2009

Evaluating task-technology fit and user performance for an electronic health record system

Matthew J. Wills
Dakota State University

Omar F. El-Gayar
Dakota State University

Amit Deokar
Dakota State University

1-1-2009

Evaluating Task-Technology Fit and User Performance for an Electronic Health Record System

Matthew J. Willis
Dakota State University

Omar F. El-Gayar
Dakota State University

Amit V. Deokar
Dakota State University

Follow this and additional works at: http://aisel.aisnet.org/amcis2009

Evaluating Task-Technology Fit and User Performance for an Electronic Health Record System

Matthew J. Wills, Dakota State University
Omar F. El-Gayar, Dakota State University
Amit V. Deokar, Dakota State University

ABSTRACT

Assessing user satisfaction, acceptance and performance impacts of information systems have long traditions in information systems research. With an increasing focus on broader adoption and implementation of electronic health records (EHR's), research examining user evaluation and performance impacts will play an essential role in the successful design, implementation, and efficient use of these systems. In this study, we analyze user evaluations of an EHR system and assess the impact on individual performance of such systems using the Task-technology Fit (TTF) theory. TTF postulates that individual performance is more likely to be positively impacted if there is a "fit" between the requirements of the task and the features of the technology. Overall, user evaluations for the eight dimensions of TTF considered in this study are positive. Moreover, the model exhibits a good fit with the data and provides a satisfactory explanatory power for individual performance impact with data quality and ease of use/training being significant determinants of performance impact.

Keywords

Task-technology fit, electronic health records, user evaluation, performance impact.

INTRODUCTION

Electronic health records (EHR) are emerging as the foundation of health information technology (HIT), although there is current evidence that fewer than 20% of physician practices have adopted the technology (DesRoches, Campbell, Rao, Donelan, Ferris, Jha, Kaushal, Levy, Rosenbaum, Shields and Blumenthal, 2008). Despite this, the current social and political environment appears to favor expansion of EHR adoption and use. As a result of increasing efforts to utilize these and other HIT's, analysis of user evaluation of performance with an EHR is an inherently valuable activity.

For more than three decades, information systems (IS) research has explored how and why people accept and use technology. IS researchers have also considered how technology impacts individual (Goodhue and Thompson, 1995) and group (Zigurs and Buckland, 1998) performance. IS practitioners who implement technology would benefit from a method of identifying factors that either inhibit, or enhance performance. In business it is essential that performance impacts are identified, understood and accordingly planned for. In health care, where the supply chain is replaced with human patients, understanding performance impact is critical to implementation and operational success.

The objective of this research is to leverage the TTF theory originally proposed by Goodhue (1988) to evaluate an electronic health record support system in a healthcare organization. Specifically, in this paper we study 1) user evaluations of the extent to which the functionality of the underlying technology (EHR) fits the needs of healthcare professionals, 2) perceived performance impact on individual performance, and 3) relationship between various task-technology fit dimensions and individual performance in a healthcare setting. From a theoretical perspective, the paper explores the applicability of the TTF model and supporting survey instrument in a new domain, namely healthcare. From a practical perspective, the research demonstrates the viability of using TTF as an underlying theoretical framework for evaluating and explaining individual performance impact in a healthcare setting. In this regard, this research represents an important first step toward the development and validation of a theoretically sound instrument squarely aimed at the evaluation of user performance impact.

The paper begins with a review of the theoretical background of acceptance, use and performance research. In section three the research model is presented along with the hypotheses. Section four discusses the methodology, setting, subjects, the survey instrument used, and the method of data collection and analysis. In section five the results are discussed, and section six concludes the paper with a summarization of the findings and a brief discussion of future research opportunities.

RELATED WORK

With respect to the behavioral determinants of use, the Technology Acceptance (TAM) model represents the first theory developed specifically for the IS context, i.e. people in business (Davis, 1989). A few years later, Taylor and Todd (1995) put

forth their theory, known as Combined TAM-TPB. TAM was further extended to TAM2 (Venkatesh and Davis, 2000). The most recent models to emerge from this long line of study are known as the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis and Davis, 2003), and TAM3 (Venkatesh and Bala, 2008).

In contrast with models predicting acceptance and use, TTF attempts to explain user performance with information systems. The premise of the theory is that individual performance can be enhanced when the functionality provided by the technology meets the user's needs, i.e., fits the task on hand. The original design of TTF was centered on the use of multiple information systems and specifically directed toward managerial decision-making. The theory measures task-technology fit along multiple dimensions. Goodhue also demonstrated the validity of an instrument for IS user evaluation based on TTF (Goodhue, 1998). Later, it was established that user evaluations were effective surrogates for objective performance (Goodhue, Klein and March, 2000).

TTF has been examined in group performance situations (Shirani, Tafti and Affisco, 1999; Zigurs and Buckland, 1998), as intended with focus on managerial decision-making (Ferratt and Vlahos, 1998), and further examined with an emphasis on ease-of-use (Mathieson and Keil, 1998). TTF has also been extended with the technology acceptance model (Dishaw and Strong, 1999; Klopping and McKinney, 2004; Pagani, 2006). More recently, TTF has been the theoretical basis for a number of studies evaluating user performance with IS, including Vlahos et. al (2004), Lin and Huang (2008), Teo and Men (2008), Junglas, Abraham, and Watson (2008) and Zigurs and Khazanchi (2008).

With the exception of Kilmon et al. (2008), there are no studies employing TTF in studying user evaluation of EHR systems. In that regard, Kilmon et al. (2008) utilize the TTF instrument presented in Goodhue (1998) as a diagnostic tool to evaluate the implementation of a first phase of an EHR at a university hospital. While the results indicate that the system implementation is a success in terms of the task-technology fit, the study does not validate the TTF instrument in the healthcare context. Moreover, the study does not attempt to evaluate performance impact or the relationship between TTF and performance impact.

RESEARCH MODEL AND HYPOTHESES

This study employs a reduced version of the TTF model. The focus is on capturing user evaluation of TTF along various dimensions as identified in (Goodhue, 1995), impact on individual performance, and the relationship between TTF and individual performance. The TTF dimensions that comprise the model employed in this study include data quality, data locatability, data compatibility, IS relationship to users, ease-of-use and training, correct level of authorization, systems reliability, and IS production timeliness. According to the TTF model, the strength of the link between information systems and performance impacts is a function of the extent system functionality responds to task needs.

The research model shown above hypothesizes the following:

H1: User evaluation of task-technology fit will have explanatory power in predicting perceived performance impact. This can be further divided among the 8 TTF dimensions as follows:

> *H1a: Data quality will significantly influence user performance. Data quality is evaluated according to the currency of the data, maintenance of the correct data and the appropriate level of detail.*

> *H1b: The locatability of the data will influence user performance. Locatability is assessed by both the ease with which data is located, and the ease with which the meaning of the data can be discovered.*

> *H1c: Data authorization will influence user performance. Authorization measures the degree with which individuals are appropriately authorized to access the data required for the task.*

> *H1d: The compatibility of data from other systems will influence user performance.*

> *H1e: Ease of use and training will significantly influence user performance. The degree to which a person believes a system is easy to use and user training.*

> *H1f: Production timeliness will influence user performance. Production timeliness is evaluated according to the perceived response time for reports and other requested information.*

> *H1g: Systems reliability will influence user performance.*

> *H1h: The IS departments' relationship with users will influence user performance. This factor includes IS understanding of business, IS interest and user support, IS responsiveness, delivery of agreed-upon solutions, and technical and unit planning support.*
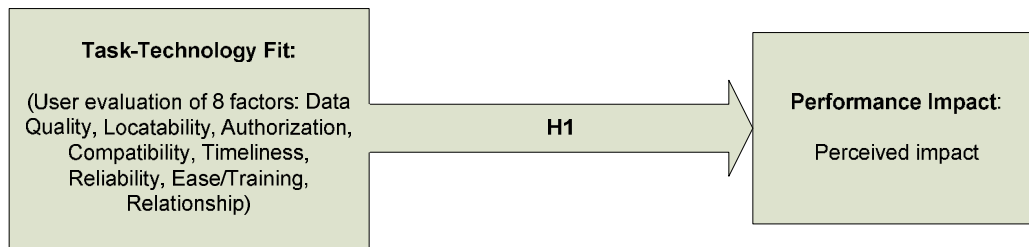
Figure 1. Determinants of Performance

METHODOLOGY

Setting, Context and Subjects

The study was conducted at a Regional Health center in South Dakota. The subjects of the study are registered nurses (RN's) employed in a hospital setting. Surveys were randomly distributed to 100 registered nurses, of which 76 subjects from 12 hospital departments participated in and successfully completed the study. The clinical departments represented include: Emergency department, Pediatrics, Medical/Surgical, Orthopedics/Neurology, Infusion center, PAC (post-acute care), Rehabilitation, Oncology, Pulmonary care, Intensive care, Coronary intensive care and Home health.

Survey Instrument

The survey instrument is based on constructs validated in prior research (Goodhue and Thompson, 1995), standardized and adapted to the context of this study. The constructs include data quality, data locatability, data compatibility, IS relationship to users, ease-of-use and training, correct level of authorization, systems reliability, and IS production timeliness. The instrument also collected additional information including gender, age, length of time of system use, and additional information requested by the partnering health system.

Data Collection

The survey was made available in paper format and randomly distributed to 100 registered nurses. The survey was distributed by hospital executive and clinical unit-level managers. Participants were assured anonymity by not being required to provide identifying information on the survey. After the survey concluded, data from the paper survey format was transferred to a spreadsheet for further analysis.

Data Analysis

Partial least squares (PLS) is the analysis technique used in this study. In studies such as this, a number of data analysis methods are available to the researcher. First generation regression models require item loadings to be analyzed in separate steps, and are generally not considered for use when complex models are involved (Gefen, 2000). Two other methods, covariance-based SEM and PLS-SEM are the most widely used methods in IS research. For this study, PLS was chosen for two reasons: 1. As an SEM technique, PLS is designed to explain the significance of the relationships in the model, as is the case in linear regression, and for this reason PLS is better suited to predictive models than covariance-based SEM approaches which focus on overall model fit, and 2. In contrast to covariance-based SEM, the estimation of significance in PLS does not require parametric assumptions, thus allowing analysis of comparatively small data sets, such as in this study (Gefen, 2000). This is accomplished by estimation of the parameters such that the residual variance of all dependent variables is minimized.

A number of recent technology acceptance studies have used PLS (e.g., Al-Gahtani (2001), Compeau (1995a), Venkatesh (2003)). To evaluate the measurement model, PLS estimates the internal consistency for each block of indicators. PLS then evaluates the degree to which a variable measures what it was intended to measure (Cronbach, 1951; Straub, Boudreau and Gefen, 2004). This evaluation, understood as construct validity, is comprised of convergent and discriminate validity. Following previous work (Gefen and Straub, 2005), convergent validity of the variables is evaluated by examining the t-values of the outer model loadings. Discriminate validity is evaluated by assessing item loadings to variable correlations and by examining the ratio of the square root of the AVE of each variable to the correlations of this construct to all other variables (Chin, 1998a; Gefen and Straub, 2005).

With respect to the structural model, path coefficients are understood as regression coefficients with the t-statistic calculated with a bootstrapping method of 200 samples. To determine how well the model fits the hypothesized relationship, PLS calculates an R2 for each dependent construct in the model. Similar to regression analysis, R2 represents the proportion of variance in the endogenous constructs which can be explained by the antecedent constructs (Chin, 1998a).

RESULTS, DISCUSSION AND FUTURE WORK

Sample Characteristics

76 of the 100 randomly selected participants successfully completed the survey, resulting in a 76% response rate. Subjects were asked to respond to questions using a seven point Likert scale, which ranged from 1 = strongly disagree to 7 = strongly agree. 2% of respondents were between the ages of 18 and 24, 28% of respondents were between the ages of 25-34, 21% between 35-44, 26% between the ages of 45-54 and 19% between the ages of 55-64. 95% of the subjects were female – a figure that is representative of the overall gender distribution of RN's at this facility.

Assessing Measurement Validity

Various versions of the TTF survey instrument have been validated in the literature (Goodhue, 1995 1998; Goodhue and Thompson, 1995). However, since the TTF instrument has not been validated in a healthcare context, we re-examine the survey instrument with respect to reliability and construct validity. Using PLS-Graph, we examine 45 variables initially included in the survey instrument. We then removed five items that exhibited loadings of less than the 0.7 as recommended in the literature (Compeau and Higgins, 1995a; Compeau and Higgins, 1995b; Fornell and Larcker, 1981). In effect, such items are deemed as not contributing to the underlying construct (Hair, Black, Babin, Anderson and Tatham, 2006). The remaining items adequately represent the underlying constructs attesting to the content validity of the instrument.

Table 1 summarizes the results for the items comprising the model. The results show composite reliability (CR) exceeding 0.8 as recommended (Nunnally, 1978). AVE, which can also be considered as a measure of reliability exceeds 0.5 as recommended (Fornell and Larcker, 1981). Together, CR and AVE attest to the reliability of the instrument. The t-values of the outer model loadings exceed 1.96 verifying the convergent validity of the instrument (Gefen and Straub, 2005). Calculating the correlation between variables' component scores and individual items reveal that intra-variable (construct) item correlations are generally high when compared to inter-variable (construct) item correlations. Discriminate validity is confirmed as the diagonal elements (representing the square root of AVE) are significantly higher than the off-diagonal values (Chin, 1998b).

Table 1 below shows the mean, standard deviation and item loading for each indicator, as well as the composite reliability and AVE at the construct level.

Table 1. Result Summary for the Model

Dimension	Code	Question	Mean	S.D.	Item Loading	CR	AVE
Data Quality	**QUAL**	(Data that I use is the right data, is current, and is at the right level of detail)				0.943	0.738
		2. The data is up to date enough for my purposes.	5.46	0.94	0.912		
		3. The data maintained by the hospital or my unit is pretty much what I need to carry out my tasks.	5.49	0.72	0.914		
		5. The hospital maintains data at an appropriate level of detail for my unit's tasks.	5.39	0.99	0.906		
		6. Sufficiently detailed data is maintained by the hospital.	5.31	0.87	0.854		
Data Locatability	**LOCT**	(Ease of determining what data is available and where)				0.900	0.693
		1. It is easy to find out what data the hospital maintains on a given subject.	4.47	1.28	0.786		
		2. It is easy to locate hospital or departmental data on a particular issue, even if I haven't used that data before.	4.22	1.34	0.841		

Dimension	Code	Question	Mean	S.D.	Item Loading	CR	AVE
		3. The exact definition of data fields relating to my tasks is easy to find out.	4.21	1.42	0.852		
		4. On the reports or systems I deal with, the exact meaning of the data elements is either obvious, or easy to find out.	4.43	1.24	0.849		
Authorization	**AUTH**	(Obtaining authorization to access data necessary to do my job)				0.906	0.829
		1. Data that would be useful to me is unavailable because I don't have the right authorization.	3.10	1.37	0.910		
		2. Getting authorization to access data that would be useful in my job is time consuming and difficult.	3.50	1.42	0.911		
Data Compatibility	**COMP**	(Data from different sources can be consolidated or compared without inconsistencies)				0.936	0.830
		1. There are times when I find that supposedly equivalent data from two different sources is inconsistent.	3.86	1.46	0.906		
		2. Sometimes it is difficult for me to compare or consolidate data from two different sources because the data is defined differently.	3.88	1.51	0.894		
		3. When it's necessary to compare or consolidate data from different sources, I find that there may be unexpected or difficult inconsistencies.	4.01	1.33	0.932		
Production Time.	**PROD**	(IS meets pre-defined production turnaround schedules)				0.848	0.736
		1. To my knowledge, the hospital information system meets its production schedules, such as report delivery.	4.89	1.08	0.884		
		2. Regular IS activities (such as printed report delivery or scheduled jobs) are completed on time.	4.72	1.09	0.831		
System Reliability	**RELY**	(Dependability and consistency of access and uptime of systems				0.879	0.786
		2. The computer systems I use are subject to unexpected or inconvenient down times which makes it harder to do my work.	3.46	1.49	0.974		
		3. The computer systems I use are subject to unexpected or inconvenient down times which makes it harder to do my work.	3.07	1.28	0.789		
Ease of Use / Training	**EASE**	(Ease of doing what I want to do and access to training)				0.962	0.740
		1. It is easy to learn how to use the computer systems I need.	4.86	1.50	0.912		
		2. The computer systems I use are convenient and easy to use.	4.82	1.36	0.892		
	EE/EOU	1. Learning to operate the EHR is easy for me.	5.07	1.38	0.825		
		2. I find it easy to get the EHR to do what I want it to do.	5.03	1.38	0.845		
		3. My interaction with the EHR is clear and understandable.	5.14	1.33	0.924		

Dimension	Code	Question	Mean	S.D.	Item Loading	CR	AVE
		4. I find the EHR to be flexible to interact with.	4.63	1.51	0.817		
		5. It is easy for me to become skillful at using the EHR.	5.13	1.32	0.866		
		6. I find the EHR easy to use.	5.19	1.34	0.937		
	TRNG	2. I am getting the training I need to be able to use the organization's computer systems, languages, procedures and data effectively.	4.82	1.41	0.701		
IS Relationship w/ Users	RELUSR					0.944	0.738
		1. The IS/IT people we deal with understand the day-to-day objectives of my unit and its mission within our organization.	3.95	1.70	0.812		
		2. My unit feels that IS/IT personnel can communicate with us in familiar, consistent terms.	4.11	1.58	0.906		
		3. IS/IT takes my unit's clinical-IT challenges seriously.	4.33	1.58	0.933		
		4. IS /IT takes a real interest in helping my unit solve its clinical-IT issues.	4.34	1.56	0.927		
		7. When a request for service or assistance is made, IS/IT normally responds in a timely manner.	4.08	1.49	0.745		
		8. So far, IS/IT has delivered agreed-upon solutions for my units clinical-IT needs.	4.24	1.32	0.816		
Performance	PERF					0.956	0.756
		1. Using the EHR enables me to accomplish tasks more quickly.	4.68	1.33	0.810		
		2. Using the EHR improves the quality of the work I do.	5.01	1.24	0.677		
		3. Using the EHR makes it easier to do my job.	4.97	1.24	0.928		
		4. Using the EHR enhances my effectiveness on the job.	5.01	1.27	0.897		
		5. IS/IT computer systems and services are an important and valuable aid to me in the performance of my job.	5.05	1.21	0.916		
		6. The organization's computer environment has a large, positive impact on my effectiveness and productivity in my job.	5.05	1.23	0.941		
		7. Using the EHR increases my productivity.	4.79	1.29	0.887		

As shown in Table 2 below, the instrument demonstrates adequate discriminate validity as the diagonal values (bold) are greater with respect to the corresponding correlation values in the adjoining columns and rows.

Table 2. Square root of AVE Scores and Correlation of Latent Variables

	QUAL	LOCT	AUTH	COMP	PROD	RELY	EOU/TRNG	RELUSR	PERF
QUAL	0.859								
LOCT	0.538	0.832							
AUTH	-0.148	-0.107	0.910						
COMP	-0.028	-0.315	0.460	0.911					
PROD	0.492	0.281	0.064	-0.006	0.858				
RELY	-0.434	-0.479	0.190	0.531	-0.331	0.887			
EOU/TRNG	0.263	0.444	-0.046	-0.012	0.221	-0.209	0.860		
RELUSR	0.426	0.390	-0.134	-0.129	0.666	-0.345	0.342	0.859	
PERF	0.563	0.412	-0.194	-0.203	0.468	-0.395	0.510	0.536	0.869

Model Testing Results and Discussion

Figure 2 below depicts the structural model with path (regression) coefficients and the R^2 for the dependent variable. As shown, the R^2 value for the dependent variable indicates that the model explains 55.2% of the variance for performance. To assess the statistical significance of the path coefficients, the bootstrap method was used in PLS-Graph.
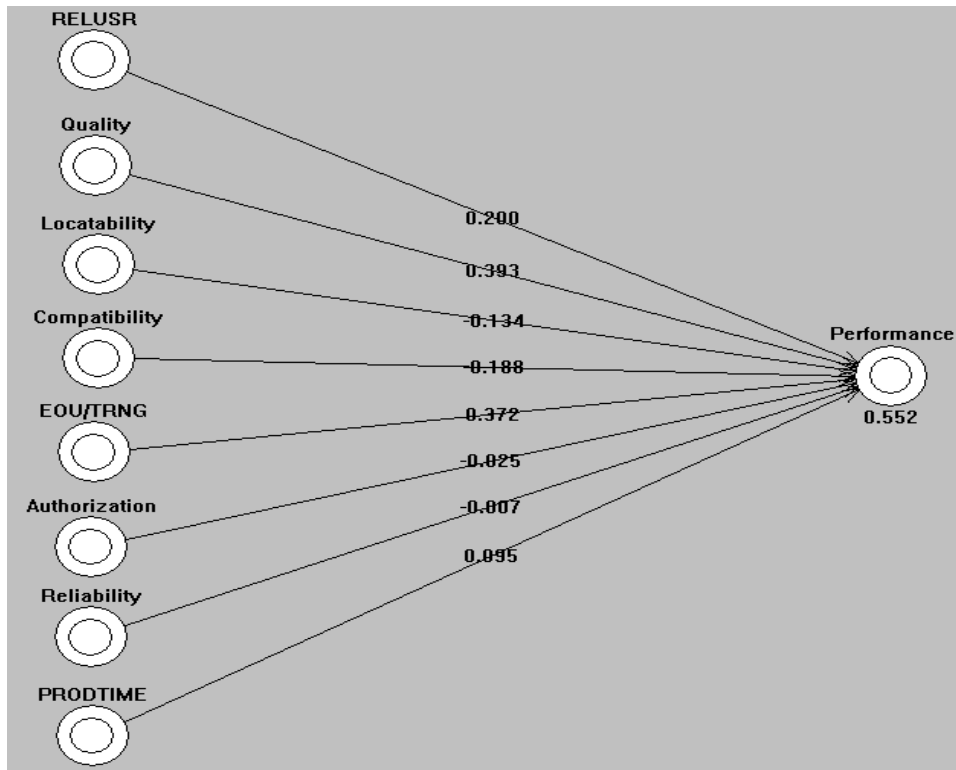

Figure 2. Model Testing Results

With respect to the hypothesized determinants of performance, two constructs significantly influence user performance: data quality ($\beta = 0.393$ p > 0.02) and ease-of-use/training ($\beta = 0.372$ p > 0.0002). These findings are consistent with H1a and H1e

respectively. H1h - IS relationship with users (β = 0.200 p > 0.10) with H4 - data compatibility (β = -0.188 p > 0.10) are significant at the 10% level. Comparing the results with that reported in Goodhue (Goodhue and Thompson), we find data quality and to a lesser extent relationship with user and compatibility are significant predictors of performance impact in both studies, while timeliness is only significant in the (Goodhue and Thompson, 1995) study. Ease/training while significant in this study was not significant in Goodhue (1995). The remaining TTF dimensions were insignificant predictors for performance in both studies.

In the context of EHR systems, it is no surprise that data quality, i.e., providing access to the right data, at the right level of detail, and that is current is a significant predictor of performance. Also somewhat consistent with the information systems literature are the significance of the strength of the relationship of the hospital IS department with user (nurses in this study), and the compatibility as predictors of performance. However, the results are particularly surprising with respect to the insignificance of timeliness and locatability which one would expect as a hallmark for implementing EHR.

CONCLUSION

In this study we report on user evaluation of EHR systems using TTF as the underlying theoretical model. From a theoretical perspective, the analysis of the results confirms the validity of the TTF instrument and supports TTF as a model for predicting performance impact in a healthcare setting. From a practical perspective, the results highlight the importance of the various TTF dimensions captured in the study. Of particular importance are data quality, ease of use/training, and compatibility. Further follow up is still needed with regard to the insignificance of timeliness and locatability dimensions which one would expect as a hallmark for implementing EHR.

This study is the second (after Kilmon, 2008) to leverage TTF to evaluate EHR systems and the first to validate the TTF instrument in a healthcare setting. While the results are promising, the study can be further improved in a number of ways. First, despite the encouraging results of validating the instrument in the healthcare domain, further work is needed to adapt the instrument to the needs of decision makers, primarily clinicians (e.g., nurses, physicians, and physician assistants), their job characteristics, and information needs as outlined in Goodhue (1998). Further research is needed to build a task model that is specific to clinicians and clinical processes. Second, it is paramount that future research incorporates objective measures of performance impact. As an example, timed evaluation of task completion can be assessed following system modification, such as when the results of usability analyses direct system design changes. Finally, the underlying theoretical model can be expanded to include job and technology characteristics as antecedents of TTF dimensions. Another possible extension is the incorporation of system utilization as in Goodhue (1995).

As the adoption of EHR systems and other HIT's increase, it is imperative that IS research shift the focus from evaluation of the behavioral aspects of adoption and use to performance impact. In most healthcare settings where systems have been implemented, their use will likely be mandatory. As a result, it becomes less important to evaluate the "why" of system use, and more important to direct our resources at evaluating how such systems impact user performance. This research is important in that it establishes the validity of the TTF instrument in the healthcare domain, and identifies opportunities for future work that will ultimately lead to an effective user evaluation tool for measuring performance impact.

REFERENCES

1. Ajzen, I., and Fishbein, M. (1980) Understanding Attitudes and Predicting Social Behavior, Prentice Hall, Englewood Cliffs, NJ.
2. Al-Gahtani, S. S. (2001) The applicability of TAM outside North America: An empirical test in the United Kingdom, *Information Resources Management Journal*, 14, 3, 37-46.
3. Bandura, A. (1977) Self-efficacy: Toward a unifying theory of behavioral change, *Psychological Review*, 84, 2, 191-215.
4. Bandura, A. (1986) Social Foundations of Thought and Action: A Social Cognitive Theory, Prentice Halls, Englewood Cliffs, NJ.
5. Chin, W. W. (1998a) Commentary: Issues and opinion on structural equation modeling, *MIS Quarterly*, 22, 1, 7-16.
6. Chin, W. W. (1998b) The Partial Least Squares Approach for Structural Equation Modelling, in G.A. Marcoulides (Ed.) *Modern Methods for Business Research,* Lawrence Erlbaum Associates, Hillsdale, NJ, 448.
7. Compeau, D. R., and Higgins, C. A. (1995a) Application of Social Cognitive Theory to Training for Computer Skills, *Information Systems Research*, 6, 2, 118-143.
8. Compeau, D. R., and Higgins, C. A. (1995b) Computer Self-Efficacy - Development of a Measure and Initial Test, *MIS Quarterly*, 19, 2, 189-211.
9. Cronbach, L. (1951) Coefficient alpha and the internal structure of tests, *Psychometrika*, 16, 297-334.

10. Davis, F. D. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology, *MIS Quarterly*, 13, 3, 319-340.
11. DesRoches, C. M., Campbell, E. G., Rao, S. R., Donelan, K., Ferris, T. G., Jha, A., Kaushal, R., Levy, D. E., Rosenbaum, S., Shields, A. E., and Blumenthal, D. (2008) Electronic Health Records in Ambulatory Care: A National Survey of Physicians, *The New England Journal of Medicine*, 359, 1, 50-60.
12. Dishaw, M. T., and Strong, D. M. (1999) Extending the technology acceptance model with task-technology fit constructs, *Information & Management*, 36, 1, 9.
13. Falk, R., and Miller, N. E. (1992) A Primer for Soft Modeling, University of Akron Press, Akron, OH.
14. Ferratt, T. W., and Vlahos, G. E. (1998) An investigation of task-technology fit for managers in Greece and the US, *European Journal of Information Systems*, 7, 2, 123.
15. Fishbein, M., and Ajzen, I. (1975) Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research, Addison-Wesey, Reading, MA.
16. Fornell, C., and Larcker, D. F. (1981) Structural Equation Models with Unobservable Variables and Measurement Error - Algebra and Statistics, *Journal of Marketing Research*, 18, 3, 382-388.
17. Gefen, D., D. Straub, et al. (2000). "Structural Equation Modeling and Regression: Guidelines for Research Practice." Communication of the AIS **4**(7): 1-76.
18. Gefen, D., and Straub, D. (2005) A practical guide to factorial validity using PLS-GRAPH: Tutorial and annotated example, *Communication of the AIS*, 16, 91-109.
19. Goodhue, D. L. (1988) IS attitudes: Toward theoretical and definition clarity, *DataBase*, 19, 3-4, 6-15.
20. Goodhue, D. L. (1995) Understanding user evaluations of information systems, *Management Science*, 41, 12, 1827.
21. Goodhue, D. L. (1998) Development and measurement validity of a task-technology fit instrument for user evaluations of information systems, *Decision Sciences*, 29, 1, 105.
22. Goodhue, D. L., Klein, B. D., and March, S. T. (2000) User evaluations of IS as surrogates for objective performance, *Information & Management*, 38, 2, 87.
23. Goodhue, D. L., and Thompson, R. L. (1995) Task-technology fit and individual performance, *MIS Quarterly*, 19, 2, 213.
24. Hair, J. F., Black, B., Babin, B., Anderson, R. E., and Tatham, R. L. (2006) Multivariate Data Analysis, 6th ed., Prentice Hall, 928.
25. Junglas, I., Abraham, C., and Watson, R. T. (2008) Task-technology fit for mobile locatable information systems, *Decision Support Systems*, 45, 4, 1046.
26. Kilmon, C. et. al. (2008) Using the Task Technology Fit Model as a Diagnostic Tool for Electronic Medical Record Evaluation, Issues in Information Systems, 9, 2.
27. Klopping, I., and McKinney, E. (2004) EXTENDING THE TECHNOLOGY ACCEPTANCE MODEL AND THE TASK-TECHNOLOGY FIT MODEL TO CONSUMER E-COMMERCE, *Information Technology, Learning, and Performance Journal*, 22, 1, 35.
28. Lin, T.-C., and Huang, C.-C. (2008) Understanding knowledge management system usage antecedents: An integration of social cognitive theory and task technology fit, *Information & Management*, 45, 6, 410.
29. Mathieson, K., and Keil, M. (1998) Beyond the interface: Ease of use and task/technology fit, *Information & Management*, 34, 4, 221.
30. Miller, N. E., and Dollard (1941) Social Learning and Limitation, Yale University Press, New Haven.
31. Nunnally, J. C. (1978) Psychometric Theory, 2nd ed., McGraw Hill, New York.
32. Pagani, M. (2006) Determinants of adoption of High Speed Data Services in the business market: Evidence for a combined technology acceptance model with task technology fit model, *Information & Management*, 43, 7, 847.
33. Shirani, A. I., Tafti, M. H. A., and Affisco, J. F. (1999) Task and technology fit: A comparison of two technologies for synchronous and asynchronous group communication, *Information & Management*, 36, 3, 139.
34. Straub, D. W. (1989) Validating instruments in MIS research, *MIS Quarterly*, 13, 2, 147-169.
35. Straub, D. W., Boudreau, M.-C., and Gefen, D. (2004) Validation guidelines for IS positivist research, *Communications of the AIS*, 13, 24, 380-427.
36. Taylor, S., and Todd, P. A. (1995) Understanding information technology usage - a test of competing models, *Information Systems Research*, 6, 2, 144-176.
37. Teo, T. S. H., and Men, B. (2008) Knowledge portals in Chinese consulting firms: a task-technology fit perspective, *European Journal of Information Systems*, 17, 6, 557.
38. Thompson, R. L., Higgins, C. A., and Howell, J. M. (1991) Personal computing - Toward a conceptual-model of utilization, *MIS Quarterly*, 15, 1, 125-143.
39. Triandis, H. C. (1977) Interpersonal Behavior, Brooke Cole, Monterey, CA.

40. Venkatesh, V., and Bala, H. (2008) Technology acceptance model 3 and a research agenda on interventions, *Decision Sciences*, 39, 2, 273-315.

41. Venkatesh, V., and Davis, F. D. (2000) A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies, *Management Science*, 46, 2, 186-204.

42. Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003) User acceptance of information technology: Toward a unified view, *MIS Quarterly*, 27, 3, 425-478.

43. Vlahos, G. E., Ferratt, T. W., and Knoepfle, G. (2004) The use of computer-based information systems by German managers to support decision making, *Information & Management*, 41, 6, 763.

44. Zigurs, I., and Buckland, B. K. (1998) A theory of task/technology fit and group support systems effectiveness, *MIS Quarterly*, 22, 3, 313.

45. Zigurs, I., and Khazanchi, D. (2008) From Profiles to Patterns: A New View of Task-Technology Fit, *Information Systems Management*, 25, 1, 8.