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# Development and Testing of an Instrument for Measuring the User Evaluations of Information Technology in Health Care

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## ABSTRACT

*We use task-technology-fit model to develop an instrument for obtaining user evaluations of IT in health care. Our results indicate that task-technology fit along with individual characteristics have an impact on user evaluation of the IT in health care. We modify the original task-technology fit model for adequate domain coverage in health care industry. The contribution of our study is towards development and testing of an instrument for measuring user evaluations of IT in health care. The proposed model is successfully tested using a survey of 156 respondents from the eastern United States.*

## INTRODUCTION

Much has been written about end-user perceptions of IT (Davis, 1989; Baroudi, Olson, and Ives, 1986; Robey, 1979; Adams, Nelson, and Todd, 1992; Moore and Benbasat 1991). But few studies address user evaluations of IT in the health care industry. The tremendous growth of the use of IT increasingly has been felt by administrators in health care. Hospital administrators now recognize IT as a powerful tool for their organization to gain competitive advantage. The widespread use of IT by end-users reinforces the importance of gaining a more complete understanding of IT, and the factors related to successful quality control, cost containment and staff scheduling.

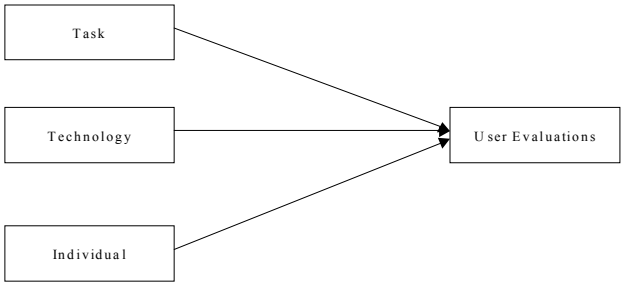
A central focus of IT in health care has been directed to the factors associated with providing high-quality patient care (Margolis and Booker, 1992). Quality control has been viewed from a variety of perspectives and has had varying definitions and measures of success, including individual hospital and department quality assurance (Hetherington, 1982; Restuccia and Holloway, 1982). However, hospital industry experts feel that health care costs could be contained by billions of dollars each year if end-users were to use IT to improve quality using other measures (Margolis and Booker, 1992). Among these, electronic management and transmission of patient data and perceived end-user benefits have not been investigated rigorously. In this study, we develop and test an instrument to measure the end-user evaluation of IT in health care.

## THE THEORETICAL FRAMEWORK

Task technology fit (TTF) model is a popular model for obtaining user evaluation of information systems. The TTF model is illustrated in Figure 1. The central premise for the TTF model is that "users will give evaluations based on the extent to which systems meet their needs and abilities" (Goodhue, 1995).

TTF model represented in Figure 1 is very general and using it for a particular setting needs special consideration. Among the three factors that determine the user evaluations of IS, technology is the most complex factor to measure in health care. Technology in health care is used for reporting, electronic information sharing and staff scheduling. Reporting is important in a health care setting because patient lives depend on accurate and timely information. There are four types of information that is reported in a health care facility. These four information categories are: Scientific and technical information, patient-care information, customer satisfaction information and administrative information (Rodger, 1997). Scientific and technical information provides the knowledge base for identifying, organizing, retrieving, analyzing, delivering and reporting clinical and managerial journal literature, reference information, and research data for use in designing, managing, and improving patient-specific and departmental processes (JCAHO, 1995). Patient-care information is specific data and information on patient that is essential for maintaining accurate medical records of the patient's medical history and physical examinations. Patient-specific data and information are critical to tracking all diagnostic and therapeutic procedures and tests. Maintaining accurate information about patient-care results and discharges is imperative to delivering quality health care (Bergman, 1993). Customer satisfaction information is information gathered on external customers such as patient and their family and friends. Customer satisfaction information is gathered from surveys and takes into account socio-demographic characteristics, physical and psychological status, attitudes and expectations concerning medical care, the outcome of treatment, and the health care setting (McLaughlin and Kaluzny, 1994). The administrative information that is reported in the health care facility is the information essential for formulating and implementing effective policies both at the organizational and departmental level. The administrative information is necessary to determine the degree of risk involved in

*Figure 1: Task Technology Fit Model*



financing expansion of services (Duncan et. al, 1995). Functional departments within the health care facility must be able to access and report new information in order to respond properly to changes in the health care environment (Longest, 1990).

Information sharing and connectivity are increasingly important as the availability of external consultative services increase. Connectivity allows diagnoses to be made in remote locations using electronic means, and information sharing decreases the chances that mistakes will be made in a health care setting. Connectivity in health care is integration of hardware, software, databases and the networks (Rodger, 1997). Venkatraman and Zaheer (1990) were one of the first to introduce the concept of connectivity, even though they used a rather narrow bandwidth approach. In fact, E-mail was the only medium available on the leading edge of connectivity at the time Venkatraman and Zaheer (1990) made their observations about communicating with others via electronic means. Today, the concept of connectivity has taken on a broader meaning, especially in the context of health care. The medium is much richer today in terms of interactivity, temporal constraints, and bandwidth. The technological infrastructure of organizations is becoming increasingly complex (Henderson, 1990). More and more, information technology is being used to improve coordination of activities both within and across organizations (Cash and Konsynski, 1985). Computers and video networks are providing long distance health care through medical connectivity. Doctors, today, can interact with each other and ancillary medical personnel through e-mail, video and audio means. A difficult patient case in rural area can be given expert specialist attention simply by using "distance" medicine. Not only can patient records, text, documents be transmitted instantaneously via electronic means- but live video, X-rays, and other diagnostic parameters can be discussed in an interactive manner with live discussions weaving a web of competency never before witnessed in medical history. Connectivity leads to shared care that comprises the continued, coordinated and integrated activities of different people from different institutions applying different methods in different time frames, all in a combined effort to aid patients medically, psychologically and socially in the most beneficial ways (Ellsasser et. al, 1995).

Staff and equipment scheduling has received a lot of attention in operations research area. IT is used for scheduling for lowering the health care cost and improving effective utilization of physical and human resources. Scheduling using statistical, time series and regression analysis is conducted to achieve lower costs through rationing assets e.g., ambulatory service, and real time forecasting of resources (Ow et. al, 1989).

Other than technology, user evaluations of IT depend on task and individual characteristics. Task characteristics in health care can be measured as formal routine and adhoc assigned/non-routine tasks. Individual characteristics are measured by level of education and orientation (clinical/administrative).

## RESEARCH METHOD

### Sampling Procedure

End-users from a pool of twenty health care facilities in the eastern United States were contacted by telephone and invited to participate in the study. This region was selected for reasons of geographical proximity of the sample and, in many cases, the existence of personal contacts within the facilities. Fourteen out of the twenty facilities agreed to participate in the study. Five hundred survey questionnaires were distributed (mailed and hand delivered) of which 167 were returned at the time of the data analyses (a response rate of 33 percent). Based on the sample's broad representation by hospital size (number of patient beds), characteristics of the end-users (experience in using HIS and their qualifications), and HIS applications; no significant biases were apparent. The 167 respondents represented the following 9 divisions: radiology, infection control, medical laboratory, secretarial, administrative, paramedic, nuclear medicine, pharmacy and nursing.

Data screening was carried out on the set of 167 responses and the final data set of 156 usable responses was used in the study.

### Instrument Development and Measurement of Variables

Our study considered only those parts of HIS that are directly used to support business decisions. The development of the instrument was carried out in two stages. The first stage was item creation. The objective of the first step was to ensure face and content validity on the instrument. An item pool was generated by interviewing 2 end-users of HIS and one of the authors (who has about 10 years of experience as an end-user of HIS) himself. The domain coverage of the developed pool of items was assessed by 3 other end-users form three different hospitals that were covered in the survey. None of the end-users that were part of the scale development filled out the final survey questionnaire. All the items were measured on a 5 point Likert scale ranging from "extremely important" to "not important".

The second step was scale (construct) development. Since there were no prior scales developed in the literature, an exploratory factor analyses was run on all the pooled items measuring three factors (technology, task and individual characteristics) (Gerbing and Anderson, 1988). The factor analysis for the items measuring technology loaded on two factors. The two factors were logically names as "IT for data analysis and reporting" and "IT for scheduling". The items that loaded below 0.6 were dropped. Tables 1A and 1B show the results of the exploratory factor analysis for multi-dimensional technology factor. The reliabilities of the two factors, as measured by Chronbach's alpha (Cronbach, 1970) was 0.981 and 0.963 respectively.

*Table 1A: Factor loading for IT for data analysis and reporting factor.*

| Variable | **Factor Loading** |
|---|---|
| Importance of IT in Document Production | 0.87407 |
| Importance IT in Word Processing | 0.90177 |
| Importance of IT in Integrating Graphs into Text | 0.85447 |
| Importance of IT in Desktop Publishing | 0.94633 |
| Importance of Document Scanners | 0.85680 |
| Importance of IT in Financial Analysis | 0.91872 |
| Importance of IT in Statistical Analysis | 0.92535 |
| Importance of IT in Time Series Forecasting | 0.96041 |
| Importance of IT in Regression Analysis | 0.95724 |
| Importance of IT in File Transfers | 0.89838 |
| Importance of IT in Data Retrieval | 0.93929 |
| Importance of IT in Data Storage | 0.93445 |

*Table 1B: Factor loading for IT for scheduling factor.*

| Variable | **Factor Score** |
|---|---|
| IT for Time Management | 0.93929 |
| IT for Personal Calendars | 0.96135 |
| IT for Deadline Reminders | 0.95333 |
| IT for Staff Scheduling | 0.86941 |
| IT for Patient Scheduling | 0.86021 |

Tables 2 and 3 illustrate the results of factor analysis on the item measuring individual and task characteristics. The items loaded on two factors but, the relibilities of the two factors was relatively low 0.6154 and 0.6532 respectively.

*Table 2: Factor loading for Task Characterstics*

| Variable | Factor Score |
|---|---|
| Formal routine tasks | 0.75662 |
| Assigned tasks | 0.75662 |

*Table 3: Factor loading for Individual Characteristics*

| Variable | Factor Score |
|---|---|
| Educational Level | 0.77046 |
| Orientation | 0.77046 |

The results of the factor analysis indicated that technology construct is a multi-dimensional construct consisting of two dimensions measured as "IT for data analysis/reporting" and "IT for scheduling". To measure the uni-dimensionality of each one of these two constructs, we ran a confirmatory factory analysis using LISREL. Figure 2 illustrates the results of the confirmatory factor analysis. The normalized goodness of fit index was 0.921 indicating that the two factors are unidimensional. The chi-square statistics was retained with the value of 55.728 and p=1.00.

The low reliabilities in task and individual characteristics factors make the measurement less reliable. Although we use task and individual characteristics in our analysis, we exercise care in interpreting the results.

## DATA ANALYSIS PROCEDURE AND RESULTS

Multiple regression was performed to assess the contribution of IT for scheduling, IT for data analysis/reporting, task characteristics and individual characteristics on the user evaluations of IT in health care. Table 4 illustrates the results of the multiple-regression analysis.

The results indicate that overall end-user evaluations of IT are determined by the TTF model. The R-square for the model was 0.61 and the individual contributions of each factor are shown in Table 5.

Based on the data shown in Table 5, it can be seen that the major factor that impact the user evaluation of IT in health care is the use of IT for reporting and analysis. The task characteristic is the second major factor followed by scheduling and individual characteristics.

*Table 5: Individual contribution of the study variables to the dependent variable*

| Source | Deg. of Free. | Sum of Sq. | F Value | $P_r$>F |
|---|---|---|---|---|
| IT for reporting and analysis | 1 | 171.02 | 206.51 | 0.0001* |
| Task | 1 | 15.09 | 18.23 | 0.0001* |
| IT for scheduling | 1 | 3.80 | 4.59 | 0.0338** |
| Individual | 1 | 3.80 | 4.59 | 0.0337** |

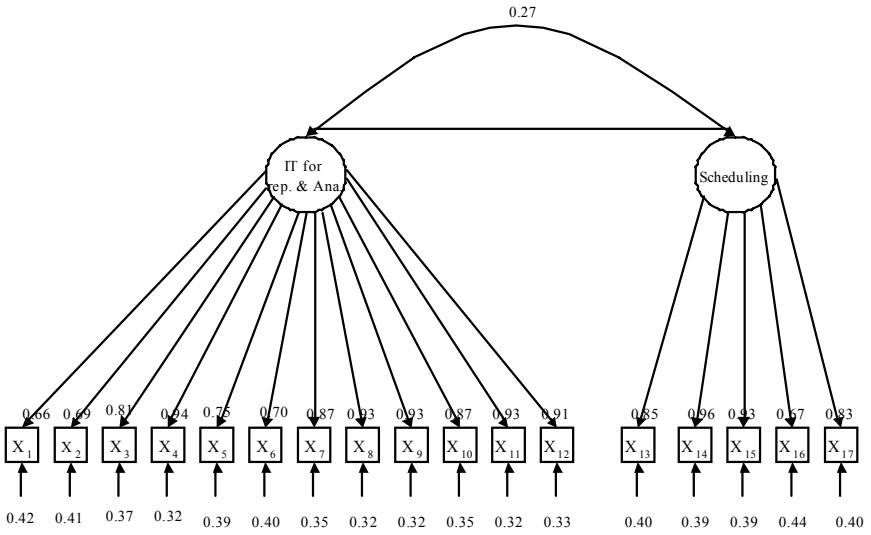
* significant at p= 0.01, ** significant at p=0.05

*Table 4: One way ANOVA table for regression analysis.*

| Source | Deg. of Fre. | Sum of Sq. | Mean Sq. | F Value | $P_r$ > F |
|---|---|---|---|---|---|
| Model | 4 | 193.73 | 48.43 | 58.48 | 0.0001* |
| Error | 147 | 121.74 | 0.828 | | |
| Corr. Total | 151 | 315.47 | | | |

* significant at p= 0.01

*Figure 2: The confirmatory factor analysis of the technology factor.*

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## CONCLUSIONS

This study represents the first development and test of an integrated model for measuring end-user evaluations of IT in the health care industry. The results have provided an instrument to measure the user evaluations of IT in health care The study's primary contribution was to development of an instrument, it has some limitations which should be addressed in further research: (1) Other variables may be added to the model as possible impacts on end-user evaluation of IT; (2) Present measures of end-user evaluations of IT may be replaced by more objective measures; and (3) The measures for the various constructs associated with end-user perceptions of IT may be improved by adding more items to measure the construct. Most importantly, it must be remembered that although the IT end-users surveyed in this study represented a wide variety of departments and health care institutions, they were drawn from a convenience sample and may not necessarily represent the entire population of IT end-users. Therefore, more empirical

research may be necessary before generalizing present results to IT end-users in other health care organizations. Each of these limitations represents an opportunity for further research in the area of end-user evaluations of IT in the health care industry.

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