Assessing User Computing Effectiveness: An Integrated Model

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The importance of end-user computing (EUC) to organizations continues to grow. Many organizations are making sizeable investments in this area. It has become increasingly important for managers to understand the important factors to EUC effectiveness. This paper reports the results of a field study that investigated the determinant EUC effectiveness among 187 end-users. A conceptual path analytic model was developed and tested. The results show that end-user computer experience and attitudes toward EUC have strong direct effects on the variety of tasks for which the system is used, and on general system usage. While lack of task structure has negative effects on end-user satisfaction, end-user attitudes toward EUC have positive effects. Finally, support for EUC has a positive effect on perceived changes in job effectiveness but task structure is found to have a negative effect.

The vast proliferation of end-user computing (EUC) has been widely reported [Van Kirk, 1995; Caginalp, 1994; Burrows, 1994; Igbaria, Pavri & Huff, 1989]. The explosion has happened in the United States as well as overseas. Indeed, it is a world-wide phenomenum occuring in Japan [Patton, 1995], in Europe [Preston, 1994], as well as other developing nations [Anonymous, 1994]. EUC has been one of the most striking of many changes in how organizations use computers since the early 1980s, and it is expected that most organizations will continue to increase their EUC expenditures and that the number of microcomputers will increase steadily in the 1990s (Van Kirk, 1995; Caginalp, 1994; Burrows, 1994).

Many authors have recognized that the expansion in end-user computing activities within relatively large organizations requires substantial investment in personnel and facilities for support [Igbaria, Guimaraes & Davis, 1995; Van Kirk, 1995; Guimaraes, 1986; Leitheiser & Wetherbe, 1986; Guimaraes, 1984a]. The large number of organizations that have established Information Centers (IC) attests to their importance in supporting end-user computing activities. Very clearly, from the beginning ICs have evolved over time [Guimaraes, 1984b] and apparently continue to evolve energetically today [Guimaraes & Igbaria, 1994; Guimaraes, 1996]. The importance of understanding the issues surrounding IC organizations and its mission has not escaped the attention of academic researchers. Critical issues such as managing data, training users, and managing end user activities have been studied widely (Igbaria et al., 1995; Guimaraes & Igbaria, 1992; Magal, Carr & Watson, 1988). Further, the determinants and consequences of job satisfaction among IC personnel were studied by Guimaraes and Igbaria [1993], including a comparison of IC versus IS personnel in terms of the same variables [Guimaraes & Igbaria, 1992].

As corporate investment to provide the computing resources and maintain support for EUC activities continues to grow, business managers wonder about the benefits from the investments. Needless to say, while the productivity increases from EUC may be hotly debated, without system usage it becomes a non-starter issue. Thus, microcomputer usage, despite its obvious weaknesses as a measure of EUC success, becomes an exceedingly important variable worthy of academic and practitioner attention.

Much of the research on computer-based system implementation has been focused on identifying factors conducive

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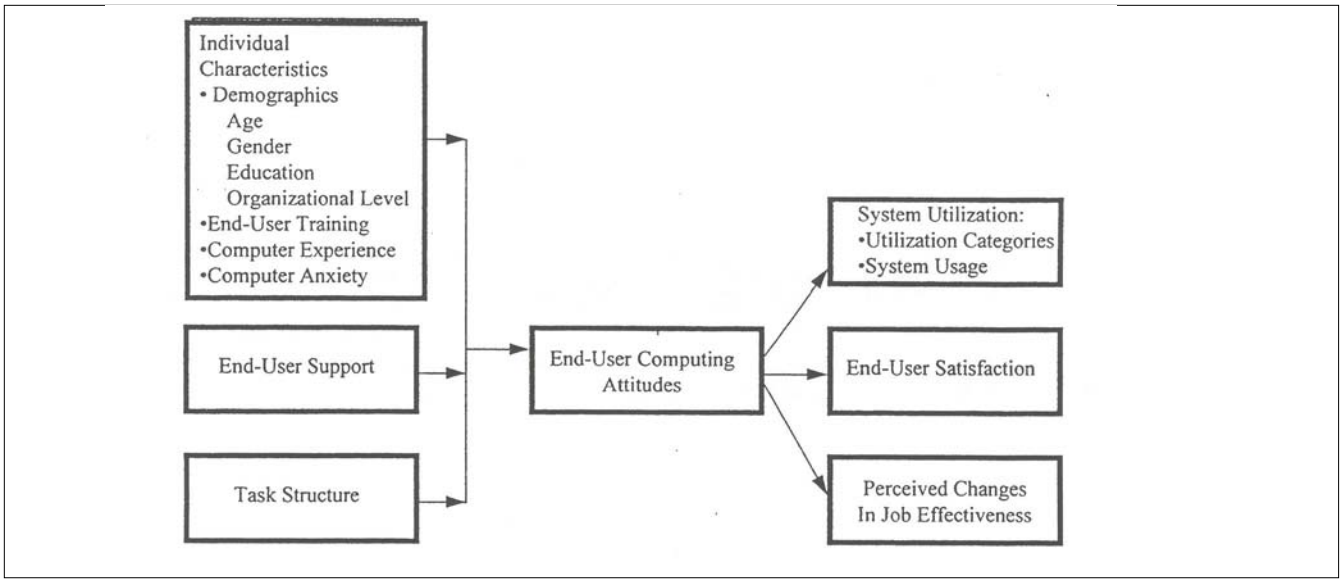

Figure 1: End-User Computing Effectiveness: A Conceptual Path Model

to success or failure, including user involvement [Barki & Hartwick, 1989; Baronas & Louis, 1988], management support [Lee, 1986; Leitheiser & Wetherbe, 1986], end-user's expectations and attitude [Robey, 1979], politics [Markus, 1983], communications between developers and end-users [DeBrander & Thiers, 1984], task structure [Guimaraes, Igbaria & Lu, 1992], and end-users' training and experience [Nelson & Cheney, 1987]. In a similar vein, the purpose of this study was to continue the investigation of the factors related to the success of EUC. The model proposed here is unique in that it integrates a broad set of variables leading to three major outcome variables representing different aspects of EUC success: system utilization, end-user satisfaction with the system, and its effect on the end-user's job.

Theoretical Framework

This study uses a broad definition of EUC including anyone who uses computer technology hands-on and is not an information systems professional. Prior research has employed various measures of system success, including user satisfaction [Galletta & Lederer, 1989; Kendall, Buffington & Kendall, 1987; Mahmood & Sniezek, 1989], system usage [Mykytyn, 1988], perceived benefits of systems [David, 1989; Money, Tromp & Wegner, 1988], improved decision quality and performance [Kottemann & Remus, 1989], and business profitability [Sharda, Barr & McDonnell, 1988]. The choice of "best" measure for system success depends on the study objectives. All the measures mentioned above, including user satisfaction, and system usage, have advantages and disadvantages. On the other hand, user satisfaction has been proposed as the most useful surrogate measure of system success [Guimaraes & Gupta, 1988], and as "the most useful assessment of system effectiveness" [Hamilton & Chervany, 1981].

End-user satisfaction and system utilization have been used as two important indicators of EUC effectiveness by Srinivasan [1985]. A comprehensive discussion of system success by DeLone & McLeen [1992] proposes that compared to other factors, user satisfaction and system usage have been widely used, making them important as enablers for inter-study comparison. For these reasons, we used these constructs in this study. End-user satisfaction refers to the affective reactions of individuals toward specific computer system applications. System utilization represents the behavioral indices of user acceptance of the application system [Ives & Olson, 1984]. Two dimensions of system utilization reflecting intensiveness and extensiveness of use were examined: system usage or time spent in use of the system, and utilization categories that refers to the number of areas for which the system is used [Delone, 1988; Srinivasan, 1985]. Last, based on Millman and Hartwick's [1987] findings that office automation results in more enriching and satisfying jobs, perceived change in jobs due to computer technology was examined as an additional indicator of EUC effectiveness.

A review of the relevant literature indicates that the potential determinants of EUC effectiveness may be grouped into three categories: (1) individual characteristics (e.g., age, gender, education, computer training, user experience), and beliefs (e.g. computer anxiety, attitudes toward EUC); (2) task characteristics, i.e., task structure; and (3) organizational characteristics (e.g., end-user support). The main objective of this research is to test the four main hypotheses presented below, while also checking the possible direct and indirect effects of the independent variables on the dependent success variables. Figure 1 presents the variables included in the study and the hypothesized relationships among them. The rationale for each relationship is reviewed next.

The importance of individual characteristics in influencing user attitudes and eventual MIS success has been emphasized by Lucas [1978], and Zmud [1979], and has been

supported by many empirical studies. Rivard and Huff [1988] found that user computer background has significant effects on their attitude toward EUC. Results indicating that computer anxiety is negatively related to end-user attitudes have been reported by Howard and Smith [1986] and Parasuraman and Igbaria [1990]. Although some studies have found no gender differences in attitudes toward microcomputers [Howard & Smith, 1986; Parasuraman & Igbaria, 1990], others have reported that women and older individuals tend to have unfavorable attitudes toward the system [Dambrot, Watkins-Malek, Silling, Marshall & Garver, 1985]. Thus, the following hypothesis is proposed:

H1: Individual differences will significantly influence end-user attitudes toward EUC.

Several researchers have emphasized the importance of EUC support by top management as a potential organizational determinant of success, and specifically EUC success [Ein-Dor & Segev, 1988; Rivard & Huff, 1988]. Lucas [1978] reported that high levels of management support and involvement served to promote more favorable attitudes. As end-user computing (EUC) becomes pervasive in most organizations, its diversity grows in terms of types of applications, types of end-users, levels of end-user computer literacy, etc. Contrary to early expectations, end-users do not become independent; instead, they increasingly demand better equipment, more training, coaching, consulting, technical support, etc. Thus, a substantial component of EUC costs to organizations are related to user support. Many authors have recognized that the expansion in EUC activities within large organizations requires substantial investment in personnel and facilities for support [31]. The large number of organizations that have established Information Centers (IC) attests to their importance in supporting EUC activities. Further, previous research has established a connection between EUC support and its effectiveness [Guimaraes, 1996]. Thus, we propose:

H2: Organizational characteristics will significantly influence end-user attitudes toward EUC.

The role of task characteristics in influencing job attitudes has been well documented in the organizational behavior literature [Hackman & Oldham, 1976]. MIS studies [Daft & Macintosh, 1986; Gorry & Scott-Morton, 1971; Ives, Hamilton & Davis, 1980] indicate that task characteristics in terms of the structure of decision problems are related to the amount of information acquired and also MIS attributes (e.g., accuracy, currency, frequency of use). Thus, the following hypothesis is proposed:

H3: Task characteristics will significantly influence end-user attitudes toward EUC.

Figure 1 indicates that end-user attitudes toward microcomputers represent a key factor in influencing the three indicators of EUC effectiveness: user satisfaction; system utilization; and perceived changes in jobs. This is based on the proposition of attitude theorists that individuals' attitudes toward an object play an important role in influencing their subsequent behavior toward it. Evidence in support of this has been reported by Lucas [1978] and Robey [1979] who found user attitudes are positively related to actual use of systems. Moreover, Rivard and Huff [1988] reported user attitudes are positively related to overall user satisfaction. Finally, the findings of Millman and Hartwick [1987] suggest user attitudes are related to end-user perceived changes in their jobs. Thus, the following hypothesis is proposed:

H4: Favorable end-user attitudes toward EUC will lead to higher EUC effectiveness.

In summary, the proposed model posits that individual differences, organizational characteristics in the form of end-user support, and task characteristics will be significantly related to the favorability of attitudes toward EUC. Favorable user attitudes, in turn, will be positively related to EUC effectiveness, which in this study is measured in terms of user satisfaction, system utilization, and perceived changes in jobs. Thus, the effects of the antecedent variables for EUC effectiveness are expected to be channeled through user attitude, which is hypothesized to play an important intervening role.

Methodology

Sample

Part-time MBA students at an urban university on the East coast of the United States were invited to participate in this survey. The participants had a wide variety of backgrounds and were employed full time in a variety of manufacturing, service, merchandising, financial services and government organizations, thus comprising a fairly representative sample of EUC end-users. The sample is obviously biased in terms of the respondents' education level since most end-users are not likely to be working on their MBA degrees. However,

Age:	Mean = 29.16	Median = 27.0	Range = 21 - 56
Gender:	Male = 68%	Female = 32%	
Education:			
Some graduate school		82.0%	
Graduate degree		18.0%	
Organizational Level:			
Professional employee without supervisory responsibilities		57.2%	
First level supervisor		21.7%	
Department heads and middle managers		18.3%	
Top management (executives)		2.8%	

Table 1: Profile of Respondents

in terms of work experience and experience with computers the sample is quite representative. Whenever applicable, readers should take the respondent's relatively high level of formal education into consideration when attempting to generalize the results to other EUC end-users. Completed questionnaires were received from 198 persons. The exclusion of questionnaires with incomplete data resulted in a final sample of 187 respondents who held professional and managerial positions in a wide range of functional areas including accounting, finance, marketing, general management, information systems, and engineering. The majority of the respondents (68 percent) were men, with women representing 32 percent of the sample. The average age of the respondents was 29.1. Table 1 presents the demographic profile of the sample.

Operational Measures of the Study Variables

User Satisfaction: User satisfaction was measured by the 12-item scale developed by Doll and Torkzadeh [1988]. The scale is a measure of overall end-user computing satisfaction as well as satisfaction with the extent to which the computer application meets the user's requirements in terms of output information content, accuracy, format, ease of use, and timeliness. Each item was measured on a 5-point Likert scale ranging from (1) almost never to (5) almost always. The internal consistency reliability of the scale in this study was .81.

System Utilization: Two indicators of EUC utilization were included in this study: (1) actual daily use of the system; and (2) application areas. Daily usage was measured by a single item adapted from Igbaria, Pavri and Huff [1989], Lee [1986], and Mittman and Moore [1984], which asked individuals to indicate the amount of time spent on the system per day, using a 6-point scale ranging from "almost never" to "more than 3 hours per day." The application areas included eight tasks for which the computer was used, including support for making decisions, looking for trends, planning, and budgeting [Igbaria, Pavri & Huff, 1989]. The participants were asked to indicate whether they personally used the EUC system to perform these tasks. A yes/no response format was used, and the sum of the eight items was used as an overall index for this measure.

Perceived Changes in Job Effectiveness: Participants were asked to indicate how EUC systems had influenced their jobs personally. Specifically, they were asked to state whether EUC had increased, decreased, or had no effect on personal, departmental and organizational effectiveness [Millman & Hartwick, 1987]. The three items, scored so that high scores were associated with perceptions of increased effectiveness, were summed and averaged. The internal consistency reliability of the scale was .77.

Attitudes toward EUC: This measure assesses user attitude toward their personal hands-on use of EUC systems in accomplishing job-related tasks. The 10 items used to construct the EUC attitude measure were adapted from prior research [Goodhue, 1986; Howard & Smith, 1986; Igbaria, Pavri & Huff, 1989; Swanson, 1982] with appropriate modifications to make them relevant to EUC specifically. Individuals were asked to indicate the extent of their agreement or disagreement with each of the 10 items on a 5-point Likert-type scale ranging from (1) strongly disagree to (5) strongly agree. Sample items are: "Using an EUC system could provide me with the information that would lead to better decisions," "Using an EUC system improves my productivity on the job," and "Using an EUC system can take up too much of my time in performing my tasks." The 10-item scale had an internal consistency reliability of .80.

EUC Support: The measure of EUC support incorporated two broad categories of support: (1) application development support, which is quite specific and includes the availability of development assistance by special EUC support personnel; and (2) general support, which includes top management encouragement, allocation of resources, and MIS staff support. The scale consisted of eight items, four representing specific support, and four items of general support. The eight items were averaged to obtain a measure of overall end-user support. The internal consistency reliability of the eight-item scale was .85.

Task Structure: This refers to the amount of structure found in the job itself, i.e., the extent to which tasks are "repetitive and routine" with clearly defined procedures and methods [Keen & Scott-Morton, 1978]. House and Dessler's [1984] four-item task structure scale was used to operationalize this variable. Individuals were asked to indicate to what extent the task is repetitive, similar, varied, and unambiguous on a 5-point Likert type scale ranging from (1) very little to (5) almost completely. The mean of the four items was used as an overall index of task structure. The alpha reliability coefficient of the measure was .81.

Computer Anxiety: General anxiety about computers was measured by the scale developed by Raub [1981], which has been found to have high internal consistency reliability in prior empirical studies [Howard & Smith, 1986; Igbaria, Pavri & Huff, 1989; Parasuraman & Igbaria, 1990]. The instrument asks individuals to indicate their agreement or disagreement with 10 statements reflecting anxiety, apprehension, confusion, hesitation, etc., in using computers in general. The response options, anchored on a five point Likert type scale, range from (1) strongly disagree to (5) strongly agree. The internal consistency reliability of the scale as used in this study was .91.

Computer Experience and Training: Computer experience was assessed by asking respondents to indicate the extent of experience they had in using different types of computer software, different computer languages, and development of computerized information systems. The response options ranged from (1) none to (4) extensive. Additionally, the respondents were asked to report the extent of training in microcomputers received from four sources: college courses, vendor training, in-house training, and self-training [Nelson & Cheney, 1987]. The items were anchored on a 4-point scale ranging from (1) none to (4) extensive.

Demographic Variables: Several single-item questions were used to ascertain respondents' gender, education, organizational level, and age. Gender of respondents was coded (1) for men and (2) for women. Age of the subjects ranged from 21 to 56. Level in the organizational hierarchy consisted of four tiers, ranging from (1) professional employee without supervisory responsibilities to (4) top management. Education consisted of two levels: (1) some graduate study; and (2) graduate degree.

Validity of the Measures

Several precautions were taken to ensure the validity of the measures used. Many of the recommendations by Carmines and Zeller [1979] were followed. To ensure content validity, a thorough survey of the relevant literature was undertaken to understand the important aspects of each major variable and its components, and not to neglect important dimensions of any variable.

As proposed by Carmines and Zeller [1979], "construct validation focuses on the extent to which a measure performs in accordance with theoretical expectations" [p.27]. To ensure construct validity the theoretical relationships between the constructs must have been previously established, and these relationships must have been empirically supported by different studies over time. As discussed earlier, the theoretical underpinnings of this study are relatively well established, with most of the constructs and the proposed relationships having been addressed before by several authors. To further reduce the possibility of any non-random error, the main source of invalidity [Carmines & Zeller, 1979, p.15], a group of three academics and two practitioners, experts in the area of EUC, reviewed the questionnaire for validity (measuring the phenomena intended), completeness (including all relevant items), and readability (making it unlikely that subjects will misinterpret a particular question). A few questions were reworded to improve readability; otherwise, the items composing each major variable remained as derived from the literature.

Reliability of the Measures

Many of the measures used were chosen because they have been previously used and their psychometric properties are relatively well known. Nevertheless, it was deemed important to re-test the reliability of the measures used. Carmines and Zeller [1979] identified four basic methods to assess measure reliability (re-test, alternative-form, splithalves, and the internal consistency methods) and discussed their strengths and limitations. The main advantage of the internal consistency method is it requires a single test, in lieu of splitting or repeating of items. "By far the most popular of these reliability estimates is given by Cronbach's alpha" [p.44] which "in most situations provides a conservative estimate of a measure's reliability" [p.45]. The authors go on to say "that although more complex computationally, alpha has the same logical status as coefficients arising from the other methods of assessing reliability." The Cronbach's alpha values in this study compare favorably with the average and median values for alpha proposed by Peterson (1994).

Data Analysis

Path analysis using least squares multiple regression analysis [Kerlinger & Pedhazur, 1973] was used to analyze the hypothesized network of relationships among the variables in the model. Path analysis is an analytical technique that permits assessment of the direct and indirect effects of the antecedent variables on the dependent variables, i.e., in this study, the pattern of relationships of individual characteristics and beliefs, as well as organizational and task characteristics with attitudes toward EUC, end-user satisfaction, system utilization, and perceived changes in job effectiveness. Several steps were taken to minimize violations of the assumptions underlying the use of path analysis, i.e., interval-scale measurement, homoscedasticity, absence of multicolinearity, linear additive relationships among variables, and uncorrelated residuals [Billings & Wroten, 1978; James 1980]. First, examination of the intercorrelations among the independent variables reported in Table 2 revealed no evidence of multicollinearity, i.e., $r > .80$ [Billings & Wroten, 1978]. The correlations among the variables ranged from -.32 to .50, and the median intercorrelation was .05. Second, the reliability of the multiple item scales which ranged from .77 to .91 was deemed to be adequate or high, and consistent with Nunnally's [1978] guidelines. Third, the residuals of the endogenous variables were tested for autocorrelation [Billings & Wroten, 1978; Heise, 1969] using the Durbin-Watson "d" test [Dillon & Goldstein, 1984; Johnston, 1985]. The results showed that the Durbin-Watson statistic was 1.79, indicating that the residuals were not correlated among themselves.

The path analysis was conducted in two stages. First, attitudes toward EUC, end-user satisfaction, system utilization, and perceived changes in job effectiveness were regressed on all of the preceding variables in the model to assess their direct effect. Next, hierarchical multiple regression was performed to determine the indirect effects of the significant variables on computer end-user satisfaction, system utilization, and perceived changes in job effectiveness [Heise, 1969]. The final step involved decomposing the path coefficients into constituent direct effects, indirect effects and unexplained effects using the procedure recommended by Asher [1983].

Results

Table 3 presents the regression results and the standardized path coefficients representing the direct effects of the predictor variables on attitudes toward EUC, system utilization as measured by system usage and utilization categories, end-user satisfaction, and perceived changes in job effectiveness. The data show that the model as a whole explained 25 percent (p - .001) of the variance in attitudes toward EUC.

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Gender (1=M, 2=F)	1.32	.47	1.00													
2. Age	29.16	6.18	-.06	1.00												
3. Education	1.18	.38	.02	.13	1.00											
4. Organizational Level	1.43	.50	-.14	.50	-.02	1.00										
5. Computer Experience	6.43	1.62	-.22	-.20	.08	-.19	1.00									
6. End-User Training	2.72	.77	-.21	-.14	.21	-.09	.49	1.00								
7. End-User Support	3.39	.87	.05	.03	.02	.01	.19	.21	1.00							
8. Task Structure	2.37	.74	.09	-.10	-.13	-.10	-.21	-.17	-.09	1.00						
9. Computer Anxiety	1.75	.85	.15	.00	-.01	.01	-.28	-.29	-.18	.13	1.00					
10. Attitudes Toward EUC	4.25	.56	.07	-.09	.06	-.13	.25	.26	.26	-.12	-.32	1.00				
11. Utilization Categories	5.11	2.36	-.26	-.14	.01	.04	.36	.25	.12	-.05	-.14	.25	1.00			
12. System Usage		4.37	1.40	.08	-.23	.11	-.14	.31	.42	.25	.07	-.27	.41	.29	1.00	
13. End-User Satisfaction	4.16	.53	.21	-.02	.04	.05	.06	.09	.06	-.22	-.03	.18	.09	.21	1.00	
14. Perceived Changes	2.79	.35	.07	.09	-.02	.07	-.02	.15	.19	-.21	-.03	.30	.08	.15	.17	1.00

Note: The absolute value of correlations • .12 are significant at .05 level or better.˘

Table 2: Matrix of Intercorrelations Among Study Variables (n=186)

	Standardized Regression Coefficients				
Antecedent Variables	**Attitudes Toward EUC**	**Utilization Categories**	**System Usage**	**End-User Satisfaction**	**Perceived Changes**
Gender (1=Male; 2=Female)	.09	-.20*	.08	.24**	.08
Age	-.02	-.19*	-.18*	-.05	.07
Education	.05	.09	.10	-.02	.04
Organizational Level	-.11	.11	-.03	.07	.06
Computer Experience	.16*	.38***	.17*	.06	-.08
End-User Training	.05	.01	.22*	.08	.11
End-User Support	.20*	.09	.15*	.02	.27**
Task Structure	-.03	.10	.05	-.23**	-.19*
Computer Anxiety	-.27**	-.03	-.20*	-.05	.02
Attitudes Toward EUC		.17*	.25**	.18*	.28**
R^2	.25***	.24***	.35***	.16**	.21**

* p - .05 ** p - .01 *** p - .001

Table 3: Summary of Multivariate Regression Results: Direct Effect of Antecedent Variables on Attitude Toward End-User Computing, System Utilization, End-User Satisfaction and Perceived Changes in Job Effectiveness (n=186)

Regarding the indicators of EUC effectiveness, the model variables explained 35 percent (p - .001) and 24 percent (p - .001) of the variance in system usage and utilization categories respectively, 16 percent (p - .01) of the variance in end-user satisfaction, and 21 percent of the variance in perceived changes in job effectiveness (p - .01).

The next step in the analysis consisted of trimming the model by eliminating the nonsignificant paths noted in Table 3. Following the procedure described by Billings and Wroten [1978] and Heise [1969], the nonsignificant paths were set equal to zero, and the reduced structural equations were reanalyzed. The two demographic variables (education and organizational level) which had no significant effects on either attitudes toward EUC, utilization categories, system usage, end-user satisfaction, or perceived changes were excluded from further analysis. Results of the reanalysis of the reduced model are presented in Tables 4, 5, and 6, respectively. The large sample chi square test [Joreskog & Sorbom, 1984; Kim & Kohout, 1975] performed to determine the adequacy of the restricted model, showed that the full and reduced models did not differ significantly in their ability to explain variance in the dependent measures.

The data in Table 4 show that the seven antecedent variables explained 25 percent of the variance in EUC attitudes (p - .001), and 22 percent of the variation in utilization categories (p - .001). Table 5 indicates that the model variables explained 35 percent of the variance in system usage (p - .001), and 15 percent of the variation in end-user satisfaction (p - .01). Table 6 shows that 20 percent of the variance of perceived changes was explained by the reduced model (p - .01). It may seen from Tables 4, 5, and 6 that of the 42 direct paths tested in the reduced model, 14 were significant at the .05 level or better.

Further, Table 4 data show that only four antecedent variables had significant direct effects on EUC attitudes. The strongest effects are noted for computer anxiety (β = -.28, p - .01), and end-user support (β = .21, p - .001). Smaller but significant direct effects are observed for gender (β = .16, p - .05), and computer experience (β = .17, p - .05). Computer experience had a strong positive effect on utilization categories (β = .32, p - .001). On the other hand, gender was negatively related to utilization categories (β = -.18, p - .05) indicating that women reported using the computer for fewer tasks than men. Additionally, attitudes toward EUC demonstrated a positive relationship with utilization categories (β = .17, p - .05).

Table 5 data show that consistent with the model's predictions, EUC attitudes had a positive effect on usage of the system (β = .25, p - .01). End-user training also showed a positive relationship to system usage (β = .21, p - .05). Three antecedent variables had significant direct effects on end-user satisfaction: gender (β = .26, p - .01); task structure (β = -.21, p - .05); and attitudes toward EUC (β = .16, p - .05). The results in Table 6 show that only end-user support (β = .21, p - .05), and attitudes toward EUC (β = .26, p - .01) had significant direct effects on perceived changes in job effectiveness.

The data reported in Tables 4, 5, and 6 also illustrate the decomposition of the total effects into direct, indirect, and unexplained effects [Alwin & Hauser, 1975; Paulson, 1974; Ross, 1975]. An indirect causal effect represents the effects of antecedent variables mediated by the intervening variables in the model, i.e., attitudes toward EUC. Thus, end-user support, computer anxiety, age, and end-user training may influence

	Attitude Toward EUC Effect			Utilization Categories Effect				
	Direct	Unexplained	r	Direct	Indirect	Total	Unexplained	r
Gender (1=Male, 2=Female)	.16*	.09	.07	-.18*	.03	-.15*	.11	-.26***
Age	-.05	.04	-.09	-.08	-.01	-.09	.05	-.14*
Computer Experience	.17*	-.08	.25***	.32**	.03	.35***	-.01	.36***
End-User Training	.05	-.21	.26***	.01	.01	.02	-.23	. 25***
End-User Support	.21**	-.05	.26***	.05	.04	.09	-.03	.12*
Task Structure	-.03	.09	-.12	-.06	.00	-.06	-.01	-.05
Computer Anxiety	-.28**	.04	.32***	-.02	-.05	-.06	.08	-.14**
Attitudes Toward EUC				.17*		.17*	-.08	.25***
R2			.25***					.22***
Ratio of correlations duplicated within ± .10			6/7					6/8

* p - .05 ** p - .01 *** p - .001˘

Table 4: Direct, Indirect, and Total Effects of Antecedent Variables on End-User Attitudes Toward EUC and Utilization Areas (n=186)

	System Usage					End-User Satisfaction				
	Effect					Effect				
Antecedent Variables	Direct	Indirect	Total	Unexplained	r	Direct	Indirect	Total	Unexplained	r
Gender (1=M, 2=F).13	.04	.17*	.09	.08	.26**	.02	.28***	.07	.21***	
Age	-.14	-.01	-.15*	.08	-.23***	.00	-.01	-.01	.01	-.02
Computer Experience	.12	.04	.16*	-.15	.31***	.03	.03	.06	.00	.06
End-User Training	.21*	.01	.22*	-.20	.42***	.05	.01	.06	-.03	.09
End-User Support	.11	.05	.16*	-.09	.25***	-.04	.03	-.01	-.07	.06
Task Structure	.06	-.01	.05	-.02	.07	-.21*	.00	-.21*	.01	-.22**
Computer Anxiety	-.14	-.07	-.21**	.06	-.27***	-.01	-.04	-.05	-.02	-.03
Attitudes Toward EUC	.25**		.25**	-.16	.41***	.16*	.16*	-.02	.18**	
R2					.35***					.14***
Ratio of correlations duplicated within ± .10					5/8					8/8
* p - .05 ** p - .01 *** p - .001˘										

Table 5: Direct, Indirect, and Total Effects of Antecedent Variables on System Usage and End-User Satisfaction (n=186)

	Effect				
Antecedent Variables	Direct	Indirect	Total	Unexplained	r
Gender (1=Male, 2=Female)	.02	.05	.07	.00	.07
Age	.07	-.02	.05	-.04	.09
Computer Experience	-.14	.06	-.09	-.07	-.02
End-User Training	.09	.03	.12	-.03	.15*
End-User Support	.21*	.06	.27**	.08	.19**
Task Structure	-.19*	-.01	-.20*	.01	-.21**
Computer Anxiety	.10	-.09	.01	.04	-.03
Attitudes Toward EUC	.26**	.02	.28**	-.02	.30***
R^2					.20**
Ratio of correlations duplicated within ± .10					8/8
* p - .05 ** p - .01 *** p - .00					

Table 6: Direct, Indirect, and Total Effects of Antecedent Variables on End-User Perceived Changes in Job Effectiveness (n-186)

utilization categories only through their effects on attitudes toward EUC, whereas gender, and computer experience had both direct and indirect effects on utilization categories through EUC attitudes. Gender, age, computer experience, end-user support, and computer anxiety influenced system usage through EUC attitudes, while task structure influenced perceived changes in jobs through EUC attitudes. Attitudes toward EUC in turn, had direct effects on utilization categories, system usage, and end-user satisfaction, and perceived changes in job effectiveness. With the exception of end-user support, the antecedent variables influenced perceived changes only indirectly through their effects on attitudes toward EUC.

The "goodness of fit" of the reduced model was assessed by comparing the original correlations between the predictor variables and the dependent measures with the recomputed correlations represented by the sum of the direct and indirect effects [Billings & Wroten, 1978; Kerlinger & Pedhazur, 1973]. If the path model efficiently captures the relationships specified among the variables, the unexplained effects should be near zero. Applying the criterion that the absolute differences between the observed and recomputed correlations do not exceed .10 [Martin, 1981; Namboodiri, Carter & Blalock, 1975], the data showed that for EUC attitudes, six of the seven reconstructed correlations were consistent with the original coefficients. The reduced model duplicated all eight correlations for end-user satisfaction and perceived changes in job effectiveness. For system usage and utilization categories respectively, five and six of the reconstructed correlations fell within the limits specified.

Discussion

Among the end-user characteristics examined, gender and level of computer experience were found to have significant direct effects on EUC attitudes, system utilization categories, and user satisfaction with the system. Interestingly, although women reported using EUC for fewer tasks, they had a more favorable attitude toward EUC, and also were more satisfied with their systems than men. While this corroborates the findings of Dambrot, et al. [1985], as with most studies, these results raise some interesting questions. Why are women using EUC for fewer tasks? Why do they have a better attitude and are more satisfied with EUC? A likely interpretation is that women are using EUC for a more limited set of tasks, perhaps less difficult than the wider variety of tasks associated with the men in this sample. A less likely interpretation is that on the average women are happier with job activities in general, including EUC, because in the past they were denied equal job opportunities. If so, in either case the gender differences are likely to fade away with time and call for no managerial action. Nevertheless, future studies designed to explore with more depth the causes of these specific gender differences are worthwhile.

The finding that user computer experience is associated with favorable user attitudes toward EUC, as well as with the variety of utilization areas, emphasizes the need to hire employees with such experience and to create opportunities to augment the level of computer experience of company personnel. Some mechanisms helpful in developing computer experience are hands on workshops, in-house computer stores which provide demonstrations and allow for end-user experimentation with new equipment. Also important is a management attitude and policy which support such end-user work related experimentation with new technology.

On a similar vein, user training is found to be an important element in producing a favorable user attitude toward EUC, and in promoting increased system usage. System usage is affected both directly and indirectly through its positive impact on end-user attitudes. This corroborates the proposition [Magal, Carr & Watson, 1988] that in each of the four stages of Information Center evolution, training and end-user support issues need to be addressed by IC management. As previously recommended [Guimaraes & Igbaria, 1994; Guimaraes, 1996], the provision of end-user training and management support by a formal or informal IC is likely to be instrumental in creating a supportive EUC environment which is responsive to end-user concerns and needs. Such environment is essential to support organizational learning and end-user experimentation with new tools and applications.

End-user attitude toward EUC is an important factor for its success. Its significant impact on all the measures of EUC effectiveness, as well as on end-user perceived changes in job effectiveness, confirm the important role prior studies of system success assigned to it [Ein-Dor & Segev, 1988; Lucas, 1978; Rivard & Huff, 1988]. Managers in companies with substantial EUC investment must periodically assess end-user attitudes and establish mechanisms to cultivate good attitude. For example, end-users should be asked to evaluate the company's EUC tools and support facilities, and provide suggestions to upgrade and make them more productive.

The negative impact of end-users' anxiety about computers on their attitude toward EUC suggested by previous studies [Howard & Smith, 1986; Parasuraman & Igbaria, 1990] is corroborated. Also corroborated is the notion that the impact of end-user anxiety about computers on system utilization, end-user satisfaction, and end-user perceived changes in job effectiveness are indirect through end-user attitude toward EUC. That demonstrates the long held key intervening role of attitudes [Fishbein & Ajzen, 1975]. Through training and personal support, managers can do a great deal to reduce end-user anxiety about computers. The measures taken to improve end-users attitude toward EUC, and to increase end-user computer usage and long-term experience are also useful in reducing their anxiety toward computers.

Without management support for EUC, it is unlikely the organization will commit enough resources for end-user training and experimentation. The importance of top management support in promoting EUC effectiveness is highlighted by the positive relationship of end-user support with user attitudes,

and with perceived changes in job effectiveness. Efforts to strengthen management support and end-user training would yield dividends in terms of more favorable attitudes toward EUC, as well as increased utilization and effectiveness of EUC systems. This supports the notion [Magal, Carr & Watson, 1988] that top management support should be at the top of the critical success factors list for EUC. These findings strongly suggest that, in organizations where EUC lacks management support, IS managers and end-users must collaborate to develop such support, lest the company investment in EUC resources be underutilized and only partly fruitful. As the results from another study indicated, regardless of the form in which the EUC support organization was under, company payoffs from EUC are clearly influenced by company support level [Guimaraes, 1996].

Conclusion and Recommendations for Future Studies

The purpose of this study was to test a more comprehensive and integrative model including the more important determinants of EUC effectiveness in organizations. The results provided partial support for the proposed model, and demonstrated the relevance of the selected variables (various end-user characteristics, organizational support, and task structure) in explaining variance in user attitudes toward EUC, and in the measures of EUC success: system utilization, end-user satisfaction, and end-user perception of changes in the effectiveness of their jobs.

The present study extends previous research by focusing on multiple indicators of EUC success, and examining the multivariate relationships of individual differences, organizational and task characteristics with different dimensions of EUC effectiveness. Although the results provide at least partial support for the pattern of relationships proposed in the model, there are some study limitations which must be acknowledged, thus providing opportunities for further research. Future research should test the moderating effects of the demographic variables addressed here on the relationships between the other independent variables and EUC effectiveness. The nonsignificant paths found for some of the variables related to perceived changes in job effectiveness, and the discrepancies between the reconstructed model and original model correlations for some variables (i.e., end-user training, system usage, and end-user satisfaction), indicate the need for caution in interpreting the results. The discrepancies suggest the possibility that one or more important variables were not included in the model [Billings & Wroten, 1978; James, 1980].

Also, given the somewhat skewed nature of the sample in terms of education level, the generalizability of the findings may be restricted to subjects with the same characteristic. Additional research using multiple data sources, as well as more objective measures of EUC effectiveness could provide increased confidence in the results obtained. Further, the model explained 22, 35, 14 and 20 percent of the variance on utilization, usage, satisfaction and perceived changes. The fact some of the variance was unexplained also suggests the need for research incorporating potential unmeasured variables, such as perceived self-efficacy and perceived ease of use. Finally, longitudinal research is needed to more effectively capture the reciprocal and dynamic relationships among the network of variables which influence EUC effectiveness. Despite these limitations, this study proposed and empirically tested a more comprehensive and integrative model for EUC effectiveness. Its results contribute to a better understanding of the variables relevant to explaining EUC success, and provide a useful building block for even larger and more sophisticated models.

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