Understanding Health Information Technology Adoption from a Socio-Technical Perspective

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ABSTRACT

Numerous studies on the adoption of health information technology (HIT) from various perspectives demands for a conceptual consolidation of knowledge across multiple levels and different landscapes in the field. Employing text mining and network analysis techniques, we conduct an exploratory investigation on the literature of HIT adoption from a socio-technical perspective. We explore the linkages among core concepts in prior research and construct an integrated theoretical framework of HIT adoption. Our theoretical framework adds to the socio-technical theory a new perspective that distinguishes between general considerations of technology adoption and issues specific to HIT adoption. We identify core and peripheral areas of prior research interest in the field and point out future research directions. The knowledge obtained is also beneficial for health care practitioners and policy-makers to improve the effectiveness in the adoption and use of HIT systems.
Key words: health information technology, socio-technical theory, technology, structure, people, task

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INTRODUCTION

Health information technology (HIT) has been recognized as one of the most important means to improve the quality, efficiency as well as effectiveness of healthcare services (Pan et al., 2008; Walker et al., 2005). However, several studies have indicated that the adoption of HIT remains limited (e.g., Ash et al., 2004; Randeree, 2007) and healthcare organizations considering the adoption of HIT face many financial, technical and cultural barriers. Understanding the factors that have significant effects on HIT adoption may assist practitioners as well as policy makers to develop effective solutions to make this process less painful and more effective/beneficial for physicians and patients.

There have been numerous studies on the adoption and use of HIT systems. Most of the prior assessments have focused on an individual HIT or health information system (HIS) such as electronic health record (e.g., Jha et al., 2009), computer physician order entry (e.g., Kaushal et al., 2003; Snyder & Fields, 2007; Teufel et al., 2009), and telemedicine (Grigsby et al., 2007; Mandl et al., 1998). Researchers have examined the adoptions of these HIT at either the organizational level such as hospitals (e.g., Jha et al., 2009; Teufel et al., 2009) or the individual level such as nurses (e.g., Eley et al., 2009; Lu et al., 2006), physicians (Snyder & Fields, 2007) and patients (e.g., Ralston et al., 2007). Some researchers examined HIT adoption for specific tasks such as the improvement in patient safety (Brooks et al., 2005) and the reduction of medical errors (McAlearney et al., 2007).

Despite the considerable effort researchers extended to advance the understanding of HIT adoptions from various perspectives, the prior literature does not ensure a conceptual consolidation and a unified accumulation of the knowledge in this field yet (Poon et al., 2006). Little is known about the overall relationship and patterns among the various factors across technologies, stakeholders and tasks (Poon et al., 2006). A systematic review of the literature across these landscapes is critical for the construction of an integrated framework of HIT adoption, which leads to an integration of the knowledge accumulated and a comprehensive understanding of the field.

We intend to integrate the research on HIT adoption from a socio-technical perspective and to point out future research directions in this field. We pursue this end by an exploratory approach. In contrast to earlier reviews of the field that focus on individual relevant articles, we employ an innovative methodology to identify HIT adoption factors and analyze the relations between them. Specifically, we use newly developed intelligent text mining techniques for a systematic review on existing literatures to build a network of socio-technical concepts of HIT adoption that have been examined in the literature; then we present a network analysis of these key concepts and the links among them to explore patterns and interrelationship underlying these socio-technical concepts. Then drawing on the socio-technical theory, we integrate the findings from the network analysis into a conceptual framework.

We contribute to the literature both methodologically, through the combination of relatively new techniques, and theoretically, through a construction of an integrated framework across multiple levels of analysis and different landscapes. The knowledge obtained is useful for healthcare practitioners and policy-makers to fully maximize the benefits and minimize the costs associated with the adoption and use of HIT systems. Specifically the contribution of our research is three fold. First, we provide an overall picture of the HIT adoption field through mapping the key socio-technical concepts examined in prior research into an integrated network. Second, we build a theoretical framework of HIT adoption by drawing on the socio-technical theory. Third, we point out several future directions of research that will complement the existing literature.

METHODOLOGY

Sample Selection

During the last two decades, information technology (IT) has become widely used in healthcare and interest in HIT adoption grows significantly among researchers. We based our review of the HIT adoption literature on the existing articles, most of which were published between 1990 and 2009. Our initial sample was collected by computerized searches through healthcare research databases, including PUBMED, MEDLINE and EMBASE. We searched all abstracts/titles with the key words "Healthcare", "Information Technology", "Adoption", "Diffusion" and "Implementation". The initial sample size is 5460. The sample comprises textual data including a unique identifier, the citation, abstract, authors' affiliation, and type of article, for each of the articles.

Because not all articles in the initial sample pertain to the socio-technical aspect of HIT adoption, both authors separately examined the abstracts and selected from the sample the relevant articles. The Measure of Agreement Kappa was 0.77, indicating an acceptable level of inter-rater reliability. The disagreements were resolved after the research team reexamined the articles. The final sample includes textual data for 979 articles, all of which concerns the socio-technical aspect of HIT adoption.

Network Analysis

The 979 sample articles established the foundation and boundaries for a network analysis of key socio-technical concepts examined in prior HIT adoption research. The objective of the network analysis is to identify socio-technical factors that influence HIT adoption and to explore the relationship among these factors.

To initiate the network analysis, we employed a computerized text mining technique to search for key socio-technical concepts in prior HIT adoption literature. Text mining seeks to extract useful information through the identification and exploration of interesting patterns from relatively large-size textual data (Feldman & Sanger, 2007). The SAS Text Miner program used in this study reveals the explicit relationships among the terms contained in the abstracts and classifies the documents into clusters based on the relationships. Utilizing this technique, we classified the 979 sample articles into 14 clusters. Each cluster is defined by several descriptive terms (Table 1).

(Insert Table 1 about here)

The descriptive terms of each cluster delineate some important concepts of the corresponding cluster. They reveal both the technical perspective and social perspective involved in HIT adoption. The topics on the technical perspective are either task-related, such as healthcare quality improvement (cluster 1), cost assessment (cluster 6) and error reduction (cluster 12), or technology-related, such as telemedicine (cluster 2), Internet (cluster 4), imaging (cluster 5), clinical decision support (cluster 9), electronic health record (cluster 11) and electronic prescription (cluster 12). The topics on the social perspective are either user-related, such as patient (cluster 8), nurse (cluster 13), student (cluster 14), or organization/structure-related, such as healthcare organization (cluster 1) and policy/standard/act (cluster 10).

Although the descriptive terms facilitate understanding the main concepts of the articles in the sample, they do not form an integrated network and the relationship among these concepts is yet to be established. Another drawback of the descriptive terms is that some important concepts that are related to HIT adoption could be overlooked because of their relatively low frequency of appearance in the sample. Therefore we employ another text mining technique, the conceptual links, to enrich the pool of key concepts we identified on the basis of the descriptive terms. The conceptual links technique utilizes predefined key words, that is, the descriptive terms, to search through the abstracts in the sample to find terms that frequently accompany the predefined key words. The predefined key word is called the root in the technique, the immediate highly related terms are called nodes, and the next highly related terms are called leaves. All the roots, nodes and leaves constitute the key socio-technical concepts and they are the building blocks of an integrated network. Figure 1 illustrates the conceptual links generated using the key word “physician”.

(Insert Figure 1 about here)

Another prominent advantage of utilizing the conceptual links technique is we are able to connect the conceptual links of each root through common nodes and leaves, hence generate an integrated network of key concepts. The theoretical foundation for the generation of such a network can be traced back to the learning psychology of David Ausubel (1963, 1968; Ausubel et al., 1978). Ausubel’s fundamental idea is that knowledge accumulation takes place by the integration of new concepts into the existing concept frameworks. Hence mapping separate concepts helps organize the existing knowledge, “even though the structure must be built up piece by piece with small units of interacting concept and propositional frameworks” (Novak & Cañas, 2008).

We obtained conceptual links for relevant descriptive terms (the root of conceptual links) from the cluster analysis. Then we connect the sets of conceptual links using common nodes and leaves into a bigger "concept map". Figure 2 presents the complete conceptual network.

(Insert Figure 2 about here)

There are 41 key concepts in the integrated network. Each concept represents a position or a collective action, that is, "subgroup within a network defined by the pattern of relations that connect the empirical actors to each other" (Knoke & Kuklinski, 1982: 18). For example, physician in the network persists although there may be frequent changes in the individuals who occupy these positions. According to Knoke and Kuklinski (1982), the advantage of constructing such conceptual network is that "the complexity of the network is typically simplified; reducing a large number of actors into a smaller number of positions, since typically several empirical actors occupy the same position (Knoke & Kuklinski, 1982: 19)".

The construction of such integrated conceptual network is critical to our research. The objective of our research is to discover the relationship among healthcare provider, patient, technology and environment in the adoption of HIT; a graphical representation of the relationship among the key concepts of HIT adoption will significantly facilitate the discovery of hidden relationships and patterns among them. The network is analyzed using UCINET, a widely adopted tool for network analysis.

RESULTS

We employ two widely adopted tools, hierarchical cluster analysis and multidimensional scaling (MDS), to examine the patterns of the relationships in the network. Both cluster analysis and MDS are designed to assess the degree of similarity among nodes and find patterns in a network. The result of such analysis manifests how "close" a set of nodes are; and nodes that are "more similar" are put closer to each other. MDS complements hierarchical cluster analysis in that in using cluster analysis, we assume that the similarity among nodes is present in a single primary dimension. However there could be multiple dimensions underlying the observed similarities; hence MDS could be employed to identify the dimensions and to reveal patterns in the similarities among nodes in a multi-dimensional space.

Hierarchical Cluster Analysis

Table 2 reports the result of hierarchical cluster analysis of seven clusters[1]. The result reinforces and refines the implications we draw from the descriptive terms analysis in the previous Section. Clusters 1 through 5 report the major HIT examined in the literature: Telemedicine, E-prescription, EHR, CPOE, Clinical decision support, and PACS & end user devices. The concepts within each of the five clusters concern the stakeholders involved in the adoption and the tasks related to each HIT. For example, the concepts in Cluster 1 imply that the literature on Telemedicine adoption views Telemedicine as the use of communication technology and Internet by health professionals to deliver healthcare services as well as health related knowledge to patients. Similarly Cluster 2 concerns utilizing E-prescription technology to improve

[1] UCINET requires users to specify the number of clusters in running cluster analysis. The model with seven clusters yielded the best fit.

patient safety, reduce the risk of medication error, promote appropriate drug usage, and empower pharmacists to deliver higher quality care.

(Insert Table 2 about here)

Clusters 6 through 7 are pertinent to some social aspects of HIT adoption. The concepts in Cluster 6 are related to general technology usability at the level of individual users. These concepts are commonly observed in the behavioral research of IT adoption, such as the technology acceptance research and the human computer interaction research. This indicates that the literature on HIT adoption has employed theories and methods from the general IT-related behavioral research. Compared with Cluster 6, Cluster 7 involves concepts mostly beyond the level of individual users: the concepts in Cluster 7 concern either the implementation of HIT (e.g. interface and standard) or the performance of healthcare services due to the use of HIT (e.g. efficiency/effectiveness, quality and cost).

Overall the hierarchical cluster analysis facilitates the understanding of the major technical and social components in the conceptual network. To validate whether the higher-level dimensions underlying the network indeed involve both the social and technical aspects of HIT adoption, we conduct MDS analysis on the network. MDS is useful in identifying the dimensions and the overall patterns in the network (Borgatti, Everett, & Freeman, 1999). It facilitates exploring the relationship among the components generated in the hierarchical cluster analysis and the patterns underlying the various concepts across technologies, stakeholders and tasks.

Multidimensional Scaling

The MDS analysis positions the concepts in the conceptual network in a two-dimension space. The values of the concepts along each dimension range from negative to positive. Concepts with positive coordinates on a dimension are included in that dimension and excluded otherwise. Figure 3 visualizes the relationships between the concepts and the two dimensions.

(Insert Figure 3 about here)

Most of the concepts are present in at least one dimension. The concepts that only emerge in Dimension 1, such as user, usability, satisfaction, need and interface, are commonly seen in the behavioral research of IT adoption. These concepts are not necessarily specific to HIT adoption, but rather general to all kinds of IT adoptions. Because most of these concepts are related to user behavior at the individual level, we name this dimension “General Usability”.

In contrast, the concepts that only emerge in Dimension 2 are specific to the delivery of healthcare services. Some concepts in this group are pertinent to healthcare outcomes, such as safety, quality, cost and act; others are regarding entities involved in medication, such as patient, physician, pharmacy, drug, and prescription. Thus, we name Dimension 2 “Healthcare Delivery”.

The concepts present in both dimensions involve the using of IT for healthcare services deliveries. These concepts cover specific HIT (e.g., Clinic decision support, Telemedicine, EHR, PACS and CPOE), technology implementation and application (e.g., design, record, decision, assessment and error), HIT devices and infrastructure (e.g. computer, Internet, communication technology and handheld) and user environment (e.g. hospital, healthcare professional, nurse, acceptance and attitude).

Only efficiency/effectiveness and standard are excluded from the two dimensions. These two concepts are separated from the other concepts probably because they are very general requirements in consideration of HIT adoption, and thus not particularly pertinent to either dimension.

Note that the classification of the concepts to the two dimensions is based on the conceptual links derived from the existing studies on HIT and may not be fully consistent with the conventional wisdom. For example, "student", "nurse" and "physician" are all healthcare personnel hence are similar according to the conventional wisdom. According to the result of MDS, however, they are classified into different groups. This is because student in the existing literature is treated as participants in IT learning and training but not necessarily in healthcare delivery; hence student is a concept more pertinent to the General Usability dimension. Physician represent an indispensible entity in medication hence are more pertinent to the Healthcare Delivery dimension than to the General Usability dimension. Nurses are often treated in the existing literature as the end-users of healthcare technologies for the delivery of services; hence are pertinent to both dimensions. Overall the classification results from MDS are based on the semantic relationships obtained from the literature on HIT adoption.

Integration of Concepts from a Socio-Technical Perspective

We draw on the socio-technical theory to interpret the important insight recognized in Figure 3. Socio-technical theory has been applied to a variety of contexts (e.g., Frohlich & Dixon, 1999; Lamb & Kling, 2003). According to the socio-technical theory, there are two systems that need to be taken into account in studying the impacts of organizational IT: the technical system and the social system. The technical system concerns the tasks of transforming inputs into outputs through technologies and related processes. The social system concerns the people who are directly and indirectly involved in the development and use of technologies (e.g., their attitudes and skills) and the social structures that regulate such endeavors (e.g. rewarding systems and laws). The two systems are jointly independent from but correlatively interacting with each other and the outcomes depend on such joint interactions. Figure 4 shows the diagram presentation of the theory.

（Insert Figure 4 about here）

The key points and components of the socio-technical theory are closely associated with the concepts, clusters and dimensions we identified previously. We adapt the socio-technical theory to the context of HIT adoption by defining the four constructs in the theory. In particular, the people construct refers to user behavior at the individual level in general IT adoption; concepts such as user, usability, interface, satisfaction and need are pertinent to this construct. The task construct refers to the various applications and usages of HIT to achieve certain outcomes and is specific to the delivery of healthcare services; concepts such as quality, cost, error and safety are examples pertaining to the task construct. The technology construct refers to technical issues in implementation and adoption; concepts such as design, interface, and functionality are relevant to the technology construct. The structure construct refers to the social structures that regulate the development and use of technologies; concepts such as act and policy are relevant to the structure construct.

Two researchers then separately map all the concepts in the conceptual network to the four constructs following the adapted definitions for the four constructs in the theory. Disagreements are resolved through reexamination. We report the mapping of the concepts to the four constructs in Table 3. For comparison, we also report the relationship between the concepts and the two dimensions from the MDS analysis in Table 3. The 'X' mark in the table indicates that a concept is included in a MDS dimension or mapped to one of the four constructs from the socio-technical perspective. For example, "Acceptance" is about the willingness of a user to apply a technology on a task. Thus, it is semantically mapped to "people", "technology" and "task".

(Insert Table 3 about here)

Among the 41 concepts in the conceptual network, clinical decision support, computerized physician order entry (CPOE), electronic health record (EHR), e-prescription, picture archiving and communication system (PACS) and telemedicine are specific HIT. We determine their relationship with the four socio-technical constructs by reviewing articles that focus on each individual HIT in our sample.

We selected the articles directly relevant to each of the HIT through searching in the titles using the name or acronym of each technology. Altogether 167 articles were selected for further manual scrutiny. We identified the aspect of the socio-technical perspective that each article mainly addressed by reading the abstract. For example, if an article employed survey method to find out physicians' attitude towards using PACS, it mainly focused on the "people" aspect. If an article discussed how to implement PACS, it mainly focused on the "technology" aspect. If an article suggested new policies to be made for promoting the diffusion of PACS, it mainly focused on the "structure" aspect. Finally, if an article explored the application of PACS on some healthcare tasks, it mainly focused on the "task" aspect.

The percentages presented at the bottom of Table 3 show the relative frequencies of studies that focus on people, technology, task and structure. The existing studies of every technology have coverage over all the four constructs. Among all the technologies on average, structure-related issues has been studied the most frequently (average 36%), and people-related issues has been studied the least frequently (average 15%).

A comparison between the left side (i.e. MDS dimensions) and the right side (i.e. Socio-Technical Perspective) of Table 3 shows pretty strong corresponding patterns. If a concept is scaled onto the "general usability" dimension only, it is typically related to the "people" and "technology" components. If a concept is scaled onto the "healthcare delivery" dimension, it is typically related to the "task" component only. If a concept is scaled onto both dimensions, it is typically related to "technology" and "task".

The adaption of the socio-technical theory to the HIT adoption context enables the incorporation of all of the concepts in our conceptual framework into the socio-technical perspective. However, the theory does not explain the two dimensions generated by MDS, that is, the general usability dimension and the healthcare delivery dimension. There seems to be another perspective for the examination of the framework. We present the modified framework in Figure 5.

(Insert Figure 5 about here)

The framework in Figure 5 shows that aside from the socio-technical perspective, there is another perspective in the framework, namely general/healthcare-specific perspective. Specifically the people, technology and structure constructs are related to the general technology usability dimension, and the structure, technology and task constructs are concerning the health care service delivery dimension. The general usability dimension excludes task because task is healthcare specific; it includes people, technology and structure because these are all involved in the evaluation for general technology usability. Similarly the healthcare specific service delivery dimension excludes the people construct because the people construct concerns general technology usability issues. The general usability/health care specific perspective is confirmed by the mapping of the concepts into the four constructs (Table 3). Concepts that belong to D1 only are those concerns people, technology and structure but not task and concepts belonging to D2 only are those that concerns technology, structure and task, but not people.

IMPLICATIONS AND CONCLUSIONS

Theoretical Implications

The complete theoretical framework (Figure 5) distinguishes the set of concepts generally applicable to IT adoption from those applicable to health care specific context and integrates them into the framework of socio-technical theory, thus generates an integrated view of the field of HIT adoption across multiple levels of analysis and different landscapes. Our theoretical framework implies that HIT adoption is a complex socio-technical phenomenon and involves both general technology usability perspective and healthcare specific perspective. The building blocks in this phenomenon include user behavior at the individual level in general IT adoption (people); the social structures that regulate the development and use of technologies (structure); the various applications and usages of HIT to achieve outcomes specific to healthcare (task); and the technical issues in implementation and adoption (technology). These building blocks are the components of two jointly independent systems in HIT adoption, the social and the technical systems. In the meantime, they enable the separation of healthcare specific technology adoption from the general technology adoption, implying that adoption of HIT has its uniqueness as compared to the adoption of general technology.

Implications to Future Research Directions

Findings from the previous Section show that the four constructs, people, technology, task and structure, are associated with each other and collectively determine the process of HIT adoption. Our understanding to this field will be greatly improved if we have deep understanding to each of these constructs. Our result shows that among all the technologies on average, structure-related issues has been studied the most frequently and people-related issues has been studied the least frequently. This calls for more research on the technology usability issues at the level of individual users such as nurses, physicians and patients. Although the technology usability issues at the individual level has been extensively studied in the IS literature, they are mostly applicable to general IT. Because HIT and the users involved in the adoption of HIT have their uniqueness, further research is necessary for better understanding of HIT specific usability issues at the individual level.

The existing studies on each technology have coverage over all the four constructs. However the coverage is not even across technologies. Fewer than 10% of the studies of PACS and EHR have addressed the people-related issues and the technology-related issues respectively. This calls for special attention by researchers to the adoptions of specific HIT.

Conclusions

Numerous literature on HIT adoption from various perspectives demands for a conceptual consolidation of the knowledge across technologies, stakeholders and tasks in this field. Employing text mining and network analysis techniques, we conducted an exploratory investigation on the state-of-the-art of the research on HIT adoption from a socio-technical perspective. We build on the socio-technical theory to integrate various factors/perspectives related to HIT adoption. In doing so, we add to the socio-technical theory a new perspective that integrates the general technology adoption concerns with the healthcare specific technology adoption. The integrated theoretical framework is used to point out future research directions. The knowledge obtained in this research is useful for healthcare practitioners and policy-makers to fully maximize the benefits and minimize the costs associated with the adoption and use of HIT systems.

TABLE 1
Clusters in the Sample

#	Descriptive Terms	Emphasis	Frequency
1	quality, +improve, healthcare, +organization	Quality Improvement	147 (15%)
2	telemedicine, +service, more, +have	Telemedicine Service	25 (3%)
3	+interaction, +device, +control, +interface	Interface/Interaction	10 (1%)
4	internet, healthcare, +technology, +new, +have	Internet	84 (9%)
5	+image, archiving, +picture, pacs, +communication	PACS	17 (2%)
6	+assessment, +cost, +technology, +new, +method	Cost Assessment	59 (6%)
7	+innovation, diffusion, +factor, +study, +technology	Innovation Diffusion	54 (6%)
8	patient, care, information, +practice, health, clinical	Clinical Information	176 (18%)
9	+digital, personal, +decision, clinical, care	Clinic Decision Support	48 (5%)
10	+standard, +development, medicare, act, +policy	Policy/Standard/Act	56 (6%)

11	ehr, electronic, +practice, +physician, +record	Electronic Health Record	125 (13%)
12	+physician, +order, +error, +medication, prescription	CPOE & E-Prescription	69 (7%)
13	handheld, +nurse, +study, medical, +technology	Nursing Technology	71 (7%)
14	education, +student, learning, +program, +computer	Health Education	38 (4%)

Note: PACS – Picture Archiving and Communication System; CPOE – Computerized Physician Order Entry.

TABLE 2
Hierarchical Cluster Analysis of the Conceptual Network

Cluster No.	Concepts	Cluster Summary
1	communication technology, health professional, knowledge, Internet, healthcare service, telemedicine, patient	Telemedicine
2	e-prescription, drug, act, error, safety, pharmacy	E-prescription
3	hospital, CPOE, design, physician, EHR, Record	EHR & CPOE
4	assessment, clinic decision, decision	Clinical decision support
5	attitude, computer, PACS, nurse, handheld, student	PACS & end-user devices
6	usability, satisfaction, need, functionality, acceptance, user	General technology usability
7	efficiency/effectiveness, HIT, interface, policy, cost, quality, standard	General considerations for HIT adoption

TABLE 3
Mapping of the Concepts

	MDS Dimensions		Socio-Technical Perspective			
Concepts	General Usability	Healthcare Delivery	People	Technology	Task	Structure
Acceptance	X	X	X	X	X	
Act		X		X	X	X
Assessment	X	X	X		X	
Attitude	X	X	X		X	
Communication technology	X	X		X	X	
Computer	X	X		X	X	
Cost		X			X	
Decision	X	X	X		X	
Design	X	X	X	X	X	
Drug		X			X	
Error	X	X	X		X	
Functionality	X			X		
Handheld	X	X		X	X	
Healthcare service		X			X	
Health professionals	X	X	X		X	
HIT	X	X	X	X	X	X
Hospital	X	X			X	X
Interface	X		X	X		
Internet	X	X		X	X	
Knowledge	X	X	X		X	
Need	X		X			
Nurse	X	X	X		X	
Patient		X	X		X	
Pharmacy		X			X	X
Physician		X	X		X	
Policy	X		X			X
Quality		X			X	
Record	X	X	X		X	
Safety		X			X	
Satisfaction	X		X			
Student	X		X			
Usability	X		X	X		
User	X		X			
Efficiency/Effectiveness					X	
Standard				X		
Specific Technologies						
Clinic decision support	X	X	12%	36%	20%	32%

CPOE	X	X	17%	20%	27%	37%
EHR	X	X	34%	8%	17%	42%
E-prescription		X	11%	14%	39%	36%
PACS	X	X	6%	33%	28%	33%
Telemedicine	X	X	11%	25%	29%	36%
		Average	15%	23%	27 %	36%

FIGURE 1
Conceptual Links of Physician

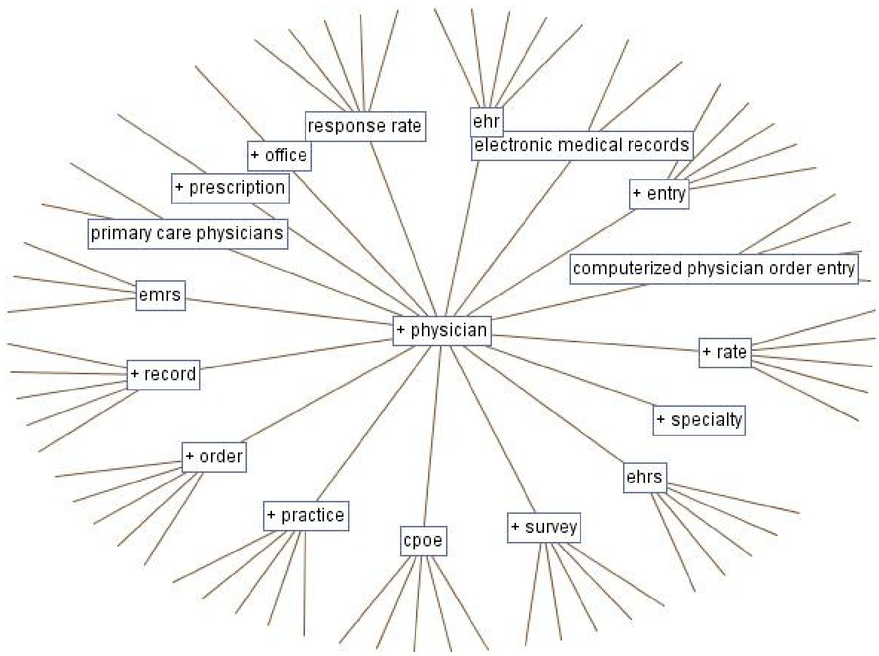


FIGURE 2
Conceptual Network of HIT adoption

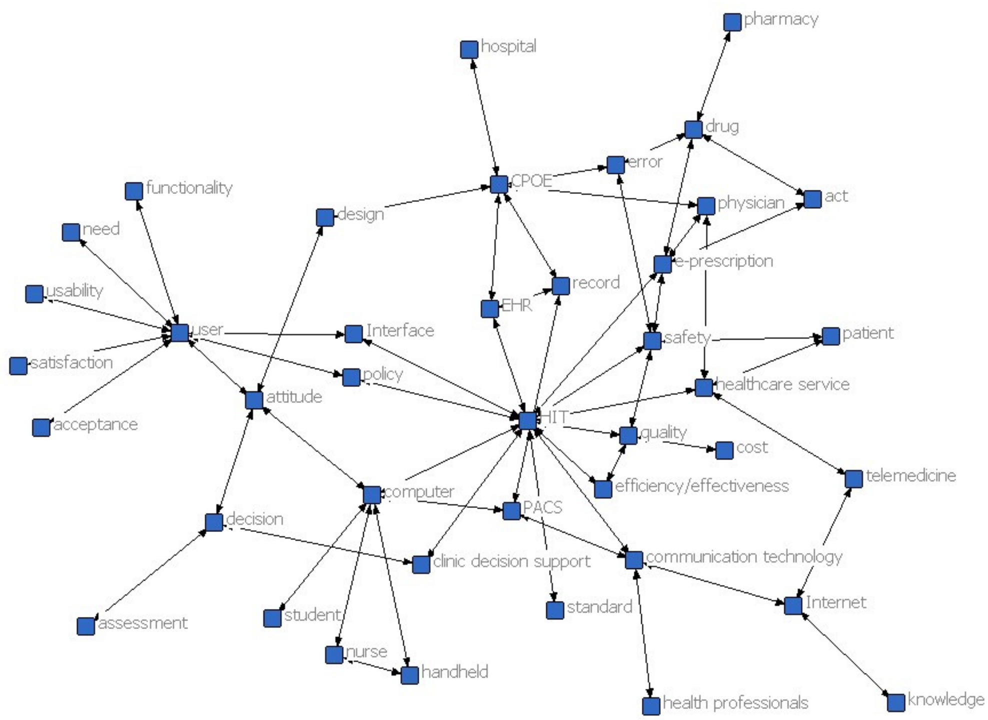


FIGURE 3
Two-Dimension Multidimensional Scaling

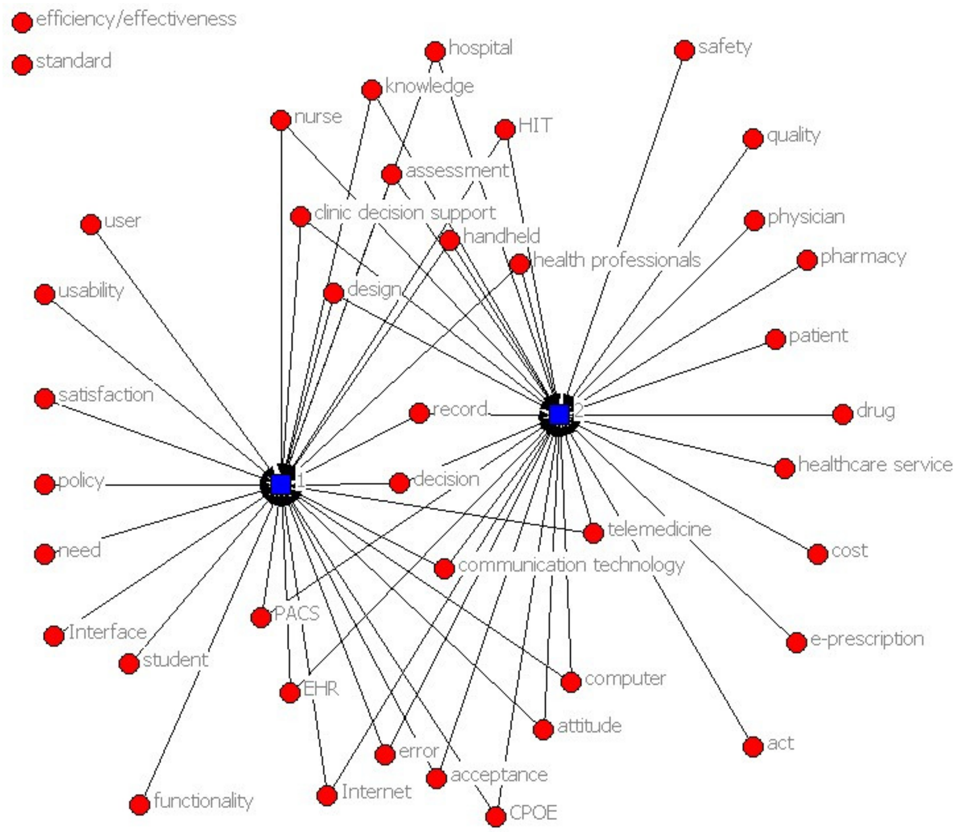
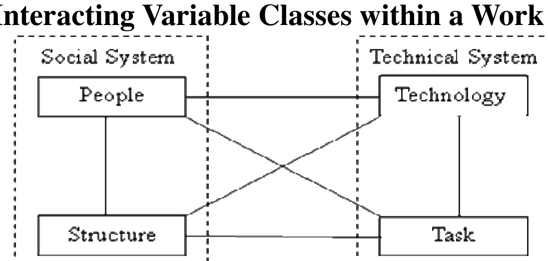
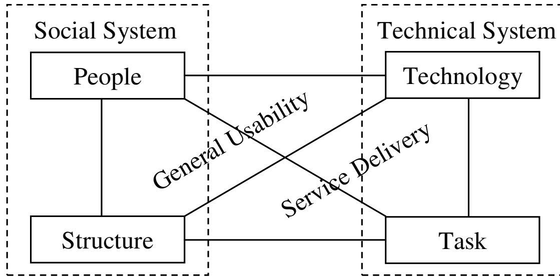


FIGURE 4
The Interacting Variable Classes within a Work System



(MIS problems and failures: a socio-technical perspective. Bostrom & Heinen, 1977)

FIGURE 5
Complete Theoretical Framework



REFERENCES

Ash, J.P., Gorman, P.N., Seshadri, V., and Hersh, W.R. 2004. Computerized physician order entry in U.S. hospitals: Results of a 2002 survey. ***Journal of the American Medical Informatics Association***, 11(2): Pages 95-99.

Borgatti, S. P., Everett, M. G., Freeman, L. C. 1999. ***Ucinet 5.0 for Windows***. Natick: Analytic Technologies.

Bostrom, R. P. and Heinen, J. S. 1977. MIS problems and failures: a socio-technical perspective. ***MIS Quarterly,*** 11(3): 17-32.

Brooks, R.G., Menachemi, N., Burke, D., Clawson, A. 2005. Patient safety-related information technology utilization in urban and rural hospitals. ***J Med Syst.***, 29(2):103-9.

Eley, R., Fallon, T., Soar, J., Buikstra, E., Hegney, D. 2009. Barriers to use of information and computer technology by Australia's nurses: a national survey. ***J Clin Nurs.,*** 18(8):1151-8.

Feldman, R. & Sanger, J. 2007. ***The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data***. New York: Cambridge University Press.

Frohlich, Markham T., & Dixon, J. R. 1999. Information systems adaptation and the successful implementation of advanced manufacturing technologies. ***Decision Sciences***, 30(4): 921-957.

Grigsby, B., Brega, A.G., Bennett, R.E., Devore, P.A., Paulich, M.J., Talkington, S.G., Floersch, N.R., Barton, P.L., Neal, S., Araya, T.M., Loker, J.L., Krohn, N., Grigsby, J. 2007. The slow pace of interactive video telemedicine adoption: the perspective of telemedicine program administrators on physician participation. ***Telemed J E Health.,*** 13(6):645-56.

Jha, A.K., DesRoches, C.M., Campbell, E.G., Donelan, K., Rao, S.R., Ferris, T.G., Shields, A., Rosenbaum, S., Blumenthal, D.N. 2009. Use of electronic health records in U.S. hospitals. ***Engl J Med.,*** 360(16):1628-38.

Kaushal, R., Shojania, K.G., Bates, D.W. 2003. Effects of Computerized Physician Order Entry and Clinical Decision Support Systems on Medication Safety: A Systematic Review. ***Arch Intern Med***, 163:1409-1416.

Knoke, D. and Kuklinski, J.H. 1982. ***Network analysis***. Sage Publications.

Lamb, R., & Kling, R. 2003. Reconceptualizing users as social actors in information systems research. ***MIS Quarterly***, 27(2): 197-235

Lu, Y.C., Xiao, Y., Mills, M.E., Soeken, K., Vaidya, V. 2006. Top barriers and facilitators to nurses' PDA adoption. ***AMIA Annu Symp Proc.*** 2006:1016.

Mandl, K.D., Kohane, I.S., Brandt, A.M. 1998. Electronic patient-physician communication: problems and promise. ***Ann Intern Med.,*** 129(6):495-500.

McAlearney, A.S., Chisolm, D.J., Schweikhart, S., Medow, M.A., Kelleher, K. 2007. The story behind the story: physician skepticism about relying on clinical information technologies to reduce medical errors. ***Int J Med Inform,*** 76(11-12):836-42.

Novak, J.D. and Cañas, A.J. 2008. The Theory Underlying Concept Maps and How to Construct and Use Them. ***Technical Report IHMC CmapTools***. Florida Institute for Human and Machine Cognition.

Pan,E., Cusack, C., Hook, J., Vincent, A., Kaelber, DC., Bates, D.W., Middleton, B. 2008. The value of provider-to-provider telehealth. ***Telemedicine Journal and E-health***, 14 (5): 446-53.

Poon, E.G., Jha, A.K., Christino, M., Honour, M.M., Fernandopulle, R., Middleton, B., Newhouse, J., Leape, L., Bates, D.W., Blumenthal, D., and Kaushal, R. 2006. Assessing the level of healthcare information technology adoption in the United States: a snapshot. ***BMC Med Inform Decis Ma.,*** 5;6:1

Randeree, E. 2007. Exploring physician adoption of EMRs: a multi-case analysis. ***J Med Sys,.*** 31(6):489-96.

Ralston, J.D., Carrell, D., Reid, R., Anderson, M., Moran, M., Hereford, J. 2007. Patient web services integrated with a shared medical record: patient use and satisfaction. ***J Am Med Inform Assoc,***14(6):798-806.

Snyder, R., Fields, W. 2007. Community hospital physician adoption of a CPOE system: perceptions of readiness, usefulness, and satisfaction. ***AMIA Annu Symp Proc.*** 2007 Oct 11:1117.

Teufel, R.J. 2nd, Kazley, A.S., Basco, W.T. Jr. 2009. Early adopters of computerized physician order entry in hospitals that care for children: a picture of US health care shortly after the Institute of Medicine reports on quality. ***Clin Pediatr (Phila)***, 48(4):389-96.

Walker, J., Pan, E., Johnston, D., Adler-Milstein, J., Bates, D.W., and Middleton, B. 2005. The Value of Health Care Information Exchange and Interoperability. ***Health Affairs,*** 19: January 2005.