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HUMAN/TECHNOLOGY ADAPTATION FIT THEORY FOR HEALTHCARE

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ABSTRACT

In this document we extend and join Adaptive Structuration Theory with Task Technology Fit Theory and apply it to a health information technology setting. In our model, Human/Technology Adaptation Fit (HTAF) Theory, we assess the interactions between individual users and health information technologies. We develop HTAF, a model that focuses on the intersection of user adaptation and technology adaptation under the contexts of voluntary or mandatory health information technology, which both scholars and practitioners can use to determine the effects of the implementation of new technologies.

Keywords

Human/Technology Adaptation Fit Theory, Adaptive Structuration, Task-technology Fit, health information technology

INTRODUCTION

Soaring health care costs, restrictive regulations, and an internet-informed populace demand improvements in medical care; advancements in Health Information Technology (HIT) have been embraced, particularly by governmental entities, as a means to provide said improvements (Carroll, et al., 2002; EO, 2004; Koonitz and Powner, 2007). President-elect Obama stated that he will continue to focus on healthcare when in office and outlined his intention to develop a plan to modernize the practices of healthcare providers to include “cutting edge technology and electronic medical records” (Shear, 2008, p. 1). Examples exist of separate hospitals and other healthcare provider offices creating strategic alliances, contracted networks, or joint ventures; and in many cases, they may be made up of multiple forms within a single coalition (Kho, Lemmon, Commiskey, Wilson, and McDonald, 2008; Page, 2003). These associations have resulted in varied levels of success due, in large part, to challenges in HIT standards and data communication. Researchers and practitioners alike are pursuing the ideal HIT that is able to span in-house creations, commercial-off-the-shelf modified systems, and vendor-built systems and standards to provide a seamless transition of data flow from one provider in one healthcare organization to another. The U.S. Departments of Defense and Veterans Affairs have made some progress but still have a long way to go (GAO, 2007b).

The emphasis on standards, communication, and data is justifiable as healthcare facilities and organizations attempt to reduce costs and errors. It has been shown that increased organizational performance can be a result of appropriate use of IT (Narasimhan, 2001; Palvia, Perkins, and Zeltmann, 1992). However, IT is not always a solution in and of itself, and IT implementation may not result in increased efficiency or effectiveness (Orlikowski, 2000; Sambamurthy and Subramani, 2005). Researchers have argued that information system capability is much more complex than simply a well-developed application and there is a considerable social component that must be understood (Bharadwaj, 2000; Roberts, 2000). An understanding of the underlying balance between the organizational social structures, the individual employees’ tasks, and their relationship with HIT can enhance development of effective healthcare information systems that infuse usage requirements of healthcare providers, management, patients, and other stakeholders within the system. Our research begins to build a conceptual foundation based on adaptive structuration and task-technology fit that can be used to understand IT use and, thus, enhance organizational performance.

THEORETICAL FOUNDATION

We conceptualize HIT to include the IT artifacts and their nomological networks, comprised of systems that support the healthcare mission and include clinical decision support systems (CDSS), computerized physician order entry (CPOE), electronic medical/health records (EMR/EHR), personally-controlled health records (PCHR, a health record accessible by both physicians and patients through varied means), (Halamka, Mandl, and Tang, 2008), other knowledge management

information systems, and administrative support functions systems. We differentiate HIT from general purpose IT by its more specific focus and potentially more restrictive and rigid structure and set of standards.

Adaptive Structuration Theory (AST) enhances the study of IT, particularly in situations of new implementations. Using Giddens's Structuration Theory (1984) as a basis, DeSanctis and Poole (1994) developed modifications that focus on the social structure within organizations and the means through which the interaction of organizational members affects and are affected by the use of IT. In contrast to the social structure focus of AST, the Task Technology Fit model (TTF) centers on whether the IT is appropriately designed to suit the task the individual user (IU) performs. While the AST model is generally used to address phenomena at the group level of analysis, TTF focuses on the individual level. Rarely is patient care the domain of an individual; groups consisting of doctors, nurses, practitioners, technicians, administrators, *and* the patient are involved in information exchange, decision-making, and actions based on decisions made. Thus, AST can be applied to the study of HIT. Further, TTF can be used to examine the relationship of each of the above-mentioned actors with the HIT systems with which they interact. We believe that these theories are particularly suited to the study of HIT.

AST focuses on the social structure viewpoint of groups in organizations and treats new IT as an ancillary structure to the organization's existing structure. Once implemented, IT has an effect on the social structure of the organization and becomes a part of that structure. The AST model posits that the individual user chooses how he or she uses the IT and that decision may lead to use in a manner other than for what it was intended; two identical systems deployed to different groups or organizations may be employed disparately (DeSanctis and Poole, 1994). Healthcare groups have authority figures (e.g., doctors, patients), mid-level managers (e.g., nurses), and workers; like virtual teams, however, they often act as separate entities in an asynchronous mode, making the action of the individual of particular interest.

We extend AST by applying the concepts of Goodhue's and Thompson's Task-Technology Fit model (Goodhue, 1995; Goodhue and Thompson, 1995). They modeled Task-Technology Fit and utilization to predict the effect on individual performance improvement an appropriate match of IT to an individual's assigned task could make and the Technology-to-Performance Chain that holds "that for an information technology to have a positive impact on individual performance, the technology *must be utilized*, and the technology *must be a good fit with the tasks it supports*" (Goodhue and Thompson, 1995, p. 213, emphasis from original article). The triad of the individual's task qualities, the IT characteristics, and the individual user's characteristics must be in confluence.

Interaction and communication are important in determining how HIT is applied and adapted to accomplish the healthcare mission, as is the use of technologies developed and implemented to improve communication, information transfer, and decision-making. This study outlines a potential model for understanding the complex social implications of HIT by joining AST and task-technology fit. Although each has merit, there is potential to improve the understanding of why certain phenomena occur and how this insight will bring practical value to healthcare practitioners and administrators. We believe there is a correlation between the level at which HIT is appropriately fitted to the individual user's task and the level to which the individual will attempt to adapt the HIT or adapt his or her own behaviors. We believe that by taking a combined approach we can garner a better understanding of the phenomena that occur during situations of HIT implementation.

In addition to considering how individuals perceive and interact with HIT (AST context) in light of the complexities of the task (TTF context), it is important to consider whether the usage of the HIT is voluntary or mandatory. Many healthcare practices are requiring physicians, nurses, and other care providers to interact directly with HIT, whether simply to record notes in an electronic medical record or to order and receive results of tests via HIT. How the provider adapts the HIT will likely differ if he or she *must* use the technology or whether usage is *recommended*. Most patients are not required to interact with a system but may be encouraged to do so (for instance, to post blood glucose readings taken at home) or may simply want to interact to obtain information or to request information. Human/Technology Adaptation Fit (HTAF) Theory focuses on the intersection of user adaptation and technology adaptation under the contexts of voluntary or mandatory HIT use.

DISCUSSION

We define Individual User (IU) adaptation as temporary or permanent modifications that a user makes to his or her behaviors or norms because of perceived or real limitations of the HIT to be able to accomplish his or her tasks. These include simple workarounds that allow the user to more effectively work on the system, as well as those that avoid features of the system. A simple workaround of employing a "cheat sheet" to remember keystroke combinations necessary in non-graphical applications by an individual primarily familiar with graphical user interfaces may result in a minor decrease in efficiency and costs little to the system or the process. Adaptations are not always of low significance, however. In a recent example in

a nursing home, the HIT was designed with built-in safety measures to ensure accurate orders would arrive at the pharmacy. However, a staff member bypassed the safety features to reduce personal workload and the “staff discussed working around these [impediments to task accomplishment] by ‘tricking the system’ to get their work done” (Vogelsmeier, Halbesleben, and Scott-Cawiezell, 2008). Certainly, patient danger is of dire concern when caregivers bypass safety mechanisms of HIT. While some authors include disuse of the system in the definition of technology adaptation (Thomas and Bostrom, 2008), we believe this is a user adaptation because the user’s behavior must change in order to forgo using the HIT.

We define information technology (IT) adaptation as the ability and actions of a user to modify HIT to facilitate job tasks. Modifications to the technology may be as simple as using voice entry over keyboard entry methods or as major as downloading data for use on other (particularly less secure) systems. Personalization, the concept of allowing individuals to arrange their workstations, desktops, and applications in a way that is most efficient, is another type of IT adaptation. IT adaptation also extends to incorrect or incomplete use of the system. Incomplete data challenges the ability to make informed, timely decisions (Tucker, Nembhard, and Edmondson, 2007). Studies indicate that there are inconsistencies in the amount and types of data entered into a system (Ballie, Burwood, and Owen, 2005) and perceived lack of information availability (Christensen and Grimsom, 2008). These perceptions lead to adaptation both of user behavior and of technology.

Although its applicability extends to other domains, the significance of HTAF in healthcare environments lies in the level of process integration of the electronic medical record and other HIT. In many healthcare organizations adopting an EMR and/or a PCHR, it is essential to the effectiveness of the system that all members of the healthcare process actually use the information system. Therefore, many healthcare facilities make it mandatory for all employees to use the system.

The HTAF model below illustrates the relationships of the following propositions (see Figure 1 below):

Proposition 1a: The closer the HIT is aligned to the individual user’s task requirements, the “perfect fit,” beginning with initial deployment, the less likely that either IU adaptation or IT adaptation will occur.

Proposition 1b: The further from perfect fit the HIT is, the more adaptation of the IU and the IT will occur.

Proposition 1c: There is a correlation between IU adaptation and IT adaptation to the HIT.

Proposition 2: The relationships in Proposition 1a through 1c are moderated by whether the use of HIT is mandatory or not.

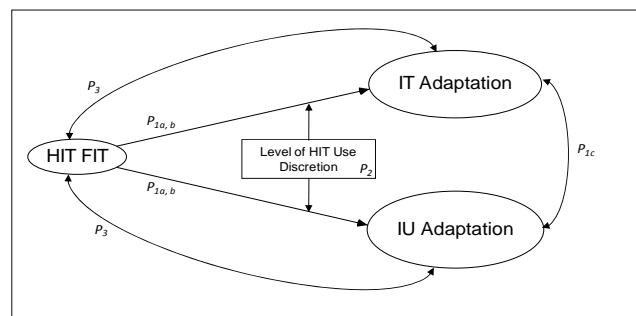


Figure 1. Human/Technology Adaptation Fit (HTAF) Model

When HIT use is mandatory (Figure 2 below), the user will adapt the HIT (solid line) to meet his or her needs based on the level to which the HIT provides the user the ability to effectively perform his or her task; the closer to a “perfect fit,” the less adaptation occurs. Likewise, IU adaptation (dashed line) occurs minimally if the technology fit to the task is near perfect and increases slowly until X. The X indicates the point at which no further IT adaptation occurs, either because it is impossible for the user to further adapt the system or effort required to adapt the IT is perceived to be too great for the value returned.

Proposition 3: There is a correlation between the level of task fit and the level of IU adaptation and the level of IT adaptation the user attempts to make.

At point X and beyond, we expect IU adaptation to increase at a greater rate to compensate for the lack of IT adaptation available to the user. However, at some point, Y, IU adaptation plateaus as adaptation options diminish. The options may diminish due to the aptitude level of the IU, because options are exhausted, or because of yet undetermined variables. Despite the mandatory use policy, we anticipate different levels of adherence to the policy based on the IU authority and position. We

reviewed anecdotal evidence of a federal healthcare facility in which, despite a mandatory EHR use policy, some physicians resist using the system and opt out through passive resistance measures. There is a shortage of physicians in that facility that places them in a position of greater power than they might otherwise hold. Due to the elevated status of a physician in the social structure of the organization, they may wield greater discrimination authority than do others. We anticipate support staff will adapt IT more than those in positions of greater authority and we expect a lower level of IU adaptation from physicians than what we expect from the support staff members despite the mandatory use policy and, in this situation, we see a model that more closely aligns with that of the discriminatory use policy model (Figure 3 below).

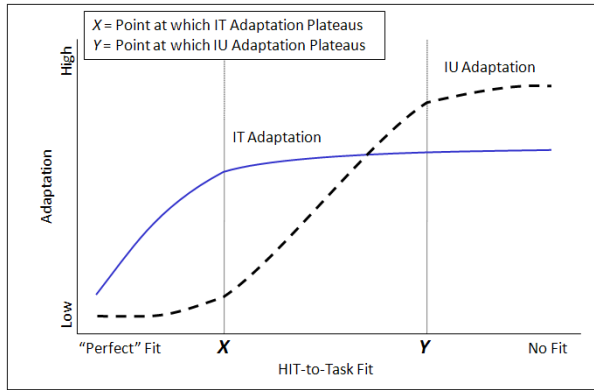


Figure 2. HTAF - Mandatory Use Policy

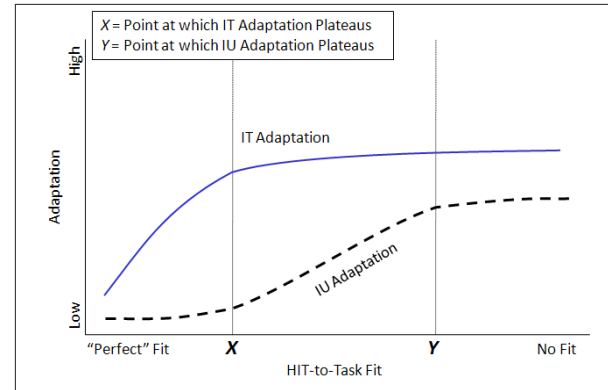


Figure 3. HTAF - Discriminatory-Use Policy

Due to standardization requirements for health records and stringent federal regulations regarding healthcare privacy and delivery of healthcare across medical departments, a mandatory use policy is assumed to be the norm in health facilities implementing HIT. However, in situations in which a healthcare facility implements a user-discriminatory policy for use of the HIT, we expect a different phenomenon. Under a user-discriminatory policy, we expect the level at which the IU adaptation occurs will be minimal if the fit of the technology to the IU task is near perfect. If the fit is less than perfect, IU adaptation will increase along the continuum until point X. At X, IU adaptation increases at a greater rate to compensate for the lack of technology-to-task requirement fit. However, at some point Y, IU adaptation plateaus as adaptation options diminish. The IU may continue to compensate as individual work ethic dictates. However, with discriminatory control within the purview of the IU, at some point Y, when effort required to adapt is greater than perceived added value of the IT, the user will cease to employ the system to perform his or her tasks.

Factors

Factors that affect the structures and design, and consequently, the performance outcomes of implementing IT in the healthcare industry are different from what is found in other industries. They require careful consideration and cautious implementation policies. One such factor is the need for healthcare information privacy. Medical information theft is on the rise (Conn, 2006), and security measures must be designed in HIT. The Government Accounting Office reports a need for enhanced security and privacy (GAO, 2007a).

Due to the sensitivity of the health record, government regulations impact both the design, and subsequently, the level of IT adaptation possible of the HIT and the level of IU adaptation required. The requirements of the Health Insurance Portability and Accountability Act of 1996 (HIPAA) are designed to protect medical information (Annas, 2003; Aronovitz, 2001). HIPAA has restrictions that impact how healthcare workers interact with protected health information whether it is a paper or an electronic record; these strict mandates manifest in measures that range from using polarizing computer monitor filters that limit screen field of view to software code standards. The U.S. is not alone in implementing stringent health information privacy as other countries struggle with implementing healthcare information technologies (Immonen, 1996). The outcome of the Food and Drug Administration's regulation of the administering of drugs impacts both IT and IU adaptation as well.

In addition to the effect government regulations play on the suitability of HIT to user functions, outside agencies generate factors. For example, health insurance company requirements and International Classification of Diseases (ICD-9) standards used to categorize conditions of injury and poisoning (Langley and Chalmers, 1999) impact the design of HIT by limiting the extent to which the individual user is able to adapt the system. These externally-applied factors require greater IU adaptation than what might be found outside healthcare. The medico-legal concerns of caregivers can limit individual user adaptation

attempted. Malpractice insurance continues to increase and doctors can be expected to choose the more conservative route when faced with decisions about adapting HIT.

While further analysis of HTAF is necessary, one factor that appears to improve HIT fit to healthcare provider task is found in a recent study (Garg, et al., 2005). Garg et al. recognized in CDSS that provide automatic prompting to the healthcare provider, the provider performance was superior to that in which only manual initiation options were available. By injecting the CDSS into the provider's workflow, fit is improved, thus reducing IU adaptation needs.

Implications for Future Research

While we approach this research from a positivist perspective as Lee suggests (Lee, 1999), we will not constrain ourselves by positivism during analysis. Our approach is similar to that used in studying phenomena through the lens of adaptive structuration; follow the processes, analyze the before and after processes of the deployed systems, identify structures produced by users in response to the change in technology, identify and measure the points at which X and Y occur, and identify the extent to which the model is validated. The breadth of the effects of our model should be telling.

As concluded by both Garg et al, and Hunt et al, in their similarly-titled papers, there is a need for increased research in determining performance and patient outcomes using HIT for CDSS and EMR (Garg, et al., 2005; Hunt, Haynes, Hanna, and Smith, 1998). The extent to which our model can be an asset to the investigative process has yet to be determined, but we see great potential utility. While we believe our model to be conceptually sound, empirical evidence is necessary to support it. It offers a base structure for HIT/user interaction in the standards-restrictive healthcare environment. Constructing empirical measures to determine points X and Y on both the Mandatory and Discriminatory models can yield a workable design model from which practitioners can make intelligent decisions on HIT expenditures and implementations.

Our model can be extended to include the patient as a unit of analysis. With ever-increasing demand for a PCHR and remote access to PCHR to aid patients in being more integrated in their healthcare decision-making, the need to assess the task fit social interaction of technology with patients is increasing. While there is some success, evidence exists that current patient-inclusive HIT are falling short of expectations; patients are seeking alternatives to hospital-created PCHR to retrieve health information knowledge, such as treatment modality and efficacy (Carroll, et al., 2002; Nijland, van Gemert-Pijnen, Boer, Steehouder, and Seydel, 2008). Patients fall into the mandatory use policy category in the model from the perspective that if they want access to the information, they have to use the system the hospital provides, but what level of discrimination do they have? We expect they have little influence over IT adaptation; therefore IU adaptation is more likely to occur. With the PCHR in its infancy, design ranges from hospital to hospital, and will result in various levels of IU adaptation.

CONCLUSION

By carefully considering our model and propositions, managers can identify potential pitfalls and barriers to successful implementation of health information technologies and avoid them. Information Systems professionals can establish a proactive stance for HIT implementation and organizational change. Applying our model to assess the appropriateness of the technology to the individual healthcare giver's task, with the perspective of a structural fit, hospital administrators and other practitioners can lead to more effective implementation and use of costly information systems resources. Our model provides a basis for both scholarly research and practitioner employment.

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