The Impact of Task Variables on End-User Computing Configuration and its Success(II): An Empirical Test*

Joong-Ho Ahn

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6. Research Methodology

This study used a survey-based field study of multiple organizations to investigate the hypotheses postulated in the previous section. A field study takes advantage of natural variation in organizational characteristics, which would be extremely difficult to simulate in the laboratory [Daft and Macintosh,

Author: Assistant Professor, Seoul National University

* This is the second half of the entire article. The first one appeared in the previous issue.

1981]. The companies included in this study were selected to assure a wide variation of task factors (*i.e.*, independent variables). This enabled us to test whether or not the independent variables have the predicted impact on the dependent variables (*i.e.*, EUC success) [Daft & Macintosh, 1981; Hall *et al.*, 1967]. The survey instrument was a questionnaire designed to collect the data necessary to meet the study objectives.

6.1. Subjects

The data for this study was gathered from two major sources; one from evening MBA students (*i.e.*, full-time workers) enrolled at two business schools. Most of these subjects are working for financial institutions in New York City. The other set of data was collected from three firms representing insurance, brokerage, and the marketing services business. A t-test reveals that there is no significant mean differences in key independent variables between these two sample groups (see Appendix A). More detailed about subjects will be presented in section 6.4.2.

6.2. Sample Size

There were 13 items for the independent variables and 22 items for the dependent variables probed by the questionnaire. Factor analysis requires at least four observations for each item [Cattel 1952]. According to that rule, at least 140 subjects were needed.

To obtain statistical power of 99%, given the number of independent variables and using a level of significance a=.05, and medium Effect Size (f^2)=.15, 200 observations are required. The power of the statistical test of a null hypothesis is defined as the probability that it will lead to the rejection of the null hypothesis [Cohen 1977] if in fact it is false. The final sample size of 250 is above the minimum needed for factor analysis and provides excellent power.

6.3. Measurement of the Research Variables

The following subsections discuss the measures used in the construction of the questionnaire.

6.3.1. Task

Task variability is measured as the stability and uniformity of inputs and outputs, routinization, repetitiveness, and stability, or rigidity, of the work. This measure is drawn from Van de Ven and Delbecq [1974]. The responses to the questions are measured on a five-point Likert scale, where a low score indicates low variability and a high score indicates high variability.

The measure for task difficulty focuses on the analyzability and predictability of the search process that individuals undertake when they encounter a task, problem, or issue [Van de Ven and Ferry 1980]. Task difficulty is measured by frequency of task problems, time spent solving task problems, ambiguity of correct performance, and uncertainty of work outcomes. This measure is adapted from Van de Ven and Delbecq [1974]. At the high end of task analyzability and predictability, the search process can be completely pre-programmed while at the low end it relies heavily on the end user's judgment.

To measure task interdependency, questions about such items as: the extent to which input depends upon other unit members, the extent to which an individual checks with other unit members during transformation, and the extent to which output depends on other unit members, are adapted from Thompson [1967] and Van de Ven and Ferry [1980]. Each item is measured on a five-point Likert scale. The higher the score, the greater the end user task interdependency.

6.3.2. EUC Success

The instrument for the end users' perceived overall satisfaction with EUC activities is adapted in part from Ives *et al.*'s [1983] work based on Bailey and Pearson's [1983] original IS satisfaction questionnaire. The measure as adapted includes only those dimensions relevant to EUC activities, since Ives *et al.*'s measure is oriented toward user satisfaction with large-scale information systems.

A measure for end users' perceived usefulness of EUC technology for enhancing work performance includes increased speed, volume, and quality of

work accomplished, as suggested by Quillard *et al.* [1983].

6.4. Administration of Questionnaire

6.4.1. Pilot Studies

Two pilot studies were undertaken on the survey instruments to assure that the questionnaire was semantically sound and that the measures selected or developed for this study were valid and reliable. The first pilot study involved three university professors in the IS field plus five consultants in the area of EUC. The second pilot study was conducted with users of EUC (consisting of thirty evening MBA students). Each subject was administered the initial version of the questionnaire and then was asked to express any further comments on the question items in feedback sessions.

In both of these studies a number of participants complained of too many questions for the task attributes. A number of users had dfficulties distinguishing between the two attributes of each question measuring EUC overall satisfaction (*i.e.*, the semantic differential method) which were adapted from Ives *et al.* [1983]. Completion time for the questionnaire was about half an hour. Based on this information, a number of question items regarding the EUC user's perceived task attributes were removed from the questionnaire. Only one attribute of each question adapted from Ives *et al.* was kept in the final version of the questionnaire. None of the participants in these pilot studies were included in the main study.

6.4.2. Main Study

With the final version of the questionnaire in hand, initial contact was made with upper management of five different firms to discuss the possibility of participation in this study. The investigator mailed a questionnaire and research proposal to management, which was followed up by a telephone call. The management were briefed that the study is about how micro-computers and timesharing systems are being used by business in order to understand how the user personally uses them to complete his/her work and how helpful he/she has found them. They were also assured that all responses were strictly

confidential. They were promised a summary report of the findings if they participated.

Among these organizations, three firms agreed to take part in the study. Firm A is one of the largest insurance companies in the U.S. and has its headquarters in Connecticut. It is well known for its commitment to awareness and assimilation of new information technologies. Firm B is a major financial institution in New York City specializing in brokerage services. Firm C is a small marketing services organization located in New York City which does market analysis for other firms.

Referrals were made to managers within these organizations who could identify EUC users. Consequently, the investigator mailed out as many copies of questionnaires as they requested. The participants returned their responses at their own expenses. Table 6-1 shows the number of questionnaires mailed and the number returned from these three firms. All in all about 75 usable responses were obtained from these sources for a response rate of about 60%.

Table 6-1: The Number of Questionnaire Mailed/Returned from the Firms

Companies	Mailed Questionnaires	Returned Questionnaires	Ratio(%)
Firm A	70	36	51%
Firm B	20	14	70%
Firm C	40	25	62%
Total	130	75	58%

For the evening MBA student subjects, the researcher contacted the course instructors to obtain permission to administer the questionnaire. Once permission was received, the researcher administered the questionnaires to the subjects in the classroom. About 170 usable responses were obtained from these sources. As an incentive for their participation, every respondent of the study was assured a copy of the research results if he/she filled out a return address on the covering letter.

6.5. EUC User Demographics and EUC Usage Patterns

6.5.1. EUC User Demographics

About forty-five percent (45%) of the respondents have worked less than one year in their current positions. On the average, they have worked for about two years. The majority (69%) of the respondents have worked in their current departments under two years. On the average, they have worked two years and four months. As for the respondents' tenure in the company, the quartile breaks represent tenure of less than one year, between one and two years, more than two years but not more than four years, and finally more than four years. On the average, respondents have worked with their companies for three years and four months. About thirty-five percent (34%) work in the finance/accounting area and the rest of the respondents work in diverse areas.

Sixty-one percent (61%) of the respondents are male, thirty-four percent (34%) are female. Seventy-one percent (71%) of the respondents were between twenty and thirty years old, and eighteen percent (18%) were between thirty-one and forty years old. The average age was twenty-eight (28). As for the respondents' educational background in terms of the highest year of schooling completed, about fifty-five percent (55%) reported having some graduate work beyond undergraduate college level. Fifteen percent (15%) of the respondents reported that they have master's degree or higher.

About seventy-two percent (72%) of the respondents reported that their college or graduate work (as major or minor) was not related to computer or information systems. Twenty-eight percent (28%) of the respondents have no experience at all with any 3rd generation programming language such as COBOL, FORTRAN, BASIS, or PL/1. Fifty-one percent (51%) reported that they have little or none experience in using any procedural language. However, about thirty-three percent (33%) of the respondents reported having a great deal of experience with 4th generation languages such as FOCUS, RAMISII, NOMAD2, and LOTUS 1-2-3. Overall, more than seventy percent

(70%) of them reported having at least some experience with new applications development tools. Forty-two percent (42%) of the respondents perceived their level of technical understanding as "high" (scaled 4 and 5).

As for the end-user classification of the respondents as suggested by Davis and Olson [1985], about thirty-seven percent (37%) of the respondents placed themselves into the category of non-programming users who access the system through a highly structured, limited, or menu-driven interface provided by others (e.g., bank teller, airline ticketing agent). Another twenty-two percent (22%) reported that they are command-level users who access and retrieve data via some applications programs using high-level commands from languages such as FOCUS, RAMISII, SQL, or SAS. Eighteen percent (18%) of the respondents reported that they are user programmers. User programmers are more sophisticated users who utilize both commands and procedural languages such as FORTRAN, COBOL, or PASCAL for solving problems specific to their own job. In other words, they develop their own applications, some of which may be used by other users. The remaining fifteen percent (15%) reported that they are functional support personnel. Functional support personnel are very sophisticated users who write programs in support of other users within their functional areas.

6.5.2. EUC Usage Patterns

As for the hours that the respondents work with micro-computers and/or timesharing systems per week in their work place, about thirty-four percent (34%) of the respondents reported that they use computers for more than 20 hours per week. On the average, the usage was 19 hours per week. As for the usage of computers at home, the majority (55%) do not use computers at home. Only twenty-six percent (26%) reported that they use computers at home.

Next, the respondents were asked about the sources of their EUC support. About twenty-three percent (23%) of the total responses indicated informal support through other people in their functional area. Another twenty percent (20%) of the multiple responses that were collected were for support from a

formal micro-computer or timesharing group within the information systems department. Support from an information center and self-sufficient support represent about sixteen percent (16%) each. Interestingly, thirty-three percent (33%) are accounted for by a combination of support from formal group in their functional area and from informal support through other people in their functional area. That is, their major source of computer support is not from an IS/DP department but from their functional area.

The next question was about the equipment used for EUC. Approximately fifty percent (50% : i.e., 120 cases) of the respondents reported that they use terminals hooked up to timesharing systems. Among these timesharing systems users, seventy-three percent (73%; 88 cases) also use micro-computer equipment. Since the respondents were asked to 'check all that apply,' the total number of multiple responses from these 88 cases (i.e., 88 respondents) was 194. They report that they use micro-computers equipped with hard (fixed) disk (39%), modems (25%), and micro-mainframe nets (20%). Looking at the entire sample, approximately seventy-seven percent (77%; 191 cases) of the respondents use micro-computers. They were asked to 'check all that apply' with regards to their use of EUC equipment. A total of 394 multiple responses were collected from 191 respondents. They report that they use micro-computers equipped with hard disk (40%), modems (23%), and micro-mainframe nets (17%).

Approximately sixty percent (59%) reported that their applications systems are used primarily for analysis/inquiry, whereas the rest, forty-one percent (41%), reported that they primarily use monitor/exception systems. About forty-eight percent (48%) of the respondents reported that their secondary applications systems are for analysis/inquiry, and fifty-two percent (52%) reported a secondary use of monitor/exception systems.

From a slightly different perspective, approximately thirty-four percent (34%) reported that they use applications systems for financial analysis. If all of the kinds of *analyses* are combined together, they account for approximately

fifty-four percent (54%) of the responses. Another fifteen percent (15%) reported their usage as report generation and 'word-processing,' 'monitoring,' 'operational,' and 'communication' accounted for 8%, 4%, 11% and 1% each. If these applications areas are combined together, they account for thirty-nine percent (39%) of the responses. This combination falls into the category of 'transaction processing operations.' These results are consistent with the empirical studies of other researchers (e.g., Benson [1983]; Rockart & Flannery [1983]). As for the respondents' secondary application, approximately twenty-three percent (23%) reported that their secondary applications area is 'report generation.' Thirteen percent (13%) reported that 'word processing' is their secondary application.

As for the programs/packages that the respondent listed as most used, about forty percent (40%) reported that their dominant uses of programs/packages is spreadsheets, thus indicating that the spreadsheets is the principal instrument of analysis. Word-processors, data base management systems (DMBS), and programming languages accounted for thirteen percent (13%) each. As for the second most frequently used programs, approximately twenty-nine percent (29%) reported that their second most used programs/packages were word-processors. Spreadsheets, and DMBS accounted for twenty-four percent (24%) and fourteen percent (14%) each.

6.5.3. Summary of Demographics and EUC Usage Patterns

User Demographics:

First, about half of the respondents have worked not more than one year in their current position. Second, about one-third of the respondents work in finance and accounting while the rest work in diverse areas. Third, more than one-third of the respondents are female and the majority of the respondents are in their twenties. Fourth, more than one-half of the respondents have some graduate work beyond the undergraduate college level, although about three-quarters of them reported that their college or graduate work was not related to computers or information systems. Fifth, more than one-half of

the respondents reported they have 'almost none' or 'little' experience in using any procedural language. Nevertheless, more than two-thirds of the respondents reported having at least some experience with new applications development tools (e.g., 4th generation languages). Sixth, about one-half of the respondents perceived their level of technical understanding (of micro-computers and/or time-sharing systems) as 'high.' Finally, about one-third of the respondents were non-programming users; one-quarter, command-level users; eighteen percent (18%), user programmers; and fifteen percent (15%), functional support personnel.

EUC Usage Patterns:

First, more than one-third of the respondents use computers for more than 20 hours per week in their work place. However, the majority do not use computers at home. Second, as for EUC support, about one-third of the respondents had support either from a formal group in IS/DP department or an information center. Another one-third reported having support from their functional area, either formally or informally. Third, about sixty percent (60%) of the respondents reported that their applications systems are used primarily for analysis and inquiry whereas the rest reported that they primarily use monitor and exception systems. Fourth, about one-third of the respondents reported that they use applications systems for financial analysis and another twenty percent (20%) use applications systems for other types of analysis. The remaining approximately forty percent (40%) reported using applications in the area of traditional transaction processing operations. Finally, about forty percent (40%) reported that spreadsheets are their dominant programs/ packages.

6.6. Construct Validity Check

The following sections present the results of construct validation and examines the reliability of the instruments. Descriptive statistics of the variables and the methods of analysis utilized are also presented.

The construct validity of a measure refers to the extent to which the scale

items measure the hypothesized constructs. This is demonstrated by validating the theory behind the instrument [Kerlinger, 1973]. As a method of construct validation, factor analysis was employed in the study. Factor analysis was conducted on (1) the 13 items measuring the task attributes (*i.e.*, independent variables) and (2) the 22 items measuring EUC success (*i.e.*, dependent variables). After the validation process was completed, the individual, unweighted item scores were summed to arrive at an individual measure for the variables. These scores were then used as part of the ensuing data analysis.

6.6.1. Factor Analysis for Independent Variables

The 13 items measuring the independent variables consist of 4 items measuring task variability, 5 items measuring task difficulty, and 4 items measuring task interdependency. It was expected that the 13 items would be distinctively loaded on these three factors. The investigator set the number of factors to be extracted to 3. A varimax rotation method was used and it converged in six iterations on three factors. The rotated factor matrix revealed that one item of the task variability questions and one item of the task difficulty questions loaded unexpectedly on two factors. Therefore, these two items were dropped. A cut-off level of .50 was employed for all factor loadings, which eliminated two additional items and resulted in a 3-factor structure with 10 items loading at that level. The result of the rotated factor matrix is presented in Appendix B-1.

An oblique rotation method was also performed, as prior research suggests that task variability and task difficulty may be correlated, which would not be possible using varimax rotation. The result, however, re-confirmed the outcome of the varimax method and therefore, we believe the items adapted capture the constructs.

6.6.2. Factor Analysis for Dependent Variables

The 22 items measuring the dependent variables were expected to load on four distinctive factors; namely, (1) EUC satisfaction which should decompose to satisfaction with: quality of information products/services, and knowledge/

involvement in IS, and (2) performance enhancement via EUC, and (3) perceived learning due to EUC. A factor analysis was performed on these 22 items.

As shown in Appendix B-2, the results revealed that FACTOR-1 and FACTOR-4 were as expected two different dimensions comprising users' overall satisfaction with EUC. The items on FACTOR-1 were items related to satisfaction with the quality of information services/products whereas FACTOR-4 items were related to satisfaction with the knowledge and involvement in EUC. FACTOR-2 were the items related to the users' perceived usefulness of EUC for performance enhancement. FACTOR-3 items were expected to be related to EUC user learning. However, the structure could not be interpreted meaningfully. In fact, one item on FACTOR-3 was almost evenly loaded on FACTOR-2 and another two items on FACTOR-3 were also loaded on FACTOR-2. Accordingly, therefore, the EUC learning variable was dropped from further investigation of the research results. The items on FACTOR-4 had very low factor loadings ranging from .42480 to .63217. If a cut-off level of .60 was used for factor loadings, fouritems out of six items would be eliminated. One possible answer to this inappropriateness is that these items measuring user knowledge and involvement in IS adapted from Ives *et al.* [1983] may not be applicable to EUC. Therefore, FACTOR-4 was discarded from further analysis.

6.7. Scale Reliability Check

Reliability of measurement refers to the degree of consistency among an individual's scores; namely, the extent of unsystematic variation in the quantitative description of an individual when that individual is measured a number of times [Ghiselli *et al*, 1981]. Cronbach's α (SPSS^x, 1983) reliability coefficient was employed to validate responses to all instruments. It has already been mentioned that wherever possible, the questions in the questionnaire included standardized measures which were externally accepted as valid measures. Table 6-2 presents a summary of the reliability results for each of the instruments used for this study.

Table 6-2. Reliability Coefficients for the Instruments

Factors	Cronbach's Alpha
Task Variability	.7520
Task Difficulty	.7131
Task Interdependency	.5248
Overall Satisfaction w/EUC	.8511
Performance Enhancement via EUC	.7883

The reliability of the overall instruments ranged from .52 to .85. The EUC users' perceived task interdependency (.5248) was considerably lower than the other scales on the questionnaire. All other instruments, however, meet the level of .70 suggested by psychometric theory (*e.g.*, [Nunnally, 1978]). As for the low score in task interdependency, further investigation was done as suggested by Elizur and Guttman [1976]. They suggest that the reliability of the scale of users' perception toward their task is acceptable if the three items comprising task interdependency have positive or zero correlations. Table 6-3 presents the intercorrelations (Pearson's product moment correlation coefficient) for the three items, all of whose values are positive. Therefore, the task interdependency score is regarded as marginally meeting the reliability criterion.

6.8. Method of Analysis

To test the research hypotheses posited in section 5, each respondent's

Table 6-3. Intercorrelation Among Task Interdependency Variables

	Pearson Correlation Coefficients		
	VAR52	VAR53	VAR54
VAR52	1.0000 (0) P=.		
VAR53	.3663(246) P=.000	1.0000 (0) P=.	
VAR54	.1384(246) P=.015	.3028(246) P=.000	1.0000 (0) P=.

(COEFFICIENT/(CASES)/1-TAILED SIG)
"." IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED
DETERMINANT OF CORRELATION MATRIX=.7856657

actual EUC configuration (refer to Figure 4-1) was compared to the hypothesized EUC configuration given the respondents' task attributes, which resulted in either a MATCH or NO-MATCH. The statistical analysis procedure was used in SPSS^{X} to determine MATCH/NO-MATCH. This procedure will be discussed in the next section and the summary of results will be found in Table 7-2.

Biserial correlations between the MATCH/NO-MATCH and each dependent variable, the two dimensions of EUC success, were calculated to test whether the 'fit' measured by MATCH/NO-MATCH has any significant associations with each EUC success variable. The result of this analysis will be discussed in section 7.

7. Research Findings & Discussions

7.1. Test of Overall Hypothesis

As discussed in the previous section, in order to decide whether or not a respondent's perceived task variability, difficulty, and interdependency is high or low, cut-off scores of 3.75, 2.66, and 3.66 respectively were chosen. Any scores above these criteria were treated as being a "high" degree of the phenomena and below the criteria as being "low." These scores were derived from the frequency tables of each independent variable and will be explained below.

The composite scores for the three independent variables and two dependent variables were calculated by summing each item for the scale to arrive at a single score for each variable. As a result, the composite scores are decimal numbers ranging from 1.00 to 5.00 for the three independent variables and for one of the dependent variable, and from 1.00 to 7.00 for the other dependent variable-overall satisfaction with EUC.

We selected the above cut-off scores because they were just above the median and mean scores (shown in Table 7-1) and should indicate that scores above and below these criteria reflect 'high' and 'low' degrees of the phenomena

Table 7-1. Summary of Criterion Scores

	Criterion Score	Percentage Accounted	Median/Mean Scores	Scale
Task Variability	3.75	43%	3.50/3.46	1~5
Task Difficulty	2.66	47%	2.33/2.52	1~5
Task Interdependency	3.66	44%	3.33/3.36	1~5

respectively. On a 1 for 5 scale, the scores greater than or equal to 3.75 in task variability accounted for forty-three percent (43%) of the respondents. For task difficulty, the scores greater than or equal to 2.66 comprised forty-seven percent (47%) of the responses while scores greater than or equal to 3.66 in task interdependency accounted for forty-four percent (44%) of the responses. Table 7-1 summarizes the scores and percentages with respective median and mean scores of the independent variables.

Based on these criteria and the respondent's task attributes, an EUC configuration that would maximize the user's overall satisfaction with EUC (i.e., SATISFAC) and the user's perceived work performance enhancement by using EUC (i.e., PERFORM) was hypothesized. This EUC configuration was compared to the actual EUC configuration to determine whether or not each respondent had a matched configuration. The basic assumption was that the EUC user would have a positive assessment of EUC success if the user had a matched configuration.

To illustrate: if a user's perceived task variability is greater than or equal to 3.75 (i.e., high task variability) and task difficulty is greater than or equal to 2.66 (i.e., high task difficulty), and task interdependency is perceived as greater than or equal to 3.66 (i.e., high task interdependency), then the expected (hypothesized) EUC configuration fitted to these task attributes will be Config II (hypothesis H1).

Table 7-2 presents the frequencies of matches. It shows that approximately forty-seven percent (47%) of the respondents have a matched configuration, which means their actual configuration is identical with that expected

Table 7-2. Frequencies of Match/No-Match

MATCH or NO-MATCH					
Value label	Value	Frequency	Percent	Valid percent	Cum percent
NO-MATCH	.00	122	49.6	51.3	51.3
MATCH	1.00	116	47.2	48.7	100.0
	.	8	3.3	Missing	
	Total	246	100.0	100.0	
Valid Cases 238	Missing cases 8				

(hypothesized) on the basis of their scores on the perceived task attributes. Forty-nine percent (49%) have unmatched configuration; the remaining three percent (3%) are unknown.

Table 7-3 presents the frequencies for each EUC configuration as reported by the respondents. Note that Config I and Config II combined (i.e., analysis/inquiry applications systems) account for about fifty-eight percent (58%) of responses. About thirty-nine percent (39%) of the respondents reported that their EUC configurations fall into the category of Config III and Config IV (i.e., monitor/exception applications systems). The remaining three percent (3%) did not respond to the question.

These results are consistent with the findings discussed in the previous section (EUC usage patterns), and other empirical studies such as those of Benson [1983] and Rockart and Flannery [1983] where it was reported that

Table 7-3. Frequencies of EUC Configuration

Config					
Value label	Value	Frequency	Percent	Valid percent	Cum percent
Config Ⅰ	1.00	68	27.6	28.6	28.6
Config Ⅱ	2.00	73	29.7	30.7	59.2
Config Ⅲ	3.00	53	21.5	22.3	81.5
Config Ⅳ	4.00	44	17.9	18.5	100.0
	.	8	3.3	Missing	
	Total	246	100.0	100.0	
Valid cases 238	Missing cases 8				

Table 7-4. Correlation Coefficients between MATCH and Dependent Variables

	Pearson Correlation Coefficients		
	MATCH	SATISFAC	PERFORM
MATCH	1.0000(238) P=.	.3336(222) P=.000	.2512(224) P=.000

(Coefficient/(Cases)/1-Tailed Sig)
"." is Printed if a Coefficient Cannot be Computed

60~70% of EUC was accounted for by analysis/inquiry applications and 30~40% was categorized as monitor/exception applications.

Once it was determined that an individual had a matched or non-matched EUC configuration, a biserial correlation between the match variable (1 or 0) and each dependent variable, was calculated to test whether or not the 'fit' measured by MATCH or NO-MATCH had a significant association with the user's overall satisfaction with EUC and the user's perceived performance enhancement by using EUC.

It is widely accepted that a biserial correlation is actually an estimate of product moment correlation (e.g., [McNemar 1969]); Pearson's product moment correlation analysis was therefore used. Table 7-4 presents the correlation coefficient matrix of the two dependent variables and the match variable.

Table 7-4 shows that the fit measured by the match variable has a significant association with each dependent variable; namely, overall satisfaction with EUC (SATISFAC), and increased work performance via EUC (PERFORM). The correlation coefficient between MATCH and SATISFAC is .3336 at significance level a=.000. The correlation coefficient between MATCH and PERFORM is .2512 at significance level a=.000. These result strongly confirms the overall research proposition posited in section 5.

EUC success will be experienced when the EUC configurations fit the perceived task demands that characterize an organization's subunits.

7.2. Test of Specific Individual Hypothesis

In the previous section, we reported the results of testing the basic research

hypothesis of the study. The test results supported the proposition. This section tests each individual hypothesis (hypotheses H1 through H8) postulated in section 5.

Based on the research model and the ensuing hypotheses of section 5, all of the 246 cases were exclusively categorized into one of eight different contingencies (i.e., eight main hypotheses). Table 7-5 shows the number of cases in each contingency.

Table 7-5. Number of Cases in Each Contingency

Hypothesis	# of cases	Hypothesis	# of cases
H1	30(30)	H5	25(25)
H2	23(24)	H6	24(24)
H3	26(27)	H7	47(45)
H4	15(16)	H8	28(29)

* Note : 1) Numbers preceding parenthesis are # of cases included in the test for SATISFAC
2) Numbers in parenthesis are cases for PERFORM

The methods of analysis for testing individual hypotheses took two forms. First, a series of t-tests were performed to examine any significant mean differences in SATISFAC and PERFORM between the two groups (i.e., MATCH versus NO-MATCH). Second, a series of Pearson product moment correlations between the match variable and dependent variables SATISFAC and PERFORM were computed to examine whether the 'fit' measured by the match variable had significant relationships with EUC success measured by SATISFAC and PERFORM. The two methods produced identical results. The following discussion presents the findings for each hypothesis.

7.2.1. Test of Hypothesis H1

H1a asserts that the EUC users will be most satisfied with EUC Config II if they perceive their tasks as having high variability, difficulty, and interdependency. The results from both methods of analysis, the t-tests and Pearson product moment correlation, support hypothesis H1a. They also support H1b; namely, given these task attributes, the users will report enhanced work

performance with EUC Config II.

The result shows that the MATCH has a significant correlation with SATISFAC (r=.4719) and PERFORM (r=.4043) at significance levels a=.004 and a=.013, respectively. The t-test also supports hypothesis H1. It shows that GROUP 1 (MATCH=1) and GROUP 2 (NO-MATCH; i.e., MATCH=0) have significant mean differences in SATISFAC and PERFORM. The t-statistic for SATISFAC and PERFORM are 2.83 (one-tail probability of p=.004) and 2.34 (p=.013), respectively. Therefore, both H1a and H1b are supported. That is, the EUC users who perceive their tasks as having high variability, difficulty, and interdependency, will be most satisfied and will positively assess EUC performance if they are provided with EUC Config II (i.e., analysis/inquiry applications with a coordinated decision-making environment).

7.2.2. Test of Hypothesis H2

Hypothesis H2 asserts that where end users perceive their tasks as having high variability and difficulty, but low interdependency, they will be most satisfied with EUC Config I (Hypothesis H2a) and they will report enhanced work performance with Config I (Hypothesis H2b). The result support for this proposition. It shows that MATCH has significant correlations with SATISFAC (r=.5736) and PERFORM (r=.6162) at significance levels a=.002 and a=.001, respectively. Therefore, both the hypotheses H2a and H2b are supported.

H2a and H2b are further confirmed by the results of the t-test which examines existence of any significant mean differences in SATISFAC and PERFORM between the two groups. The result shows that t-values for SATISFAC and PFRFORM are 3.21 (one-tail probability p=.002) and 3.67 (p=.001), respectively. In fact, the mean score for SATISFAC for the MATCH=1 group was 5.4364 out of 7-scale, and 4.5667 for the MATCH=0 group. As for PERFORM, the mean score for the MATCH=1 group was 4.5556, and 3.6528 for the MATCH=0 group.

These tests indicate that the EUC users who perceive their tasks as having high variability and difficulty, but low task interdependency, will be most satisfied and will positively assess EUC performance if they are provided with EUC Config I (i.e., analysis/inquiry applications with an individual decision-making environment).

7.2.3. Test of Hypothesis H3

It was argued in section 5 that high task variability but low task difficult (i.e., the typical task characteristics facing technical-professional subunits) and low degree of task interdependency among subunits will necessitate either EUC Config III or Config I. Accordingly, hypothesis H3 asserts that under this task environment they would be most satisfied (H3a) and they would report enhanced work performance (H3b) if they are provided with EUC Config III or Config I. The need for EUC Config I depends on whether or not the users' tasks necessitate more decision aids like modeling, simulation, and optimization tools to understand and make sense of the task uncertainty.

The result reveals that the hypotheses H3a and H3b are supported. It shows that the match has significant correlation with SATISFAC ($r=.3091$) and PERFORM ($r=.2687$) at significance levels $a=.062$ and $a=.088$, respectively. However, note that the significance levels shown here are higher than those that are widely used in empirical studies in the social sciences, usually $a=.05$. Nevertheless, these are still lower than $a=.10$, which is also widely accepted as a cut-off critical value for exploratory hypothesis testing or early stages of research.

The t-tests show that there were significant differences assuming one-tailed testing on means in SATISFAC and PERFORM between the two groups. The t-statistics for SATISFAC and PERFORM are 1.59 ($p=.062$, one-tail) and 1.40 ($p=.0875$, one-tail), while mean scores for SATISFAC and PERFORM are 6.0941 and 4.3981 each for the MATCH=1 group, and 5.4667 and 4.0370 for the MATCH=0 group.

These tests indicate that the EUC users who perceive their tasks as having

high task variability but low task difficulty and low task interdependency, will be most satisfied and will positively assess EUC performance if they are provided with EUC Config III or Config I.

7.2.4. Test of Hypothesis H4

Hypothesis H4 asserts that end users who perceive their tasks as having high variability, but low difficulty and high interdependency, will be most satisfied (H4a) and will report enhanced work performance (H4b) with EUC Config IV or Config II. It is argued in chapter 5 that the choice between Config IV and Config II depends upon whether the end users take actions without making further efforts to understand a situation, or whether they need to understand and make sense of task uncertainty.

The result reveals that there is a significant correlation between the match variable and SATISFAC ($r=.3803$, $a=.081$). However, it shows that there is not a significant correlation between MATCH and PERFORM ($r=.0544$, $a=.421$). Therefore, hypothesis H4a is supported, but H4b is not.

The t-test confirms the result of this correlation analysis. It shows that mean scores of SATISFAC are 6.0833 and 5.3333, respectively for the MATCH=1 (i.e., matched) group and the MATCH=0 (i.e., NO-MATCH) group. It also shows that the t-statistic for SATISFAC is 1.48 ($p=.081$, one-tail). These results indicate that hypothesis H4a is supported. That is, end users who perceive their tasks as having high variability, but low difficulty and high interdependency are most satisfied with EUC Config IV or Config II.

However, note that the arguments made regarding H4 are rather weak in a statistical sense, because the results are based on 15 cases. In particular, the number of cases used for testing the mean difference in SATISFAC for MATCH=0 group is only 3, which indicates weakness in our argument for either supporting or not supporting H4.

In addition to the correlation analysis and t-test, hypothesis H4 is further analyzed using a contingency table. Recall that hypotheses H4a and H4b assert

that the most positively assessed configuration, given task attributes (i.e., high variability, but low difficulty and high interdependency), will be either Config IV or Config II. Further, we argued in section 5 that the choice between EUC Config IV and Config II depends on whether the users refer to prespecified rules and frequent statistical reports, or whether their work necessitates More powerful decision aids such as modeling and simulation tools.

Although a choice was available, in reality the most positively assessed configuration was Config II (rather than Config IV) for both hypotheses H4a and H4b. This leads us to believe that users more often refer to decision tools, which resulted in Config II. A contingency table (Table 7-6) supports this argument. The cases selected for this analysis are the same ones that were used for the above correlation analysis and t-test of H4a and H4b. In other words, we are discussing EUC success in the same task environment as that of hypothesis H4a. Also, note that SATISFAC scores are converted to dicho-

Table 7-6. CrossTab of Satisfac by Config for H4a

CROSSTABULATION OF

SATISFAC BY CONFIG

COUNT / ROW PCT / COL PCT	CONFIG 1.00	2.00	3.00	4.00	ROW TOTAL
SATISFAC .00			1	1	2
			50.0	50.0	13.3
			50.0	33.3	
1.00	1	9	1	2	13
	7.7	69.2	7.7	15.4	86.7
	100.0	100.0	50.0	66.7	
COLUMN TOTAL	1	9	2	3	15
	6.7	60.0	13.3	20.0	100.0

CHI-SQUARE	D.F.	SIGNIFICANCE	MIN E.F.	CELLS WITH E.F.<5
4.90385	3	0.1790	0.133	7 of 8 (87.5%)

STATISTIC	VALUE	SIGNIFICANCE
CRAMER'S V	0.57177	
CONTINGENCY COEFFICIENT	0.49636	

NUMBER OF MISSING OBSERVATIONS= 2

tomous values so that SATISFAC=1 means that the score is greater than 5.00 in original scale, whereas SATISFAC=0 means a score less than or equal to 5.00 on a scale of 1.00 to 7.00. Table 7-6 shows that the cell with SATISFAC=1 and Config II has the largest number of observations (9 cases). Therefore, the most positively assessed EUC configuration was Config II, given task attributes under hypothesis H4a.

7.2.5. Test of Hypothesis H5

The proposed hypotheses H5a and H5b deal with EUC users who perceive their task attributes as having low variability, but hihg difficulty and high interdependency as in Perrow's [1980] 'craft work.' Hypotheses H5 postulate that given these task attributes, users will be most satisfied (H5a), and they will report enhanced work performance (H5b) with EUC Config II or Config IV. In this environment, unlike the other examples of 'mixed-in-routineness' (*i.e.*, H3 and H4), there is no store of rational knowledge and techniques to be applied in a 'search process.' We argue that accomplishing tasks fitting this description will involve a great deal of personal judgment and experience.

The result shows that the hypothesis H5a is supported if the significance level a=.10 is accepted. MATCH is correlated with SATISFAC (r=.3128, a=.064). The t-test also confirms H5a, with the mean scores for SATISFAC being 5.2889 and 4.5125 for MATCH=1 group and MATCH=0 group, respectively. However, H5b is not supported. The result reveals that there is no significant correlation between MATCH and PERFORM (r=.2181, a=.148). The same is true of the t-test. Therefore, we can only say that end users who perceive their tasks as having low variability, but high difficulty and high interdependency are most satisfied if they are provided with EUC Config II or Config IV.

7.2.6. Test of Hypothesis H6

The hypotheses H6a and H6b deal with the craft work tasks; namely, where end users perceive their tasks as having low variability, but high difficulty and low interdependency. The hypotheses asserts that the users given

these task attributes will report most satisfaction (H6a) and enhanced work performance (H6b) with either Config I or Config III.

The results support neither H6a nor H6b. MATCH has no significant correlations with SATISFAC (r=.0302, a=.444) and PERFORM (r=−.0629, a=.385). The t-test analysis does not reveal any significant differences for the two groups.

7.2.7. Test of Hypothesis H7

The hypotheses H7a and H7b assert that given tasks that end users perceive as having low variability, low difficulty, and low interdependency, users will report most satisfaction (H7a), and enhanced performance (H7b) with EUC Config III. We argue that these task attributes require exception and monitor applications.

The results support H7a and H7b. In fact, MATCH has significant correlation with SATISFAC (r=.2770, a=.030) and PERFORM (r=.2577, a=.044). The t-test reveals that there are significant differences on means in both SATISFAC (t=1.93, one-tail p=.030) and PERFORM (t=1.75, p=.044) between the two groups. In other words, users with tasks that are relatively programmable (low task coping difficulty), have few exceptions (low task variability), and are self-contained (independent tasks), report that they are most satisfied with EUC Config III (*i.e.*, analysis/inquiry applications supporting individual decision-making). They also report enhanced work performance with EUC Config III.

7.2.8. Test of Hypothesis H8

Hypothesis H8 deals with the end user's perceived task attributes as having low variability, low difficulty, but high interdependency. We argued in section 5 that the most successful EUC configuration given these task attributes will be Config IV (H8a). We also argued that end users will report enhanced work performance with EUC Config IV (H8b).

The results, however, do not support either H8a or H8b. MATCH has no significant correlation with SATISFAC (r=.0801, a=.343) or PERFORM

Table 7-7. Summary of Tests of Hypotheses

Hypotheses	Result	Hypothesis	Result
H1a	S	H5a	S
H1b	S	H5b	NS
H2a	S	H6a	NS
H2b	S	H6b	NS
H3a	S	H7a	S
H3b	S	H7b	S
H4a	S	H8a	NS
H4b	NS	H8b	NS

Legend : S : Supported
NS : Not-Supported

(r=.0080, a=.484). Neither does the t-test show any significant mean differences.

7.3. Summary of Tests

To summarize the tests of hypotheses, Table 7-7 presents a table for the tests of individual hypotheses of this section.

In concluding this section, three additional observations are in order. First, in looking at the hypotheses that were not supported, they tended to be ones involving high task interdependency. While the results were in the right direction, the magnitude was not sufficient to reach statistical significance. It seemed that the propositions of Tushman and Nadler [1978] and Daft and Macintosh [1981] were not supported particularly when high task interdependency was coupled with 'routine task.' This could be due to the relatively small sample which comprised each highly interdependent task contingency and hypothesis. A closer examination of this is needed in the future.

Second, we observed a tendency for differences on mean scores for satisfaction and performance, although in the right direction, to fall short of statistical significance in caces where respondents reported low task variability. This tendency is observed particularly when low task variability was coupled with high task difficulty; therefore, the propositions of Miles [1980] 'mixed-in-routineness' and Perrow's [1980] 'craft work' were not supported. It appears that any configuration is able to meet the needs of the users when they have

low task variability. A more sophisticated EUC configuration while unnecessary does still meet their basic needs although this is an expensive solution.

Finally, in each of the eight task contingencies, the respondents' mean scores on satisfaction and performance were higher for respondents whose actual EUC configuration matched that postulated as optimal under each hypothesis than for those not so matched. This is true even for those cases where the difference in mean scores failed to reach statistical significance. The clear implication for EUC management is that the likelihood of EUC success, as we have defined it, will be improved by understanding the EUC scope and application needs of their users and providing the appropriate EUC configuration.

8. Conclusion

To conclude the study, (1) research findings are summarized; (2) recommendations for management are suggested; (3) limitations and suggestions for future research are discussed; (4) concluding remarks on the study are made.

8.1. Summary Findings and Recommendations for Managers

New developments in computer technology, the expanding availability of ever more finely tailored software applications, and the growing sophistication of employees at various organizational levels have continued, on the one hand, to increase the potential contribution of this technology to business and, on the other, to promote demand for greater processing capability by the users of information themselves. We have called such use "end-user computing."

This study has sought to explore a small corner of this world. Its central purpose has been to probe how the relationship between the features of particular information processing tasks and the way end-user computing is organized affects the success and satisfaction which users experience in doing their work. Three features were used here to capture differences between various tasks: (1) the uncertainty with which information users will be called upon to

perform particular tasks, with special regard to the timing of the required work; (2) the extent to which tasks involve original as opposed to stock solutions or recipes; and (3) the extent to which employees depend on others in the course of their work, either for support, information, or authority. For reasons which are largely historical we have called these three features, respectively, task variability, task difficulty, and task interdependency.

Based on concepts which, for the most part, had already been developed in the literature of organization theory, we expected to find (and in fact found) that employees whose tasks are characterized by a high degree of uncertainty and difficulty would be most successful and satisfied when working in environments equipped with applications packages designed for analytic uses. Conversely, we found that employees engaged in tasks of low uncertainty and difficulty reported greater success and satisfaction working with applications software geared to facilitate routine data management.

The issue here for management is that the choice of personal computer applications is a critical one for achieving success. Our study found that slightly over one half of our respondents had been miscast from this point of view. These respondents had been configured with applications and software which were ill-suited to their needs. More judicious analysis of their tasks by management in terms of the level of analytic capability required would have led to perception of higher performance and greater satisfaction.

It is worth noting that if one is to err in drawing implications from the task analysis, it is probably better to err on the side of providing greater analytic power rather than less. This may reflect the growing capability and experience which corporate users seem to enjoy. By utilizing the items measuring task attributes of end users such as those in the questionnaire, EUC management can perform task analysis easily. Our sample, does not, permit broad generalization about the sophistication and competence of the employees in any particular company. However, it is our view that, at least in many offices, skill levels may be surprisingly high. Our survey suggests that end

users are becoming more and more knowledgeable about computers and information systems. One third of our respondents were user programmers or functional support personnel who develop their own applications. Many other users were knowledgeable in computer technology; many had experience with 4th generation languages, even though they had little or no prior academic training relating to mainframe computers or information systems. More than one-third of the respondents reported that they use computers at work more than 20 hours per week. Interestingly, their major sources of support came not from an information systems or data-processing department but from their own functional area. This suggests that management should look in its own back yard to exploit and cultivate this increasingly sophisticated resource.

Finally, we would suggest that management review as part of any task analysis the relationship between actual task interdependency and the extent of institutionalized required coordination in decision making. The study suggests that management might improve both efficiency and morale by gearing expected levels of coordination to the interaction which individual tasks in fact require.

The majority of end users reported that their primary usage of applications systems were for analysis and inquiry rather than for monitoring and exception notification. The primary area for which these applications systems were used, was 'financial analysis.' Forty percent of the respondents reported that their most used programs and/or packages were spread-sheets. Database management systems, word processors, and programming languages received thirteen percent each of the responses. This suggests that there are numerous other areas that EUC can be used that is not yet happening.

8.2. Limitations and Suggestions for Future Research

The central premise of this study is that EUC activities should be congruent with the end users' perceptions of task attributes. The task attributes determine the appropriate EUC configurations which then lead to EUC success. Like any other model, the research model of this study, however, has some limitations. Future research is invited to solve these limitations.

First, there is no doubt that organizational characteristics are not static. Organizations grow, evolve, and change over time. In particular, the changing task attributes of end users should in turn change the information processing requirements of the organization. This implies that the EUC configurations most appropriate to users at any one point in time may not be appropriate at another point in time. This time variable, however, was not included in the present study.

Linked to the time variable, this study is non-experimental (more specifically, *ex post facto* cross-sectional) research, inherent in which is the problem of demonstrating causality. Nevertheless, this research enable us to understand the associations between the independent and dependent variables, thereby providing us with a grounding from which further research can progress.

Third, some of the measures for the constructs in this study are subjective rather than objective. For instance, a cost/benefit analysis as an objective measure may be a better way to measure EUC success. However, it is extremely difficult to assess the dollar benefits of EUC, particularly for EUC that supports sophisticated analysis and inquiry applications. Future research should focus on developing more objective standardized measures of EUC activities.

8. 3. Concluding Remarks

This study has made several important contributions to our knowledge of information systems. First, the study complemented prior research into the relationships among key organizational components (that is, technology, people, task, and structure), by investigating the link between task and technology, where EUC was the particular form of technology. Second, the study provided management with demographics and usage patterns of EUC in multiple organizations which until now were unknown. Third, the results of the study indicate to management that if the EUC configuration is matched to the task environment, the overall satisfaction of users with EUC and their perceived usefulness of EUC for enhancing work performance will increase. Therefore,

management are urged to carefully analyze the task attributes of EUC users before providing users with EUC technology. Correctly matching EUC configuration to the task attributes will lead to fuller utilization of this new and important information technology at the least possible cost to the organization.

APPENDIX A: T-Test for Independent Variables between the two Group

Group 1—Company Eq 1.00
Group 2—Company Eq 2.00

Variable	of Cases	Variable	of Cases	Variable	of Cases
Taskvar		Taskdiff		Taskint	
Group 1	172	Group 1	170	Group 1	173
Group 2	71	Group 2	72	Group 2	70
F Value	2-Tall Prob.	F Value	2-Tail Prob.	F Value	2-Tail Prob.
1.35	0.150	1.18	0.424	1.18	0.433

APPENDIX B-1: Rotated Factor Matrix for Independent Variables

Rotated Factor Matrix

	Factor 1	Factor 2	Factor 3
VAR43	.81619		
VAR46	.78400		
VAR44	.70428		
VAR45	.62154	(.32936)	
VAR50		.82315	
VAR51		.81498	
VAR49		.61475	
VAR47	(.36755)	(.45371)	
VAR48		(.40765)	
VAR53			.79405
VAR54			.60448
VAR52			.58852
VAR55			(.45068)

APPENDIX B-2: Initial Rotated Factor Matrix for Dependent Variables

Rotated Factor Matirx

	Factor 1	Factor 2	Factor 3	Factor 4
VAR66	.84552			
VAR68	.82525			
VAR65	.63023			
VAR67	.63023			
VAR62	.62495			
VAR72		.75509		
VAR71		.75184		
VAR74		.65200		.34320
VAR73		.67069		.35531
VAR69		.61612	.33909	
VAR70		.60420	.36657	
VAR58			.83978	
VAR57			.79562	
VAR59			.78390	
VAR78			.66521	
VAR77		.38470	.48566	
VAR76				.63217
VAR61				.61297
VAR64	.3510			.57239
VAR63				.54662
VAR75		.31699		.51228
VAR60				.42480

FACTOR 1→Satisfaction with Information Production/services

FACTOR 2→Performance

FACTOR 3→Learning due to EUC

FACTOR 4→Satisfaction with Knowledge/Involvement in IS

APPENDIX B-3: Rotated Factor Matrix for Dependent Variables

Rotaded Factor Matrix

	Factor 1	Factor 2	Factor 3
VAR66	.85914		
VAR65	.82355		
VAR68	.80578		
VAR62	.63309		
VAR67	.62193		
VAR64	.51377		(.34201)
VAR61	(.45083)		(.30988)
VAR60	(.40952)		
VAR63	(.40089)		
VAR71		.75413	
VAR72		.74495	
VAR74		.73002	
VAR73		.72879	
VAR69		.57546	
VAR70		.55124	
VAR75		(.42674)	
VAR76		(.37311)	
VAR58			.84661
VAR57			.79424
VAR59			.76652
VAR78			.69241
VAR77		(.42707)	.50389