Impact of HIT-Induced Error on Practice-Level EHR Use
Emergent Research Forum Paper
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Abstract
Even though there is a strong recognition of the benefits of healthcare IT (HIT), the actual usage of electronic healthcare record (EHR) is low. What explains such inconsistency? Prior research on EHR use has mostly focused on the human element and largely ignored the technical element. One such technical aspect that can potentially impede EHR usage behavior is the HIT-Induced error - errors arising from the design, development, implementation, and use of HIT. Guided by the theoretical position of “Technology frame viewpoint”, the proposed research explores the mechanism through which HIT-induced error influences practice level EHR use. Simultaneously, we also examine the effect of HIT-induced error on technology avoidance behavior. We propose three relationship to be tested empirically in the healthcare settings. Insights from this study can potentially advance our understanding of the nature of relationship between HIT-induced error and practice level EHR usage.

Keywords
EHR use, IS avoidance behavior, HIT-induced error

Introduction
Even though there has been rapid growth in the implementation of electronic health record (EHR) systems, the relationship between EHR use and healthcare outcomes remains inconsistent (DesRoches et al. 2012; Landrigan et al. 2012; IOM 2012). Spurred by the Health Information Technology for Economic and Clinical Health Act (HITECH), healthcare institutions are rapidly digitizing clinical and diagnostic workflow through substantial investment in healthcare Information Technology (HIT). HIT can bring about tremendous efficiency in a sector that is plagued by large scale inefficiency and high cost of care (Hillestad et al. 2005; Jha et al. 2009). For instance, a recent report suggests that the total measurable loss due to inefficiency in the healthcare sector is US $ 750 billion (IOM 2012). The report also suggests that healthcare institutions have not been able to benefit from the substantial investment in HIT.

Prior research suggests that healthcare users are not enthusiastic about integrating HIT into work routines (Aron et al. 2011; Goh et al. 2011). While actual use is key to realizing the benefits of HIT (Devaraj and Kohli 2003), low level of system use is a major concern. An improved understanding of actual EHR use at the practice level is more critical than ever. Increasing interest of IS and informatics scholars has led to a growing literature providing rich and insightful accounts of EHR use by healthcare providers in healthcare delivery process (Bleich and Slack 2010; Saleem et al. 2009). For example, prior research has focused on understanding EHR adoption rate (DesRoches et al. 2008; Ford et al. 2009), EHR use related outcomes such as quality of care and cost effectiveness (Chaudhry et al. 2006; Ludwick and Doucette 2009; Venkatesh et al. 2011), and impact on healthcare culture and clinical workflow (Aarts et al. 2012; Abraham and Reddy 2010). The extant literature emphasizes the need for more in-depth understanding of the social underpinning or the human element involved in the EHR acceptance, implementation and use.

In a rush to implement HIT across the healthcare delivery system, little attention has been paid to the unintended consequences of such deployment. There is a growing body of research pointing to a new type of errors associated with design, development and implementation of HIT (Borycki et al. 2009; Magrabi et al. 2012). This error has been termed as HIT-induced error or system related error. The present
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research explores the relationship between the HIT-induced error and the variation in physicians EHR use. While significant focus has been on the positive consequences of HIT on healthcare outcome, little or no research exists on the impact of negative unanticipated consequences on individual level EHR system use. In light of the lack of research on the mechanism through which HIT-induced errors influence EHR use, this project proposes an exploratory research on unraveling the nature and mechanism on how technology induced errors influences EHR use. We argue that physicians’ perceptions will be influenced by the errors due to technological artifacts and can potentially influence EHR use patterns.

To examine the phenomenon of interest, we use the “Technology frame view” as the theoretical lens to guide our exploration of the proposed relationship (see Agarwal et al. 2010). The theory suggests that individuals have cognitive structure (e.g. mental models) related to the perception of technology that influences decision to the use a certain system. The key objective of the proposed research is to examine the impact of HIT-induced error on EHR use patterns at the individual practice level. The key questions being asked: (1) How does HIT-induced error impact EHR use patterns of physicians, (2) How does HIT-induced error impact usage behavior (IS avoidance) of individual physicians?, and (3) What is the relationship between HIT-induced error, IS avoidance behavior and practice level EHR use?

Theoretical Background and Prior Research

This section summarizes prior research in the key areas of focus. This section first introduces the theoretical lens – i.e., Technological Frame View (TFV). The section subsequently discusses prior literature on EHR use, technology-induced error and the IS avoidance behavior in the context of information system use in the healthcare context.

Technological Frame View

The project draws on the perspective of “Technological frame view” to examine the effects of HIT-induced error on EHR use (Agarwal et al. 2010; Mishra and Agarwal 2010). While literature extensively points to the slow adoption of EHR (e.g., Gans et al. 2005; Jha et al. 2010), limited theoretical understanding of the adoption factors is a major constraint. One possible reason may be the associated with the underlying assumptions related to the users’ technological frame of reference (Orlikowski and Gash 1994). Technological frame reflects an individuals’ cognitive structure through which the individual makes sense of the nature and the role of technology, its use, and the consequences of such use. Perceptions generated due to these cognitive structures aid individuals in understanding the capabilities of the innovation and can potentially become facilitators or inhibitors of effective use of organizational information systems. Individual’s technological frame of reference aid in interpretation and adaptation to HIT. These frames also define users’ expectations and desires related to the adoption and use (Elsbach 2005; Moen and Brenan 2005). Agarwal et al. (2010) suggested seven distinct frames that individual users will be influenced by in the case of system use. These frames range from positive to neutral to negative. Positive frames reflects frames that create an environment conducive to effective system use, whereas negative frames reflects frames that impede effective system use. The neutral frames reflects the continuum lying within the positive frame of reference to the negative frame of reference. Positive frames influences effective use of systems whereas negative frames impede effective use of systems.

EHR Use

Practice level EHR use is defined as “the utilization of EHR in a way that (1) fundamentally displaces a manual or paper-based process, (2) is used as intended by its designers, and (3) provides the greatest likelihood of delivering on anticipated value objective” (Agarwal et al. 2010). Even though system use has been a dominant stream of research in IS discipline (Davis et al. 1989; Venkatesh et al. 2003), there has been limited study on system use in the context of healthcare. The use of EHR in clinical and diagnostic workflow is increasingly becoming mandatory in nature (Jha et al. 2010). Given the critical nature of EHR use, it is imperative that we have theoretical understanding of what influences such use. Research suggests that there is tremendous variations in practice level EHR use across the healthcare sector (Menon and Kohli 2013). What explains such inconsistency? There exists a significant knowledge gap on the mechanism that influence the variation of EHR use. Understanding EHR use at the practice level is critical for achieving larger scale benefits through EHR use (e.g., quality of care, patient satisfaction).
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HIT-Induced Error

While EHR use and assimilation has been a key focus of the IS community, recent informatics literature documents growing concern of technology induced errors on healthcare outcomes (Ash et al. 2004; Borycki 2013; IOM 2012). A recent report from the Office of the National Coordinator for Health Information Technology (ONC) articulated the lack of understanding of the unintended consequences of HIT on adoption and use (Fluerant et al. 2012). In a rush to digitize the healthcare system, little or no attention has been paid to the potential harm from badly designed system (Borycki et al. 2009; Magrabi et al. 2010; Magrabi et al. 2012). These errors, also known as HIT-induced error, arise from the design, development, implementation, and use of HIT in the healthcare workflow (Borycki 2013). For instance, poor system interfacing between EHR modules can lead to fatal data related errors. Similarly, poor system integration may cause errors to spread across systems without being easily detected (e.g., Aarts 2012; Weiner et al. 2007). Given the nature of healthcare system, such errors can have fatal consequences on clinical and patient care processes. While HIT-induced error have been known to impact patients, health professionals and healthcare outcomes (Kuziernsky et al. 2012; Weiner et al. 2007), little is known about the mechanism by which it impacts such negative outcomes. Evidence also suggests that HIT-induced error is now being very frequently documented in institutions that have high level of automation (Samaranayake et al. 2012). Given the critical nature of the impact of such errors, what effect does it have on the EHR use of systems by actors, specifically the physicians? How does HIT-induced effect physician’s attitude towards EHR use at practice level?

IS Avoidance Behavior

Care giver resistance to HIT is particularly problematic in healthcare settings (Hendy et al. 2005; Kane and Labianca 2011). Care givers avoidance behavior negatively impacts efficiency of care process, which ultimately effects the cost of care. There is evidence to suggest that HIT avoidance by doctors effects healthcare efficiency by 20%-40% (Poon et al. 2004). Given the interdependent nature of work (e.g., specialties and subspecialties), resistance behavior can affect workflow coordination and communication. IS scholars are emphasizing the need for more research on avoidance behavior and how such behavior influences EHR use and healthcare outcomes (e.g., Jasperson et al. 2005; Lapointe and Rivard 2007). IS avoidance behavior has been defined as an individual’s preference to avoid using an HIT despite the need and the opportunity to do so (Kane and Labianca 2011). IS avoidance is generally associated with relatively mild responses (e.g. passive resistance, apathy) compared to extreme responses (e.g., disruption, sabotage). If caregivers’ negative perception of the system is associated with IS avoidance, then what effect does HIT-induced error have on such behavior? While extant literature has focused on the drivers of IS avoidance behavior, little or no research exists on how the technology itself contributes to such behavior.

Research Propositions

In this section, we theoretically develop our arguments for the proposed relationship. Leveraging on the foundations describe above, Figure 1 reflects the proposed research model.

![Figure 1: Proposed Research Model](image-url)
HIT-Induced errors leads to increase in the perception of irreducible uncertainty capable of causing patient harm (Aarts et al. 2012). Such kind of uncertainty associated with enhanced perception of complexity and unpredictable path (Han et al. 2007). Perceptions of uncertainty and complexity is associated with the individuals' cognitive structure. High level of uncertainty will be associated with a negative frame, whereas low level of uncertainty will be associated with a positive frame. Since HIT-induced error create perception of uncertainty, the negative frame will be the most dominant frame of view. A physician with a negative frame is likely to see the EHR as unreliable artifact with the potential to cause patient harm. Prior research suggests that physicians differ in how they perceive and respond to uncertainty (Politi et al. 2011). This variation in perception and response will be manifested in the variations of practice level EHR use. Thus, we posit:

**Proposition 1 (P1): HIT-Induced error will be negatively associated with practice level EHR use.**

Prior research suggests disproportionately powerful influence of negative stimuli on human behavior (Taylor 1991). HIT-Induced error acts as a negative stimuli for individuals using the EHR and is likely to drive individual judgment and behavior. The influence of negative stimuli on usage related behavior can be extended to user-system relationships. IS avoidance behavior reflects the negative attitude towards the system. When physicians perceive HIT as a threat then their effort is mostly oriented towards either diminishing emotional distress associated with the technology or reducing the perceived negative consequences. In such circumstances, individuals use avoidance behavior as the coping mechanism. The physicians perceives these technology induced error as threat and is more likely to use the dominant negative frame of reference. A physician with positive frame of view is less likely to be associated with IS avoidance behavior compared to a physician with negative frame of view. The technological frame of reference is a continuum and will reflect the variations in the IS avoidance behavior. Same time, the research also recognizes that the IS avoidance behavior may be an antecedent of HIT-Induced error. Thus, we posit:

**Proposition 2 (P2): HIT-Induced errors will be positively associated with IS avoidance behavior.**

When individuals face negative events during the process of user system interactions, they are more likely to see these events as threat. Physicians are less likely to trust the system that manifests frequent system related error. When faced with such circumstances, individuals will focus their efforts in minimizing the perceived threat. If they are unable to minimize the perceived threat, then they may avoid interaction with the system. Physicians who view the technology as an effectiveness enhancing tool and harbinger of new practices would see the positive benefit of the EHR use and are more likely to be associated with high level of EHR use. Low IS avoidance would most likely be associated with positive or beneficial frame of view and thus would be associated with high level of EHR use. High IS avoidance would most likely be associated with negative frame of reference and low EHR usage. High level of IS avoidance behavior reflects the physicians’ negative perception of the system. A physicians with high level of IS avoidance generally tends to perceive the system as a threat and therefore more likely to be a low EHR user. Thus, we posit:

**Proposition 3 (P3): IS avoidance will be negatively associated with practice level EHR use.**

**Conclusion**

This research study expects to make several key contributions specifically to the literature involving HIT and also to general IS literature. First, the study will provide insights and new understanding regarding the linkage between HIT-induced error and practice level EHR use. Second, the research highlights the role of negative usage behavior on the linkage between unintended consequences and EHR use. Given the challenges faced by the healthcare delivery systems today, extensive use of EHRs will continue to grow and become more prevalent in order to address these challenges. While EHR acceptance and adoption has been the key focus of extant literature, significant challenges remain particularly in terms of our understanding of how the technology induced errors influences EHR acceptance, implementation and use. Understanding the HIT-induced errors impact on EHR use may potentially provide a path towards achieving more beneficial EHR use in healthcare settings. Moreover, insights from the study can generate knowledge about the technical aspect of EHR use and may also potentially provide insights for future HIT
implementations. As researchers and healthcare managers seek to understand the relationship between HIT use and performance, it may be important to consider the role of unintended consequences such as technology induced error on performance and process outcomes. In light of the heterogeneity in the usage behavior among key stakeholders, the results of this study can aid in developing a more targeted interventions for EHR implementation. The study also brings to attention a potential new paradox - high level of digitization may lead to low system use. The findings can potential generate insights for designing, implementing, and managing HIT.

REFERENCES


