Adoption of Electronic Health Records (EHRs): A Review of Technology Acceptance Studies

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Over the last decade developed countries have invested considerable funds in health-related information technology research. Electronic health records (EHRs) represent an important innovation in healthcare information technology. EHRs can facilitate the process of patient management and care, and significantly reduce operational costs in healthcare settings. Healthcare professionals play a critical role in the success of EHRs but many of them are reluctant to adopt EHRs in their daily practice. The present paper reviews research derived from the Technology Acceptance Model (Davis, 1989), a behavioural model of acceptance and utilization of technological innovations in professional settings, including healthcare services. Following a systematic search and review of the literature, the empirical studies published between 1990 and 2012 are presented, and a synthesis of their main findings and implications for EHRs acceptance by healthcare professionals are discussed.

Keywords

Electronic health records, health informatics, technology acceptance model, usage intentions.

1. Introduction

Over the last decade, governments in many developed countries have invested considerable funds in the development of innovative healthcare information technologies. For example, in the US, governmental spending in health informatics increased from 25.8 to 30.5 billion dollars between 2004 and 2006 [1]. Similarly, in the European Union (EU) some states spend up to 15% of their total budget for digitized healthcare, and the European Commission allocated more than €50 billion to health informatics research between 2007 and 2013. The 'Digital Agenda for Europe', an EU 2020 initiative, aims to further promote health informatics research and development in order to produce innovative products and services that will make healthcare more meaningful and efficient for both patients and service providers [2]. The expansion of e-health technologies has also reached low to middle-income economies, and a cross-border understanding and global partnership for e-health is included in the agenda of both governments and relevant stakeholders [3,4]. Nevertheless, these investments are unlikely to pay back unless end-users, healthcare providers and patients alike, endorse them. As Berg noted [5], the success of any technological healthcare innovation will be eventually decided on the workfloor.

1.1 Electronic Health Records

Ewing (2007) suggested that in today's healthcare systems it is all too easy to receive the wrong medication or treatment in emergency medicine, especially when physicians do not have access to patients' documentation [6]. The Institute of Medicine (1999) report revealed that between 44,000 and

Proceedings of the 16th International Symposium on Health Information Management Research – ISHIMR 2013 98,000 Americans die every year because of medical errors [7]. Ewing argued that the lack of proper information in the right place and at the right time constitutes a major administrative problem in modern healthcare, and has a negative impact on the quality of healthcare services and patient outcomes [7]. EHRs provide a cost-effective solution to the problem of sharing patient information among health care providers. East reported that the mere gathering of information is not sufficient to warrant quality care and facilitate patient management [8]. He proposed a higher level of sophistication, in order to achieve comprehensive and cost-effective EHR systems. Meidani et al. noted that the development and adaptation of EHR is a complex process and integrates many building blocks such as: health record management, business process involvement, collaboration and innovation, change management, and user governance [9]. EHRs should be able to be used to communicate and exchange clinical information in a secure way among all healthcare providers, as well with other stakeholders in the healthcare supply chain. When a patient sees a physician in ambulatory or hospital settings, a huge number of transactions and sharing of information is needed among the various systems: laboratory orders for the clinical laboratory centre, radiology tests and results for the radiology centre, prescriptions for retail pharmacy, billing information for the patient, and public health information for the state public authority [10]. Healthcare providers play a critical role in the adoption and utilization of healthcare technologies, such as Electronic Health Records (EHRs), and there have been legislative measures to promote the substitution of paperwork and implementation of EHRs in hospitals and clinics [11,12]. However, many healthcare professionals, from nurses to ambulatory care physicians, are still reluctant to utilize the available technologies, leading to limited system use and, eventually, system failure [5,13,14].

1.2 Understanding Physicians' Acceptance of EHRs

In order to promote EHR use in clinical settings effectively, it is imperative to understand first healthcare professionals' attitudes and intentions towards using EHRs [15,16,17]. Research in the Technology Acceptance Model (TAM) [18] can provide useful insights into the study of physician's acceptance and utilization of EHRs [15]. Nevertheless, TAM and its successor theories and models, such as TAM2 [19], Unified Theory of Technology Acceptance and Utilization (UTAUT) [20], and TAM3 [21], were developed primarily to assess technology acceptance in commercial, business and education settings. As such, the applicability of TAM to healthcare technologies in general, and to EHRs in particular, may be limited [22,23]. Indeed, compared to TAM studies in other professional domains, related research in health informatics is less well developed. However, the available studies support the applicability of the TAM approaches to health information technology and e-health applications [15].

TAM posited that the adoption and utilization of technological innovations is the function of the endusers' intentions, attitudes, and beliefs about perceived usefulness (PU) and easiness of use (PEOU) [18]. Similar assumptions were made by the successors of TAM, albeit using different labels to the original variables and additional predictors of adoption/usage intentions were used. For instance, TAM uses the label 'perceived usefulness' to define outcome expectancies in relation to task efficiency, whereas UTAUT defines the same construct with the term 'performance expectancy' [20]. In their comprehensive review of the literature in the healthcare domain, Holden and Karsh reviewed over 20 empirical studies published before 2008 that used technology acceptance models (e.g., TAM, TAM2, UTAUT) to assess end-users' acceptance and utilization of several health information technology applications, ranging from computerized physician order entry (CPOE) to electronic medical records (EMRs) [15]. In addition, Holden and Karsh's review included both physicians and non-physicians, such as nurses, pharmacists, and physician assistants. They found that the TAM predicted a large proportion of the variance in acceptance of health information systems, but also noted that TAM models have to be contextualized to the unique features of healthcare settings in order to provide more meaningful findings for policy-makers and researchers interested in the effective promotion of health information technology [15,23].

The present study set out to review empirical studies on the technology acceptance of EHRs by physicians. Unlike the review provided by Holden and Karsh [15], which included several target groups and health informatics applications, our study takes a narrower focus on physicians and their use of EHRs. Also, our review differs from the one by Ward, Stevens, Brentnall, and Briddon [24], who reviewed studies about healthcare staff general attitudes towards information technology. The primary aim of the study was to review and synthesize the available data on physicians' acceptance of EHR as

explained by theoretical models of technology acceptance, such as TAM and its successors (e.g., TAM2 and UTAUT). A secondary aim was to identify the gaps and challenges in technology acceptance research relevant to EHRs and, accordingly, to inform future studies in this area. We believe that our review, albeit narrow in focus, can provide useful findings about EHR acceptance by physicians. This target group plays a critical role in EHR acceptance and success, and therefore, there is a need for reviews that will comprehensively summarize research on this topic [1].

2. Methods

This section describes the methodology used to identify and retrieve empirical studies on TAM and EHR adoption by physicians.

2.1 Eligibility criteria

Studies included in the review had to fulfil the following eligibility criteria: a) be published in English between 1990 and 2012; b) be focused only on technology acceptance of EHRs, there is a difference between EHRs and other similar terms such as EMR, EPR, PHR [25, 26, 27]; c) reflect original research work published in peer-reviewed journals, therefore studies presented in dissertations and conference proceedings were not eligible; d) be accessible from scientific databases enabling both open access and subscription services; e) explicitly assess the relationships described in TAM models, including the original TAM [18] and most recent reformulations of the model (e.g., UTAUT [20]); f) use quantitative research methods and analysis; and g) use physicians and non-physician healthcare staff employed in both hospitals and private practice.

2.2 Databases and key terms

The following databases were used: EBSCO, Medline, PubMed, LISA, CINAHL, Web of Knowledge, and Google Scholar. For the purpose of the study the following range of terms was used: e-Health, health informatics, electronic health record (EHR), electronic patient record (EPR), electronic medical record (EMR), technology acceptance Model (TAM), technology acceptance model 2 (TAM2), unified theory of acceptance and use of Technology (UTAUT).

In the US, the terms EMR and EHR are used interchangeably. However, Garets and Davis argued that EMR and EHR describe totally different concepts, and various stakeholders, such as patients, healthcare providers, employees, insurers, including the government have unintentionally created confusion with regards to the meaning of these concepts [25]. In order to clear this confusion the authors proposed that EMR is created in healthcare institutions and serves as a source for data of EHR. On the other hand, EHR represents the ability to share medical information among end users which enables information to be shared between various modalities of care engaged by that individual. Garets and Davis also proposed that if provider organisations want to achieve an effective EHR, they must provide an effective EMR system [25]. This is similar to findings from a previous study by Terry and Francis who pointed out that, when electronic records are used within the offices of individual healthcare providers, they are known as EMR, and when records are linked and used across multiple providers they are called an EHR [26]. Tang et al. wrote about differences between EHR and PHR (Personal Health Records) [27]. According to the authors, the EHR system functions to serve the information needs of health care professionals, while PHR systems consists of health data entered by patients. The PHR can also include decision support capabilities that assist patients in managing chronic disorders, and in general helps them to have a more active role in their health.

However, argued that the EHR is a product between the health care professional and large highlystructured databases, and stressed the need for standardization of the EHR [28]. He also pointed out that patients are not presenting their history in a structured data format, which is why EHR users must translate what they see or hear into a format that can be used by the computer. The data provided by different health care providers should therefore be standardized and produced in a form recognized by any computer. In the present review, although we included the term EHR in the literature search, we carefully inspected the retrieved studies by reading their abstracts, and selected only the ones that dealt specifically with EHR as defined by Garets and Davis [26]. Following that, the full text articles of the selected studies were accessed and reviewed.

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3. Review of the identified literature

Overall, seven papers, covering six separate studies, were identified that met the eligibility criteria described in the previous section, and were published between 2009 and 2012. The characteristics of these studies are presented in Table 1. Four of the six studies (71.4%) were conducted in the United States, one study was undertaken in Canada, and only one study was conducted in Europe (Spain). There were no studies from Asia or developing countries.

3.1 Settings, methods, and models used

Physicians (academics, primary care, ambulatory care, and resident physicians) were the main target group in the reviewed studies, and they were employed working primarily in hospitals, and the study from Spain considered physicians in private practice. One study used physicians and other clinical staff (e.g., nurses), and another study was conducted only among health information managers. Four studies used online surveys and the remaining studies employed paper-and-pencil questionnaires that were mailed to participants.

Sample sizes varied considerably from 70 to 995 participants (Median = 254, Mean = 421.5, SD = 379.5), and different approaches were used to recruit participants. The studies by Morton & Wiendenbeck used the same sample size/dataset, albeit at different time points [29,30]. Response rates were reported in five out of six datasets (18.04% to 74.5%). It is worth noticing that only two studies had response rates greater than 40%.

All the studies were based on TAM research. Two studies used extended versions of the original TAM and integrated non-TAM variables like finesse, which is defined as the user's capacity to transfer skills and knowledge from one domain to another [31], trust and risk-related factors [32], and one study compared TAM with TAM2 and UTAUT [33].

3.3 Synopsis of the empirical findings

Most of the researchers applied modified or extended versions of TAM, or a combination with other technology acceptance models such as TAM2 or UTAUT. Traditional TAM variables, such as perceived usefulness (PU) and perceived ease of use (PEOU), influenced self-reported acceptance of EHRs in most studies. The constructs used in the extended TAM models (e.g. finesse, predictive value and perceived trust) significantly added to the predictive power of the models. In one study that also assessed contextual variables, greater technological complexity appeared as an impediment to EHR acceptance [34].

4. Discussion

The present study has assessed the research on EHR acceptance among healthcare professionals. There is limited research in this area, although TAM studies have been conducted in relation to other aspects of healthcare technology. The vast majority of the reviewed studies comes from the US and Canada. Although there is investment in e-health and a considerable expansion of healthcare technologies in developing economies, there is limited published research emerging from these countries. The research agenda on EHR and healthcare technology acceptance should be expanded in Europe and developing countries if investments in these domains are expected, because this will show the variables that can be targeted in educational campaigns and interventions aimed to increase healthcare technology acceptance in specific professional groups.

Wilkins reported differences in PU and PEOU between managers who had already adopted and those who were preparing to adopt EHRs [35]. Morton and Wiedenback showed that PU has strong positive influence on EHR, while the effect of PEOU was not proven [29]. Menechemi et al. concluded that the

Proceedings of the 16th International Symposium on Health Information Management Research – ISHIMR 2013 high technological complexity of the EHRs, reduces healthcare professionals' willingness for adoption [34]. Morton and Wiedenback showed that individual user characteristics cannot always predict users' attitudes [30]. Egea and Gonzalez noticed that 'attitude' is only direct determinant of user's intention to use EHRs [32]. Archer and Cocosila reported that high performance expectancy and little effort expectancy about EHRs are strong predictors of technology acceptance among healthcare professionals [33].

On the methodological part the response rates were rather low, in the range of 20%, with only two studies achieving response rates greater than 40%. Sample sizes also varied, with most studies using samples in the range of 240 (Median = 239) participants. The methods used to recruit the samples also varied as some studies used large panels of registered physicians, whereas other were based on available resources. Generally, the studies reviewed did not utilise random probability samples.

Regarding the theoretical models used, it appears that, although traditional TAM approaches prevail (including more recent reformulations of TAM, such as TAM3 and UTAUT), there are studies using integrative models in an attempt to gain more information about the influences on technology acceptance. Finesse, perceived risk and trust appear as useful additions to the TAM models. However, it is important that the additions are made based on a clear theory-driven rationale and are not based on arbitrary decision criteria.

5. Conclusions

More research is needed to contextualize technology acceptance theories in healthcare settings, especially in relation to EHR acceptance. Further research is needed to develop an evidence base to inform the development of health informatics applications [36], including electronic health records, and specifically to examine the influence of external variables such as sociodemographics in technology acceptance of EHRs [32]. Holden proposed that the TAM approach should be contextualized for healthcare professionals, as there is a difference between them and IT company employees [23]. Walter and Lopez and Romano and Stafford proposed the development of a model applicable to healthcare settings with of measuring the adoption barriers, effectiveness and actual use of EHRs [37,38]. This is even more so for European and developing countries where such research is scarce. The shift towards integrating and expanding the traditional TAM approaches might help in building contextualized models, but this has to be followed by a clear and comprehensive understanding of the underlying theories, and be based on theory-driven (and not necessity-driven) criteria.

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Table 1. Synopsis of the reviewed studies on EHR acceptance.

Study	Objective	Country	Participants	Model/Methodology	Findings	Implications	Limitations
Menechemi et al. (2007)	Examines the extent of use of crucial parts of EHR	USA	995 physicians currently using EHRs	TAM/mail survey, questions asking physicians to identify the EHR functionality commonly used in their practices	Greater technological complexity, decreases physicians willingness to adopt the functionality	Functionalities not been adopted are with great potential to improve safety. Continuous incomplete EHR adoption raises concerns about potential benefits	This study only identifies trends in usage, while PU and PEOU or other constructs were not tested. Suboptimal response rate. Focus on only one state
Wilkins (2009)	To examine factors which influence health information managers in adoption of EHR	USA	94 Health information managers	TAM/Internet based survey, 7 demographic questions + questions to measure PU, PEOU, and BI as factors influencing health information managers implementing EHR. Likert scale	PU, PEOU, BI have influence on health information managers who already adopted EHR	If health information managers understand the EHR, its usefulness, easy to use & impact on their job, they will take roll in implementation	Focused on only one state. Physicians and other health providers are not included
Morton & Wiendenbeck (2009)	Determination of individual characteristics, social and technical factors related to EHR adoption	USA	802 faculty, fellow and resident physicians	TAM/self-reporting online questionnaire. Five point Likert scale	PU highly correlated with attitude about EHR. PEOU do not have direct impact on attitude about EHR	EHR system must provide clear benefit to physicians. Addressing physician's immediate needs rather than emphasizing future benefits.	Conducted in one large academic healthcare system, and may not be relevant to other physicians. Unequal distribution between fellow and resident physicians, low response rate.
Morton & Wiendenbeck (2010)	Examines the EHR acceptance factors in academic based healthcare system	USA	802 faculty, fellow and resident physicians	TAM/self-reporting online questionnaire. Five point Likert scale	Individual user characteristics are not accurate predictors of attitude	Need for strong project management techniques to ensure successful implementation of EHR	Conducted in one large academic healthcare system, and may not be relevant to other physicians. Unequal distribution between fellow and resident physicians

Devine et al. (2010)	To assess attitudes toward e- prescribing adoption in the context of EHR	USA	188 physicians and staff	Modified TAM, 37 questions survey, covered PU, PEOU, finesse & intent to use, 5 & 7 point Likert scale	PU, PEOU & finesse are strong constructs	Proposed survey instrument can predict adoption acceptance in a parsimonious fashion	Conducted in primary care staff in one clinic – may not represent entire population, low response rate among staff
Egea & Gonzalez (2011)	To examine physician's acceptance of EHR in terms of usage intentions	Spain	254 physicians in private medical practices	Extended TAM/postal mail, demographic questions + PU, PEOU, attitude towards use and usage intentions extended with trust and risk related factors. Likert scale	Established relationship between PU, PEOU, and attitude towards use and usage intentions. Additional predictive value of trust and risk factors	Need to develop positive attitude among physicians to improve acceptance and future use of EHR	Included physicians from only one region. Other health care professionals not included, low response rate
Archer & Cocosila (2011)	To compare perceptions of physicians using EHR with those not using one	Canada	220 physicians across Canada	TRA, TAM, TAM2, UTAUT, outsourced online cross- sectional survey, two versions of the survey for EHR users/non users, seven point Likert scale	PEOU was found to be strong motivator among EHR users, while PU & PEOU were key determinants for non users	Showed differences in factor influences between EHR users/nonusers	Small sample size for such study, did not differentiate between various levels of EHR experience