A Holistic Framework for Understanding Acceptance of Remote Patient Management (RPM) Systems by Non-Professional Users

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Abstract

The successful integration of Information and Communication Technologies (ICT) in healthcare facilitates the use of the sophisticated medical equipment and computer applications by medical practitioners. If earlier medical systems were mainly used by the health professionals (e.g. medical staff or nurses), nowadays with the appearance of Internet health systems are becoming available to the broader user groups, particularly patients and their families. eHealth has become an active research and development area within healthcare industry. Another important tendency in the development of ICT for health is a shift from "hospital-centered" to "person-centered" health systems which can enable maintaining and improving the quality of care without exploding costs. While technological side has been intensively developed within several research areas, the adoption of eHealth from a user's perspective has gained too less research attention. Our current understanding of factors that affect acceptance of ICT-based eHealth systems by prospective non-professional users (patients) is still in its infancy. In information systems research the Unified Theory of Acceptance and Usage of Technology (UTAUT) has been applied by many researchers. There are already some uses of it in the eHealth area. In this paper we consider the UTAUT-model and its eHealth applications and suggest a holistic framework for further studies of user acceptance in Remote Patient Management (RPM).

1. Introduction

Chronic diseases are the leading cause of death and healthcare costs in the developed countries. Chronic heart failure alone costs US economy over 33.7 billion dollars per year, of which 16 billion due to re-hospitalization (`http://www.americanheart.org/`). EU healthcare system is experiencing similar cost expenditures.More than one third of re-hospitalizations are preventable by adequate patient monitoring, instruction, education and motivation (all of which can be done outside of the hospital). Hence, in order to maintain and improve quality of care without exploding costs, healthcare systems are undergoing a paradigm shift from patient care in the hospital to the patient care at home [21]. In that context, remote patient management (RPM) systems offer a great potential in reducing hospitalization costs and worsening of symptoms for patients with chronic diseases, e.g., coronary artery disease, heart failure, and diabetes.

RPM systems (Figure 1) ideally should have both the ability to monitor vital signs and provide a feedback to the patient in terms of appropriate information, education and coaching and to the medical professionals responsible for RPM about the current status and progress.

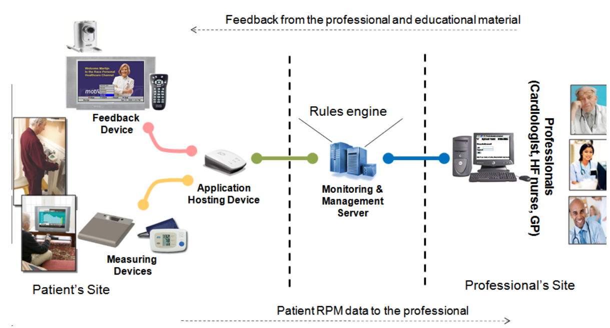

Figure 1. Architecture of an RPM system

Although the technological side of RPM systems development evolves, a wide adoption of RPM technologies is still to come. At the moment only the first judgements of their benefits and potential weaknesses are based on the observations from the clinical studies, like e.g. [4]. However, even from this relatively controlled and small scale experiences it is possible to judge that acceptance, particularly persistent use of RPM related technologies is a serious concern. Some patients may stop temporarily or permanently use the system as expected by medical professionals and/or designers of such systems.

It is important that an RPM system has a feedback loop to the patient that enables the professional to provide appropriate education and counseling (coaching) of the patients. However, most of the educational material provided by RPM systems nowadays is generic and given to all patients regardless of their condition, physical, or mental state. The recent clinical studies show that education and coaching tailored toward the patient is a promising approach to increase adherence to the treatment and potentially improve clinical outcomes [20].

In general, personalization and adaptation of the information services provided in RPM (educational material, motivational and informational feedback) is one foreseen opportunity to cope with the issues of technology acceptance. For example [16] presents an architecture of the next generation RPM systems that facilitates personalization of educational content and its delivery to patients. However, it is not difficult to see that the problem of new technology acceptance is much wider.

In this work we aim at studying the whole spectrum of factors potentially influencing the acceptance of RPM as an Information System (IS) and construct a holistic framework for studying non-professional users' (i.e. patients and their family) acceptance of RPM systems. Particularly, we consider three levels of RPM acceptance: 1) intention of use, 2) enrolment, i.e. a start of using the technology and 3) consistent use of the technology, i.e. there is no sudden drop out (explicit or implicit) and two groups of factors 1) user- or patient-related[1] and 2) facilitation conditions including both technological and organizational aspects.

The rest of the paper is organized as follows. In Section 2 we consider the Unified Theory of Acceptance and Usage of Technology (UTAUT) introduced and widely accepted in information systems research. We also review the existing uses of this theory in eHealth. In Section 3 we consider the contextualization of UTAUT-model to eHealth applications and suggest a holistic framework for further studies of patient's, as a (prospective or current) RPM system user, acceptance of RPM technology. We conclude our work with the discussion (Section 4), in which personalization issues are reconsidered in the light of the proposed framework.

[1] In this paper we focus on the patient side. However, it is known that many of the "resistance to use" come from other sources than the patient. Particularly, the reimbursement of the RPM services (economical incentives), adoption of RPM paradigm by the medical professionals (RPM systems can introduce more workload since patients are more closely monitored on daily basis as compared to the current situation – monitoring on bi-weekly basis by nurses. Hence, RPM systems need to be fitted more effectively into clinical workflow and this workflow needs to be optimized accordingly). Therefore, an acceptance of the technology by healthcare stakeholders, medical experts or personnel and society are also important issues to study. However, they fall beyond the scope of this work.

2. Background and related work

2.1 Unified Theory of Acceptance and Usage of Technology (UTAUT)

Venkatesh et al. [19] unified eight previously published models into a model called Unified Theory of Acceptance and Use of Technologies (UTAUT) (Figure 2).

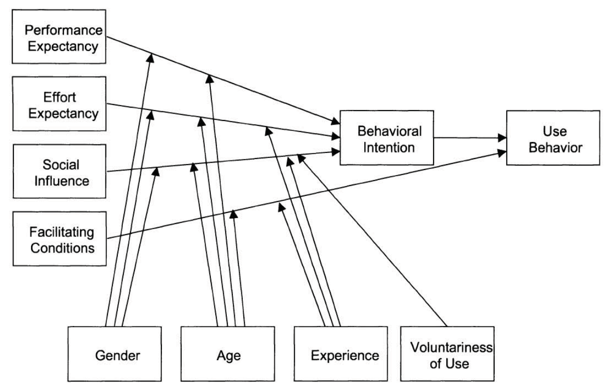

Figure 2. UTAUT

These eight models were the *Theory of Reasoned Action* (TRA) [8], the *Technology Acceptance Model* (TAM) [6], the *Motivational Model* (MM) [5], the *Theory of Planned Behaviour* (TPB) [1], the *Combined TAM and TPB* [15], the *Model of PC Utilization* (MPCU) [17], the *Innovation Diffusion Theory* (IDT) [13], and the *Social Cognitive Theory* [3]. Venkatesh et al. recognized from these eight models seven constructs to be significant direct determinants of intention or usage in one or more of the individual models. Of those they theorize that four constructs will play a significant role as direct determinants of user acceptance and usage behaviour: *performance expectancy*, *effort expectancy*, *social influence*, and *facilitating conditions* ([19], pp. 446-447). Those are the four boxes on the left hand side of Figure 2. Two constructs: *self-efficacy* and *anxiety* they expected to behave similar with effort expectancy and thus to have no direct effect on intention above and beyond effort expectancy. The third construct that they left away from their model was *attitude* towards using technology. Their argumentation leaving this construct out from model based on their notion that the attitudinal constructs were significant only when constructs related to performance and effort expectancies were not included in the model ([19], p. 455). The other argument given was based on existing empirical evidence to suggest that affective reactions (e.g. intrinsic motivation) may operate through effort expectancy (see [18] and [19], p. 455). Thus in the UTAUT model attitude toward using technology is not expected to have a direct or interactive influence on intention.

2.2 UTAUT use in eHealth: related work

Patrice Nuq [11] selected UTAUT-model as the best model to explain behavioral intention of eHealth services by medical personnel. She adapted the model to be used for understanding medical professionals behavioral intention of eHealth services in developing countries. She added as constructs: eHealth champions (side by side with social influence), governmental policy, medical education, and inadequate medical knowledge. She based her construct additions and related hypothesis on her and her colleagues qualitative study, literature review and expert interviews in the field of eHealth in developing countries.

Arning & Ziefle [2] highlighted the difference between acceptance of eHealth technology and acceptance patterns of ICT in general. The following reasons for this difference are mentioned: (1) the utilization context of eHealth technologies is different from ICT usage as eHealth devices are not used voluntarily, but for medical reasons (although eHealth applications might improve patient safety and reassurance, they refer to "taboo-related" areas, which are strongly associated with disease and illness); (2) utilization motives are different, because using an eHealth device, e.g. to keep informed about one's own health status, is not comparable to e.g. mobile phone usage to communicate with friends; (3) there is a higher heterogeneity in user groups and there is a strong impact of individual factors on acceptance for eHealth technologies, as users/patients might be far older than typical ICT-users' and they might additionally suffer from multiple physical and psychological restraints in comparison to healthy user groups. According to [2] the special nature of eHealth technology acceptance was investigated only in a few studies up to now (e.g. in [23], [14], [24], [25]). Arning & Ziefle in [2] contrasted central application characteristics of eHealth and ICT technologies using the scenario technique in order to explore the role of technology type on acceptance. A questionnaire measuring individual variables (age, gender) and attitudes regarding an eHealth application (blood sugar meter) in contrast to an ICT device (Personal Digital Assistant, PDA) was used. The research demonstrated that older users approved the utilization of health-related technologies and perceived lower usability barriers. In addition, main utilization motives of eHealth technology and technology-specific acceptance patterns, especially regarding issues of data safety in the eHealth context were identified. Effects of age and gender in acceptance ratings suggest a differential perspective on eHealth acceptance.

Wilsonet et al. in [22] studied demographic factors (age, gender, income, race/ethnicity and education) contributing to adoption by patients of advanced eHealth services in the areas of transaction, communication, and personal support. The research was based on the analysis of the results of Health Information National Trends Survey (HINTS), conducted in 2003, 2005, and 2007 by the U.S. National Cancer Institute. The findings showed that while use of advanced eHealth services is increasing overall, adoption trends vary substantially by service and by patients' demographic characteristics. The results of the analysis indicated that (1) the elderly are sensitive to benefits offered by eHealth services and sufficiently flexible to go online to gain those benefits; (2) some eHealth services have a lower attraction to women, (3) the digital divide remains an important obstacle to achieving potential benefits of eHealth across the broad population.

Or & Karsh in [12] presented a systematic literature review identifying variables promoting consumer health information technology (CHIT) acceptance among patients. 94 different variables (patient factors (sociodemographic characteristics, health- and treatment-related variables, and prior experience or exposure to computer/health technology); human-technology interaction factors; organizational factors; and one factor related to the environment). In total, 62 (66%) were found to predict acceptance in at least one study. Their review demonstrated that (1) existing literature focused largely on patient-related factors; (2) no studies examined the impact of social and task factors on acceptance, and (3) few tested the effects of organizational or environmental factors on acceptance.

In [7] a new model to understand the reasons why individuals would use new ICT to perform a change in their lifestyle is presented. The model tries to explain the different stages the user is in, in terms of the perception of healthcare and the use of technology to perform any change. The suggested model proposes a general framework and may be applied to the conception, design and evaluation of any eHealth application.

3. Contextualization of UTAUT model to RPM

In Figure 3 we present the contextualization of UTAUT model for eHealth and particularly RPM. We consider it as the framework model offering a backbone for defining a research framework within which different hypothesis and R&D questions related to eHealth and RPM acceptance in particular can be formulated and tested.

We consider three levels of RPM acceptance: 1) *intention of use*, 2) *enrolment*, i.e. a start of using this technology and 3) *consistent use* of the technology, i.e. there is no explicit or implicit (not using as expected, e.g. stopping to perform daily measurements for vital signs) sudden drop out, and two groups of factors: 1) *user-* or *patient-related factors* and 2) *facilitating conditions*.

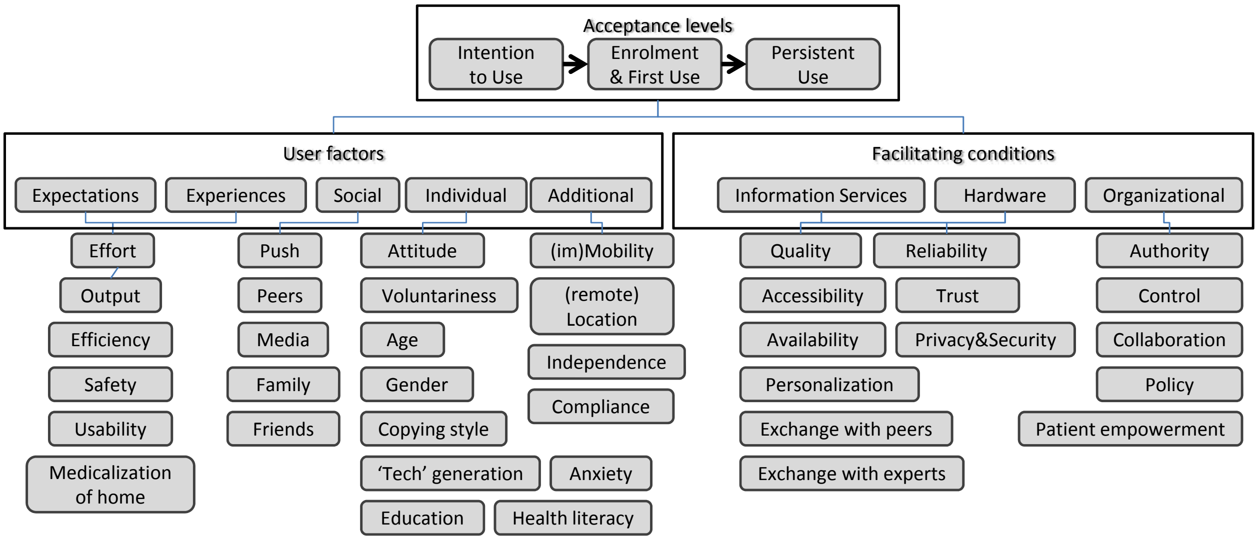

Figure 3. Framework for studying user acceptance of RPM

3.1 User factors

First, we consider the *user* or *patient-related factors*, which we divide into five following groups: *user expectations* and *experiences*, *individual* and *social* factors, and *additional* personal factors or user-related facilitating conditions.

In the UTAUT model performance expectancy was defined as user's belief to achieve gain in job performance by using the system [19]. Fitterer et al. in [9] divided in their taxonomy this factor into four key variables which they named information quality, health outcome, efficiency, and governance. In the UTAUT model effort expectation was defined as "the degree of ease associated with the use of the system" [19] that Fitterer et al. in [9] translated as access and capability from all stakeholders point of view. The constructs self-efficacy (included SCT), anxiety (included in SCT), and attitude towards using technology (included e.g. in TRA, TPB, MPCU, and Combined TAM and TPB) were not included in the UTAUT -model.

In the original UTAUT model age and gender were recognized as key moderators affecting with performance expectancy to behavioral intention and age, gender, and experience were recognized as key moderators affecting with effort expectancy to behavioral intention. We selected as two first groups of user factors *expectations* and *experiences* (Figure 2). We assume that experiences have also effect on performance expectancy and place effort and output as variables under both factors. We include also to these two first groups as variables *efficiency*, *safety*, *usability* and *medicalization of the home* as important user factors effecting users' expectations and experiences in eHealth context. Particularly special factor for RPM context is the medicalization of the home as patients' homes become sort of medical office, and they are faced with their disease on daily basis making at least some of the patients less willing to use the system.

User expectations and experiences groups share similar kinds of individual factors, namely expectations and/or experiences with respect to the *efforts* to be put, an *outcome* of RPM system use (e.g. staying in a stable condition or enhancing life-style and quality or life in general), the *efficiency* and *usability* of the system, *safety* (as technical issues as phycological and emotional, including e.g. privacy, trust and reliability). Feeling of safety is considered as a major RPM system adoption indicator - patients feel safe that someone is looking after them. While expectations themselves affect primarily the intention of use by prospective RPM system users, first time user experience and further continuous use of the system can be affected as by use experience as by the difference between the expectation and the actual experience from the use.

Social factors include so-called *social 'push'*, necessity to communicate with different *peers* (people of same age, or profession, or same disease or diagnosis), citizens' and government position (possibility of providing timely care for many more patients if RPM paradigm is widely adopted, effect on taxes, insurances, etc.), and reflections in *media*. *Family* support is known to be an especially important factor for chronic patients.

In the UTAUT model the social influence was defined as "the degree to which an individual perceives that important others believe he or she should use the new system". The key moderators in that model were age, gender, experience, and voluntariness of use. We decided to separate social and individual variables under separate factors. This division gives in our opinion more focus to the current trend and advance of social media technologies which give raise to variables as peers and friends beside media and push in the social context of eHealth user. The key moderators of the UTAUT model: *age*, *gender*, and *voluntariness* are included as variables into individual factor. Under this factor we recognized natural place also the UTAUT leftout constructs *anxiety* and *attitude*. We added as new variables in the individual factor *education*, *health literacy*, *copying style*, and *'tech' generation* (the general experience of individual about different technologies as defined in [10]).

Additional factors or user related facilitating conditions may include patient's *mobility*, *location*, e.g. proximity of home to closest hospital, (physical) *independence* or some *compliance* with RPM system use requirements. For example, for someone it may be an additional decisive factor to become (or not to become) a home-monitored patient if (s)he lives in a remote area and have difficulties to commute to a hospital on a regular basis or has no relatives who can(not) provide necessary assistance.

3.2 Facilitation conditions

The facilitation conditions are divided into three groups of lower-lever factors: *information services*, *hardware*, and *organizational groups*.

The information services and hardware groups have a number of factors in common. These include e.g. *quality of information*, its *accessibility* and *reliability*, *possibility to exchange* (some of) it with peers and medical professionals. Certainly, similar criteria apply to the measuring devices, display, communication, network connection etc.

Within organizational group it is interesting to distinguish such factors as *the level of authority* (Wii console-like environment vs. strict formal setting), *level of control* (how often the formal contacts are made with the medical professionals), *possibilities of communicating* and *collaborating* with peers and medical professionals, and selected *policies* (consider 'push' policy, where certain activity is prescribed, vs. 'promoting', where certain activities are recommended, vs. 'find it out yourself', where users are motivated to explore, learn, and use different services and functionality). *Patient empowerment* is a key factor for preventive medicine to be effective. Considering patients as consumers who have the right to make their own choices and act on them and understanding that patients cannot be forced to follow a lifestyle dictated by others lead to providing educational support to heart failure patients via their television in advanced RPM system. For example, recent CARME (Catalan Remote Management Evaluation) study that was conducted in Spain using Philips Motiva (`www.healthcare.philips.com`) has shown that this support significantly contributed to empowering patients and a consequent strong impact on outcomes.

Please notice that discussed lowest-level factors (in Figure 3) are not necessarily independent. On the contrary, there may exist a number of dependencies between different factors within and between these two groups. We do not draw explicit connections to keep the figure simple, but some of the dependencies we discuss in the text. Particularly, we consider the factor of personalization in more detail in the following section.

Please notice also that even though such factors as reliability, trust, privacy and security from the information services and hardware group are tightly connected with corresponding user factors (safety), their definition (cf. feeling), quantitative and qualitative interpretation may be different at user and engineer or medical expert sides.

4. Discussion

The conceptual framework we proposed in this paper based on the contextualization of the well-known UTAUT model may serve as a reference for studying and understanding what factors and relationships between them influence the acceptance of RPM systems by non-professional users.

Let us consider the issues related to the personalization of the information services in RPM. The level of personalization of information services and hardware and software interfaces may affect all three levels of acceptance. A prospective user may have an explicit or implicit question "*Is this system suitable for my needs, abilities and current and foreseing circumstances?*". The first time experience of a user with the system may have a dramatic effect on further interaction and satisfaction level of the patient.

Personalization may affect not only the effectiveness and usability of the system but suggest the most appropriate way of organizing RPM for a particular patient with respect to the level of authority (different environments may be appropriate for different 'tech' generations and people of different age groups), the level of control and supervision (that can be wanted by some users but found to be annoying, unpleasant and not helpful for others).

It is interesting to observe that depending on the assumptions about the user different design choices can be made. Consider for example a person who is sceptical about RPM technology yet is forced to or voluntarily preferred to use it. If we believe that the original scepticism has something to do with particular properties of the system operation or settings, we can try to provide such level of personalization that the user will change from being sceptical to convinced. On the other hand, if we recognize scepticism simply as a strong character or personality of some patients, the reasonable action may be to design two versions of the system, one for 'sceptic' stereotype and another for 'convinced' users. Similarly, different policies can be assigned to active (e.g. browsing through the available resources and menus of the system) and passive (waiting for an authoritive order or message saying what must be done) users.

Even properly designed elements of personalization may have not only positive effects. Some users may believe that their privacy is compromised if they share certain data with the system, others may be negatively surprised by an unexpected behavior of the system. For example the use of communication tools by patients may facilitate information awareness, motivation to use the system, share experiences yet may puzzle some users if via discussions they realize that they receive different educational material or information presented or accessible in different ways. Furthermore, differently selected policies may be considered as discriminating by certain groups of patients. Clearly, such issues need to be taken in the design of RPM systems functionality and policies and their adaptation and personalization to users needs and expectations.

Our further work includes case studies aimed to quantify the importance of and relations between different factors related to the development of personalized information services within RPM systems.

However, we hope that the proposed holistic framework for studying user acceptance in RPM will serve as a reference point for many other researchers investigating user acceptance in RPM and eHealth in general.

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