Building Capacity for Health Informatics in the Future
F. Lau et al. (Eds.)

doi:10.3233/978-1-61499-742-9-286

A Conceptual Model for Increasing Use of Electronic Medical Records by Primary Care Physicians Through End-User Support

Gurprit K. RANDHAWA[a,b,c 1]
[a] *Manager, Clinical Improvements & Informatics, Island Health, Victoria, BC*
[b] *PhD Candidate, School of Health Information Science, University of Victoria, BC*
[c] *Health Informatics Course Developer and Instructor, McMaster University, ON*

Abstract. A conceptual model for exploring the relationship between end-user support (EUS) and electronic medical record (EMR) use by primary care physicians is presented. The model was developed following a review of conceptual and theoretical frameworks related to technology adoption/use and EUS. The model includes (a) one core construct (facilitating conditions), (b) four antecedents and one postcedent of facilitating conditions, and (c) four moderators. EMR use behaviour is the key outcome of the model. The proposed conceptual model should be tested. The model may be used to inform planning and decision-making for EMR implementations to increase EMR use for benefits realization.

Keywords. Electronic Medical Records, End-User Support, Conceptual Model

1. Introduction

The adoption and use of EMRs is a priority for the Canadian health care system [1] to improve health care quality and safety, facilitate cost savings, and promote health system efficiency [2]. Improved provider effectiveness and health outcomes require better adoption of advanced EMR features by primary care physicians (PCP), such as creating chronic disease registries and recall lists. However, the majority of PCPs do not fully adopt these advanced features [1].

The literature widely suggests that end-user support (EUS) is a critical success factor for increasing EMR use (*i.e.*, overall use of all EMR features). EUS is any information or activity (*e.g.*, training, support from physician champions, etc.) that is intended to help physicians solve problems with and better utilize their EMR [3]. However, many PCPs must learn the true capabilities of their EMR with little effective EUS [4]. Existing research in EUS is limited [5] and is inconsistently described and measured, which impedes efforts to improve EUS quality and EMR use. A valid and reliable tool to assess EUS for EMRs is needed. Additional research on the relationship between EUS and EMR use is also required [5]. At the same time, there is a need for theory to explain the relationship between EUS and EMR use.

[1] Corresponding Author.

2. Background

To explore the relationship between EUS and EMR use, the EMR End-User Support (EMR-EUS) model (Figure 1) was developed following a review of conceptual and theoretical frameworks related to technology adoption/use and EUS.

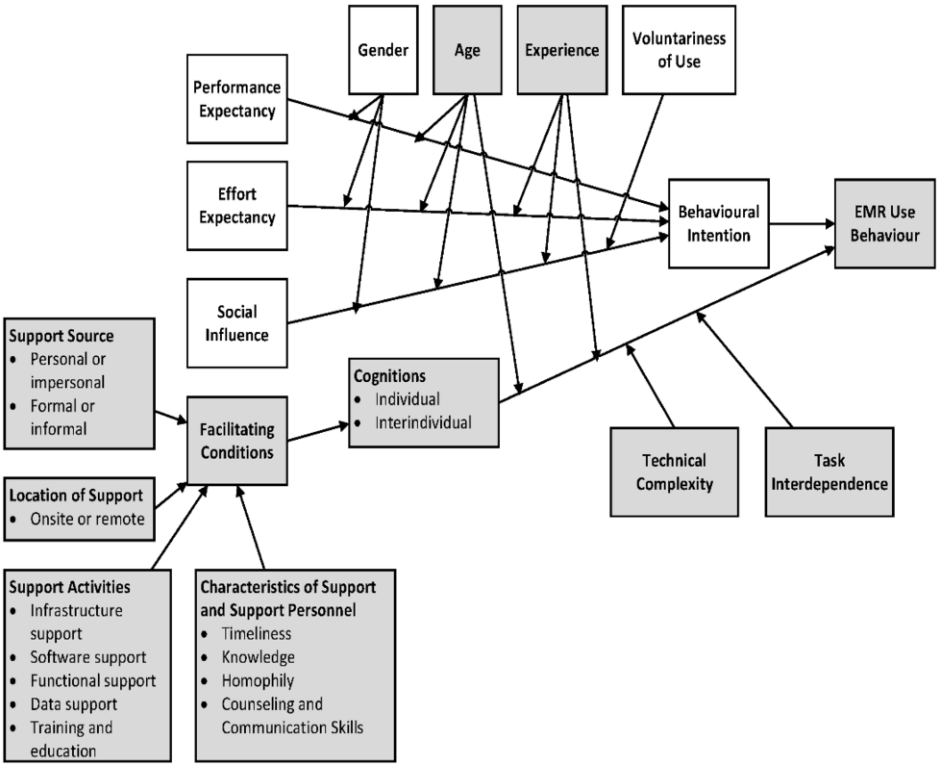

Figure 1. EMR End-User Support (EMR-EUS) Model

The EMR-EUS Model is based on three theories/models: (1) Venkatesh et al.'s Unified Theory of Acceptance and Use of Technology (UTAUT) [6], (2) Shachak et al.'s theoretical framework for describing and characterizing EUS for Health Information Technology (HIT) [3], and (3) Sharma and Yetton's Conceptual Model of the Effect of Training on Implementation Success [7]. The UTAUT model is a comprehensive model that was developed following a meta-analysis of eight theories of technology acceptance and use [6]. With over 15,000 citations, it is the most widely cited recent model of technology adoption and use [8], and has been applied in many settings and to a variety of technologies, including electronic health records (EHR) and EMRs [8, 9, 10]. Following extensive testing, the UTAUT has been found to outperform eight individual models of technology adoption and use. It explains about 70% of the variation in intention to use technology and approximately 50% of the variation in technology use [3].

The theoretical model by Shachak et al. [3] was developed based on a scoping review of the information systems and medical informatics literature on EUS. It is the only holistic framework currently available for characterizing and analyzing EUS for

health information technology, including EMRs. Sharma and Yetton's conceptual model is based on a meta-analysis of the information systems literature on the effects of training on implementation success. It extends previous theory and explains inconsistent findings that were previously reported about the effects of training on implementation success by testing the contingent effects of technical complexity and task interdependence on implementation success [7]. To create the EMR-EUS Model, these three frameworks/models were amalgamated to explore the relationship between EUS and EMR use, as illustrated in Figure 2 below. Specifically, the EUS facets of the theoretical framework by Shachak et al. [3] were used as antecedents to describe EUS in the UTAUT. In the form of a postcedent and two additional relationship moderators, the "pathways" and "contingent effects" from Sharma and Yetton's model were included to describe how EUS influences EMR use.

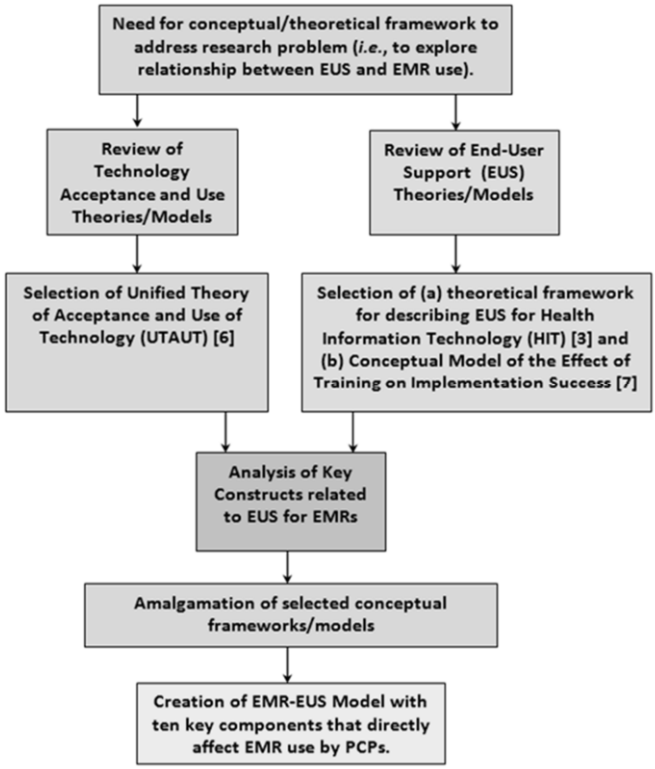

Figure 2. Process for Developing the EMR-EUS Model

The EMR-EUS model contains ten EUS components that affect EMR use by PCPs (highlighted in grey in Figure 1). These include: (a) one core construct (facilitating conditions), (b) four antecedents and one postcedent of facilitating conditions, and (c) four moderators. “EMR use behaviour” is the key outcome of this conceptual model. The aforementioned antecedents exert equal influence on facilitating conditions. Facilitating conditions directly impacts Cognitions, which directly impacts EMR use behaviour. The details of these model elements and relationships are outlined below, as well as other constructs affecting behavioural intention to use an EMR.

3. Model Components

3.1. Core Construct: Facilitating Conditions

In this model, "facilitating conditions" represents the concept of ongoing EUS for EMRs. This includes all EUS factors that make it easier to use an EMR (*e.g.*, provision of computer support). Facilitating conditions is a core construct of this model that impacts individual and interindividual Cognitions (described in Section 3.6), which directly impact EMR use behaviour. According to this model, as the existence of facilitating conditions increases, EMR use also increases.

3.2. Antecedent 1: Support Source

Within this model, the source of EUS is an antecedent for facilitating conditions. The support source can be personal (*i.e.*, provided by a person) or impersonal (*i.e.*, in the form of user documentation, help menus, video tutorials, *etc.*) [3, 11]. At the same time, the EUS may be formal (*i.e.*, provided by a person whose job it is to provide EUS or through vendor-generated user documentation) or informal (*i.e.*, assistance from physician or medical office assistant (MOA) champions, online communities, or user-generated tutorials and manuals) [3]. As the number of EUS support sources available to a PCP increases, the existence of facilitating conditions also increases in this model.

3.3. Antecedent 2: Location of Support

As an antecedent for facilitating conditions, EUS may be provided on-site where the user is located (*e.g.*, presence of a technician to solve a hardware problem) or remotely (*e.g.*, help desk) according to this model [3]. As PCPs receive EUS from different/multiple locations, the existence of facilitating conditions increases.

3.4. Antecedent 3: Support Activities

This model includes five categories of EUS activities that are antecedents for facilitating conditions: (1) infrastructure support, (2) software support, (3) functional support, (4) data support, and (5) training and education [3]. As the number, duration, and frequency of EUS activities available to a PCP increases, the existence of facilitating conditions also increases.

3.5. Antecedent 4: Characteristics of Support and Support Personnel

This model stipulates four characteristics of support and support personnel that serve as antecedents for facilitating conditions. These include: timeliness of support, knowledge, homophily, and counseling and communication skills. As the quality of support personnel increases (*i.e.*, the desired characteristics are present in support personnel), the existence of facilitating conditions also increases.

3.6. Postcedent: Cognitions

As revealed by Sharma and Yetton's model [7], training affects individual and interindividual cognition. Individual cognition includes the application knowledge (*i.e.*, knowledge about the command and tools in the EMR) and business context knowledge (*i.e.*, use of the EMR to effectively perform work tasks), whereas interindividual cognition includes transactive memory (*i.e.*, knowledge about other group members' knowledge) and collaborative task knowledge (*i.e.*, knowledge about how others use the EMR in their tasks) [7]. In the EMR-EUS model, individual and interindividual Cognitions directly impact EMR use. The relationship between Cognitions and EMR use is especially critical for PCPs given the division of EMR tasks (*e.g.*, administrative vs. clinical) between PCPs, MOAs, and other teams members such as nurses.

3.7. Moderators: Age, Experience, Technical Complexity, Task Interdependence

Age and experience are moderators of the relationship between facilitating conditions and EMR use behaviour in this model. They are both important considerations for understanding the background and support needs of different PCPs. As suggested by the UTAUT [6], Age and experience may have an effect on PCP perceptions of EUS and the support activities required by a PCP to increase EMR use. Other moderators of EUS include technical complexity (*i.e.*, technical complexity of the EMR) and task interdependence (*i.e.*, need for communication and coordination between team members), which Sharma and Yetton [7] found to serve a contingent function in the effect of training on implementation success. Similarly, in the EMR-EUS model, as technical complexity and task interdependence increase, the effect of facilitating conditions on EMR use increases. As technical complexity and task interdependency decreases, the effect of facilitating conditions on EMR use also decreases. Technical complexity and task interdependence can be measured using the scales developed by Sharma and Yetton [7].

3.8. Key Outcome: EMR Use Behaviour

In this model, EMR use behaviour is the actual use of the EMR (*i.e.*, overall use of EMR features). It is directly affected by facilitating conditions and behavioural intention to use the EMR. EMR use behaviour can be measured using objective system logs or self-report measures [10] in this model.

3.9. Other Constructs of the EMR-EUS Model

Originating from the Theory of Reasoned Action, behavioural intention refers to how strongly one intends to perform a specified behaviour. Based on the UTAUT, the EMR-EUS Model has three constructs that are direct determinants of behavioural intention to use technology: (1) performance expectancy, (2) effort expectancy, and (3) social influence. **Performance expectancy** is an individual's belief that system use will help to attain gains in job performance [3]. It is comprised of five constructs from previous theoretical models: perceived usefulness (Technology Acceptance Model), extrinsic motivation (Motivational Model), job-fit (Model of PC Utilization), relative advantage (Innovation Diffusion Theory), and outcome expectations (Social Cognitive Theory). Gender and age moderate the direct effect of performance expectancy on

behavioural intention. **Effort expectancy** is "the degree of ease associated with the use of the system" [3, p. 459], and is derived from perceived ease of use (Technology Acceptance Model), complexity (Model of PC Utilization), and ease of use (Innovation Diffusion Theory). Effort expectancy is mediated by gender, age, and experience. **Social influence** is "the degree to which an individual perceives that important others believe he or she should use the new system" [3, p. 451]. The root constructs of social influence are subjective norm (included in almost all eight theories that form the basis of the UTAUT)), social factors (Model of PC Utilization), and image (Innovation Diffusion Theory). Gender, age, experience, and voluntariness of use moderate social influence.

4. Discussion

This paper contributes a conceptual model for exploring the relationship between EUS and EMR use that is based on existing technology adoption/use theories in the information systems and health informatics literature. This model may be applied by researchers, practitioners, or decision-makers to design EUS interventions and examine their effects on EMR use. Additional research is needed to test this conceptual model to determine if it describes the reality of the relationship between EUS and EMR use. Further research is also required to determine how this model can be evaluated.

References

[1] M. Price, A. Singer, J. Kim, Adopting electronic medical records, *Can Fam Physician* **59** (2003), e322-e329.
[2] N.C. duPont, D. Koeninger, J.D. Guyer, & D. Travers. Selecting an EMR for small physician practices, *NC MD J* **70** (2009), 399-403.
[3] A. Shachak, J. Barnslet, K. Tu, A. Jadad, & L. Lemieux-Charles. Understanding end-user support for HIT, *Inform Prim Care* **19** (2011), 169-172.
[4] C.E. Bredfeldt, E.B. Awad, K. Joseph, & M. Snyder. Training providers: beyond the basics of electronic health records, *BMC Health Serv Res* **13** (2013), 503.
[5] A. Shachak, C. Montgomery, R. Dow, J. *Barnslet*, K. Tu, A.R. Jadad, & L. Lemieux-Charles. End-user support for primary care EMRs, *Health Syst* **2** (2013), 198-212.
[6] V. Venkatesh, M. Morris, G. Davis, & F. Davis. User Acceptance of Information Technology: Toward a Unified View, *MIS Q* **27** (2003), 425-478.
[7] R. Sharma, & P. Yetton. The Contingent Effects of Training, Technical Complexity, and Task Interdependence on Successful Information Systems Implementation, *MIS Q* **31** (2007), 219-238.
[8] V. Venkatesh, T.A. Sykes, & X. Zhang. 'Just what the doctor ordered': a revised UTAUT for EMR system adoption and use by doctors. In *System Sciences (HICSS)*, 2011 44th Hawaii International Conference. IEEE.
[9] M. Wills, O. El-Gayar, & D. Bennett. Examining healthcare professionals' acceptance of electronic medical records using UTAUT, *Issues Inf Syst* **4** (2008), 396-401.
[10] A. Hennington, & B.D. Janz. Information systems and healthcare XVI: physician adoption of electronic medical records: applying the UTAUT model in a healthcare context, *Comm Assoc Inf Syst* **19**, (2007) 5.
[11] R. Munkvold. End-user support usage. *Computing Information Technology: the human side*. Idea Group: Hershey, PA, (2003),146-60.