHR adoption. The rest of the paper is organized as follows: we start by providing a theoretical background on the theory of planned behavior and innovation diffusion model, then we present our theoretical model and hypotheses. Finally we conclude our paper with a discussion of the implication of the model and its limitations.

THEORETICAL BACKGROUND

The theory of planned behavior (TPB) extends the theory of reasoned action (TRA) in broadening the limited explanation of TRA on willful behavior, that is, behavior that is under incomplete volitional control (I. Ajzen, 1985; Fishbein & Ajzen, 1975). TPB has been used to explain a wide range of behavior and has received strong empirical support in explaining these behaviors (Sheppard, Hartwick, & Warshaw, 1988).

In TPB, intention to perform a behavior represents the central factor in explaining behavior. Intention is a behavioral disposition formed by an individual and translated into a behavior in the right time and under the right circumstances (Icek Ajzen, 2005). Intention was found to correlate with performing a behavior with an average correlation of .53 (Sheppard et al., 1988) with stronger correlation when the behavior is completely under the individual control because, in this case, it is enough to have an intention to perform the behavior (I Ajzen, 1991). Intention is predicted by *attitude towards a behavior*, *subjective norms*, and *perceived behavior control* (I. Ajzen, 1985).

Attitude towards a behavior represents the personal motivational incentives towards a behavior, and is associated with an individual's beliefs about the behavior. If individuals associate a behavior with high value, then they are more likely to have the intention to perform this behavior.

Subjective norms refer to the social pressure towards performing a behavior (Icek Ajzen, 2005). This pressure may come from significant others, where the importance of people depends on the context of the behavior, and how the behavior is seen as important (I Ajzen, 1991). For example, in a personal context, friends and family may represent the important people, while in a work environment, colleagues and managers may be considered the significant others. Subjective norms may also include how the behavior is represented in the media and the attractiveness of this behavior.

Attitudes and subjective norms are important in predicting behavior. However, TPB adds *perceived behavior control* (PBC) as another factor to predict intention and behavior. PBC represents the non-motivational factors in predicting behavior (I Ajzen, 1991). PBC is associated with the perception of an individual of how easy or difficult it is to perform a behavior (I Ajzen, 1991). Originally, PBC was considered in single dimension related to how individuals perceive their own ability to perform a behavior (I. Ajzen, 1988) and was considered equivalent to self-efficacy. However, it has been argued that PBC has two dimensions that reflect both perceived internal capability to perform a behavior and external factors (e.g. opportunity and information) that facilitate performing the behavior. These dimensions are: (1) *Self-efficacy* and (2) *Controllability* (I. Ajzen, 2002; Pavlou & Fygenson, 2006).

Self-efficacy is defined as the individual's perceived capabilities to perform a behavior (A. Bandura, 1997). Self-efficacy represents internal perceived behavior control and it has found to play an important role in predicting behavior (Sheppard et al., 1988). However, individuals' capability to perform a behavior does not depend only on their confidence in themselves, but also on external factors such as adequate resources and opportunities to perform the behavior (e.g. skills and education). These factors are grouped under the *controllability* dimension of PBC which is defined as the perceived availability of resources and opportunities to perform a behavior (I. Ajzen, 2002).

Innovation diffusion theory is a sociology based theory that has been used to study the adoption of innovations in different domains (Tornatzky & Klein, 1982). In the IS field, the innovation diffusion theory has been used to examine the adoption of new information systems (Moore & Benbasat, 1991). According to this theory, the adoption of innovation is determined by: (1) The relative advantage of this innovation which is the benefits it provides over existing predecessors (2) Compatibility which refers to the consistency of the innovation with the users' prior values, beliefs, and past experiences. (3) Visibility: the degree by which the outcome of innovation use is visible to others. (4) Complexity: the perceived difficulty of using the innovation. And (5) Trialability: The ability of the users to try the innovation before adoption (Rogers, 2010).

In this research we mainly use the theory of planned behavior to explain the relation between mobile communications and MPHR. However, we adopt the notion of relative advantage and compatibility from the innovation diffusion theory to explain specifically how attitude towards using MPHR is affected by the idiosyncrasies of mobile technology.

THEORETICAL MODEL

Figure 1 shows the theoretical model we use in this study

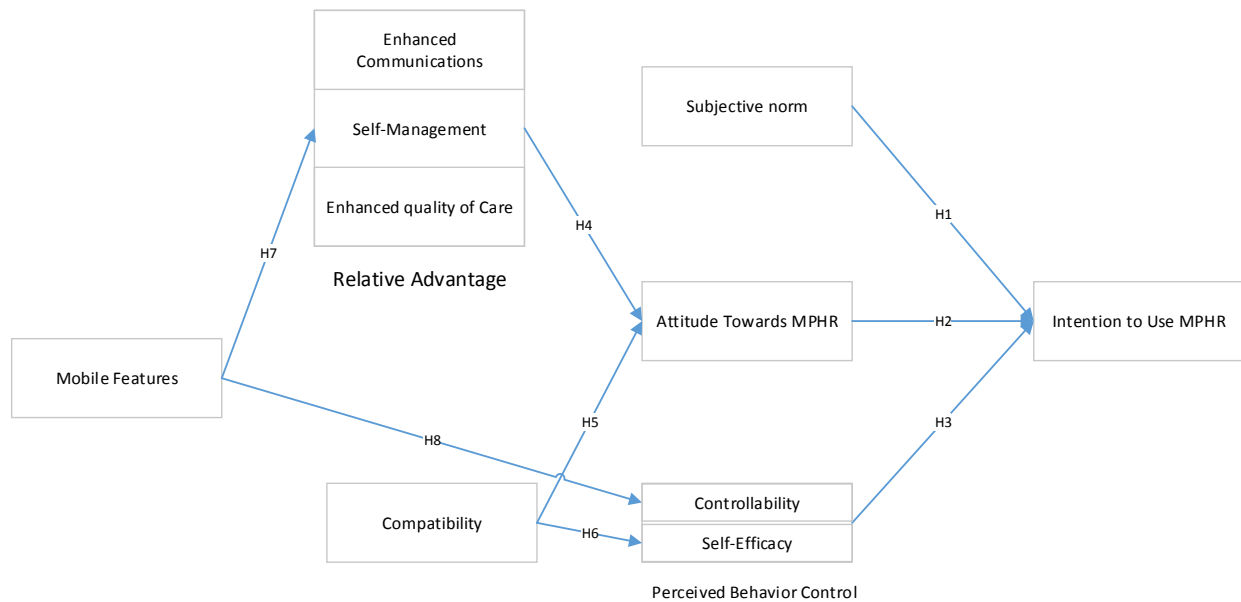


Figure 1: Theoretical Model

Intention to Use MPHR

According to TPB, intention to perform a behavior predicts the actual behavior. This proposal is supported by empirical results that found an average correlation of 0.53 between intention and behavior (Sheeran, 2002). Moreover, Icek Ajzen (2005) argued that intention is expected to have stronger correlation with the behavior than

other predictors. In the context of information systems, intention has been found to predict information systems adoption (Taylor & Todd, 1995).

Subjective Norm

In the context of this research, subjective norm is divided into two components: (1) How the providers or physicians perceive the importance of using MPHR and how they communicate the importance of using MPHR to users. And (2) How the important others surrounding the user of MPHR such as family and friends perceive the behavior of using MPHR and the level of support and encouragement they provide to users of MPHR. Healthcare literature demonstrated the importance of patient-physician relationship as well as the role of family support and encouragement in patient's compliance with treatment plans (Cameron, 1996; Griffith, 1990; Waggoner, Jackson, & Kern, 1981). Furthermore, in a 2005 survey on the use of PHR, 21% of PHR users attributed their use to physician's advice (Holland, 2006). Therefore, we propose that subjective norm has a significant effect on the adoption of MPHR

H1: Subjective norms are positively related with the intention to use MPHR

Attitude towards MPHR

Attitude towards behavior represent the motivational factor of performing the behavior, and they refer to the value an individual associates with performing a behavior (Ajzen, 1991). In the context of MPHR, Attitude reflects the value users associate with using MPHR. We propose that attitude towards MPHR determines the intention to adopt MPHR, hence:

H2: Attitude towards MPHR is positively related with the intention to use MPHR.

Perceived Behavior Control (PBC)

In the context of users' participation and contribution to OSN, PBC is the perception of how easy or difficult it is to participate in OSN. Following (Pavlou & Fygenon, 2006), We propose that PBC has two components: (1) Controllability, and (2) Self-efficacy.

Controllability

We define controllability in this study as the perceived availability of opportunities and resources to use MPHR (Ajzen, 2002). In MPHR context, users may need to access their health records, or communicate with their health providers in cases of emergency. In order to do so, they need to have the necessary skills and opportunities such as accessibility to mobile communications.

MPHR Self-efficacy

Self-efficacy is the individual's perceived capability of using mobile technology. Self-efficacy represents a major factor in most technology adoption models such as TAM (Moon & Kim, 2001), and TPB (Ajzen, 1991). In the context of mobile technology, self-efficacy has been found to affect mobile Internet acceptance (Chong, Zhang, Lai, & Nie, 2012), in the adoption of mobile commerce (Islam, Khan, Ramayah, & Hossain, 2011) and mobile payment. We expect mobile self-efficacy to positively affect the use of MPHR because, as we mentioned earlier, using MPHR requires users to utilize mobile technology features to facilitate their use of MPHR, and hence how they perceive their capability of using these features encourages them to exert more effort and overcome usage obstacles (Albert Bandura & Schunk, 1981).

Based on the above discussion we propose:

H3: Perceived behavior control has a positive relationship with the intention to use MPHR

Relative Advantage

The relative advantage of MPHR reflects the benefits of MPHR over traditional health information systems such as paper based personal health records.

Research identified several advantages that influence MPHR adoption. Enhanced communications between users and healthcare providers is a key benefit of MPHR. MPHR enable patients to communicate their medical condition or vital signs to their physicians and receive feedback from them. Patients can also use MPHR to request appointments and receive general information about their condition(Wald et al., 2004). These capabilities are not present in paper based health records and thus represent an advantage for MPHR.

Self-management in healthcare refers to the patient capability to monitor their own condition and take part in their treatment plans(Zheng et al., 2008). MPHR enable patients to record their own vital signs and healthcare data and use these data to follow up treatment with their physicians. Smartphones can be used as hubs for patient-attached health sensors that record patient data directly in the MPHR system(Otto, Milenkovic, Sanders, & Jovanov, 2006). Health self-management is a key feature of MPHR that can utilize mobile features to enhance the value of personal health records, and hence can be considered a relative advantage for MPHR.

Patient-centered care(Bergeson & Dean, 2006) aims to provide care based on patients' needs and circumstances and it improves the output of healthcare(Oates, Weston, & Jordan, 2000). MPHR enable providers to capture the needs and concerns of patients and hence design treatment plans to satisfy these patients. The mobility components improves patients' capability to communicate their expectations from any place which enhance the patient-centered treatment and hence quality of care.

Mobile MPHR can play an important role in supporting patients in cases of emergencies. The location awareness capability of smartphones enables patients to locate the nearest provider and to share their health data with them(Li et al., 2012) and therefore enabling the provider to treat patients in accordance with their health condition.

H4: MPHR relative advantage has a positive relationship with attitude towards MPHR

Compatibility

Compatibility in our context refers to how using MPHR is consistent with users' prior beliefs, values and experience(Rogers, 2010). Prior research showed a significant effect of compatibility on the acceptance of new IS innovations(Cooper & Zmud, 1990). In relation to TPB, Compatibility is positively related with attitudes towards using a new IS system (Moore & Benbasat, 1991, 1996; Plouffe, Hulland, & Vandenbosch, 2001). Compatibility of MPHR is achieved because users are already accustomed to using their mobile phones for communicating as well as for other purposes such as gaming and social networking hence they have prior experience related to MPHR and they value the use of mobile technology in MPHR.

H5: MPHR compatibility with mobile technology has a positive relationship with attitude towards MPHR

Moreover, compatibility enhances MPHR self-efficacy. This is because prior use of mobile technology enhances users' confidence in their capabilities to use MPHR. For example, a user who has an enjoyable prior experience in using a mobile social networking application is more likely to have confidence in using her phone to access and update her personal health records. Hence:

H6: MPHR compatibility with mobile technology has a positive relationship with MPHR self-efficacy

Mobile Features

In this paper. We propose that mobile technology features are one of the driving forces behind the adoption of MPHR. These features, described below, provide enhance users' experience of using MPHR and provide them with the tools necessary to harvest the advantages of MPHR. We propose that the most salient features of mobile communications include ubiquitous connectivity, physical attachment, viewing and authoring capabilities, and context awareness.

Ubiquitous connectivity is the ability of users to connect to their PHR from anywhere using their mobile phones. Ubiquitous connectivity is made possible through the availability of high speed wireless networks such as 3G and 4G networks. These networks transformed mobile data communications from being slow and costly to being fast and cheap, and hence provided users with enough bandwidth to access PHR from anywhere, and upload data of large size (e.g. images or lab results). Therefore, we expect ubiquitous connectivity to positively affect the use of MPHR.

We define physical attachment as the close proximity and availability of mobile phones to users. Physical attachment is an important feature of mobile phones that emerges when users perceive the role of mobile phones in their lives such as social interactions and therefore, attempt to keep their phones close by (Palen, Salzman, & Youngs, 2000). Physical attachment provides users with the opportunity to use MPHR and hence enhances their perception of control over using MPHR. Therefore, we expect mobile availability to positively affect the use of MPHR.

There are many features of mobile phones that enhance the viewing and authoring capabilities of users (Cochrane & Bateman, 2010). These features are mostly related to the development of smart phone capabilities such as processing power and storage which permitted for the development of MPHR applications. For example, MPHR applications provide mobile users with the tools to access and browse their health records as well as communicate with healthcare providers and add content to health records. The large and high resolution colored screen provides users with the ability to easily browse their records. The touch-screen input capability also provides users with the tools to update their health records intuitively and habitually.

Context awareness represents a major and unique feature of smart phones that enables them to capture and utilize user context (Emmanouilidis, Koutsiamanis, & Tasidou, 2012). Examples of context awareness tools in smartphones are the smartphone camera, microphone, different sensors and location awareness (Kofod-Petersen, Gransæther, & Krogtstie, 2010) using technologies such as GPS which enables users to identify their current location and navigate to designated destinations. Context awareness can play an important role in enhancing the effectiveness of MPHR because it enables users to capture and communicate different types of health related data that can be used by the physician to understand patient's condition. One of the prominent examples of the role of mobile capabilities is the Women's college hospital in Toronto (Semple, 2012) which developed an application that utilize the smartphone input capabilities of touch screens to provide patients with an intuitive way to communicate their post-surgical conditions through MPHR, and utilizes the context awareness of the smartphone by using its camera to capture images of the post-surgical patient progress and communicating these data to the hospital. Women's college hospital managed to change from an in-patient hospital to an out-patient one with a reduction in cost of 30%.

We propose that mobile features enhance both perceived relative advantage of MPHR as well as controllability. Prior research has found a significant relationship between system features and usefulness as well as ease of use (Wixom & Todd, 2005). In MPHR context, mobile features are direct enablers of the outcomes of using MPHR and at the same time, they provide patients with the tools they need to use MPHR. For example, smart phone camera and sensors enable users to capture their medical symptoms and communicate these symptoms to their physicians realizing a major benefit of MPHR. Hence we propose:

H7: Mobile features have a positive relationship with the relative advantage of using MPHR

H8: Mobile features have a positive relationship with controllability over using MPHR

DISCUSSION AND CONCLUSION

In this paper, we presented a theoretical model that attempts to explain the relationship between mobile technology and the intention to use MPHR. It uses mobile related constructs such as mobile features and compatibility between MPHR and other mobile applications to explain the adoption of MPHR.

The contribution of this paper is both theoretical and practical. Theoretically, to our best knowledge, mobile technology constructs have not been used before to explain the adoption of PHR. Using these constructs emphasize

the role of mobile technology in the adoption of PHR and encourages further research about the role of additional mobile related factors (e.g. emotional attachment) in the adoption of MPHR. This study also utilizes TPB and IDT to explain the relationship between mobile technology and MPHR adoption. Although these two theories have been used before ((Moore & Benbasat, 1996), they have never been used in PHR context.

Practically, this study provides some insights on how to overcome barriers of using PHR. For example, the use of mobile technology help in overcoming the digital divide problem since mobile phones are wide spread among society members with no gender or ethnic difference. The widespread of mobile phones enhance individuals' self-efficacy and encourage them to adopt PHR systems. Therefore, PHR developers and vendors are encouraged to utilize mobile technology in their PHR implementations.

Finally, this paper has several limitations. First, this research should be regarded as a work in progress and as such, future research should address empirically testing the proposed model to assess its validity. The proposed model focuses on the role of mobile technology in enhancing PHR adoption and should not be considered a comprehensive model for the adoption of PHR systems.

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