

2010

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

Omar F. El-Gayar
Dakota State University

Amit Deokar
Dakota State University

Matthew J. Wills
Dakota State University

Follow this and additional works at: <https://scholar.dsu.edu/bispapers>

Recommended Citation

El-Gayar, O. F., Deokar, A. V., & Wills, M. J. (2010). Evaluating task-technology fit and user performance for an electronic health record system. *International Journal of Healthcare Technology and Management*, 11(1-2), 50-65.

This Article is brought to you for free and open access by the College of Business and Information Systems at Beadle Scholar. It has been accepted for inclusion in Faculty Research & Publications by an authorized administrator of Beadle Scholar. For more information, please contact repository@dsu.edu.

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

Omar F. El-Gayar*, Amit V. Deokar
and Matthew J. Wills

College of Business and Information Systems,
Dakota State University,
820 N. Washington Ave,
Madison, SD 57042, USA
E-mail: Omar.El-Gayar@dsu.edu
E-mail: Amit.Deokar@dsu.edu
E-mail: willsm@pluto.dsu.edu
*Corresponding author

Abstract: Assessing user satisfaction, acceptance and performance impacts of information systems have long traditions in information systems research. With an increasing focus on broader international adoption and implementation of electronic health records, research examining performance impact resulting from system use will play an essential role in the successful design, implementation, and efficient use of these systems. In this study, we analyse user evaluations of an electronic health record system and assess the impact on self-reported, perceived individual performance using the task-technology fit theory. Overall, user evaluations for the eight dimensions of task-technology fit considered in this study are positive.

Keywords: task-technology fit; electronic health record; user evaluation; performance impact.

Reference to this paper should be made as follows: El-Gayar, O.F., Deokar, A.V. and Wills, M.J. (2010) 'Evaluating task-technology fit and user performance for an electronic health record system', *Int. J. Healthcare Technology and Management*, Vol. 11, Nos. 1/2, pp.50–65.

Biographical notes: Omar F. El-Gayar is a Professor of Information Systems at the College of Business and Information Systems and the Dean of Graduate Studies and Research at Dakota State University. His research interests include: decision support systems, multiple criteria decision making, and the application of decision technologies in healthcare, security planning and management, and environmental management. He has an inter-disciplinary educational background and training in information technology, computer science, economics, and operations research. In addition to his academic credentials, he has industry experience as an analyst, modeller, and programmer. He is a member of AIS, ACM, INFORMS, and DSI.

Amit V. Deokar is an Assistant Professor of Information Systems in the College of Business and Information Systems at Dakota State University. He holds a BE in Mechanical Engineering from V.J. Technological Institute, Mumbai, a MS in Industrial Engineering from the University of Arizona, and a PhD in Management Information Systems from the University of Arizona. His areas of research interest include business process management, collaboration technologies, distributed decision support systems, healthcare

informatics, and research methodologies. He has published in journals such as *Journal of Management Information Systems*, and *IEEE Transactions on Intelligent Transportation Systems*.

Matthew J. Wills is currently a Graduate Student in the Doctor of Science Information Systems program at Dakota State University, Madison, SD, USA. He holds an MSc in Information Systems from Dakota State University. He has published on a broad range of health care related topics including clinical decision support systems, clinical knowledge management systems, electronic health records and comparative effectiveness cyberinfrastructure research systems. He has presented his research at international and national conferences including IACIS, HICSS, DSI, AMCIS and the Mayo Clinic Systems Engineering/Operational Research Conference. He is a member of the ACM, DSI, AMIA, INFORMS and AHIMA.

1 Introduction

Electronic health records are emerging as the foundation of health information technology, although there is current evidence that fewer than 20% of physician practices in the USA have adopted the technology (DesRoches et al., 2008). Despite this, international efforts appear to favour expansion of electronic health record adoption and use. As a result of increasing efforts to utilise these and other health information technologies, analysis of user evaluation of performance impact with electronic health record systems is an inherently valuable activity. Although an understanding of how information systems are accepted and used continues to be important, it is essential that researchers offer practitioners the means to measure and evaluate the performance impact of such use.

For more than three decades, information systems research has explored how and why people accept and use technology. Information systems researchers have also considered how technology impacts individual (Goodhue and Thompson, 1995) and group (Zigurs and Buckland, 1998) performance. Practitioners who implement electronic health records would benefit from a method of identifying factors that either inhibit, or enhance user 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, as well as issues of safety and quality.

The objective of this research is to leverage the task-technology fit theory originally proposed by Goodhue (1988) to evaluate an electronic health record support system in a health care organisation. Specifically, in this paper we study

- 1 user evaluations of the extent to which the functionality of the underlying technology fits the needs of health care professionals
- 2 perceived performance impact on individual performance
- 3 relationships between various task-technology fit dimensions and individual performance in a health care setting.

From a theoretical perspective, the paper explores the applicability of the task-technology fit model and supporting survey instrument in a new domain, namely health care. From a practical perspective, the research demonstrates the viability of using task-technology fit as an underlying theoretical framework for evaluating and explaining individual performance impact in a health care setting. In this regard, this research represents an important first step toward the development and validation of a theoretically sound instrument aimed at the evaluation of user performance impact.

The paper is organised as follows: In Section 2 we review the theoretical background of acceptance, use and performance research. In Section 3 the research model is presented along with the hypotheses. Section 4 discusses the methodology, setting, subjects, the survey instrument used, and the method of data collection and analysis. In Section 5 the results are presented and discussed. Section 6 concludes the paper with a summarisation of the findings and discussion of limitations and future research opportunities.

2 Related work

IS/IT utilisation research has been impacted by the theories of individual human and social behaviour emerging from the disciplines of psychology and sociology. With its origin in the area of Social Learning Theory by Miller and Dollard (1941), Social Cognitive Theory (SCT) is focused on the process of knowledge acquisition through observation (Bandura, 1977). This theory was later expanded, in particular by Bandura (1986) and became known as Self-Efficacy Theory (SET). In the years prior to Bandura's work on Self-Efficacy, Fishbein and Ajzen (1975) published their research on the Theory of Reasoned Action (TRA). The theoretical basis for TRA lies in the tenets of social psychology, and has been widely accepted as a foundational theory of human behaviour.

A product of TRA and SET, the Theory of Planned Behaviour (TPB) emerges as an extension of TRA with perceived behavioural control from SET as an additional determinant of intention (Ajzen and Fishbein, 1980). In 1991, Thompson et al. (1991) published an alternative to TRA and TPB, the Model of PC Utilisation (MPCU). This theory too has its roots in psychology, emanating most distinctly from the Triandis' (1977) work on human behavioural research.

The Technology Acceptance Model (TAM) is the first theory directly developed for the IS context, i.e., people in business (Davis, 1989). Shortly after TAM was proposed, Taylor and Todd (1995) proposed Combined TAM-TPB, or C-TAM-TPB. This theory of technology acceptance effectively combined the predictive elements of TPB with the concept of perceived usefulness from TAM. TAM was further extended to TAM2 (Venkatesh and Davis, 2000), and included subjective norm as a predictor in settings where use is mandatory.

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 et al., 2003), and TAM3 (Venkatesh and Bala, 2008). Central to models predicting acceptance and use is the notion that various contextual and behavioural factors contribute to enhanced intention to use, thereby resulting in increased actual use. In many of

these models, it is implied implicitly or explicitly that increased use will result in increased performance. However, as noted, the use of the technology is not always voluntary, e.g., use of EHR systems is usually mandatory. Moreover, it cannot be assumed that increased use is necessarily positively correlated with increased performance (Goodhue, 1998).

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. As originally proposed TTF was oriented to the use of multiple information systems and specifically directed toward managerial decision-making tasks. The theory was first formally proposed by Goodhue (1988), and measures task-technology fit along multiple dimensions. Goodhue also demonstrated the validity of an instrument for IS user evaluation based on TTF (Goodhue, 1998). Additionally, Goodhue established that user evaluations were effective surrogates for objective performance (Goodhue et al., 2000).

The model has been used in a variety of studies since it was originally proposed. TTF has been examined in group performance situations (Shirani et al., 1999; Zigurs and Buckland, 1998), as intended with the 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 TAM (Dishaw and Strong, 1999; Klopping and McKinney, 2004; Pagani, 2006; Wills et al., 2009), leading to a model with the behavioural elements of TAM as well as the 'fit' components of TTF.

More recently, TTF has been the theoretical basis for a number of studies evaluating user performance with IS. Vlahos et al. (2004) investigated German managers and their use, perception of value and satisfaction with IT. They discovered that the greatest TTF was related to resource allocation, alternatives evaluation, problem identification and short-term decision making. Another example includes a study that combined TTF with a cognitive element from SCT (Lin and Huang, 2008). This study investigated Knowledge Management System (KMS) usage in IT. Here, perceived TTF, KMS self-efficacy and personal and performance outcome expectations were found to also have significant influences on use.

Another study addressed KM technology usage and performance, this time in the context of a Chinese consulting firm (Teo and Men, 2008). Teo et al. found that output quality, data compatibility and knowledge tacitness (an extension of Goodhue's original model) were positively related to usage. The authors also concluded that utilisation and compatibility were positively related to performance, and TTF was more strongly related to performance than utilisation. Other research examined TTF in the context of mobile information systems (Junglas et al., 2008), where the TTF construct of data locatability is examined in significant detail, and Zigurs and Khazanchi (2008) who apply the theoretical perspective of frames to the challenges of virtual collaboration technologies.

With the exception of Kilmon et al. (2008), there are no studies employing task-technology fit in studying user evaluation of electronic health record systems. In that regard, Kilmon et al. (2008) utilise the task-technology fit instrument presented in Goodhue (1998) as a diagnostic tool to evaluate the first phase of an electronic health record implementation 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 instrument in the health care context. Moreover, the study does not attempt to

evaluate performance impact or the relationship between task-technology fit and performance impact.

3 Research model and hypotheses

This study employs a reduced version of the task-technology fit model. The focus is on capturing user evaluation of task-technology fit along various dimensions as identified in Goodhue (1995), impact on individual performance, and the relationship between task-technology fit and individual performance. The task-technology fit dimensions that comprise the model employed in this study include data quality, data locatability, data compatibility, information systems department relationship to users, ease-of-use and training, correct level of authorisation, systems reliability, and information systems production timeliness. According to the task-technology fit 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 (Figure 1) hypothesises 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 eight task-technology fit 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 authorisation will influence user performance. Authorisation measures the degree with which individuals are appropriately authorised to access the data required for the task.

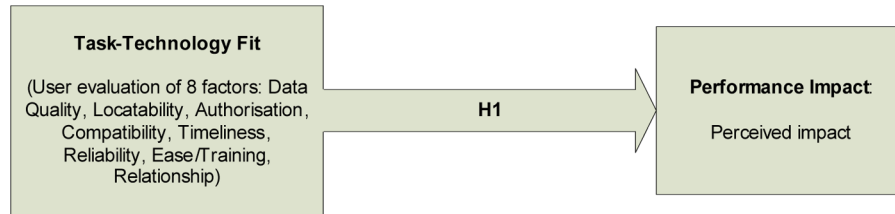
H1d: The compatibility of data from other systems will influence user performance.

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 information system's departments' relationship with users will influence user performance. This factor includes the information systems departments understanding of business, the interest in user support, responsiveness, delivery of agreed-upon solutions, and technical and unit planning support.

Figure 1 Determinants of performance (see online version for colours)

4 Methodology

4.1 Setting, context and subjects

The study was conducted at a regional health centre in South Dakota, USA. The subjects of the study are registered nurses 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 centre, post-acute care, Rehabilitation, Oncology, Pulmonary care, Intensive care, Coronary intensive care and Home health.

4.2 Survey instrument

The survey instrument is based on constructs validated in prior research (Goodhue and Thompson, 1995), standardised and adapted to the context of this study. The constructs include data quality, data locatability, data compatibility, information systems department relationship to users, ease-of-use and training, correct level of authorisation, systems reliability, and information systems department 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.

4.3 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.

4.4 Data analysis

Partial least squares 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 analysed in separate steps, and are generally not considered for use when complex models are involved (Gefen et al., 2000). Two other methods, covariance-based structural equation modelling and partial least

squares – structural equation modelling, are the most widely used methods in information systems research. For this study, partial least squares was chosen for two reasons:

- 1 As a structural equation modelling technique, partial least squares is designed to explain the significance of the relationships in the model, as is the case in linear regression, and for this reason partial least squares is better suited to predictive models than covariance-based structural equation modelling approaches which focus on overall model fit.
- 2 In contrast to covariance-based structural equation modelling, the estimation of significance in partial least squares does not require parametric assumptions, thus allowing analysis of comparatively small data sets, such as in this study (Gefen et al., 2000).

This is accomplished by estimation of the parameters such that the residual variance of all dependent variables is minimised.

A number of recent technology acceptance studies have used partial least squares (e.g., Al-Gahtani, 2001; Compeau and Higgins, 1995a; Venkatesh et al., 2003). To evaluate the measurement model, partial least squares estimates the internal consistency for each block of indicators. Partial least squares then evaluates the degree to which a variable measures what it was intended to measure (Cronbach, 1951; Straub, 1989; Straub et al., 2004). This evaluation, understood as construct validity, is comprised of convergent and discriminate validity (Straub, 1989). 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 hypothesised relationship, partial least squares calculates an R^2 for each dependent construct in the model. Similar to regression analysis, R^2 represents the proportion of variance in the endogenous constructs which can be explained by the antecedent constructs (Chin, 1998a).

5 Results and discussion

5.1 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 and 34, 21% between 35–44, 26% between the ages of 45–54 and 19% between the ages of 55–64. Ninety five percent of the subjects were female – a figure that is representative of the overall gender distribution of registered nurses at this facility.

5.2 Assessing measurement validity

Various versions of the task-technology fit survey instrument have been validated in the literature (Goodhue, 1995, 1998; Goodhue and Thompson, 1995). However, since the task-technology fit instrument has not been validated in a health care context, we re-examine the survey instrument with respect to reliability and construct validity. Using PLS-Graph software 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, 1995b; Fornell and Larcker, 1981). In effect, such items are deemed as not contributing to the underlying construct (Hair et al., 2006). The remaining items adequately represent the underlying constructs attesting to the content validity of the instrument.

Table 1 summarises the results for the items comprising the model. The results show composite reliability 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, composite reliability 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 Result summary for the combined model

<i>Dimension</i>	<i>Code</i>	<i>Question</i>	<i>Mean</i>	<i>SD</i>	<i>Item loading</i>	<i>CR</i>	<i>AVE</i>
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		
		3. The exact definition of data fields relating to my tasks is easy to find out	4.21	1.42	0.852		

Table 1 Result summary for the combined model (continued)

<i>Dimension</i>	<i>Code</i>	<i>Question</i>	<i>Mean</i>	<i>SD</i>	<i>Item loading</i>	<i>CR</i>	<i>AVE</i>
Data locatability	LOCT	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		
Authorisation	AUTH	(Obtaining authorisation 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 authorisation	3.10	1.37	0.910		
		*2. Getting authorisation 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 timeliness	PROD	(Information systems department 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 information systems department 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		

Table 1 Result summary for the combined model (continued)

<i>Dimension</i>	<i>Code</i>	<i>Question</i>	<i>Mean</i>	<i>SD</i>	<i>Item loading</i>	<i>CR</i>	<i>AVE</i>
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 electronic health record is easy for me	5.07	1.38	0.825		
		2. I find it easy to get the electronic health record to do what I want it to do	5.03	1.38	0.845		
		3. My interaction with the electronic health record is clear and understandable	5.14	1.33	0.924		
		4. I find the electronic health record to be flexible to interact with	4.63	1.51	0.817		
		5. It is easy for me to become skilful at using the electronic health record	5.13	1.32	0.866		
		6. I find the electronic health record easy to use	5.19	1.34	0.937		
	TRNG	2. I am getting the training I need to be able to use the organisation's computer systems, languages, procedures and data effectively	4.82	1.41	0.701		
Information systems department relationship w/users	RELUSR	(Information systems department relationship with system users)				0.944	0.738
		1. The hospital information systems people we deal with understand the day-to-day objectives of my unit and its mission within our organisation	3.95	1.70	0.812		
		2. My unit feels that information systems personnel can communicate with us in familiar, consistent terms	4.11	1.58	0.906		
		3. The hospital information systems department takes my unit's clinical-information technology challenges seriously	4.33	1.58	0.933		
		4. The hospital information systems department takes a real interest in helping my unit solve its clinical-information technology issues	4.34	1.56	0.927		
		7. When a request for service or assistance is made, the hospital information systems department normally responds in a timely manner	4.08	1.49	0.745		

Table 1 Result summary for the combined model (continued)

<i>Dimension</i>	<i>Code</i>	<i>Question</i>	<i>Mean</i>	<i>SD</i>	<i>Item loading</i>	<i>CR</i>	<i>AVE</i>
Information systems department relationship w/users	RELUSR	8. So far, the information systems department has delivered agreed-upon solutions for my units clinical-information technology needs	4.24	1.32	0.816		
Performance	PERF					0.956	0.756
		1. Using the electronic health record enables me to accomplish tasks more quickly	4.68	1.33	0.810		
		2. Using the electronic health record improves the quality of the work I do	5.01	1.24	0.677		
		3. Using the electronic health record makes it easier to do my job	4.97	1.24	0.928		
		4. Using the electronic health record enhances my effectiveness on the job	5.01	1.27	0.897		
		5. Hospital 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 organisation'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 electronic health record increases my productivity	4.79	1.29	0.887		

Table 1 shows the mean, standard deviation and item loading for each indicator, as well as the composite reliability and AVE at the construct level. Items marked with an asterisk are reverse-coded.

As illustrated in Table 2, 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.

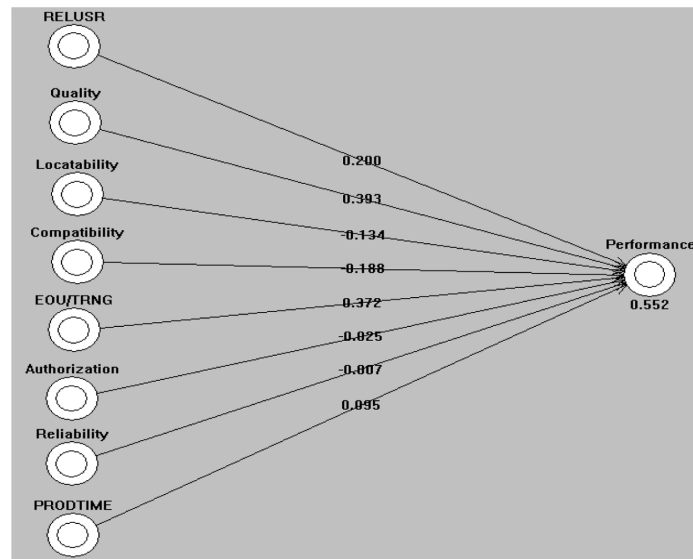
Table 2 Square root of AVE scores and correlation of latent variables

	<i>QUAL</i>	<i>LOCT</i>	<i>AUTH</i>	<i>COMP</i>	<i>PROD</i>	<i>RELY</i>	<i>EOU/TRNG</i>	<i>RELUSR</i>	<i>PERF</i>
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

5.3 Model testing results and discussion

Figure 2 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 hypothesised 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 hypotheses H1a and H1e respectively. H1h – information system department relationship with users ($\beta = 0.200$ $p > 0.10$) with H4 – data compatibility ($\beta = -0.188$ $p > 0.10$) are significant at the 90% level. Comparing the results with that reported in Goodhue and Thompson (1995), 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-of-use/training while significant in this study was not significant in Goodhue (1995). The remaining task-technology fit dimensions were insignificant predictors for performance in both studies.

In the context of electronic health record systems, it is no surprise that data quality, i.e., providing access to the right data, at the right level of detail and currency 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 information systems department with system users (nurses in this study), and the compatibility as predictors of performance. However, the results are particularly surprising with respect to the insignificance of information systems department

production timeliness and locatability – which one would expect as a hallmark for implementing electronic health records.

6 Conclusion and future work

In this study we report on user evaluation of electronic health record systems using task-technology fit as the underlying theoretical model. From a theoretical perspective, analysis of the results confirms the validity of the task-technology fit instrument and supports task-technology fit as a model for predicting performance impact in a health care setting. From a practical perspective, the results highlight the importance of the various task-technology fit dimensions captured in the study. Of particular importance are data quality, ease-of-use/training, and data compatibility. Further follow up is still needed with regard to the insignificance of information systems department production timeliness and data locatability dimensions.

This study is the second (after Kilmon et al., 2008) to leverage task-technology fit to evaluate electronic health record systems and the first to validate the task-technology fit instrument in a health care 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 health care domain, further work is needed to adapt the instrument to the needs of decision makers, primarily clinicians (e.g., nurses and physicians), 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-specific characteristics as antecedents of task-technology fit dimensions. Another possible extension is the incorporation of system utilisation as in Goodhue (1995).

As adoption of electronic health record systems and other health information technologies gains momentum, it is imperative that information systems research efforts consider not only the behavioural aspects of adoption and utilisation, but also the performance impact resulting from system use. In most health care settings where electronic health records have been implemented, system use is likely mandatory. As a result, it may be less important to evaluate the ‘why’ of system use, and more important to direct resources at evaluating how such systems impact user performance.

This study is significant in that it establishes the validity of the task-technology fit instrument in the health care domain, provides a validated instrument for use by health care practitioners who wish to assess user reports of performance impact, and identifies opportunities for future work to improve upon the methods described herein.

Acknowledgements

The authors are deeply grateful to Rapid City Regional Hospital and Regional Health System for their support of this research.

References

- Ajzen, I. and Fishbein, M. (1980) *Understanding Attitudes and Predicting Social Behavior*, Prentice-Hall, Englewood Cliffs, NJ.
- Al-Gahtani, S.S. (2001) 'The applicability of TAM outside North America: an empirical test in the United Kingdom', *Information Resources Management Journal*, Vol. 14, No. 3, pp.37–46.
- Bandura, A. (1977) 'Self-efficacy: toward a unifying theory of behavioral change', *Psychological Review*, Vol. 84, No. 2, pp.191–215.
- Bandura, A. (1986) *Social Foundations of Thought and Action: A Social Cognitive Theory*, Prentice-Hall, Englewood Cliffs, NJ.
- Chin, W.W. (1998a) 'Commentary: issues and opinion on structural equation modeling', *MIS Quarterly*, Vol. 22, No. 1, pp.7–16.
- Chin, W.W. (1998b) 'The partial least squares approach for structural equation modelling', in Marcoulides, G.A. (Ed.): *Modern Methods for Business Research*, Lawrence Erlbaum Associates, Hillsdale, NJ, p.448.
- Compeau, D.R. and Higgins, C.A. (1995a) 'Application of social cognitive theory to training for computer skills', *Information Systems Research*, Vol. 6, No. 2, pp.118–143.
- Compeau, D.R. and Higgins, C.A. (1995b) 'Computer self-efficacy – development of a measure and initial test', *MIS Quarterly*, Vol. 19, No. 2, pp.189–211.
- Cronbach, L. (1951) 'Coefficient alpha and the internal structure of tests', *Psychometrika*, Vol. 16, pp.297–334.
- Davis, F.D. (1989) 'Perceived usefulness, perceived ease of use, and user acceptance of information technology', *MIS Quarterly*, Vol. 13, No. 3, pp.319–340.
- 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*, Vol. 359, No. 1, pp.50–60.
- Dishaw, M.T. and Strong, D.M. (1999) 'Extending the technology acceptance model with task-technology fit constructs', *Information and Management*, Vol. 36, No. 1, p.9.
- 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*, Vol. 7, No. 2, p.123.
- Fishbein, M. and Ajzen, I. (1975) *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesey, Reading, MA.
- Fornell, C. and Larcker, D.F. (1981) 'Structural equation models with unobservable variables and measurement error – algebra and statistics', *Journal of Marketing Research*, Vol. 18, No. 3, pp.382–388.
- Gefen, D., Straub, D. and Boudreau, M.C. (2000) 'Structural equation modeling and regression: guidelines for research practice', *Communication of the AIS*, Vol. 4, No. 7, pp.1–76.
- Gefen, D. and Straub, D. (2005) 'A practical guide to factorial validity using PLS-GRAPH: tutorial and annotated example', *Communication of the AIS*, Vol. 16, pp.91–109.
- Goodhue, D.L. (1988) 'IS attitudes: toward theoretical and definition clarity', *DataBase*, Vol. 19, Nos. 3–4, pp.6–15.
- Goodhue, D.L. (1995) 'Understanding user evaluations of information systems', *Management Science*, Vol. 41, No. 12, p.1827.
- Goodhue, D.L. (1998) 'Development and measurement validity of a task-technology fit instrument for user evaluations of information systems', *Decision Sciences*, Vol. 29, No. 1, p.105.

- Goodhue, D.L., Klein, B.D. and March, S.T. (2000) 'User evaluations of IS as surrogates for objective performance', *Information and Management*, Vol. 38, No. 2, p.87.
- Goodhue, D.L. and Thompson, R.L. (1995) 'Task-technology fit and individual performance', *MIS Quarterly*, Vol. 19, No. 2, p.213.
- Hair, J.F., Black, B., Babin, B., Anderson, R.E. and Tatham, R.L. (2006) *Multivariate Data Analysis*, 6th ed., Prentice-Hall, Upper Saddle River, NJ, p.928.
- Junglas, I., Abraham, C. and Watson, R.T. (2008) 'Task-technology fit for mobile locatable information systems', *Decision Support Systems*, Vol. 45, No. 4, p.1046.
- Kilmon, C., Fagan, M.H., Pandey, V. and Belt, T. (2008) 'Using the task technology fit model as a diagnostic tool for electronic medical record evaluation', *Issues in Information Systems*, Vol. 9, p.2.
- 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*, Vol. 22, No. 1, p.35.
- 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 and Management*, Vol. 45, No. 6, p.410.
- Mathieson, K. and Keil, M. (1998) 'Beyond the interface: ease of use and task/technology fit', *Information and Management*, Vol. 34, No. 4, p.221.
- Miller, N.E. and Dollard (1941) *Social Learning and Limitation*, Yale University Press, New Haven.
- Nunnally, J.C. (1978) *Psychometric Theory*, 2nd ed., McGraw-Hill, New York.
- 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 and Management*, Vol. 43, No. 7, p.847.
- 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 and Management*, Vol. 36, No. 3, p.139.
- Straub, D.W. (1989) 'Validating instruments in MIS research', *MIS Quarterly*, Vol. 13, No. 2, pp.147-169.
- Straub, D.W., Boudreau, M-C. and Gefen, D. (2004) 'Validation guidelines for IS positivist research', *Communications of the AIS*, Vol. 13, No. 24, pp.380-427.
- Taylor, S. and Todd, P.A. (1995) 'Understanding information technology usage – a test of competing models', *Information Systems Research*, Vol. 6, No. 2, pp.144-176.
- Teo, T.S.H. and Men, B. (2008) 'Knowledge portals in Chinese consulting firms: a task-technology fit perspective', *European Journal of Information Systems*, Vol. 17, No. 6, p.557.
- Thompson, R.L., Higgins, C.A. and Howell, J.M. (1991) 'Personal computing – toward a conceptual-model of utilization', *MIS Quarterly*, Vol. 15, No. 1, pp.125-143.
- Triandis, H.C. (1977) *Interpersonal Behavior*, Brooke Cole, Monterey, CA.
- Venkatesh, V. and Bala, H. (2008) 'Technology acceptance model 3 and a research agenda on interventions', *Decision Sciences*, Vol. 39, No. 2, pp.273-315.
- Venkatesh, V. and Davis, F.D. (2000) 'A theoretical extension of the technology acceptance model: four longitudinal field studies', *Management Science*, Vol. 46, No. 2, pp.186-204.
- Venkatesh, V., Morris, M.G., Davis, G.B. and Davis, F.D. (2003) 'User acceptance of information technology: toward a unified view', *MIS Quarterly*, Vol. 27, No. 3, pp.425-478.
- 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 and Management*, Vol. 41, No. 6, p.763.

- Wills, M.J., El-Gayar, O.F. and Deokar, A.V. (2009) 'Evaluating the technology acceptance model, task-technology fit, and user performance for an electronic health record system', *Proceedings of the 40th Annual Decision Science Institute Conference*, New Orleans, LA, Upcoming 14–17 November.
- Zigurs, I. and Buckland, B.K. (1998) 'A theory of task/technology fit and group support systems effectiveness', *MIS Quarterly*, Vol. 22, No. 3, p.313.
- Zigurs, I. and Khazanchi, D. (2008) 'From profiles to patterns: a new view of task-technology fit', *Information Systems Management*, Vol. 25, No. 1, p.8.