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Extending the Technology Acceptance Model in Healthcare: Identifying the Role of Trust and Shared Information

Sabrina Terrizzi
Economics and Business, Moravian College, Bethlehem, PA, United States., terrizzis@moravian.edu

Susan Sherer
Management, Lehigh University, Bethlehem, PA, United States., sas6@lehigh.edu

Chad Meyerhoefer
Economics, Lehigh University, Bethlehem, PA, United States., chm308@lehigh.edu

Michael Scheinberg
Lehigh Valley Health Network, Allentown, PA, United States., Michael.Sheinberg@lvhn.org

Donald Levick
Lehigh Valley Health Network, Allentown, PA, United States., donald.levick@lvhn.org

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Sabrina Terrizzi
Moravian College
terrizzis@moravian.edu

Susan Sherer
Lehigh University
sas6@lehigh.edu

Chad Meyerhoefer
Lehigh University
chm308@lehigh.edu

Michael Sheinberg
Lehigh Valley Health Network
michael.sheinberg@lvhn.org

Donald Levick
Lehigh Valley Health Network
donald.levick@lvhn.org

ABSTRACT

We propose extensions to the TAM for the adoption of integrated electronic health records that are shared by multiple health care providers. In particular, we propose a conceptual model in which we incorporate two new factors, trust and access to shared information, into the TAM. Preliminary results confirm the statistically significant and positive impact of perceived usefulness on behavioral intent to use integrated electronic health records and a significant and positive impact of perceived ease of use on perceived usefulness. We also find a statistically significant effect of shared information on behavioral intent to use integrated health records. We expect that further analyses of additional data we are collecting will offer improved insights into the effects of these factors on intention to use integrated electronic health records.

Keywords

Electronic health records, TAM, trust, shared information

INTRODUCTION

As the incentives authorized by the American Recovery and Reinvestment Act (P.L. 111-5) accelerate the adoption of electronic health records (EHRs) [Jha, DesRoches, Kralovec and Joshi, 2010], health organizations continue to adopt integrated records shared by multiple care providers. We expect that adoption and use of these integrated record systems will be impacted by availability of shared information and trust of this information by the users.

Healthcare represents a unique industry, with employees (physicians and other healthcare staff) intimately vested in the outcome of their service (patient health). Patient health is a complex outcome that is impacted by services provided by multiple care providers, often in different care settings. Integrated EHRs enable health care physicians and staff to share information between departments and practices within a hospital. Multiple providers have access to each patient's record causing the updating and processing of patient records to become a group responsibility. We believe the extent to which employees will use these systems will be a direct result of their trust in the shared data within them. If the workers do not trust the data, we expect they will find ways to work around the system, leading to inefficiencies and unrealized benefits of implementation.

The TAM has been widely applied to adoption of new technology. Researchers using TAM have found different relationships between its key components, which have often been attributed to cultural differences [Yousafzai, Foxall and Pallister, 2007]. We believe that the healthcare industry may have unique characteristics that impact these relationships. Also, the TAM research has reported different results for mandatory usage. The rollout of a shared electronic health record requires mandatory use of the system if it is to be effective for everyone. This represents a departure from the premise of the standard TAM, which operates differently under varying volitional contexts [Brown, Massey, Montoya-Weiss and Burkman, 2002; Rawstorne, Jayasuriya and Caputi, 2000].

The objective of our research is to extend the TAM in the healthcare environment, particularly for the adoption of integrated health records that require providers to share information. In subsequent sections, we present background on the literature related to the TAM, its use in healthcare, and its application in environments where shared information is critical. We propose an extension to the TAM in the conceptual model section. The data and preliminary analyses follow. This data is

preliminary; we are continuing to gather additional data as the system is adopted. We offer some conclusions and ideas for future research in the final section of the paper.

LITERATURE REVIEW

Modeling Technology Acceptance

The technology acceptance (TAM) model provides a general theoretical foundation for how users accept and use technology [Davis, 1989], highlighting the role of perceived usefulness (PU) and perceived ease of use (PEOU) on attitude (ATT), behavioral intent (BI) and actual system usage. Additional factors that influence these variables have been introduced over time in TAM2 [Venkatesh and Davis, 2000] and the UTAUT model [Venkatash, Moffis, Davis and Davis, 2003]. In addition to these extended theories, many other studies have conducted expanded analyses. In some instances, these studies validate TAM [Pai and Huang, 2011; Melas, Zampetakis, Dimopoulou and Moustakis, 2010; Bhattacherjee and Hikmet, 2007; Venkatesh and Davis, 2000], but in other instances they criticize it for simplicity and lack of contextualization [Holden and Karsh, 2010; Bagozzi, 2007].

Researchers using the TAM have found different relationships between PEOU-BI, PU-BI, and PEOU-PU [Yosafzai et al., 2007]. Some research suggests that PEOU has only an indirect effect on BI through PU [Davis, 1989; Adams, Nelson and Tood, 1992; Chau, 1996; Gefen and Straub, 2000]. Other studies find PEOU to have a direct effect on BI, with a magnitude that is equal to the effect of PU on BI [Adams et al., 1992; Agarwal and Prasad, 1997]. Further studies find PEOU to have a direct effect on BI that is larger than the effect of PU on BI [Chau, 1996; Karahanna and Limayen, 2004]. One proposed explanation for differences in the relationships is the voluntariness of adoption. In a mandatory setting, researchers have found an increased effect of PEOU on BI, and a diminished direct effect of PU on BI. Also, in mandatory contexts [Brown et al. 2002, Venkatash and Davis, 2000] PEOU and PU directly affect ATT, which subsequently influences BI [Brown et al., 2002].

Culture has been found to be a contributing factor to the applicability of the TAM [Yousafzai et al., 2007]. Table 1 provides a brief snapshot of the types of conflicting results across employee groups and countries. The importance of culture suggests that application in the healthcare industry, which has its own unique culture, may require specific contextualization.

Study	Country	Employee Type	Significant Findings	Non-significant Findings
Lowry (2002)	UK	Professional Engineers	PEOU to BI PEOU to PU	PU to PI
Schaik, Bettany-Saltikov and Warren (2002)	UK	Physiotherapists	PU to BI	PEOU to BI
Spitler (1999)	USA	Brokers and Sales Assistants	PEOU to PU	PEOU to BI PU to BI
Benamati and Rajkumar (2002)	USA	Outsourcing Managers	PU to BI PEOU to BI PEOU to PU	

Table 1. Conflicting TAM Findings

Technology Acceptance in Healthcare

In studies analyzing the TAM in the healthcare industry, the inconsistent results identifying the relationship between PEOU and BI still exist. One theory suggests that lack of exposure to IT systems may be consistent with non-significant PEOU-ATT and PEOU-BI relationships, but another suggests employee role could be the influencing factor. Of the seven studies with non-significant relationships, six of them contained only physician samples, further suggesting that different factors influence the behavior among physicians as compared to other healthcare workers [Holden and Karsh, 2010].

More recent studies attempt to identify the external factors influencing PEOU and PU in the healthcare industry. Melas et al. (2010) test external factors influencing participants' attitudes towards the computer information system (CIS), and determine that self-reported measures related to information and communication technology understanding influence PEOU and PU, but do not influence BI. Additionally, Melas et al. (2010) confirm findings that healthcare professionals are more likely to adopt

systems that they perceive to be compatible with their current work processes, and also confirm the predictive pattern of attitude to usage. Walter and Lopez (2008) find that perceived threat to autonomy has a significant negative effect on PU and BI when considering the adoption of both clinical decision support systems (CDSs) and electronic medical records systems (EMRs). Both of these studies validate the use of the TAM in the healthcare industry.

Despite these positive findings and the determination of some external factors applicable in this context, the existing studies have limitations. The findings of Walter and Lopez (2008) consider pre-adopters, so these results cannot be generalized to other phases of IT implementation. Additionally, the analysis considers only office-based practitioners responding to general questions about CISs and EHRs, not specific systems [Walter and Lopez, 2008]. Melas et al. (2010) conduct a similar analyses, in which they survey respondents about general CIS usage and not a specific system. Further, neither of these studies considers the mandatory adoption environment.

Holden and Karsh (2010) identify further limitations of existing studies in this field. Existing studies capture the healthcare fields of telemedicine, picture archiving and communication systems, and computerized provider order entry (CPOE); there is a lack of information related to EMRs and collaborative information systems. Additionally, the existing studies identify PU in a broad context by defining it as follows: leading to the enhancement of gains in job performance. In healthcare, usefulness may also be defined in terms of efficacy, cost reduction, and improved quality and safety of care. Usefulness could also be assessed from the point of view of various people involved in the care process: physicians, specialists, patients, and family members. Current studies are not able to distinguish between these varying aspects of usefulness, but these items may play a particularly important and distinctive role in health IT. In general, the existing studies focus on a limited and generic method of considering the constructs of usefulness, perceived ease of use, and social influence. This could result in missing constructs or important factors influencing user acceptance, and leaves many opportunities for future research in the field [Holden and Karsh, 2010].

Technology Acceptance, Trust, and Shared Information

Because a shared Electronic Health Record (EHR) system involves user reliance on shared information across multiple practices within a hospital, we believe trust will be an important factor influencing BI, through ATT. Trust is a significant factor in the TAM when considering the adoption of electronic commerce (e-commerce) [Benamati, Fuller, Serve and Baroudi, 2010; Gefen, Karahanna and Straub, 2003; Hart and Saunders, 1997]. Tan and Thoen (2001) believe trust to be such an important component of e-commerce adoption that they claim it to be the single factor contributing to e-commerce success. The few studies incorporating trust into the TAM find that it has a statistically significant impact on BI [Benamati et al., 2010], in addition to a significant impact on PU and PEOU [Gefen et al., 2003]. Benemati, et al. (2010) and Gefen et al. (2003) both find that the impact of PEOU and PU on BI continues to be significant, even with the addition of trust in the model.

Trust appears to be such an important concept in the technology acceptance of e-commerce due to the risk that e-vendors might participate in harmful opportunistic behaviors, including: unfair pricing, conveying inaccurate information, or violating privacy laws [Gefen et al., 2003]. Trust becomes a crucial component of the buyer-seller relationship because of this element of risk. Further, lack of trust is cited as the principal reason that some consumers and companies do not use e-commerce [Tan and Thoen, 2001].

Sending information between departments in an organization may be similar to sending information between agents using EDI. Information asymmetry can exist in both cases, and trust is paramount for the information sharing to occur. During the EDI adoption process, trust increases the probability of greater EDI use, further reinforcing the trust relationship. As more and more information is shared, higher levels of trust must be attained amongst those who share and use the information [Hart and Saunders, 1997].

We expect that trust is also a critical influencing factor when information is being shared amongst different practice areas in a hospital. When trust is incorporated into the TAM in the context of information sharing across parties, it is consistently found to have a statistically significant effect on use [Benemati et al., 2010; Gefen et al., 2003; Tan and Thoen, 2001; Hart and Saunders, 1997]. Additionally, Gefen et al. (2003) find that trust also influences PU in the TAM applied to e-commerce. We believe the inclusion of trust and access to shared information in the TAM of integrated healthcare information systems will provide increased understanding of technology acceptance in this industry.

CONCEPTUAL MODEL

Drawing upon the literature, we proposed an extension to the TAM for the adoption of mandatory-shared EHRs shown in Figure 1. We introduce two additional factors to the model: trust (T) of the accuracy of the data and access to shared information (SI). As described in a previous section, we identify the empirical analyses indicating the significant impact of

trust on BI and PU when the TAM is applied to e-commerce. Because of the importance of information sharing in the system we analyze, we expect to find similar results. Further, Hertzum (2002) argues that trust is a fundamental aspect of cooperative work, and exists whenever people exchange information. Trust is prominent in healthcare because it is a team effort [Berwick, 2003]. Additionally, Paul and McDaniel (2004) find that physicians place a larger emphasis on trust than usefulness or ease of use in adoption decisions.

In our analyses, we define trust according to McAllister (1995): 'trust is the extent to which a person is confident in, and willing to act on the basis of, the words, actions, and decisions of another.' In order to obtain beneficial results from this HIT implementation, physicians and other healthcare workers must use the shared information regarding patient health status to make clinical decisions. Because this technology adoption represents a mandatory adoption situation, subsequent analyses will consider the model proposed by Keat and Mohan (2004) in which trust enters the TAM as a separate factor, influencing BI through ATT. Due to current data limitations, we test the model identified in Figure 1, without the additional factor of ATT.

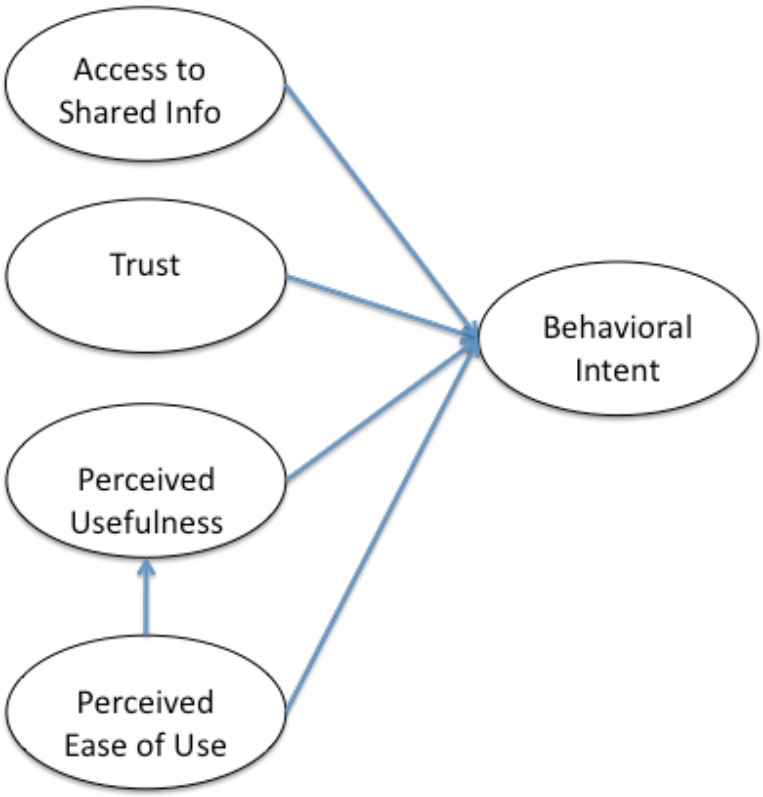

Figure 1: Proposed Extended TAM

Because physicians and other staff members must rely on medical records partially completed at locations outside their office, we expect the availability and access to this information to influence the extent to which personnel use the EHRs. We define SI as 'relevant information from other departments is maintained in the system in a timely manner, and is easily accessible from within the system'. O'Malley, Grossman, Choen, Kemper and Pham (2009) assess the impact of EMRs on the coordination of patient care, and find the following factors necessary for appropriate care across departments: timely exchange of relevant information, timely communication between inpatient and outpatient settings, and ability to access necessary information from the EHR. We expect with more available, accessible, and timely information, providers and other staff members will be more inclined to use the EHR for patient care. On the other hand, medical and non-medical staff members may resort to working around the system, and accessing patient information through other methods, if this information is not readily available or current, which could result in a negative relationship between SI and BI.

DATA AND SETTING

We analyze a Pennsylvania hospital currently implementing a shared EHR system. All physician-owned ambulatory practices in this network are implementing the same system, which has shared EHRs for patients seen across specialties. Additionally, for the obstetrics (OB) specialty, patient-level data from the hospital system is input at the hospital triage unit.

Discrete data elements are interfaced bi-directionally between the ambulatory and triage environments, and a visit summary from the triage unit is interfaced to the ambulatory record. Our initial study focuses specifically on the OB ambulatory practices, as they have the most significant shared information. We survey physicians and office staff to capture information about their attitudes and adoption of these systems.

The questions we use to analyze our proposed model are in Table 2. We use questions validated in past studies of TAM, information systems, and psychology [Pai and Huang, 2011; Bhattacherjee and Hikmet, 2007; Gefen et al., 2003]. In order to capture the complexities of this industry, we formulate the questions to be specific to healthcare, when appropriate. We expect this detailed analyses to provide more insight into the adoption and usage of shared EHRs. All responses are scored on a five-point Likert scale: 1—disagree strongly, 2—disagree slightly, 3—neutral, 4—agree slightly, and 5—agree strongly.

Question ID	Question
SI1	The information that I need from visits to `X' is complete.
SI2	The information that I need from visits to `X' is easily accessible.
SI3	Documentation from visits to `X' is incorporated into the office prenatal record.
SI4	Laboratory tests and diagnostic studies performed at `X' are recorded in the office prenatal record.
SI5	New diagnoses determined on `X' are recorded in the office prenatal problem lists within one week.
T1	I am willing to rely on the information within `Y'.
T2	I feel comfortable depending on the information within `Y', if no other source of patient information is available.
T3	If I had my way, I would not permit other providers to update data in patients' records.
T4	If I had my way, I would not permit other providers to add documents to my patients' records.
PU1	Using `Y' increases my productivity.
PU2	I find `Y' useful.
PU3	Using `Y' would improve my job performance.
PU4	Using `Y' would enhance my effectiveness on the job.
PEOU1	`Y' is easy to use.
PEOU2	My interaction with `Y' is clear and understandable.
PEOU3	I find it easy to complete documentation within `Y'.
PEOU4	I find it easy to find previously documented information in `Y.'
BI1	In the next year, I intend to use `Y' as my primary source of historical patient information.
BI2	In the next year, I intend to document more patient information in `Y'.
BI3	In the next year, I intend to adjust my work practices to better utilize `Y'.

Table 2. Survey Questions

At this point, we can only report data from one of the four ambulatory practices. Thus, our results should be interpreted with caution as they reflect only 31 usable surveys. We recognize this as a limitation of the current phase of our study, analyses, and reported findings. However, we are administering surveys in all of the practices and are confident that we should have more than 100 completed surveys to subsequently test our complete model.

DATA ANALYSES AND DISCUSSION

Given the small sample that we currently have, we analyze subsets of our proposed model. We begin with verification of the basic TAM model. Table 3 shows the means and standard deviations of each survey question for the first group of surveys from one ambulatory practice.

Variable	Mean	Std. Dev.	Min	Max
PEOU1	3.77	1.06	2	5
PEOU2	3.67	1.03	2	5
PEOU3	3.74	1.15	1	5
PEOU4	3.23	1.26	1	5
PU1	3.43	1.22	1	5
PU2	4.03	0.81	2	5
PU3	3.63	1.10	1	5
PU4	3.67	1.03	1	5
BI1	3.77	0.97	2	5
BI2	3.57	0.73	2	5
BI3	3.70	0.79	2	5
T1	4.00	0.91	2	5
T2	3.70	1.06	1	5
T3	2.48	1.06	1	4
T4	2.43	0.97	1	4
SI1	3.00	0.89	2	5
SI2	2.84	1.16	1	5
SI3	2.81	1.05	1	5
SI4	2.52	0.89	1	4
SI5	2.83	0.95	1	4

Table 3. Summary Statistics

We begin our factor analyses by validating the general fit of the data. The overall fit of the data is 0.7699, which corresponds to a KMO rating of middling. This value falls slightly under the rating of meritorious, so we feel comfortable moving forward with the factor analyses. In addition to the KMO for the entire data set, we review the individual MSA values to ensure that specific variables will not compromise the overall fit of the data. We do not find any MSA values below 0.50, so we do not drop any questions from our initial analysis.

We use the twelve questions corresponding to PU, PEOU, and BI to validate the standard TAM. Using principal component factor analysis, three factors result with an eigenvalue greater than one, and we drop PEOU3 because it does not load onto any factor. We validate the internal reliability of the factors by calculating each Cronbach's alpha. The PEOU and BI factors score above 0.80, corresponding to a good internal consistency. The alpha for the PU factor is above 0.9, representing excellent internal consistency. Our path analysis of these factors identifies a positive and statistically significant effect of PU on BI and of PEOU on PU. This result is shown in Figure 2.

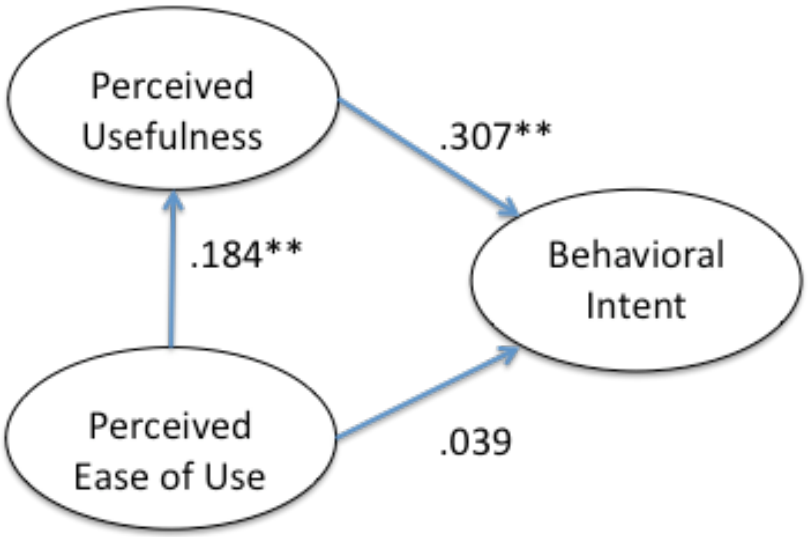

Figure 2: Path Regression Results: Validation of TAM

Our findings are consistent with the studies that found PEOU to directly impact PU, and PU to impact BI. These findings are inconsistent with those reported for mandatory use situations, which found an increased effect of PEOU. However, we posit that while usage is mandatory, perhaps the usage of the shared information by the providers is not mandatory in the healthcare setting. For example, the providers may be required to use the system, but they could utilize other ways to determine critical patient information, such as asking patients, requesting notes from other providers, or ordering additional tests. As identified in Table 1, this result is consistent with the study conducted by Schaik et al. (2002), within the healthcare industry.

Because of our limited sample size, we directly test the impact of SI and T on BI. The overall fit of this data is 0.66, as measured by the KMO. All internal consistency measures for each factor are greater than 0.8, so again we feel comfortable moving forward with this analysis. Our final factor analysis includes all measures of SI, T3, T4, BI2, and BI3. We dropped BI1 from the analysis due to an inconsistent loading; we dropped T1 and T1 because of MSA values less than 0.5. Our path regression yields a significant and negative effect of SI on BI, as shown in Figure 3.

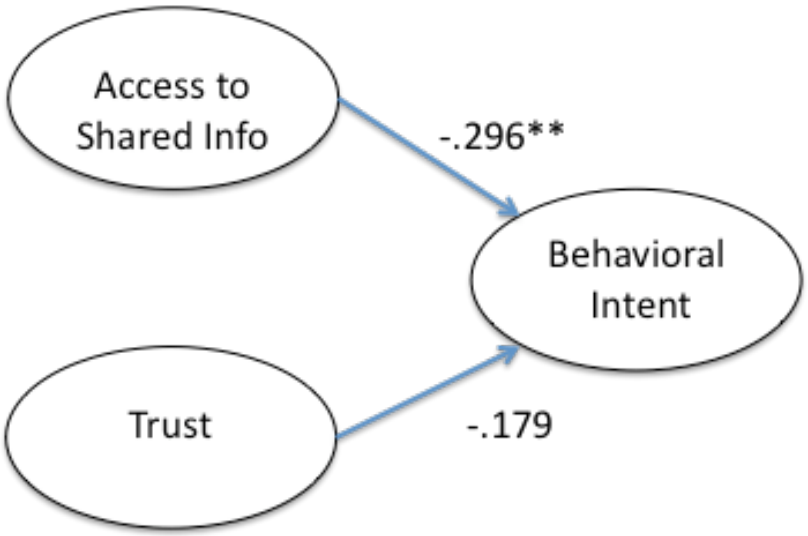

Figure 3: Path Regression: Impact of SI and T

We believe the negative impact of SI on BI highlights an interesting aspect of technology adoption in this setting. The negative coefficient is interpreted as decreased amounts of SI increasing behavioral intention to use the technology. This may imply resistance among users to sharing information and its access across practices and practitioners. This resistance may further limit the timeliness, completeness, and accessibility of the records, reducing intention to use the technology. As determined by O'Malley et al. (2009) these factors would be necessary for EMRs to have effective coordination of care. Our preliminary results indicate a concern regarding the willingness to access shared information, and its negative impact on intention to use.

Because our limited sample resulted in our inability to maintain all trust questions in this factor analyses, we cannot report conclusive results related to this factor. Although it is not significant, the negative sign on this factor can be attributed to the fact that two questions (T3 and T4) comprising this factor were asked from the negative perspective.

Subsequent analyses of the entire sample will provide the ability to simultaneously test all components of our proposed TAM. We may find that the existence of shared information continues to be a significant obstacle to successful adoption of shared EHRs. We also expect to fully identify the relationship between trust and BI with an increased sample.

CONCLUSIONS AND FUTURE RESEARCH

We posit that the unique aspects of the healthcare industry need to be included in the TAM when applied to health information systems adoption. We include T and SI as important factors in the adoption and use of integrated EHRs. Our work extends the literature by providing a contextualized model of the TAM suitable for application in cases of integrated health care systems, specifically concerning systems with shared information. Our model provides improved insight into the specific behaviors and attitudes that influence intention and subsequent adoption of HIT. We conduct our analyses using the introduction of a specific system at a large hospital in Pennsylvania, so our analyses provide insight into users' actual perceptions during the adoption process, as opposed to their hypothetical perception of a to-be-adopted technology. Additionally, we test our contextualized and extended TAM in a mandatory environment, further expanding the literature in the mandatory-adoption situation.

We recognize that our current data analyses are limited, but we expect that, with the addition of more data, we will be able to test our proposed model across all four OB practices. Our initial analyses provide evidence for the importance of SI on BI associated with HIT adoption. This brings attention to the importance of different influencing factors in situations of shared electronic data, as is the case with this technology adoption scenario.

In the future, we are interested in analyzing sub-samples of the population by position, because we believe physician influences may be different from staff influences. Hu, Chau, Sheng, and Tam (1999) consistently find that physicians differ from other types of users when accepting technology, specifically in the area of telemedicine. These differences can be attributed to their specialized training, autonomous practices, and professional work environments [Walter and Lopez, 2008]. Our preliminary analyses are suggestive of this difference, but we require a larger sample of physicians in order to determine the reliability of our factor analyses. Further, we believe our contextualized model can provide additional insight into influencing behaviors of technological adoption in the healthcare industry. Management can use this information to improve the implementation process and acceptance of HIT.

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