

Integrating Information Systems and Healthcare Research to Understand Physicians' use of Health Information Systems: a Literature Review

Completed Research Paper

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Abstract

Healthcare has been of great importance to societies for centuries and this importance is reflected in the abundance of healthcare research that involves, not only new interventions, but clinicians' response to change in the medical practice as well. Information systems (IS) research failed to take full advantage of healthcare research focusing on studying IS as an intervention or change in clinical workflows. To fill this gap, we conducted an extensive literature survey in both IS and healthcare research which included 175 papers from healthcare, IS journals and conferences that study physicians' use of HIS and clinical guidelines. Results of this review show that there are two different streams of HIS research in IS and healthcare domains and by integrating those streams we can create a rich understanding of HIS use. We build a model for HIS use based on our review and provide areas for future research.

Keywords: Adoption, Health information systems, physicians' attitude, literature review

Introduction

Healthcare has been of great importance to societies for centuries. This importance is reflected in the creation of a large body of healthcare research that studies not only new interventions to improve healthcare, but care processes and how physicians adapt to change as well. As information systems (IS) developed, their potential value in the healthcare industry was recognized and researchers started to explore ways to use these emerging systems (Ledley et al. 1959). However, research in the area of Healthcare IS (HIS) did not start to gain attention until the early 2000s when healthcare industry acknowledged the growing cost of healthcare and the increase in medical errors and proposed HIS as a solution to these problems (Bloom 2002).

Even as HIS research gained momentum, research followed traditional medical research in studying the efficacy of HIS in improving care and neglecting to a great extent studying whether these systems are used by care providers and why (Kaplan 2001). This focus on efficacy resulted in a gap in our understanding of healthcare provider use of HIS, and hence led to the failure of numerous HIS implementations due to care providers' resistance (Archer et al. 2011; Doolin 2004). To address this gap, IS researchers studied factors impacting physicians use of HIS. Most of the IS research in this area used established IS acceptance theories such as technology acceptance model (TAM) (Davis 1989). Although these studies succeeded in explaining a significant percentage of variance in HIS use, another significant percentage of variance remains unaccounted for suggesting the existence of other factors that impact the use of HIS (Holden et al. 2010). Several researchers proposed that this unexplained variance is because of the lack of context in technology acceptance theories (Benbasat et al. 2007; Venkatesh et al. 2011a). For HIS, the impact of contextual factors may be even higher than other types of IS because of the role of professional values resulting from training and education in shaping the behavior of clinicians (especially physicians) and their attitude towards HIS, as well as the strong role of medical community in influencing physicians' behavior (Freidson 1988; Freidson 1994).

Existing healthcare research focusing on studying care providers adoption of new technologies and interventions represents a rich body of research that can be used to understand the contextual factors that influence physicians' use of HIS. However, this research suffers from a serious drawback. Most of healthcare oriented studies do not employ a theoretical model behind the contextual factors they study. For example, while the role of peers in enhancing adoption of clinical guidelines has been studied in several healthcare studies (e.g., Greer 1988; Lomas et al. 1991), none of these studies approached peer effect as a part of a theoretical model. This lack of theoretical model negatively affects IS researchers ability to incorporate contextual constructs identified in healthcare research to IS research.

The goal of this paper is to bridge this gap, the difficulty of incorporating healthcare contextual factors in IS research, by creating a theoretical model that integrates theory-based IS constructs with contextual constructs to provide a better understanding of factors influencing care providers' use of HIS. To achieve this goal, we review literature on HIS use and clinical guidelines adoption in healthcare and IS domains. Because of the diversity in care providers, we focus our review on papers studying physicians' use of HIS since they are the most studied HIS users and because they have distinctive characteristics than other care-givers.

This review provides several contributions to literature. First, this study describes the similarities and differences between HIS use literature and change in healthcare literature. Second, it integrates two streams of research, IS research and healthcare research, to identify new constructs that are rarely studied in HIS use literature and which are salient in physicians' attitudes towards HIS. Third, this study attempts to classify constructs from IS and healthcare literature in a theoretical model that explains the relationship between these constructs and future study of HIS use. Finally, this study opens the window to incorporate past non-IS research with IS research to create more comprehensive models to study other types of IS.

Literature Review

For this study, we define *healthcare research* as research focusing on healthcare related subjects such as the efficacy of interventions as well as enhancing the skills of care providers to improve quality of care and convincing them to adopt changes. This research is conducted by healthcare researchers (not IS researchers). The differences between healthcare research and IS research have been long recognized (Kaplan 2001; Kaplan et al. 2004). These differences stem from the different origin and goals of both types of research. While IS research is considered a type of social science research with focus on understanding and explaining the theoretical underpinnings of IS (Wade et al. 2004), healthcare research follows medical research traditions that have existed for decades and is more oriented towards practice and towards finding ways to improve quality of care rather than understanding the theoretical base behind these ways. This difference is reflected in the methodologies mostly used by each research stream. IS research typically uses social sciences tools of surveys and qualitative methods while healthcare research prefers the use of randomized controlled trials (RCT) which are very useful in differentiating between what works and what does not work (Kaplan 2001).

Although most of healthcare research focused on the efficacy of interventions and changes, there is a large body of research focusing on physicians' attitude towards change and whether they adopt or resist the implementation of this change. This behavioral branch of healthcare research follows the same tradition of focusing on what factors influence physicians attitudes and neglects the relationship between these factors and the theoretical arrangement of them. When IS are introduced in healthcare, they are considered changes and studied in the same way.

The difference between how healthcare research and IS research approach studying the use of HIS represents a challenge and an opportunity. The challenge stems from the differences in methodologies and the lack of theoretical base for healthcare use-related constructs make it very difficult to incorporate these constructs in theoretical models in IS studies. The opportunity is because by integrating both streams of research we can create a very rich understanding of HIS landscape and the different factors, from system and user perspective, that influence physicians' decision to use or to abandon a system. This understanding will facilitate controlling these factors and achieving improvements in quality and reduction in costs.

In order to utilize this opportunity, we conducted an in-depth literature survey of journal papers focusing on IS use and guideline adoption by physicians from 1970 to 2014. We used a multi-stage process following (Webster et al. 2002). We then used this literature survey to identify constructs used in IS and healthcare streams and the relationships between those constructs. Finally, we classified these constructs in a theoretical model that enhances our understanding of these constructs.

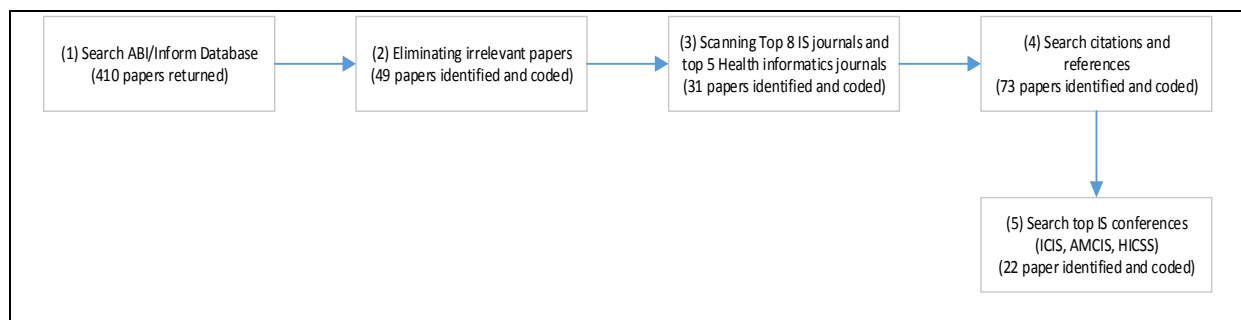


Figure 1. Literature search steps and results

As figure 1 shows, the first step in our literature survey was to identify papers involving IS use or guidelines adoption in ABI/Informs database¹. This step resulted in 410 papers being identified. In step 2, we reviewed the identified papers and eliminated papers not related to our research goals based on the exclusion criteria outlined in table 1, we ended up with 49 research papers to be included in the review. The papers were jointly coded by two information systems researchers and one healthcare (MD) researcher for journal type, topic, theory and constructs. Journal type was identified by its classification in “Web of Science”. Topic was selected based on the main focus of the paper (guidelines or HIS). Theory was identified by examining the theoretical model of the paper (if it exists), and by examining the literature review section of the paper for qualitative studies. Constructs were identified by examining authors' definitions of those constructs and by relating them to the employed theoretical model.

| Reason for exclusion | Number of excluded papers |
|---|---------------------------|
| Papers are related to the effectiveness of IS and not use | 228 |
| Papers related to patients and not physicians | 7 |

¹ The exact search term was: all((physicians or doctors)) AND all((use OR acceptance OR adoption OR resistance OR threat OR diffusion)) AND all(("information systems" OR ehealth OR telemedicine OR guidelines)) and was conducted in December 21st, 2014

| | |
|--|----|
| Papers related to system design and/or implementation | 29 |
| Papers not related to guidelines or IS | 49 |
| Papers related to disease management and not guideline use | 48 |

Table 1*. Excluded papers

** Papers are related to the effectiveness of IS and not use: These papers focus on the benefits of using HIS and not factors influencing physicians use. Papers related to patients and not physicians: papers focus on factors influencing patients' use (and not physicians' use) of HIS. Papers related to system design and/or implementation: papers related to designing or implementing HIS (e.g. technical specifications of HIS). Papers not related to guidelines or IS: Papers that appeared in the search but are not related to HIS or guidelines at all (e.g. disease management). Papers related to disease management and not guideline use: Papers that focus on disease management guidelines but not on factors influencing physicians' use of these guidelines.*

In step 3, we browsed the top 8 journals in IS domain and the top 5 journals in health informatics domain following (Webster et al. 2002) and identified those papers related to our study using the same exclusion criteria of step 2. This step led to the identification of additional 31 papers as shown in table 2. These papers were independently coded by the three researchers and Cohen's Kappa (Fleiss et al. 1969) was used to identify level of agreement between reviewers. A Cohen's Kappa of 82 percent was established indicating a substantial agreement between reviewers (Landis et al. 1977). The coding then proceeded independently by individual researchers for subsequent phases of literature review.

| Journal | Additional papers identified |
|---|------------------------------|
| MIS quarterly | 1 |
| EJIS | 3 |
| JIT | 4 |
| Info systems journal | 1 |
| Journal of the American Medical Informatics Association : JAMIA | 12 |
| Implementation Science | 1 |
| Journal of Medical Internet Research | 4 |
| International Journal of Medical Informatics | 4 |
| BMC Medical Research Methodology | 1 |

Table 2. Papers identified from top IS and healthcare journals

In step 4, we browsed the references of the papers identified in steps 2 and 3 and identified papers relevant to our study using criteria implemented in step 2. We then searched for papers citing key papers identified in step 3 using web of science citation search tool. This step led to identifying and coding additional 73 papers.

Finally, for the completeness of study, we browsed the proceedings of top IS conferences (ICIS, HICSS, and AMCIS) to identify papers related to HIS use. We identified and coded 22 more papers.

Findings

In total, we included 175 papers in this literature survey, with 58 papers focusing on clinical guidelines adoption and 22 conference papers. Table 3 summarizes those findings.

| IS/guidelines | IS journals/conferences | Healthcare/Health informatics journals/conferences |
|---------------|-------------------------|--|
| IS | 48 | 69 |
| Guidelines | 0 | 58 |

Table 3. Distribution of coded articles according to type of journal

The literature survey revealed several interesting results. The first finding is that while HIS use literature dates back to the late 1990s (Hu et al. 1999), guidelines adoption studies go back to the 1970s (Bridgstock 1979) which signifies the potential contribution of 20 more years of research to studying HIS use. As tables 3 and 4 show, two distinct streams of research are evident. The first stream considers HIS as business information systems and applies business IS theories to study HIS with TAM being the prevailing theory used as shown in table 4. The second stream, research conducted by medical researchers, is characterized by a clear lack of theory behind the study of physicians' behavior (table 4) and a focus on understanding and addressing factors influencing physicians adoption of IS or clinical guidelines. Surprisingly, the number of HIS studies in the second stream is larger than that in the first (table 3).

| Theory | Number of papers in IS literature | Papers in healthcare literature (including guidelines) |
|--|-----------------------------------|--|
| Technology Adoption Model TAM | 21 | 5 |
| Innovation Diffusion Theory IDT | 2 | 2 |
| Theory of Planned Behavior TPB | 4 | 2 |
| Unified Theory of Acceptance and Use of Technology (UTAUT) | 1 | 0 |
| Identity theories | 2 | 0 |
| Avoidance theory | 1 | 0 |
| Institutional theory | 2 | 0 |
| Social network theories | 6 | 2 |
| Expectation-confirmation theory | 1 | 0 |

Table 4. Theoretical models used to study IS and guidelines adoption

Moreover, the constructs employed in studying HIS and clinical guidelines are similar (as shown in table 5, 6), with constructs such as ease of use and attitude widely studied in both streams. This finding again signifies the benefits of using prior research on guidelines adoption to form a comprehensive model for HIS use. Despite the similarity between guidelines and HIS use constructs, some constructs are unique to one of those streams. For example, awareness of the guidelines and agreement with these guidelines were found to influence physicians' attitude toward using the guidelines, while system attributes (e.g. responsiveness) were studied in IS and not in guidelines adoption literature (Weeger et al. 2014).

| Rank | Construct | Number of papers |
|------|---|------------------|
| 1 | Usefulness | 56 |
| 2 | Ease of use | 41 |
| 3 | Attitude | 13 |
| 4 | Subjective norm | 17 |
| 5 | Training | 26 |
| 6 | Threat (loss of autonomy, changes in workflows) | 9 |
| 7 | Satisfaction | 6 |
| 8 | Involvement | 6 |
| 9 | Time pressure | 5 |
| 10 | Cost | 4 |

Table 5. Most used constructs in IS research

| Rank | Construct | Number of papers |
|------|--|------------------|
| 1 | Attitude | 19 |
| 2 | Peer influence | 16 |
| 3 | Threat (Loss of autonomy, changes in workflows, patient rejection) | 11 |
| 4 | Ease of use | 10 |
| 5 | Disease management complexity | 6 |
| 6 | Familiarity/awareness | 6 |
| 7 | Patient acceptance of guidelines | 3 |
| 8 | Flexibility | 2 |
| 9 | Source of guidelines | 2 |
| 10 | Involvement | 2 |

Table 6. Most used constructs in healthcare research

The dual nature of HIS

As the above results indicate, HIS can be viewed as being of dual nature: A business IS system that is created to enhance the efficiency of the work performed by care-providers in a way similar to corporate IS (such as an inventory management system or customer relationship management system). This view is mostly held by IS researchers and is evident in the prevailing use of TAM and its constructs in studying IS use (e.g., Chismar et al. 2003; Hu et al. 1999). TAM was originally created and tested for business IS before expanding to other areas of IS. Several researchers (e.g., Benbasat et al. 2007) proposed that TAM may not be suitable to study other contexts of IS use and called for using basic theories (such as theory of planned behavior) to study these contexts. Other researchers (Holden et al. 2010) called for including contextual constructs with TAM to study IS use especially in healthcare domain. These contextual constructs can be identified by considering the second nature of HIS, a change or intervention that aims at improving the quality of care. This view is supported by healthcare researchers and physicians who consider HIS a change to their workflows and an innovation to improve their role as care-givers. This view is promoted by how physicians see their role as seeking the well-being of their patients and how they see new interventions or HIS as supporting to this role (Haux 2006).

This dual role of HIS is not unique to these systems. It exists in other contexts such as electronic commerce (e-commerce) websites which are viewed as IS and at the same time as sellers or stores (Gefen 2000). By understanding this dual nature of e-commerce, researchers were able to consider contextual constructs such as trust and create comprehensive models for using e-commerce. We propose that understanding the dual nature of HIS is essential in building a comprehensive model that explains why physicians adopt or resist HIS systems. By considering HIS adoption as a change in physicians' practice similar to the adoption of new clinical guidelines, it is possible to identify significant contextual constructs that can be employed in HIS use models.

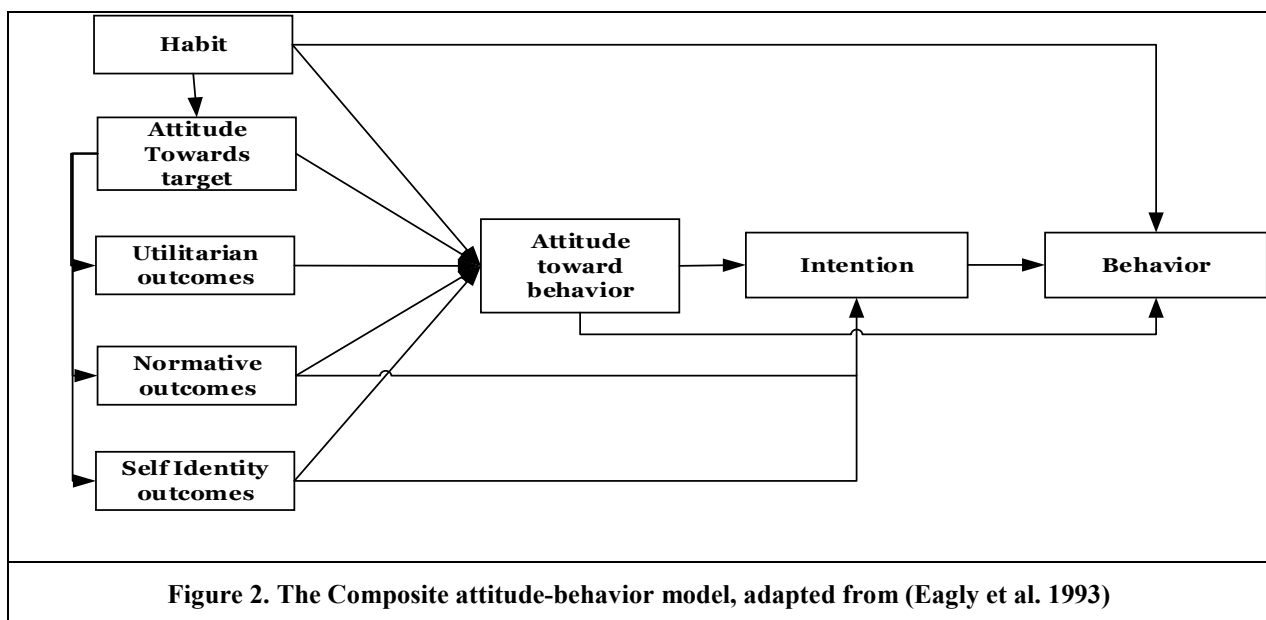
HIS use model development

Attitude in HIS use

Attitude toward a behavior is the tendency to evaluate the behavior as favorable or unfavorable (Ajzen 2005). Attitude has been studied extensively in psychology since the early 20th century which resulted in several models that explain attitude relationship with behavior such as theory of reasoned action (TRA) and theory of planned behavior (TPB). These theories are the basis for most IS use models (e.g. TAM) (Davis 1989). However, when IS use models were tested in corporate contexts, attitude was found to have

insignificant effect on use in the presence of other constructs such as usefulness and ease of use (Venkatesh et al. 2003), and was therefore eliminated from IS use models such as TAM. However, as researchers noted (Benbasat et al. 2007), these business oriented IS models may not work in all contexts and therefore, basic theories need to be used instead. On the other hand, healthcare researchers consider attitude an important factor in determining physicians' behavior to adopt guidelines or HIS. This is evident in influential models created to explain physicians' adoption of guidelines (Pathman et al. 1996) and in attitude being the main predictor of HIS and guidelines use in healthcare studies (e.g., Cabana et al. 1999; Howes et al. 2012; James et al. 1997; Solà et al. 2014).

There are several models that explain the relationship between attitude and behavior such as TPB (Ajzen 2011) and TRA (Fishbein et al. 1975) which have been widely accepted in attitude and IS research. However, these theories have been criticized for focusing on cognitive factors and beliefs and ignoring affect, identity and prior behavior (Maio et al. 2009). Because healthcare studies indicate a relationship between physicians' identity as care-givers and their behavior, we consider the Eagly et al. (1993) composite attitude-behavior model (A-B model) which is considered one of the most influential attitude models in psychology (Maio et al. 2009) (figure 2) to include those factors.



We chose to use this model as a framework because it considers both normative outcomes and self-identity outcomes which are proposed to be influential factors in predicting HIS use. Therefore, this model allows us to integrate our IS related constructs and identity related constructs in a comprehensive framework. Based on literature review, this section discusses factors influencing behavior in the A-B model

Attitude towards target (HIS)

Attitude toward HIS is defined as the positive or negative user evaluation of the information system (Wixom et al. 2005). In the reviewed literature, we identified two forms of attitude toward HIS: satisfaction and trust. It is worth mentioning here that both of these attitudes are formed with use. That is we expect their effect on attitude to increase as physicians continue to use the system.

Satisfaction with HIS

Satisfaction refers to physicians' positive attitudes towards HIS based on their cognitive and emotional appraisal of the system (Wixom et al. 2005). Hence satisfaction represents the attitude toward target factor in A-B model. Several IS models identified the effect of satisfaction on user behavior such as DeLone and McLean IS success model (DeLone et al. 1992). Although, the direct relationship between satisfaction

and attitude toward behavior has not been established in IS literature, it was established in empirical results in healthcare domain (Gagnon et al. 2012; Jensen et al. 2009; Murff et al. 2001) . Moreover, A-B model proposes that in addition to the indirect effect of attitude toward target as an external variable (Ajzen 2005), attitude toward target can also have a direct effect on attitude. For example, as physicians have a positive attitude toward the HIS, they are likely to express this attitude as a positive attitude toward using it. Therefore, we propose a positive relationship between satisfaction and attitude toward using the system.

Trust

Generally speaking, trust is often viewed as a property of social interactions between two parties where one party (trusting party) believes that the other (trusted party) will fulfill the trusting party expectations of their interaction (Gefen 2000). The main value of trust in social interactions is to reduce the complexity of future interactions by reducing uncertainty and to provide a basis for making decisions regarding these interactions (Gefen et al. 2003).

In IS literature, trust is most often used in studying systems that encompass interactions between parties such as e-commerce (McKnight et al. 2002) and recommendation agents (Xiao et al. 2007). However, there has been a long disagreement about whether the concept of trust applies in IS that do not encompass any social or economic interactions (Komiak et al. 2006).

In this research, we adopt the view that trust is applicable to studying system use which agrees with several researchers (Vance et al. 2008). We define trust in the context of HIS as the physicians' willingness to depend on the HIS (Gefen 2000). We propose that when physicians are making a decision to use HIS, part of their decision making process is to compare the benefits of using the system such as improved efficiency and better patient care with the risks associated with this use such as loss of autonomy and loss of control over care processes. Trust reduces the complexity and uncertainty of this decision (Gefen et al. 2003) and provides physicians with a basis to use the system. This use of trust agrees with prior IS research which found trust to play an important role in encouraging system continuing use (Gefen et al. 2003) and with Innovation diffusion theory which propose that innovation users seek ways to reduce uncertainty associated with use (Rogers 2010). Few studies examined the effect of trust on HIS use. For example, healthcare research argues that physicians can lose their "trust" in CDSS systems if they do not provide accurate and correct information (Magnus et al. 2002), while in IS literature, trust was found to have a positive relationship with attitude (Pavlou et al. 2006) and on willingness to disclose information to HIS (Anderson et al. 2011).

Utilitarian outcomes

In A-B model, Utilitarian outcomes refer to benefits resulting from using the system (Eagly et al. 1993). Utilitarian outcomes construct then is similar to perceived benefits (Davis 1989) or performance expectations (Venkatesh et al. 2003) constructs. The relationship between perceived benefits and attitude has been supported in IS (Egea et al. 2011; Hu et al. 1999; Melas et al. 2011) and healthcare research (Buenestado et al. 2013; Dünnebeil et al. 2012).

An important point to note here is that although perceived benefits has been considered as a unique construct in IS, several studies proposed that benefits are context dependent. For example, Mishra et al. (2011) used the identity theory to show that physicians perceive their benefit from the system depending on their perception of their professional identity as care-givers. This agrees with the sense making theory which proposes that the benefits perceived by users depend on how they perceive the system as related to their role (Jensen et al. 2009). When physicians experience the benefits of the system, they will evaluate their interactions with the system as positive and hence will have a positive attitude toward continuing to use the system (Venkatesh et al. 2003). Although the A-B model does not propose a direct relationship between perceived benefits (utilitarian outcome) and intention, the positive relationship between perceived benefits and intention to use the system has been proposed in several IS use models including TAM (Davis 1989). Moreover, this relationship can be seen if we consider perceived benefits as a component of self-identity outcomes as proposed by Mishra et al. (2011).

Normative outcomes

Normative outcomes refer to the social benefits users receive because of using the system. In the healthcare domain that may include recognition by peers (Greer 1988; Venkatesh et al. 2011b), a sense of belonging to the medical community (Foy et al. 2005; Freeman 1985), or adhering to the professional principles of the medical profession (Freidson 1988).

Social identity theory proposes that when one identifies oneself with a group, one's perceptions are influenced by this identification (Abrams et al. 1990; Chreim et al. 2007). For physicians, this influence is more salient given how physicians perceive their belonging to the medical community as fundamental in their profession and how they associate themselves with the medical community much more than with their employer (Freidson 1994). This influence is evident in the great importance of medical community meetings and conferences for physicians. The role of medical community in forming physicians' beliefs about the system is emphasized in the institutional theory which poses that widely accepted institutional beliefs or "institutionalized myths" influence individuals' beliefs and that individuals adhere to institution normative influence (Jensen et al. 2009; Meyer et al. 1977)

We propose that physicians highly value each other's opinions and experiences because of their common education and life-long training (Hilton et al. 2005; Tallis 2006) and identify themselves as members of the medical community. Therefore, when the HIS is widely accepted and used by medical society members, this is likely to boost physicians' positive evaluation of using the system and hence will positively influence their attitude toward the system. Moreover, as physicians perceive that the medical community favors their use of the system, this will directly enhance their intention to use the system (Eagly et al. 1993; Venkatesh et al. 2003).

Self-identity outcomes

Physicians' position in society has long been established with patients trusting those physicians to take decisions directly affecting patients' health. This trust and respect towards physicians is mainly a result of their professionalism and their dedication to patients (Real et al. 2009). Aspects of physicians' professionalism include their autonomy (Blumenthal 2009) decision making and judgment, and their focus on patients' best interests (Roland et al. 2011). These aspects are created and enhanced through the long medical education as well as ongoing communications among physician community members (Freidson 1994).

According to the identity theory, identity is how one perceives oneself as different from others (Stryker et al. 2000). An important process in this theory is self-categorization which proposes that one categorizes oneself by one's role in society (e.g. a physician, a professor, etc...). Physicians view their role in society as taking care of patients and making decisions for their patient's best interest (Roland et al. 2011; Tallis 2006). They value their autonomy and decision making independence as a core part of their role. Physicians regard these values as a symbol of their professionalism and commitment to patients beyond their "employment contract" (Tallis 2006). Previous research in healthcare associated physicians' resistance to change with threats to their care-taking role (Rundall et al. 2002). In IS, resistance to new healthcare systems has also been associated with threat to this role such as negative effect on physician-patient communications (Mishra et al. 2012), threat to autonomy (Walter et al. 2008), and threat to control over the care-taking process (Bhattacharjee et al. 2007).

Mishra et al. (2011) divided self-identity outcomes into benefits related to identity above, and threats to identity. There is abundant research, especially in healthcare, that focuses on studying resistance to HIS and the threats that generate this resistance. Therefore, we propose that when physicians perceive the system as threatening to their role identity as care-takers, they perceive the HIS as identity-challenging or identity-threatening and hence they will perceive negative self-identity outcomes of the system leading to a negative attitude toward continuing to use the system. Moreover, as physicians consider the negative consequences of using the system on their self-identity, they are likely to be less motivated to continue using the system and hence their intention to continue using the system will be negatively affected.

Habit

Although habit is a part of the A-B model, there has been very scarce research on the influence of habit on HIS use. This is because: (1) habit, when defined as an automatic behavior that requires little or no self-instruction (De Guinea et al. 2009) requires a stable context (Limayem et al. 2007), similar or even identical conditions under which the behavior is performed. This stable context is not common in using HIS, because physicians regard each patient as unique and engage in cognitive effort to decide whether it is suitable to use the system with this patient, hence their behavior is not automatic. (2) In psychological studies (e.g., Haddock et al. 1994) as well as in IS research (e.g., Limayem et al. 2007), attitude is found to be related with satisfaction and quality of previous behavior more than the frequency of behavior. So, patient satisfaction may act as a proxy to previous behavior.

External beliefs influencing HIS use

When proposing their TPB, Ajzen (2005) discussed a set of external variables which are context specific, cannot be generalized to other contexts and can indirectly influence behavior. He suggested selecting five to nine beliefs which are in the same context as the behavior. These set of beliefs would be very important in healthcare context because there is a variety of HIS which perform different tasks. Therefore, generalizing external beliefs over all HIS systems is inaccurate and can be misleading. At the same time, there is some similarity between those beliefs since they are within the same context.

We identified those beliefs through the literature review, and we classified them into three categories: (1) system quality which refers to the physicians' subjective evaluation of the quality of the system; (2) information quality which refers to the usefulness and desirability of the information produced by the system; and (3) Patient related beliefs which refer to the perceived effect of using the system on patients. These beliefs, summarized in table 7, are characterized by not having a direct relationship with system use.

| Class | Construct |
|----------------------------|--|
| System quality | Ease of use Flexibility Accessibility Involvement |
| Information quality | Agreement Currency Trust in information source Accuracy |
| Patient related constructs | Patient adherence Improved communication with patients Perceived improvement in patient care Patient satisfaction |

Table 7. External variables Constructs

Perceived system quality

System quality reflects system attributes that influence physicians' experience with the system. We identified several of these attributes including: (1) *Ease of use* which has usually been used as a direct predictor of use intention (e.g., Davis 1989). However, other studies (Petter et al. 2008) considered ease of use as an attribute of system quality. Therefore, we use ease of use as an attribute of system quality. The effect of ease of use has been extensively studied in IS and healthcare domains, and while IS research found a strong relationship between ease of use and usefulness (Venkatesh et al. 2003), healthcare research found that ease of use has a positive effect on the use of HIS (Chen et al. 2012) and guidelines (Ferrier et al. 1996; Salinas et al. 2011) alike. However, no theoretical framework was provided to explain this relationship. (2) *Flexibility*: Physicians regard each case as different from other cases (Sleath et al. 1999). Therefore, they value system flexibility and adaptability to different cases, and sometimes, they

refuse systems that treat all cases the same (Cabana et al. 1999). Flexibility (Escobar-Rodríguez et al. 2012) has been employed in IS literature as a system quality attribute (Wixom et al. 2005). (3) *Involvement*: When physicians are involved in building the HIS, they will develop a sense of ownership towards this system and see the system as their own and hence will perceive the quality of the system as high and expect more benefits from this system. As a system attribute, involvement has been found to influence attitude toward using HIS, but the nature of this influence has not been studied theoretically (Majumdar et al. 2004). (4) *Accessibility*: Accessibility refers to the capability of the system to provide access to all information required by the physician to manage a case. Accessibility is important in two different ways. First, the HIS system should provide the physician with required information to manage patients, and second, this information should not be overwhelming so that it takes them a lot of time to find what they are looking for. Several healthcare studies related accessibility to the perceived benefits of using HIS (Wager et al. 2000).

Perceived information quality

Information quality represents the attributes related to the information presented to physicians through HIS. We identified the following attributes: (1) *Agreement with provided information*: Physicians value their long training and expertise which is reflected in their professionalism. Therefore, they have the capacity to evaluate the quality of information presented by the system based on their experience. If they agree with the information presented by the system, they are likely to perceive this information as being of high quality and follow it, otherwise, they may ignore this information and perceive the HIS as less useful (Heneghan et al. 2007; Tunis et al. 1994). (2) *Trust in information source*: Several studies (Carlsen et al. 2011; Salinas et al. 2011) found that physicians may be wary of information influenced by some sources such as pharmaceutical companies and have more trust in information coming from medical societies. In many cases of clinical guidelines, physicians refused to follow guidelines because they doubted their source. (3) *Currency*: In order to care for patients, physicians need to have the most recent information on these patients as well as most recent clinical evidence. Therefore, the currency of the information provided by the system and how often it is updated can be an important attribute of information quality (Graham et al. 2005; Heffner et al. 2000). (4) *Accuracy*: Obviously, for physicians to make a decision, they not only need current information, but accurate information as well. For example, missing patient allergies information can have dramatic effects. Therefore, information accuracy is an important factor in determining system usefulness (Dillon et al. 2010; Majumdar et al. 2004).

Patient related constructs

As discussed earlier, Physicians regard themselves as care-givers and they value their relationship with their patients and patients value this relationship as well. Therefore, the effects of using HIS to manage patients should influence physicians' perceptions of these systems. Surprisingly, despite the numerous studies that examine the effect of using HIS on patient outcome (e.g., Venkatesh et al. 2011b), *very few* studies examined the reverse effect, how patients influence physicians' decision to use an HIS system. Existing literature on clinical guidelines proposes that patients' acceptance and adherence to guidelines influence physicians' decision to use these guidelines (Cabana et al. 1999) with few studies proposing that physicians would stop using a system if their patients do not adhere to recommendations based on this system outcome (Brooks et al. 2006). Patient satisfaction can also influence how physicians perceive the usefulness of the system but we could not find any studies on the effect of patient satisfaction on HIS use. More research is needed in this area and researchers are encouraged to find and measure construct to represent patient influence on physicians' adoption of HIS.

Relationship between external beliefs and use

After discussing the above external beliefs, the question becomes: where would these attributes fit in the proposed theoretical model? DeLone and McLean IS success model (D&M model) (DeLone et al. 1992) answers this question by proposing a relationship between information quality, system quality and perceived benefits and satisfaction. Although D&M model was originally developed to define IS success, it has been used to study use (Seddon 1997). In our model we can propose the same relationship between system quality, information quality, and patient related construct on one hand; and system use and satisfaction on the other. As physicians perceive the system as of high quality and the information

provided as an output of the system as useful, accurate, and current, they are likely to be more satisfied with the system and perceive it as useful. Moreover, as patient-physician relationship is improved as a result of using the system, and because of physicians' perceived role as care-givers, they are likely to be more satisfied with the system and perceive it as more useful.

Attitude-intention mediators

Even if physicians have a positive attitude towards using the system, this does not mean they will have the intention to use it (Eagly et al. 1993). There may be several factors that physicians must assess before intending to use the system. These factors mediate the relationship between attitude and intention. For example, even if physicians evaluate using a system highly, they would not use it if the cost of the system is too high or if they lack the necessary training to use the system. Healthcare literature has considered several factors that may mediate the relationship between attitude and intention. These factors are: (1) *Training*: The role of training in motivating physicians to use HIS has been widely studied in healthcare and IS literature (e.g., Escobar-Rodríguez et al. 2012; Friedberg et al. 2013; Glodek 2012). In this study, we consider training to be an a mediator of the attitude-intention relationship because physicians may have a positive attitude towards the system but still not consider using it because they lack the necessary skills to do so, therefore, providing training to physicians may enhance their intention to use the system (Ash et al. 2005). (2) *Self-efficacy*: Self-efficacy refers to physicians' judgement of their capability to use HIS. As in training, physicians may have a positive attitude toward using HIS but refrain from using it because they do not believe they can (Mun et al. 2006; Salinas et al. 2011; Zwerver et al. 2013). Therefore, we propose that self-efficacy mediates the relationship between intention and attitude. Moreover, training can enhance physicians' self-efficacy and encourage them to use the system (Zwerver et al. 2013), therefore, we propose a positive relationship between training and self-efficacy(3) *Cost*: Healthcare research associated cost of implementing a system with physicians' reluctance to use the system especially in small practices (Deom et al. 2010; Wirtz et al. 2012). This result led to governments passing laws to support the adoption of HIS (Zlabek et al. 2011). We therefore propose that the implementation cost of the system may be prohibitive for physicians even if they have a positive attitude toward using the HIS.

Based on the above discussion, we propose the model in figure 3 to predict use of HIS systems. Table 8 represents the mapping between A-B model and our proposed model.

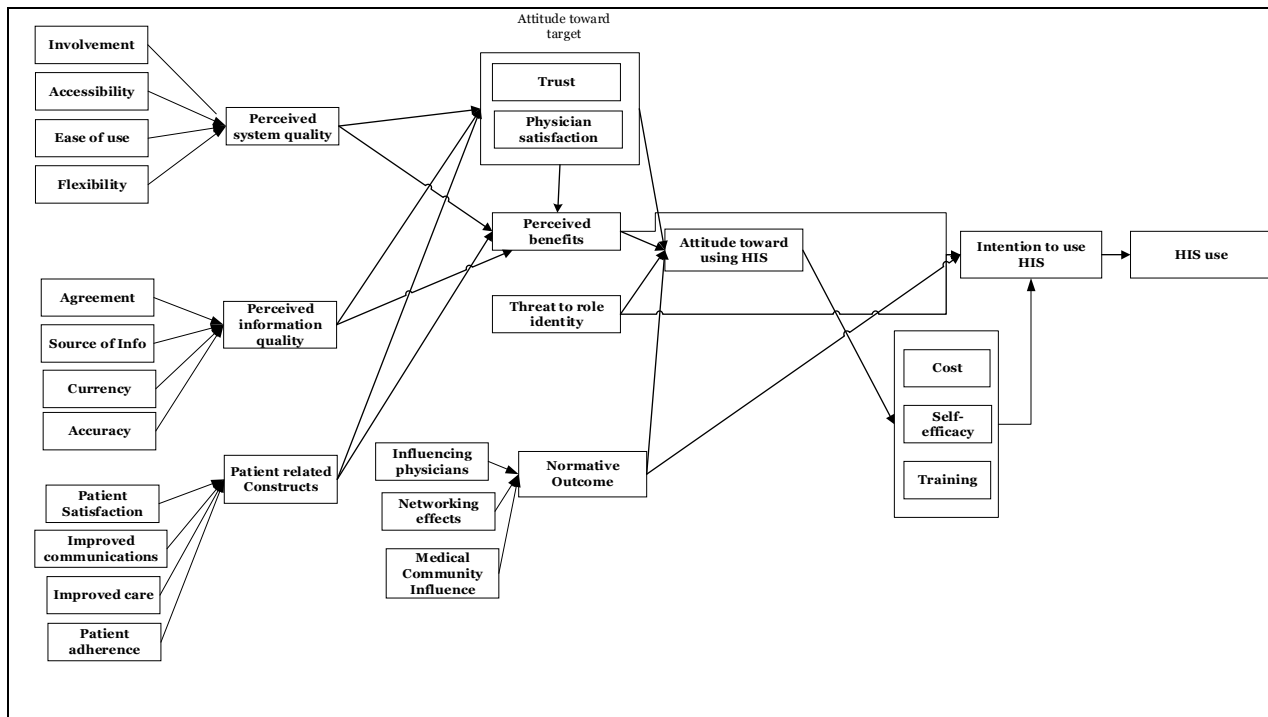


Figure 3. A comprehensive HIS use model

| A-B model Construct | Proposed Model Construct |
|--------------------------|---|
| Behavior | HIS use |
| Intention | Intention to use HIS |
| Attitude toward behavior | Attitude toward using HIS |
| Habit | Satisfaction and perceived outcomes are used as proxies for habit |
| Attitude towards object | Satisfaction, trust |
| Utilitarian outcome | Perceived benefits |
| Normative outcome | Normative outcome |
| Self-Identity Outcomes | Threat to role identity |

Table 8. Mapping between A-B constructs and proposed model constructs

Future research direction

This literature review reveals several interesting research areas. First, our review shows that IS research in the area of HIS use is scarce. Although we were able to identify numerous studies in this area, they are limited in terms of methodology and theory. For example, most IS research employs TAM (with some variations) to study HIS use, while healthcare research focus on qualitative methods and surveys. There is an apparent need to study HIS use using other theories and methodologies to cover this research gap. As attitude represents an important predictor of HIS use, we propose expanding the use of attitude based theories such as TPB to study HIS use.

Second, this review reveals that physicians perceive HIS differently than IS practitioners; they see it as a change in their workflows and a tool to enhance their role. Ignoring this perception and limiting the study of HIS to system constructs can lead to resistance and rejection. Therefore, this perception should be considered in future HIS use as proposed before by other researchers.

Third, habit represents an interesting construct that requires more examination by IS and healthcare researchers alike. As discussed above, physicians perceive patients differently and therefore, logically, we do not expect habit to be significant in studying HIS use. However, habit has other dimensions. In some types of HIS, such as guideline-based clinical decision support systems, the habit of applying these guidelines in practice may influence the decision to use the system because physicians may find the system more supportive to their work. At the same time, if physicians are used to certain workflows, they may reject HIS if it opposes these workflows as they perceive HIS as threatening to their role. Therefore, HIS use research should focus on understanding the role of previous habit in encouraging physicians to use HIS and how to develop HIS systems that facilitate change instead of creating a threat to physicians' workflows.

Fourth, patient related constructs have often been ignored in IS and healthcare research. There is abundant research on how HIS affect patients' outcomes but to the best of our knowledge, there are no studies that examine the effect of patients' outcome or satisfaction on physicians' use of HIS. This effect can logically be deducted given how physicians perceive their role in society as care-givers and how they perceive their mission as making decision for the benefit of their patients. A reason behind lack of research in this area may be that patients usually rate their physicians high on satisfaction surveys and therefore, there may be no motivation to study the effect on patient satisfaction on HIS use. However, physicians have their own perceptions of their relationship with patients and hence, researchers should find a construct to represent this relationship and use it in building HIS use models.

Fifth, when HIS is viewed as a tool to improve care, HIS use research should extend to studying how use influence knowledge translation, the application of knowledge in practice, and whether physicians actually use the information they get from HIS systems to manage their patients.

Finally, most research on HIS studies physicians as target population, with limited research for other types of care-givers. The current view of the care process is that it is a patient-centric collaborative process that involves different stakeholders including for example, physicians, nurses, pharmacists, and case managers. Several HIS are developed to enhance this collaboration. The success of this care process then depends on all stakeholders using HIS in a coordinated way. Hence, there is a need for more research on HIS use by other care-givers especially under-studied ones such as pharmacists and case managers.

Conclusion

With the ever growing cost in healthcare industry and the need to improve quality of care, HIS importance is continuously growing. The benefits of HIS can only be reached if they are used in practice. Existing research in HIS use is scarce and separates system-based constructs from users-based constructs creating an incomplete picture of HIS use behavior. In an attempt to make most use of extant research, we developed a comprehensive model that employs IS and healthcare constructs to provide more understanding of physicians' HIS use. In addition to the research implications detailed above, this research has several theoretical and practical implications.

Theoretically, it emphasizes the need to employ general behavior models such as TPB, and the A-M model to study physicians' use of HIS. This need has been discussed before in IS literature (Benbasat et al. 2007) and is emphasized by the contextual factors identified in healthcare research and which extend beyond traditional IS models such as TAM or UTAUT. This research also presents a set of contextual constructs not widely employed in IS research such as effect of medical community and threat to role identity that play a role in physicians' use of HIS. Finally, even for the well-established constructs of system quality and information quality. Prior research Wixom et al. (2005) proposed that these constructs are dependent on system context (different user groups can view system and information quality differently). Our research model identified several factors that influence users' perceptions of system and information quality which are unique to healthcare context such as the proposed influence of agreement on information quality and involvement on system quality.

Practically, our proposed model highlights factors related to system and process design and implementation that encourage HIS use. For example, the model proposes physicians' involvement in system design and implementation as a driver of HIS adoption. Therefore, vendors and system designers should try to engage and involve physicians in identifying system requirements and in designing HIS that fulfil these requirements. System designers should also design HIS with flexibility to accommodate different physicians' preferences because physicians tend to consider each patient as an individual case and prefer to be able to tailor the system to each patient condition. On the process side, physicians not only consider attributes related to system design, but they also consider the processes governing these systems such as the currency of the information provided by the system and how often the system is updated, whether physicians believe the information provided by the system is beneficial to their patients, and whether they trust the source of system information. Therefore, healthcare organization should address these factors as a part of HIS implementation projects by involving physicians in system selection and implementation processes and by maintaining information currency as an essential system support process.

The model also proposes that HIS use is a social process that involves the medical community as well as established care workflows. Therefore, HIS developers should seek acceptance from the medical community as an essential step towards individual physicians' adoption. Moreover, HIS implementation projects should be compatible with existing care workflows or engage physicians in a change management process that aims at emphasizing the role of the HIS in improving patient care. This change management process should include walkthrough and training sessions that focus on the benefits of the implemented system and how this system is received and used by members of the medical community.

Finally, the cost of using and maintaining HIS is a source of concerns for physicians that can lead to resisting new HIS implementations. Therefore, change management processes that aim to improve HIS usage should include incentives for physicians to use the system (on government and organization levels). They should also emphasize the benefits of using the system and the cost savings that may be associated with using this system.

Limitations

The goal of this study is to develop a comprehensive theoretical model that aims to explain and predict physicians' use of HIS. However, because the literature review employed in this study considered IS and healthcare research that differ in methodology as well as theory, the relationships of the proposed model need to be tested in subsequent studies. Moreover, the model presented in this study may not be fully applicable to all types of HIS. For example, agreement with system information may be more applicable to clinical decision support systems (CDSS) than electronic medical records (EMR) and hence researchers should only consider constructs related to their context when studying HIS use.

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