

EXPLORING THE BENEFITS OF EXPERT SYSTEMS USE IN ORGANIZATIONS

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INTRODUCTION

Expert systems (ES) are one of the earliest and most practical applications of artificial intelligence technology. A recent survey of published materials on ES uncovers approximately 2500 developed systems, which could represent about a fifth of all systems actually developed (4). Some major companies, such as Digital Equipment, Du Pont and IBM, have reportedly generated huge financial returns as well as competitive advantages from using ES (6, 11, 14). While these success stories of ES implementation make the technology exciting and robust, some argue that ES rarely succeed in delivering expert performance (1, 8). Several case studies (e.g., 9, 12), report failures in implementing ES in organizations. Many well-publicized ES have proved to be pure hypes or product failures (5). It seems that there are still mixed opinions regarding the usefulness of ES in the real world despite a decade of efforts to use them.

In order to better understand the usefulness of ES, this study attempted to examine the benefits of ES use in organizations, focusing on how closely the benefits actually arising from the use can fulfill the original expectations. The results of the study are based upon an analysis of data from a survey of information systems (IS) professionals within organizations that have actually used ES for their operations. The study can extend the line of research on organizational aspects of ES implementation, to which relatively little attention has been paid to date. Also, the results of this study can help us understand the kinds of benefits that are expected from ES as well as the extent to which these expectations are actually fulfilled in organizations. The results can help us assess the usefulness of ES in organizations and set the stage for the future in the field.

CONCEPTUAL FRAMEWORK

Rogers' model of the innovation decision process (10) states that an adopter forms a certain attitude toward an innovation during the two stages of the adoption process: the persuasion stage and the confirmation stage. First, a favorable attitude leads to a behavioral intention during the persuasion stage of the decision process. Second, attitude formation takes place in the confirmation stage of the decision process when the adopter reevaluates his or her attitude toward the innovation depending upon the correspondence between prior expectations and actual outcomes of the innovation. This study focuses on the confirmation stage, that is, the extent of

correspondence between the benefits expected from ES use and benefits actually realized from the use.

Based upon this model of innovation decision process, we posit that the degree of usefulness of ES in organizations can be expressed as a function of the degree of fit between expected and realized benefits of ES use. Drawing from previous studies that are relevant to the implementation and organizational impacts of ES (2, 5, 13, 14), we investigated the benefits of ES use in organizations in three major areas: value-added, productivity, and managerial areas. The value-added area includes such benefits as improved decisions and reporting (in terms of consistency, accuracy and timeliness), improved customer service, and improved competitiveness and market share. The area related to productivity includes such benefits as improved productivity (in terms of cost and time savings), more creative work, and less routine tasks. The managerial area includes such benefits as improved managerial control and improved education and training.

METHODS

We used data from a survey of IS professionals within organizations that have actually used ES for their operations. There are several reasons for aiming at IS professionals for this study. First, IS professionals are presumed to have some knowledge of ES technology itself as well as of the status of ES use in their organizations. Also, they can provide more objective information regarding the consequences of ES implementation in a neutral position between ES practitioners or advocates (e.g., knowledge engineers) and end users in other functional areas. Thus, IS professionals, who also play important roles in the process of ES adoption and implementation, are deemed to be appropriate respondents for this study.

The survey instrument was pre-tested by several local IS professionals in order to test its validity. Their responses and comments were subsequently used to modify the instrument. Then, the questionnaire was mailed out to 600 IS professionals across organizations in the United States. The mailing list was made up of different names from the member directories of the Association of Information Technology Professionals and the Association for Systems Management, of which most members are IS practitioners. We attempted to distribute questionnaires across distinct geographical regions where regional chapters of the associations are established. Potential respondents in each region were selected randomly with the number being proportionate to the number of chapter liaisons and

representatives of the region. In this way, we could significantly enhance the chance of each response from a distinctive organization.

We asked the IS professionals to state the degree their organization actually used ES for its operations. Then we asked only those reporting the actual use to classify the extent to which they agree on the factors of expected as well as realized benefits of ES use. If more than one ES has been in use in the organization, they were asked to classify each of the factors regarding the one ES with which they are most familiar. The extent of their agreement on the factors was measured using a five-point Likert-type scale (i.e., 1 - no benefit; 3 - moderate benefit; 5 - great benefit).

RESULTS AND DISCUSSION

Responses were received from 143 IS professionals, but 15 responses did not indicate the status of ES use in their organizations. Of the remaining 128 responses, only 25 reported that their organization has been involved in ES projects. Of these 25 adopters, 16 reported current use, four reported current development, and five reported discontinuance of ES use. Seventeen of the 25 adopters reported involvement with only one ES, while eight reported involvement with more than one ES.

Our results on the extent of ES use suggest that ES have not been widely used in organizations, contrary to the hypes and speculations made earlier. It seems that many organizations merely "talk the talk" of ES use, not being motivated enough to use the technology themselves. ES use might have waned in recent years, as predicted by a majority of AI practitioners (3), yet the relatively high rates of ES use in other surveys seemed due in large part to the makeup of the samples. For example, Byrd (2) surveyed knowledge engineers who were directly involved with ES projects, and Philip and Schultz (7) surveyed readers of *AI Expert* who were presumably very interested in ES technology. Unlike those surveys that aimed at ES practitioners or advocates, we surveyed a broad spectrum of IS professionals across organizations, and thus our results seem to portray a more general picture regarding the extent of ES use in the real world.

In examining the factors of expected and realized benefits of ES use, we used the 21 responses that reported that actual use of ES. Using this sample, we first calculated the means and standard deviations of all variables to see the relative

importance of individual variables. Then we performed *F*-test to see any differences in the means of major areas constituting expected and realized benefits. Finally, we performed paired *t*-test to investigate the degree of correspondence between the expected and realized benefits of ES use.

Table 1 shows the mean ratings of the expected benefits of ES use in organizations. The respondents perceived that moderate or great benefits (with mean ratings ranging between 3.00 and 4.13) were expected to arise in all the areas considered. They perceived that the greatest benefit was expected to arise in the area of improved decisions and reporting (with mean rating of 4.13), followed by the area of improved productivity (with mean rating of 4.00). Within the area of improved decisions and reporting, they perceived that the benefits of consistency and accuracy (both with mean rating of 4.19) were expected to be slightly greater than the benefit of timeliness (with mean rating of 4.00).

TABLE 1
Mean Ratings of Expected Benefits of ES Use

Value-added benefits (X_1):	
Improved decisions and reporting	4.13
Improved customer service	3.81
Improved competitiveness/market share	3.81
Productivity benefits (X_2):	
Improved productivity	4.00
More creative work	3.81
Less routine tasks	3.81
Managerial benefits (X_3):	
Improved managerial control	3.38
Improved education and training	3.00

Table 2 shows the results of the simultaneous test on mean differences between the three major areas of expected benefits of ES use. The respondents perceived that less benefit was expected to arise in the managerial area than in the value-added and productivity areas. But no significant difference between the value-added and productivity areas was observed. These results suggest that value-added and productivity benefits, which are directly associated with business operations, are more important in influencing an organization's intention to use ES than managerial benefits.

TABLE 2
Mean Differences Between Major Areas of Expected Benefits

Test	$X_1 - X_2$	F	p
$u_1 - u_2 = 0$	0.042	0.727	0.790
$u_2 - u_3 = 0$	0.683	23.494	0.001
$u_3 - u_1 = 0$	-0.725	17.961	0.002

Table 3 shows the mean ratings of the realized benefits of ES use in organizations. The respondents perceived that while benefits were realized in all the areas considered, the extent to which they were actually realized was generally moderate (with mean ratings ranging between 2.33 and 3.56). Within the area of improved decisions and reporting that shows the highest

mean rating (3.56), the benefit of more consistent decisions was the greatest (4.33), followed by the benefits of more accurate decisions and reporting (3.33) and more timely decisions and reporting (3.00). Regarding the extent to which the benefits are realized, our results are somewhat different from those from a survey conducted by Tyran and George (13).

Tyran and George (13) report that ES have very positive impacts on consistency of work output, quality of work output, and relationships with customers, but their results are based on information from managers whose ES are thought to be successful. Our results, which are based on data from those who report current use of ES as well as discontinuance of ES use, are more consistent with the findings of Byrd (2). Using data from a survey of knowledge engineers across organizations, Byrd (2) reports that moderate or small benefits in the areas of productivity, competitiveness/market share, and education and training, are gained from ES implementation.

TABLE 3
Mean Ratings of Realized Benefits of ES Use

Value-added benefits (X_1):	
Improved decisions and reporting	3.56
Improved customer service	2.67
Improved competitiveness/market share	2.67
Productivity benefits (X_2):	
Improved productivity	3.00
More creative work	2.67
Less routine tasks	2.67
Managerial benefits (X_3):	
Improved managerial control	3.00
Improved education and training	2.33

Table 4 shows the results of the simultaneous test of mean differences between the three major areas of realized benefits of ES use. While value-added benefits were perceived to be greater than managerial benefits, no significant difference was

observed between productivity benefits and either of the other two major areas of benefits.

Table 5 shows the results of the paired *t*-test of differences between the expected and realized benefits of ES use. It is notable that significant difference was observed in all the areas except the area of improved managerial control. In general, the respondents perceived that the actual benefits of ES use did not fulfill the original expectations. Even within the area of improved decisions and reporting where the greatest benefit was perceived to arise, only the benefit of improved consistency of decisions slightly exceeded the expectation (4.33 vs. 4.19) and the actual benefits regarding accuracy and timeliness of decisions and reporting did not meet the expectations (3.33 vs. 4.19 and 3.00 vs. 4.00, respectively). Overall, the respondents perceived that the actual benefits that arose from ES use were far less than expected.

CONCLUSION

This study attempted to examine the benefits of ES use in organizations, as perceived by IS professionals in organizations that have actually used ES for their operations. IS professionals perceived that their organizations had relatively high expectations regarding the benefits that would arise from ES use. They also perceived that the organizations expected greater benefits in the value-added and productivity areas than in the managerial area. But they perceived that the benefits that actually arose from ES use were only moderate or small and more importantly, the actual benefits did not meet the expectations in most areas considered. The only areas where the actual benefits were perceived to satisfy the expectations were those related to consistency of decisions and managerial control.

TABLE 4
Mean Differences Between Major Areas of Realized Benefits

Test	$\bar{X}_1 - \bar{X}_j$	F	p
$u_1 - u_2 = 0$	0.185	2.059	0.167
$u_2 - u_3 = 0$	0.111	0.831	0.373
$u_3 - u_1 = 0$	-0.296	5.130	0.035

TABLE 5
Comparison of Expected and Realized Benefits of ES Use

Factor	V1	V2	V3	P1	P2	P3	M1	M2
Expected Benefit	4.13	3.81	3.81	4.00	3.81	3.81	3.38	3.00
Realized Benefit	3.56	2.67	2.67	3.00	2.67	2.67	3.00	2.33
Paired Difference	0.57*	1.14*	1.14*	1.00*	1.14*	1.14*	0.38	0.67*

Note: * $p < 0.01$; V1 - improved decisions and reporting, V2 - improved customer service, V3 - improved competitiveness/market share, P1 - improved productivity, P2 - more creative work, P3 - less routine tasks, M1 - improved managerial control, M2 - improved education and training.

The results of this study, particularly on the discrepancy between the expected and realized benefits of ES use, suggest that the actual usefulness of ES in organizations is still limited. There may be various reasons for this, from technical and

developmental issues of ES technology itself all the way to managerial and organizational issues involved in ES implementation. Apart from these moderating factors on which we need more studies, it seems that ES technology has been

oversold with high expectations regarding its capabilities and benefits. In this regard, the results of this study can help alleviate the hype and speculations made earlier and assess the usefulness of ES technology in the real world.

Several limitations are recognized in this study. First, we considered a restricted set of factors regarding the benefits of ES use. These factors are certainly not comprehensive, although previous studies find them to be important factors associated with ES implementation and impacts. Second, we relied on the respondents' retrospective perceptions, particularly in measuring the variables of the expected benefits, mainly because of the convenience of the survey. It would be more desirable to examine the expected and actual benefits of ES use in a longitudinal way. Third, this study is liable to problems of small sample sizes as well as problems related to perceptual studies. However, given the importance of IS professionals' perceptions and attitudes in the process of ES adoption and implementation, this study can shed some light on the issues regarding the consequences of ES use that may expedite or hamper the process. These limitations are not exhaustive but rather important ones. Obviously, these limitations suggest several possibilities for future research.

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