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INFORMATION SYSTEMS AND HEALTHCARE XVI: PHYSICIAN ADOPTION OF ELECTRONIC MEDICAL RECORDS: APPLYING THE UTAUT MODEL IN A HEALTHCARE CONTEXT

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ABSTRACT

This study applies the Unified Theory of Acceptance and Use of Technology (UTAUT) to the phenomenon of physician adoption of electronic medical records (EMR) technology. UTAUT integrates eight theories of individual acceptance into one comprehensive model designed to assist in understanding what factors either enable or hinder technology adoption and use. As such, it provides a useful lens through which to view what is currently taking place in the healthcare industry regarding EMR adoption. This is mutually beneficial to both the healthcare and MIS communities, as UTAUT offers valuable practical insight to the healthcare industry in explaining why EMR technology has not been more widely adopted as well as what prescriptions may facilitate future adoption, while offering the MIS community the opportunity to strengthen existing theory through an illustration of its application.

Keywords: technology acceptance, healthcare, electronic medical records

I. INTRODUCTION

Of the $20 billion that U.S. healthcare providers spent on information technology in 2001, only $6.5 billion went toward the development and implementation of clinical information systems such as electronic medical records, electronic prescription ordering systems, and automated drug dispensing systems [Burt and Hing 2005]. Almost three-quarters of physicians' offices used information technology (IT) for billing purposes during 2001-2003, but the number incorporating IT into their practices for clinical purposes, such as maintaining patient medical records and ordering prescriptions, was considerably lower. Electronic medical records (EMRs) were used in only 17 percent of physicians' offices during 2001-2003 while electronic prescription ordering capabilities were used only 8 percent of the time [Burt and Hing 2005].

Although as many as 74 percent of physicians have reported using the Internet to search for medical information [Goldsmith et al. 2003], the incorporation of clinical information systems into daily practice is far from common. It is estimated that the healthcare industry is at least ten years behind other industries in terms of IT investment [Skinner 2003]. The low rate of adoption comes despite ITs' increasing ubiquity, decreasing costs, and the potential for benefits in the clinical decision-making process. This is due, in part, to the unique structure of the healthcare industry. Healthcare organizations are different from organizations operating within other business contexts, particularly in terms of operational independence and individual autonomy [Hu et al. 1999]. In most cases physicians are not employees of the healthcare organizations with which they are affiliated. Therefore, it is difficult for administrators to mandate any sort of behavior. In addition, healthcare's payment system does not compensate physicians based upon the quality of the care they provide, and thus does not reward them for investing in systems designed to improve quality of care. This is true even though poor information management is known to cause medical errors [Goldsmith et al. 2003].

Bates [2002] describes the situation thus:

> *Healthcare in the U.S. today is inefficient, error-prone, and of variable quality. Information technology has the potential to substantially improve care by bringing decision support to the point of care, by providing vital links and closing "open loop" systems, and by allowing routine quality measurement to become reality. [p. 7]*

The benefits to be gained from the incorporation of IT into the clinical decision-making process include increased productivity for doctors and nurses, better information for decision making, better product/service customization, higher quality patient outcomes, and better service [Skinner 2003]. If this is in fact true, the low adoption rate of IT in clinical decision making sets up a paradox worthy of investigation.

To date, EMR adoption has received little attention in the management information systems (MIS) literature. The preceding paragraphs detail the practical, "real world" need to facilitate EMR adoption, and the purpose of this study is to bring this phenomenon to the attention of MIS researchers. While MIS theories have been applied within the healthcare context [e.g., Hu et al. 1999; Pouloudi 1999; Kohli and Kettinger 2004], they have not been applied often. As the worth of any theory is enhanced through its application in different contexts, healthcare affords MIS the opportunity to test the limits of its theoretical models of technology acceptance and use to see if they hold within a variety of contexts.

This study applies the Unified Theory of Acceptance and Use of Technology (UTAUT) [Venkatesh et al. 2003] to the phenomenon of physician adoption of EMR technology. User acceptance is one of the most comprehensive streams of MIS research, and UTAUT integrates eight theories of individual acceptance into one comprehensive model. As such, it provides a useful lens through which to view what is currently taking place in the healthcare industry regarding EMR adoption. There is a wealth of existing EMR research in the medical and medical informatics literature, most of which is descriptive in nature. These studies offer rich contextual analyses of the factors both contributing to and acting as barriers to EMR adoption. By turning our attention to the EMR adoption phenomenon, MIS researchers can aid the medical community by providing theoretical foundations that can help in the explanation and prediction of EMR adoption. Its application is thus mutually beneficial to the healthcare and MIS communities, as it offers valuable practical insight to the former while offering the opportunity to strengthen existing theory for the latter.

II. THE UTAUT MODEL

Venkatesh et al.'s [2003] UTAUT model draws upon and integrates eight previously developed models and/or theories that relate to technology acceptance and use. Theoretical underpinnings include the Theory of Reasoned Action [Fishbein and Ajzen 1975], Technology Acceptance Model [Davis 1989], Motivational Model [Davis et al. 1992], Theory of Planned Behavior [Ajzen 1991], a combination of Technology Acceptance and Theory of Planned Behavior models [Taylor and Todd 1995a], Model of PC Utilization [Thompson et al. 1991], Innovation Diffusion Theory [Rogers 1995; Moore and Benbasat 1991], and Social Cognitive Theory [Compeau and Higgins

1995a; Compeau and Higgins 1995b]. Figure 1 shows the UTAUT model. The core constructs asserted to impact behavioral intention to use technology are performance expectancy, effort expectancy, and social influence. Facilitating conditions are asserted to impact directly on use behavior.

Performance expectancy is defined as “the degree to which an individual believes that using the system will help him or her to attain gains in job performance” [Venkatesh et al., 2003 p. 447]. The root constructs for this construct are perceived usefulness, extrinsic motivation, job-fit, relative advantage, and outcome expectations. Perceived usefulness is derived from the Technology Acceptance Model [Davis 1989; Davis et al. 1989] and is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” [Venkatesh et al., p. 448]. Extrinsic motivation is derived from the Motivational Model [Davis et al. 1992] and is defined as “the perception that users will want to perform an activity because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions” [Venkatesh et al. p. 448]. Job-fit is derived from the Model of PC Utilization [Thompson et al. 1991], and is defined as “how the capabilities of a system enhance an individual’s job performance” [Venkatesh et al. p. 448]. Relative advantage is derived from Innovation Diffusion Theory [Moore and Benbasat 1991; Rodgers 2003], and is defined as “the degree to which an innovation is perceived as being better than its precursor” [Venkatesh et al. p. 448]. Outcome expectations are derived from Social Cognitive Theory [Compeau and Higgins 1995; Compeau et al. 1999]. They are differentiated into performance and personal outcomes, in which performance outcomes deal specifically with job-related outcomes whereas personal outcomes address individual esteem and sense of accomplishment. The full UTAUT model suggests that gender and age moderate the relationship between performance expectancy and behavioral intention, although those moderating effects are beyond the scope of this paper.

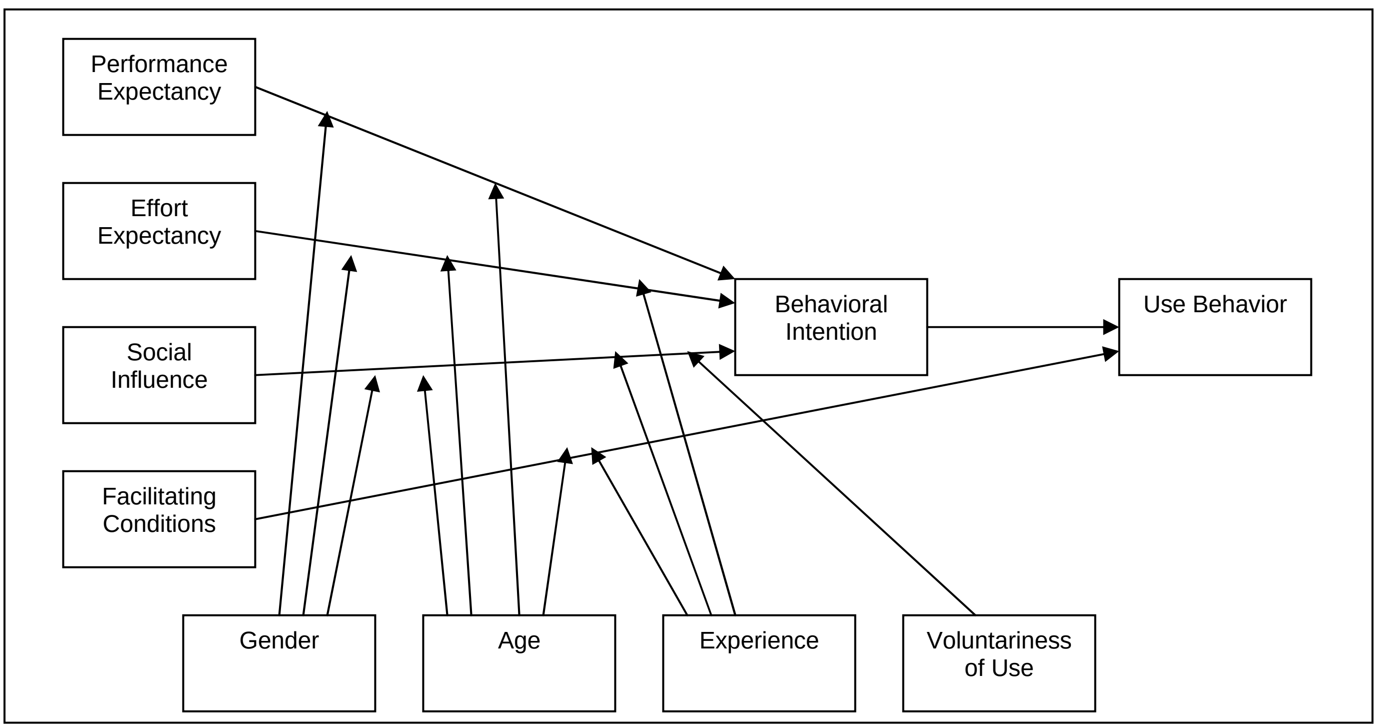


Figure 1. The UTAUT Model [Venkatesh et al. 2003]

Effort expectancy is defined as the “degree of ease associated with the use of the system” [Venkatesh et al. 2003, p. 450]. Its root constructs are perceived ease of use, complexity and ease of use. Perceived ease of use is derived from the Technology Acceptance Model [Davis

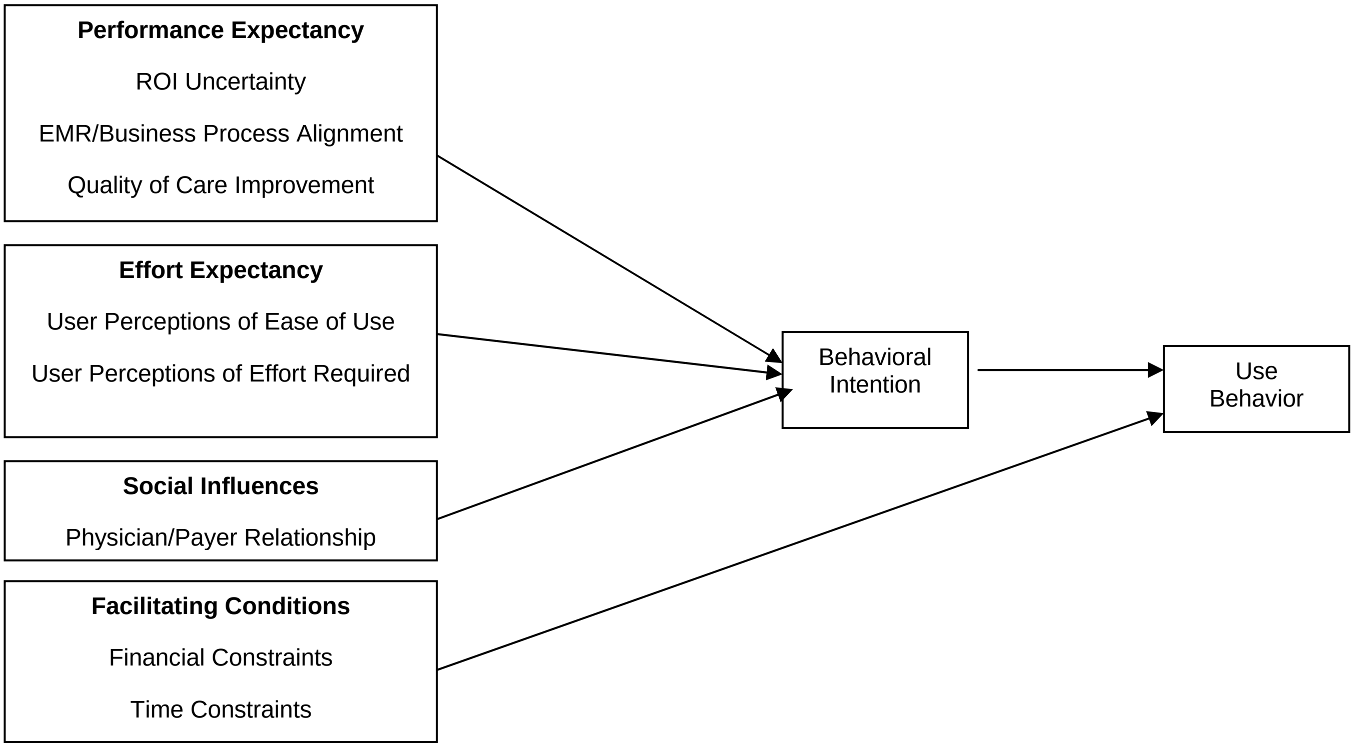
1989; Davis et al. 1989], and is defined as “the degree to which a person believes that using a particular system would be free of effort” [Venkatesh et al., p. 451]. Complexity is derived from the Model of PC Utilization [Thompson et al. 1991], and is defined as “the degree to which an innovation is perceived as relatively difficult to understand and use” [Venkatesh et al., p.451]. Ease of use is derived from Innovation Diffusion Theory [Moore and Benbasat 1991], and is defined as “the degree to which an innovation is perceived as being difficult to use” [Venkatesh et al., p. 451]. The full UTAUT model suggests that gender, age, and experience moderate the relationship between effort expectancy and behavioral intention.

Social influence is defined as “the degree to which an individual perceives that important others believe he or she should use the new system” [Venkatesh et al. 2003, p. 451]. Its root constructs include subjective norm, social factors and image. Subjective norm is included in almost all of the theories upon which UTAUT is built [Ajzen, 1991; Davis et al. 1989; Fishbein and Azjen 1975; Mathieson 1991; Taylor and Todd 1995a, 1995b], and is defined as “the person’s perception that most people who are important to him think he should or should not perform the behavior in question” [Venkatesh et al. 2003, p. 452]. Social factors are drawn from the Model of PC Utilization [Thompson et al 1991], and are defined as “the individual’s internalization of the reference group’s subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations” [Venkatesh et al. 2003, p. 452]. Image comes from Innovation Diffusion Theory [Rogers 1995; Moore and Benbasat 1991], and is defined as “the degree to which use of an innovation is perceived to enhance one’s image or status in one’s social system” [Venkatesh et al., p. 452]. Gender, age, experience and voluntariness are suggested to moderate the relationship between social influence and behavioral intention in the UTAUT model.

Facilitating conditions are the variables asserted to have a direct impact on system usage. They are defined as “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system” [Venkatesh et al. 2003, p. 453]. Root constructs for this facet of the UTAUT model include perceived behavioral control, facilitating conditions, and compatibility. Perceived behavioral control’s definition is adapted from the Theory of Reasoned Action/Theory of Planned Behavior [Ajzen 1991; Taylor and Todd 1995a, 1995b]. It “reflects perceptions of internal and external constraints on behavior and encompasses self-efficacy, resource facilitating conditions, and technology facilitating conditions” [Venkatesh et al., p.454]. Facilitating conditions are derived from the Model of PC Utilization [Thompson et al. 1991]. They are “objective factors in the environment that observers agree make an act easy to do, including the provision of computer support” [Venkatesh et al., p.454]. Compatibility is derived from Innovation Diffusion Theory [Moore and Benbasat 1991; Rogers 1995] and is defined as “the degree to which an innovation is perceived as being consistent with existing values, needs, and experiences of potential adopters” [Venkatesh et al., p.454]. Age and experience are asserted to moderate this relationship in the UTAUT model.

Behavioral intention is asserted to have a direct impact upon individuals’ actual use of a given technology. This construct originates in the Theory of Reasoned Action (TRA) [Fishbein and Ajzen 1975] and is defined as “a measure of the strength of one’s intention to perform a specified behavior” [Davis et al. 1989, p. 984]. Davis [1986] introduced the behavioral intention construct to the MIS discipline via his Technology Acceptance Model (TAM), an adaptation of TRA designed specifically for the information systems context. Davis retained TRA’s operationalization of behavioral intention in TAM. Although no definition of behavioral intention was provided by Venkatesh et al. [2003] in their development of the UTAUT model, they do say that they measured behavioral intention using items adapted from Davis et al. [1989] that have been “extensively used in much of the previous individual acceptance research” [Venkatesh et al. 2003, p. 438]. These items are consistent with the original TRA definition of behavioral intention.

Use behavior can also be traced back to TRA. In developing TAM, Davis et al. [1989] surmised that the generality of TRA to explain a wide array of human behaviors “should therefore be appropriate for studying the determinants of computer usage behavior as a special case” [p. 983]. Like behavioral intention, use behavior was not explicitly defined in the development of the



Proposition 1: A physician's perception of the likelihood of reaping a return on EMR investment is related to his or her behavioral intention to adopt the technology.

Proposition 2: A physician's perception of how EMRs will integrate with existing business processes is related to his or her behavioral intention to adopt the technology.

Proposition 3: A physician's perception of EMRs' potential to improve quality of care is related to his or her behavioral intention to adopt the technology.

Proposition 4: A physician's perception of the ease of use of a given EMR is related to his or her behavioral intention to adopt the technology.

Proposition 5: A physician's perception of the degree of effort associated with changing workflows to accommodate EMR adoption is related to his or her behavioral intention to adopt the technology.

Proposition 6: A physician's perception that payers are going to mandate EMR adoption is positively related to his or her behavioral intention to adopt the technology.

Proposition 7: A physician's perception that payers will use the information contained in EMRs as a means of denying payment will negatively impact his or her behavioral intention to adopt the technology.

Proposition 8: Financial resource constraints act as a facilitating condition that directly impact actual usage of EMR technology.

Proposition 9: Time constraints act as a facilitating condition that directly impact actual usage of EMR technology.

Figure 2. A Synthesized View of How EMR Adoption Issues Fit into the UTAUT Model

UTAUT model, although it was measured via system logs. While Davis et al. [1989] used a self-report measure to assess use behavior, they said their approach was a means of operationalizing use behavior in an instance where "objective usage logs" were not available. Thus, the use of system logs by Venkatesh et al [2003] is both consistent with and is the seemingly preferred method of measuring use behavior in information systems research.

III. APPLYING UTAUT IN A HEALTHCARE CONTEXT

One of the implications drawn from Venkatesh et al.'s [2003] UTAUT study was the importance of analyzing contextual factors when developing implementation strategies. The medical informatics literature contains a large body of research pertaining to EMR adoption and use. Much of this work is descriptive in nature; however, it lacks theoretical underpinnings that might offer some explanation of the current low rates of EMR adoption. For this study, we reviewed this literature – focusing primarily on publications from 2000 to the present – to identify the most commonly discussed barriers to EMR adoption and analyze them within the UTAUT framework. We identified seven barriers – the uncertainty of financial return on EMR investment, misalignment of EMRs with existing business processes, the relationship between EMRs and improved quality of care, increased effort on the part of EMR users, the physician/payer relationship, financial resource constraints, and time constraints. While this is not an exhaustive list of issues, we found these factors to be among the most widely acknowledged issues related to EMR adoption, and are illustrative of the challenges faced by physicians in EMR adoption. In the following paragraphs, we will discuss these themes within the context of the UTAUT constructs in which we categorized them and offer several research propositions designed to guide future research. Figure 2 shows our conceptual mapping and outlines our research propositions.

PERFORMANCE EXPECTANCY

Physicians' performance expectancy is shaped by their belief that EMR usage improves job performance and is superior to traditional paper-based record keeping (relative advantage). Our review of the literature revealed three performance-based themes that we propose to be related to physicians' behavioral intention to adopt EMR systems – financial performance, business process alignment, and improvement in the quality of care provided.

ROI Uncertainty

From a financial perspective, there are two broad questions that physicians must ask when considering EMR adoption: 1) What is the likelihood of seeing a positive return on the investment? 2) Are there financial means available to purchase and maintain the system? We assert that these two questions tap different UTAUT constructs. The former question pertains to physicians' performance expectancy, whereas the second addresses whether or not facilitating conditions exist. We will discuss the issues pertaining to performance expectancy in this section and reserve our discussion of financial resource constraints for the section devoted to facilitating conditions.

In order to gain a better understanding of the financial barriers to adoption, it is necessary to understand how physicians are compensated. The majority of income received by a medical practice comes via contracted agreements with private insurers and/or government healthcare agencies. Two of the most common payment methods used by payers are fee-for-service and capitation. Fee-for-service is a *retrospective* form of compensation in which physicians are only compensated for the services provided. Capitation is a *prospective* form of payment in which physicians are paid a lump sum based upon the number of patients they treat per a given time period.

In actual practice, most payers use a blended combination of retrospective and prospective payments to physicians [Robinson 2001]. While capitation was the predominant model under managed care in the 1990s, the current trend is away from capitation and toward fee-for-service models that pushes more financial risk to patients through "patient cost-sharing approaches, such as differential co-payments, high deductible options, and health savings accounts" [Wang et al. 2003, p. 402]. The conceptual simplicity of fee-for-service and capitation models is appealing, because most physicians contract with numerous payers, with no guarantee of consistency of payment methods across contracts [Robinson 2001]. From an EMR adoption standpoint, neither fee-for-service nor capitation, nor any blended combination thereof, directly encourages EMR adoption.

Physicians' performance expectancy is shaped to some extent by their perceptions of how EMR adoption will impact their bottom line. The literature suggests that the financial return on such systems is uncertain [Miller and Sim 2004]. Wang et al. [2003] found that the net benefit of using EMRs in a primary care setting for a five-year period was $86,400 per physician[1]. They found their model to be sensitive to a physician's mix of capitation vs. fee-for-service patients, with those physicians seeing a higher proportion of capitated patients reaping larger benefits. For physicians seeing a high quantity of fee-for-service patients, the savings accrued from EMR usage were more likely to pass on to the payer. Indeed, the cost savings associated with EMR implementation disproportionately accrue to payers (e.g., private insurance companies, government healthcare agencies), rather than the physicians implementing them [Bria 2006; Taylor et al. 2005; Berner et al. 2005]. Hillestead et al. [2005] estimated that wide use of interoperable EMRs could allow Medicare to save $23 billion per year while private insurance companies could save $31 billion. They also acknowledge that physicians have little incentive to adopt EMRs because "their investment typically translates into revenue losses for them and healthcare spending savings for payers" [p. 1008].

In hospital settings, the savings associated with the use of healthcare information technology come from "reducing hospital lengths of stay, nurses' administrative time, drug usage in hospitals, and drug and radiology use in the outpatient setting" [Hillstead et al. 2005, p. 1107]. When considering the cost savings that accrue to hospitals, however, it is important to note that, while hospitals' cost savings are contingent upon physicians using the systems, the savings do not accrue to the physicians.

Given that financial performance is one means of gauging job performance, we assert that physician' expectations regarding the financial impact of EMR investment will affect their adoption decision. Thus:

> **Proposition 1: A physician's perception of the likelihood of reaping a return on EMR investment is related to his or her behavioral intention to adopt the technology.**

EMR/Business Process Alignment

One of the often-cited barriers to EMR adoption is the misalignment of EMR processes with existing work processes. This leads to frustration on the part of physicians, staff, and patients as everyone tries to cope with the new system. In addition, fear that EMR implementation will result in a long-term slowdown in workflow serves as another barrier [McIntyre 2004; Bates et al. 2003a]. While some argue that the value to be derived from healthcare IT investments will only come through clinical process redesign [Skinner 2003], the majority of the literature indicates that physician concerns surrounding EMR adoption center more on integrating EMRs into existing clinical processes than on the need to fundamentally alter those processes. We suggest here that a physician's perception of how EMRs will incorporate with existing work processes is one component of their performance expectancy.

Much of the conflict between EMRs and existing work processes stems from EMR system designs that assume clinical treatment occurs in a strictly linear fashion. Bria [2006] cited EMR designers' poor understanding of clinical workflows as one reason for low EMR adoption rates among chest physicians, noting system designers' failure to recognize the role of group interaction in the clinical process. Johnson and FitzHenry [2006] found that the interrelated, nonlinear nature of the workflow between doctors, nurses, and other clinicians required a development team to fundamentally alter its original design of an electronic prescribing application prototype. Ash et al. [2004], noted that existing EMR systems are not suited for use in

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[1] These benefits came from better use of radiology tests, reductions in medication spending, the better capture of billable charges and a reduction in the amount of billing errors.

the highly interruptive healthcare context, and that this misalignment can lead to errors in both entering and retrieving information.

In one case study example, Baron et al. [2005] illustrated the process-related difficulties encountered by physicians in a small group practice:

> *A well-run primary care office is a complex interdependent operation with well-defined work flows. Responding to a request for a prescription refill, for example, requires 3 or 4 people performing interrelated but distinct tasks to deliver it safely, reliably, and promptly; we average 30 to 40 such requests daily. The collective integrated operation of our office represents 15 years of weekly and monthly staff meetings that constructed our functional systems piece by piece over time. On 14 July 2004, we had to redesign every office system we had in place. Our commitment to "going live" would mean that documentation of clinical care on or after that date would be created and found in the electronic health record seemed simple, but "clinical care" included not only office visits but telephone calls, prescription refills, handling of laboratory results, and other functions. Each of these tasks had a work flow, and all work flows had to be redesigned more or less simultaneously.* [p. 223]

When information technology is not aligned with business processes in healthcare, the results can be hazardous to patients' health. Koppel et al. [2005] found that a computerized physician order entry system in use at a large North American hospital actually *facilitated* 22 types of medication error risks. While a number of the risks identified dealt with information errors generated by the system, the majority of the risks were attributed to the misalignment of the rules imposed by the system and organizational or individual behaviors. Based upon their assessment, the physicians who authored the study recommended that future information systems implementations focus first on understanding how work is organized rather than on the technology.

Given that performance expectancy is fundamentally about an information system's ability to enhance job performance, we assert that physician perceptions of whether or not EMRs will disrupt existing processes, and thus worsen their performance, will have an impact upon their adoption decision. Thus:

> **Proposition 2: A physician's perception of how EMRs will integrate with existing business processes is related to his or her behavioral intention to adopt the technology.**

Quality of Care Improvement

Another common theme found in the medical literature is EMR systems' potential to improve the end product: the quality of healthcare provided. This theme includes discussions of the relative advantage of EMRs over paper-based records, as well as the potential for EMRs to include quality-related decision support tools that exceed what can be achieved via manual methods. It also includes several existing studies that surveyed physicians' perceptions of EMR systems' ability to improve quality of care. Taken together, this body of work is instrumental in shaping our view that quality improvement comprises a part of physicians' performance expectancy.

Ortiz et al. [2002] argued that the current state of healthcare does not offer sufficient quality of care:

> *The overwhelming amount of medical information, coupled with the rapid growth of new pharmacotherapies and technologies, increasing time constraints placed on providers, mounting pressures to reduce costs, and suboptimal systems for delivering care, make it virtually impossible for individual clinicians to provide high-quality, error-free care on a consistent basis.* [p. S3]

There are many advocates of the use of clinical information systems as a means of improving healthcare quality [e.g., Bates et al. 2001; Bates 2002; Bates et al. 2003a; Bates et al. 2003b; Fernandopulle et al. 2003; McIntyre 2004]. The U.S. Federal Government's Agency for Healthcare Research and Quality has been funding projects related to the computerization of healthcare for over 30 years [Fitzmaurice et al. 2002], and the Veteran's Administration's quality improvement efforts have long included the use of clinical information systems [Hynes et al. 2004; McQueen et al. 2004]. Some argue that EMRs will play an important role in improving both preventative medicine and chronic disease management [Hersh 1995; Hillestad et al. 2005], while others suggest that the computerization of medical information will improve clinical research, resulting in long-term benefits [Hersh 1995; McDonald 1997; Murray et al., 2003; Lenhart et al. 2000; McQueen et al. 2004]. By allowing for the analysis of clinical data, EMRs can improve the quality of care by allowing physicians to look for trends and analyze treatment outcomes [McIntyre 2004, p. 244].

It is also thought that EMRs can help reduce medical errors. Ortiz et al. [2002] cited a 1998 Institute of Medicine report that estimated the number of people in U.S. hospitals who die each year from medical errors as somewhere between 44,000 and 98,000 – an estimate that places medical errors ahead of motor vehicle accidents, AIDS, and breast cancer as a cause of death. Bates et al. [2001, 2003b] advocate the integration of clinical decision support tools into EMRs as a means of improving quality of care. "We believe that decision support delivered using information systems, ideally with the electronic medical record as the platform, will finally provide decision makers with tools making it possible to achieve large gains in performance, narrow gaps between knowledge and practice, and improve safety" [Bates et al., 2003b, p. 523].

Most EMRs offer a basic level of decision support via clinical reminders. Some EMRs also include a decision support component containing clinical guidelines based upon evidence-based medicine (treatment recommendations based upon the most recent scientific research). The impact of clinical guidelines on quality of care is a source of much research [e.g., Mikulich et al. 2001; Maviglia et al. 2003; Bates 2002], and while the use of these guidelines is often associated with quality improvements, many researchers note the gap between the existence of evidence-based medicine and its actual use in clinical practice [Bates 2002; Bates et al. 2003b; Feifer et al. 2006].

Computerization advocates also note the relative advantages of EMR systems over traditional, paper-based documentation. The limitations of paper records include limited access (they can only be reviewed in one place at one time), illegibility, disorganization, incompleteness, unwieldiness, and lack of security [Bates et al. 2003a; Hersh, 1995; Major et al. 2003]. While there are limitations associated with paper record-keeping, it is unclear that these limitations translate into a perception of relative advantage among doctors [Loomis et al. 2002, p. 636].

EMRs may also introduce new challenges for physicians in terms of information overload. Berner and Moss [2005] proposed that the volume of information that becomes available through the use of EMRs might pose a quality problem:

> *We assume that decision making with more complete information will be better, but simply having the information available will not guarantee that it is properly used, and too much information could potentially confuse rather than enlighten. [p. 615]*

The results of studies assessing physicians' perceptions that EMRs improve quality of care are mixed. Some indicate that physicians' perceive quality can be improved via the use of healthcare information systems [Nielsen et al. 2000; Overhage et al. 2001; Leung et al. 2003]. However, other studies found evidence to the contrary [Likourezos et al. 2004; Loomis et al. 2002; Koppel et al. 2005; McDonald 2006; Ash et al. 2004]. Further, clinical information systems have been found to evoke negative emotional responses from physicians [Sittig et al. 2005; Ash et al. 2004].

Perhaps most important to the present discussion of EMR adoption is the finding that physicians' perceptions differ based upon whether they are adopters or non-adopters of the technology.

Loomis et al. [2002] surveyed the active members of the Indiana Academy of Family Physicians and found that EMR nonusers (85.6 percent of the 1328 respondents) were significantly less likely than EMR users to believe that current EMRs were useful to physicians or that EMRs improved record quality and decreased the number of medical errors. The same study found that nonusers were much less likely than users (54.3 percent to 78.4 percent respectively) to believe that EMR use would improve quality of care in the U.S.

Insofar as physicians perceive that EMRs will have an impact upon the quality of care they provide their patients, this perception will help shape their performance expectancy. Thus we propose:

> **Proposition 3: A physician's perception of EMRs' potential to improve quality of care is related to his or her behavioral intention to adopt the technology.**

EFFORT EXPECTANCY

A physician's effort expectancy is shaped by his or her perceptions of the ease of use associated with a system. We suggest that physicians' effort expectancy is shaped not only by the ease of use of the EMR, but also by the effort required to incorporate EMRs into existing work processes.

EMR User Perceptions of Ease of Use

Calls for better usability are often seen in the literature. McIntyre [2004] suggested the use of a template format that would allow orthopedic physicians to easily generate medical notes. Clemmer [2004] cites ease of use as one of the most important design elements for facilitating the incorporation of decision support tools into EMRs.

> *One of the most important features for clinicians is speed and ease of use. Any time a screen takes more than 2 seconds to appear the clinician deems it unacceptable. If they have to page through more than 2 to 3 screens to get what they want they turn away. If the system is not intuitive they will not take the time to learn it. Of all the acceptance issues these are probably the key ones.* [Clemmer, 2004, p. 203].

Current research suggests that physicians do not perceive EMRs to be easy to use. Loomis et al. [2002] found that nonusers of EMRs were significantly less likely than users to believe that data entry using EMRs was easy. Iakovidis [1998] details EMR usability problems that include speed of data retrieval, non-intuitive data input, slow login time, an inability to interact with the system while at home or moving through the hospital. In our own research in hospitals, we have observed or heard complaints relating to each of these problems. Furthermore, in personal interviews with hospital staff, we have repeatedly heard of misalignments between how a system expects data to be entered and how the healthcare professional needs to enter it. Lærum et al. [2003] found that 22-25 percent of physicians practicing in a Norwegian hospital found the retrieval of patient information via an EMR to be more difficult than it was previously. Saleem et al. [2005] found poor usability to be one of the barriers to the use of clinical reminders. Given this research, we propose:

> **Proposition 4: A physician's perception of the ease of use of a given EMR is related to his or her behavioral intention to adopt the technology.**

EMR User Perceptions of Effort Required

EMRs are complex systems that require extensive training for physicians and their staff. This is in addition to the previously discussed workflow redesign necessary to properly integrate the system. Additional data entry and file management responsibilities placed on physicians by the use of EMRs might negatively impact physicians' perceptions regarding the amount of effort required to use the system. Unless better input interfaces are developed, these process changes will reflect a permanent increase in effort on the part of physicians [Baron et al. 2005]. Given the level of effort required to both use an EMR and incorporate it into existing workflow, we submit:

> **Proposition 5: A physician's perception of the degree of effort associated with changing workflows to accommodate EMR adoption is related to his or her behavioral intention to adopt the technology.**

SOCIAL INFLUENCE

Venkatesh et al. [2003] offered the following description of social influence's impact on behavioral intention:

> *Social influence has an impact on individual behavior through three mechanisms: compliance, internalization, and identification*[2] *(see Venkatesh and Davis 2000; Warshaw 1980) . . . Prior research suggests that individuals are more likely to comply with others' expectations when those referent others have the ability to reward or punish nonbehavior (e.g., French and Raven 1959; Warshaw 1980). This view of compliance is consistent with results in the technology acceptance literature indicating that reliance on others' opinions was significant only in* mandatory *settings (Hartwick and Barki 1994). . .* [Venkatesh et al. 2003, pp. 452-453]

Physician/Payer Relationship

Given the nature of the relationship between physicians and payers, it is possible to conceptualize payers as the "important others" who have the ability to reward and punish physicians via payment or nonpayment. Thus, payers are in a position to exert social influences over physicians.

As was discussed in the quality improvement section, it is widely thought that EMRs will play a strong role in improving healthcare quality. Indeed, there are many who offer discussion regarding whether current physician payment systems should be abandoned altogether and replaced with a performance-based system based on quality measures [Baron et al. 2005; Davis et al. 2005; McLoughlin and Leatherman 2003; Miller and Sim 2004]. EMRs are often cited as an important means of capturing the data necessary to assess quality of care [Bates 2002, Skinner 2003], which might actually lead to lower rates of adoption among physicians. There are concerns related to the ability to capture meaningful quality data and how such data will be used by payers.

These concerns also apply to the use of clinical guidelines. In spirit, clinical guidelines are meant to aid clinicians in their encounters with individual patients so they can discuss the best treatment options; however, the fear is that EMRs containing clinical guidelines might be misused by payers as a means of monitoring and withholding payment to physicians based upon their non-compliance with the recommended treatment, regardless of the specifics of an individual case [Bates et al. 2003b].

Browman [2000] cited tensions between various stakeholder groups as to how guidelines should be used as one of the challenges involved in the use of clinical guidelines in the twenty-first century. He encouraged payers to avoid the use of disincentives, such as withholding payment for services rendered when a physician does not adhere to clinical guidelines, stating ". . . clinical

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[2] The three processes of attitude change discussed by Venkatesh et al. [2003] (compliance, internalization, and identification) can be traced back to Kelman's [1958, 1961] work.

practice guidelines are intended to inform clinical judgments, not replace them" [p. 964]. He argued that this "guilty until proven innocent" approach to the application of evidence-based medicine can serve as a disincentive for physicians to adopt EMRs. Research exists that suggests social influences exerted on physicians by payers impact physicians' intention to adopt EMR technology. Despite fears as to how the information will be used, some physicians have already adopted EMRs in anticipation of future mandates [Baron et al. 2005].

Taken altogether we believe that payers have the authority to mandate physician adoption of EMRs and thus facilitate adoption. However, we also appreciate that some physicians might be leery of payers' motives in mandating adoption such that it would make them resistant to adopt the technology. Stated formally:

> **Proposition 6: A physician's perception that payers are going to mandate EMR adoption is positively related to his or her behavioral intention to adopt the technology.**

> **Proposition 7: A physician's perception that payers will use the information contained in EMRs as a means of denying payment will negatively impact his or her behavioral intention to adopt the technology.**

FACILITATING CONDITIONS

Should a physician intend to adopt an EMR system for his/her practice, the existence of facilitating conditions would contribute to his or her actual usage of the technology. Venkatesh et al.'s [2003] definition of facilitating conditions encompasses individuals' beliefs regarding the existence of both "an organizational and technical infrastructure" that would support actual usage. In performing our literature review, we found that time and financial resource constraints were commonly mentioned as barriers to EMR adoption and usage. We propose that these two resource constraints are part of the facilitating conditions that impact directly upon EMR usage.

Financial Constraints

Even if physicians do intend to adopt EMRs, they may not be capable of doing so because of monetary constraints. The high cost of EMR adoption is often cited as a barrier to adoption [e.g., Bria 2006; Leung et al. 2003; McIntyre 2004; Miller and Sim 2004; van Ginneken 2002]. Only 16 percent of physicians are salaried employees of private hospitals [Bureau of Labor Statistics 2006]; most physicians operate in either individual or group private practices. The ability of a practice to afford the initial EMR investment, in addition to the necessary ongoing maintenance costs, is in large part a function of the size of the practice. A 2004 survey by the Commonwealth Fund showed that physicians practicing in large practices were over seven times more likely to work in offices using EMRs than physicians practicing alone [Conn 2005]. Bates [2002] cited the lack of financial incentives as one of the most problematic barriers to the adoption of quality-related IT within the healthcare context. Initial implementation costs are high and include the purchasing and/or upgrading of hardware, buying new software, training staff, and scanning or manually entering data to get paper medical records into an electronic format [Swartz 2004].

At present, it appears that there is a disparity between what physicians can afford and the actual cost of EMRs. Loomis et al. [2002] surveyed physicians and found that approximately 75 percent of the nonusers of EMRs thought an affordable initial cost for an EMR fell between $1000 and $9999. The actual cost, however, is far greater. Fiscella and Geiger [2006, p. 407] offer the following estimate for the initial costs of EMR adoption:

> *Start-up expenses for [EMRs] in small practices average $44,000 per full-time provider. However, these cost estimates do not account for providers' working longer hours during the implementation phase [Miller et al. 2005]. Charting time could increase by 50 percent*

> *during early phases, which would mean that fewer patients could be seen per hour [Keshavjee 2001]. . .Thus initial start-up costs could be closer to $64,000 per provider. [Miller et al. 2005]*

Given these figures, there would appear to be a large disconnect between the actual costs of EMRs and what physicians believe to be doable. How much they know about actual implementation costs prior to beginning the adoption process is not known. It may be that many physicians only realize that they lack sufficient monetary resources to adopt and use EMRs once they begin gathering information specific to their implementation.

Iakovadis [1998] attributes the higher rate of EMR usage in primary care in Europe to government reimbursement schemes that subsidize physicians' purchase of the hardware and software necessary for implementation. It is commonly thought that payers' financial incentives will have to be altered in order to facilitate EMR adoption. Some have called for government policy to facilitate widespread diffusion of EMRs [Hillstead et al. 2003; Bates at al. 2003a; Taylor et al. 2005; Fiscella and Geiger 2006]. Potential financial incentives for EMR adoption include grants, tax credits, low interest loans, or payment scales that recognize whether or not a practice uses healthcare IT [Bates 2002].

> **Proposition 8: Financial resource constraints act as a facilitating condition that directly impact actual usage of EMR technology.**

Time Constraints

Time is another often cited reason for the low rate of IT adoption [e.g., Hersh 1995; Bria 2006; Leung et al. 2003; McIntyre 2004; Bar-Lev and Harrison 2006]. The time it takes for a physician to learn how to use the system during the course of performing daily tasks is one of the major impediments to the adoption of EMRs [Miller and Sim 2004]. Even well-designed EMR systems impact physicians' time and workload demands. McIntyre [2004] asserted that the time required to enter information into EMR systems is one of the greatest challenges to EMR adoption. Miller and Sim [2004] reported that "most physicians using EMRs spent more time per patient for a period of months or even years after EMR implementation" [p.120] Makoul et al. [2001] found that it took physicians using an EMR an average of 37.5 percent longer to get through a patient's initial visit (the one requiring the most data entry) than a group of control physicians using paper-based records. Poissant et al. [2005] reviewed several time efficiency studies and concluded that the ". . . goal of decreased documentation time in an [EMR] project is not likely to be realized" [p. 505].

While no literature was found that reported the EMRs required less time to use than paper records or decreased physician workload, some studies indicated that EMRs did not necessarily require more time. Overhage et al. [2001] found that the implementation of a computerized order entry system improved workflow in an ambulatory primary care internal medicine practice while not requiring substantially more time per patient. While physicians did spend more time per patient overall, the increase was negligible once administrative and duplicative tasks were accounted for. In the clinical trial of an online EMR, Earnest et al. [2004] found that, although physicians anticipated that use of the system (and patient's access to it) would increase their workload and result in adverse consequences, this did not turn out to be the case.

> **Proposition 9: Time constraints act as a facilitating condition that directly impact actual usage of EMR technology.**

IV. DISCUSSION: AN OVERALL VIEW OF EMRS AND THE UTAUT MODEL

Thus far, we have offered no discussion of the UTAUT model's moderating variables. This is not due to oversight, but rather to the dearth of research found relating these variables to EMR adoption and usage. The following paragraphs detail the studies found to capture gender, age, and experience data. No studies were found that measured voluntariness of use.

In their analysis of the barriers and incentives to computerizing in Hong Kong, Leung et al. [2003] did not find significant differences in physicians' responses based upon gender, work experience, or type of medical specialty. O'Connell et al. [2004] captured demographic information including medical specialty, gender, computer sophistication, and computer optimism. Of those variables, they found only medical specialty to be a significant predictor of EMR satisfaction. They did not find any correlation between gender and level of computer sophistication. Likourezos et al. [2004] did not find that computer experience correlated with EMR satisfaction for emergency department physicians and nurses. Loomis et al. [2002] found, however, that there were differences between EMR users (those with experience) and nonusers (those lacking experience). They found: "A chasm exists between EMR users and nonusers regarding issues that affect EMR implementation, including necessity, usefulness, data entry, cost, security, and confidentiality" [Loomis et al., 2002, p. 636].

Johnson et al. [2004] conducted a survey of clinical working group members of the American Medical Informatics Association in order to determine what features of computer-based documentation might be improved in next-generation systems. They collected demographic information including medical specialty, gender, age, and computer skill level. While they reported the gender and age demographics of the respondents, there were no tests for differences based upon these characteristics. They did, however, find that medical students reported higher computer skill levels than either primary care physicians or specialists, which speaks to a correlation between age and computer experience.

In discussing the factors that might facilitate EMR adoption, Berner et al. [2005] said, "Another key difference in today's health care environment is the experience of the new crop of health professionals. Future physicians currently in medical school and residency training are very different from their predecessors of even a decade earlier with regard to their comfort with computers" [p.6]. Anecdotally, we have heard similar comments relating to the comfort level that new nurses have with EMR technology when compared with nurses with longer tenure in the field.

Overall, our efforts to map EMR adoption research results against the UTAUT model illustrates that EMR adoption is a phenomenon with the potential to extend theories relating to technology adoption and use. Venkatesh et al. [2003] state:

> *While the variance explained by the UTAUT model is quite high for behavioral research, further work should attempt to identify and test additional boundary conditions of the model in an attempt to provide an even richer understanding of technology adoption and usage behavior. This might take the form of additional theoretically motivated moderating influences, different technologies . . . different user groups . . . and other organizational contexts . . . Results from such studies will have the important benefit of enhancing the overall generalizability of UTAUT and/or extending the existing work to account for additional variance in behavior.* [p. 470]

The conceptual mapping exercise presented here strongly suggests that the EMR adoption phenomenon is a worthy candidate for testing the UTAUT model's "boundary conditions." It is a different kind of information technology being used in a different organizational context than that typically found in MIS research. Conceptualizing EMR adoption issues in terms of the UTAUT model not only serves as an additional test of the model, it also illustrates that there are complex contextual dynamics at work that contribute to all four of the major antecedents of behavioral intention and usage of information technology. This mapping exercise also demonstrates that the UTAUT model is a useful framework for applying and organizing extant literature. As the review presented here illustrates, there is a wealth of descriptive literature related to EMR adoption. The UTAUT model helps to bring order to that body of literature, which is of great benefit to readers interested in learning more on the topic.

The intent of this research is to understand the applicability of the UTAUT model to healthcare by explaining EMR adoption (or the lack thereof) within the theoretical framework. This research contributes to the body of knowledge by providing MIS researchers with a much-needed introduction to the complex, dynamic issues currently impacting EMR adoption. It is hoped that it will benefit readers seeking to familiarize themselves with the important issues surrounding EMR adoption, as well as deepen their theoretical understanding of technology adoption and use in general. The application of the UTAUT model to the literature reviewed here suggests that the dynamics contained in the UTAUT model exist and are relevant to EMR adoption. Based upon this finding, we conclude that this phenomenon is worthy of further empirical research, and suggest that future research efforts directed here would be fruitful.

Studying EMR adoption is also of great practical importance. The healthcare industry lags in terms of information systems adoption. One potential benefit of this lag in adoption is that the healthcare field can now reap the benefits of a cumulative research tradition around technology acceptance/adoption. Applying our technology acceptance knowledge to EMR adoption should generate important prescriptive advice for those interested in overcoming adoption barriers. MIS researchers have an opportunity to contribute to the lowering of both system design and organizational barriers to EMR adoption. While EMRs have great potential to reduce medical errors and improve the overall quality of care provided, the benefits will not be realized unless the challenges associated with adoption can be addressed in a manner that facilitates physician adoption and use of the technology. These challenges include managing physicians' expectations of how EMRs will change their workflow and impact their performance, reducing the resource constraints that inhibit adoption and usage, and developing positive payer incentives that will also foster adoption and usage.

Of course, there are limitations in the work presented here. First and foremost, while we have sought to extend the boundaries of where the UTAUT model apply, we have focused on the unique context of healthcare. While a good case can be made to extend UTAUT here, we caution readers not to generalize to broader contexts without the due diligence required to determine if the model applies. A second limitation of the paper is its conceptual nature, and the lack of personal empirical data to support the model. While future research of these and other researchers will hopefully fill this need, the objective of the paper was to show how other empirical results from the healthcare literature apply, and indeed support the tenets of UTAUT. This application of findings has allowed us to develop researchable propositions for future testing. Finally, while we feel we have conducted a fairly exhaustive review of the technology adoption literature in healthcare, there are no doubt research findings we have overlooked.

V. CONCLUSION

The primary purpose of this paper was to bring the EMR adoption phenomenon to the attention of the MIS research community. The EMR adoption phenomenon offers important opportunities for both theoretical development and practical contributions. The application of the UTAUT model presented here hopefully illustrates one area of MIS research where theory could be extended through its application in the healthcare context; there are no doubt other research areas that would likewise benefit. It is hoped that this work will serve as the impetus for future work in these areas as well as in the healthcare industry.

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> *Editor's Note:* The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that
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