ORGANIZATIONAL FACTORS CONTRASTING ADOPTERS AND NON-ADOPTERS OF EXPERT SYSTEMS

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ABSTRACT

Using data from a survey of information systems (IS) professionals, this study examines the current status of expert systems (ES) adoption in organizations and introduces several organizational context factors which may be associated with ES adoption. The results regarding the current status of ES adoption show that ES are generally not widely adopted in organizations, while there are some variances across industries. Also, the results of a comparison between adopters and non-adopters of ES suggest that there are some differences in organizational factors between the two groups. Furthermore, ES adoption is more associated with organizations which have a decentralized decision-making structure and practice strategic IS planning than those which do not. The findings of this study are expected to contribute to increasing our understanding of ES adoption and associated organizational factors. In addition, they provide a comprehensive view of the phenomenon, which is useful in setting the stage for the future, as well as a guide for IS managers concerning organizational conditions and practices which are most appropriate to adopting ES.

INTRODUCTION

Expert systems (ES) are one of the earliest and most practical applications of artificial intelligence technology. Their ability to use specialized symbolic reasoning, gives ES the potential to handle ill-structured problems and complement existing management information systems and decision support systems. It is this potential that makes the number of possible applications for ES impressive. A recent survey of published materials on ES uncovers approximately 2,500 developed systems, which could represent about a fifth of all systems actually developed [12]. Also, about half of the Fortune 500 firms are estimated to have invested in ES, ES tools, and ES shells [24]. Some major companies, such as Digital Equipment, Du Pont and IBM, have reportedly implemented tens or even hundreds of ES and generated huge financial returns, as well as competitive advantages, from using those systems [27][35][44]. While these success stories of ES development and implementation make the technology exciting and robust, some argue that ES rarely succeed in delivering expert performance [4][32]. Several case studies, e.g., [34][36], have reported failures in adopting and implementing ES in organizations. Many well-publicized ES proved to be pure hypes or product failures. As a result, major companies reduced or eliminated their commitment to ES [15]. Even a majority of artificial intelligence practitioners polled in a recent survey predicted that the artificial intelligence industry, in which ES are probably the largest application area, would either remain flat or decline between 1993 and 1999 [9]. At the present time, there are mixed opinions regarding the extent of ES adoption and implementation in the real world despite a decade of commercializing efforts.

In the last decade or so, there have been many studies reporting on various ES applications, including both successes and failures. Most studies addressing managerial and organizational aspects of ES, with the exception of a few, are based upon case studies of single organizations. A few field surveys involving larger samples, e.g., [15][41][44], provide more generalizable information regarding ES

adoption and implementation in organizations. However, most of them still focus on post-adoption issues, based upon the perceptions and experiences of those who already adopted the systems. The objective of this study is to examine the current status of ES adoption in organizations and to introduce several organizational factors that may be associated with ES adoption. We use the results of a cross-sectional mail survey of information system (IS) professionals in the United States. Emphasis is on the status of ES adoption, that is, whether or not ES are adopted, since one of our aims is to examine any difference in organizational context factors between adopters and non-adopters of ES. The findings from this study are descriptive in nature and expected to contribute to increasing our understanding of ES adoption and associated organizational factors. Specifically, the findings regarding the current status of ES adoption will provide a comprehensive view of the phenomenon, which may be useful to both researchers and practitioners in setting the stage for the future. Also, the findings regarding the organizational factors delineating adopters and non-adopters of ES will provide a guide concerning organizational conditions and practices which may be most associated with ES adoption. Such guidance may be useful to IS managers in assessing the suitability of their organizations with respect to ES adoption. In the following, we first present the conceptual constructs for this study, followed by a description of the survey and responses. Then, we present the results of the survey, along with some implications for the adoption of ES in organizations. Finally, we provide our concluding remarks.

CONCEPTUAL CONSTRUCTS

There is a wide body of research investigating the organizational context as it relates to the adoption and implementation of IS and innovation. The conceptual constructs for this study, which are based upon research in these areas, include several organizational factors under two broad categories: general and IS-related factors. The general organizational factors include: centralization, top management's risk propensity, and the size of the organization. The organizational factors relevant to IS practices include: links between IS and business plans, top management support for IS, and the diffusion of IS within the organization. While there is significant empirical research discussing organizational factors as being associated with the adoption and implementation of IS and innovation, little is known, except for some anecdotal information in a few case studies, e.g., [11][34][39], about these factors in the ES context. In this study, we posit that these organizational factors are also associated with ES adoption. Like other management support systems, ES adoption can require appropriate organizational conditions and practices to be successful and have significant impact on the organization. Table 1 lists the organizational factors and the items for each factor which are included in this study. A brief review of the relevant research on which the conceptual constructs for this study are based is presented below.

General Organizational Factors

Organizational structure is one of the most frequently investigated factors in IS and innovation implementation research. A major dimension regarding organizational structure is centralization or concentration of decision-making activity [13][16][17]. Centralization is often found to have a negative association with innovation adoption because of decreased autonomy and a bounded perspective [16][28]. In contrast, a decentralized decision-making structure is likely to offer fast development speed, foster user ownership and create broad organizational support, as demonstrated in the case of over 600 ES at Du Pont [27]. Therefore, we hypothesize that ES adopters are likely to have a more decentralized decision-making structure than non-adopters. Regarding centralization, we examine four items originated by Hage and Aiken [17]: (1) the degree to which participation of subordinates in organizational decision making is encouraged; (2) the degree to which action can be taken before a superior approves a decision; (3) the degree to which a person who wants to make his/her decisions is encouraged; and (4) the degree to which subordinates participate in decisions on the adoption of new policies.

Studies in the IS area also suggest that the level of risk an organization is willing to take influences the adoption of IS projects [16][25]. An organization's position regarding this risk is reflected in top management's innovative uses of IS and the decisions regarding the changes in methods and procedures. For example, top management may have a conservative orientation, preferring to use standard methods and procedures, or they may encourage risk taking and change. ES adoption may be viewed as risky, since the technology has the potential to change the methods, procedures and skills needed for a job. Some studies [39][40] further suggest that ES may have an unfavorable impact on the social aspects of the workplace and thereby increase risk. Therefore, we hypothesize that top management of ES adopters is likely to have a higher risk-taking propensity than that of non-adopters. Drawing from Clemons et al. [8], we examine three items of top management's risk propensity: (1) the degree to which top management is willing to accept changes in organizational structure, work force composition, skills, and consequences that may result from a decision; (2) the degree to which top management is willing to absorb technology, hardware and software with which the organization is not familiar; and

Table 1. Organizational Factors Included in the Study

Organizational Factors	References
General organizational factors:	
Centralization:	[13][16][17][28]
CENT1. Encouragement of participation of subordinates in decision making	
CENT2. Taking action before a superior approves a decision	
CENT3. Encouragement of a subordinate who wants to make his or her decisions	
CENT4. Participation of subordinates in decisions on the adoption of new policies	
Top management risk propensity:	[8][13][16][25]
RISK1. Willingness of top management to accept changes in organizational structure, workforce composition, skills, etc. that may result from a decision	
RISK2. Willingness of top management to absorb technology, hardware and software with which the organization is unfamiliar	
RISK3. Willingness of top management to commit large investments to new information technology	
Organization size:	[10][13][16][21][42]
SIZE1. Sales or revenue or budget in terms of dollar amount	
SIZE2. Number of employees	
SIZE3. Size relative to the relevant industry	
IS-related organizational factors:	
Strategic IS planning:	[3][16][26]
ISPL1. Constant involvement of IS management in business planning	
ISPL2. Consideration of competitive strategy in IS planning	
ISPL3. Active involvement of top management in IS planning	
ISPL4. Continuous assessment of information technology in IS planning	
Top management support for IS:	[16][20][31][33]
TOPS1. Top management's encouragement of IS use	
TOPS2. Top management's consideration of IS as important to the organization	
TOPS3. Top management's effective communication of its support for IS	
IS diffusion:	[7][11][38]
ISDF1. Diffusion of IS within the organization	
ISDF2. Penetration of IS into the organization in terms of importance and impact	
ISDF3. Sharing of databases for various applications	

(3) the degree to which top management is willing to commit large investments to new IS applications.

Organization size is another factor which has been well tested in IS and innovation implementation research [10][21]. While organization size is widely recognized as an important factor affecting IS success [13], the results on this factor are ambivalent. That is, arguments are made for both larger sizes (great slack, economies of scale) and smaller sizes (greater flexibility) fostering IS and innovation adoption [16][42]. In addition, high development cost and lack of necessary talents, like knowledge engineers, are often cited as main barriers in developing ES [1][23]. Larger organizations, which in general have more resources, are likely to be in better positions to adopt ES than smaller organizations, which in general have less resources, because of the heavy time and resource commitment required for ES adoption. Therefore, we hypothesize that ES adopters are likely to be larger in organization size than non-adopters. Adopting from Ein-Dor and Segev [13], we examine three dimensions of organization size: (1) sales in terms of dollar amount, which is replaced by revenue or budget in non-profit organizations and government agencies; (2) number of employees; and (3) size relative to the relevant industry.

Organizational Factors Related to Information Systems Practices

The use of IS as a competitive advantage has recently received quite a bit of attention [2]. Links between IS and business plans are particularly important for IS activities to enhance competitive strategy [26]. Strategic IS planning establishes a link between the organizational strategy and IS strategy to establish the course for IS in organizational performance [16]. A study of several organizations that successfully developed ES emphasizes the overall link between ES projects and the business strategy of an organization as being one of the most important factors for success [29]. Therefore, we hypothesize that ES adopters are likely to have a higher degree of strategic IS planning than non-adopters. Deriving from Benson and Parker [3], we examine four items of strategic IS planning: (1) the degree to which IS management is actively involved in business planning; (2) the degree to which IS plans are aligned with the organization's business strategy; (3) the degree to which top management is actively involved in IS planning; and (4) the degree to which there is a continuous assessment of new information technology in IS planning.

Top management support is consistently recognized as an important factor in IS adoption and implementation [20][31] and a good predictor of successful introduction of new or different IS [16]. The importance of top management support is signified in several cases of ES implementation, e.g., XCON at Digital Equipment [22], Management Advisor at Krypton Chemical [34], and Life Underwriter at Lincoln National [29]. The results of a survey of knowledge engineers [5] also show that management support is an important factor to ES success. Therefore, we hypothesize that ES adopters are likely to have a higher degree of top management support for IS than non-adopters. Based upon Raymond [33], we examine three items of top management support for IS: (1) the degree to which top management encourages use of IS; (2) the degree to which top management considers IS as important to the organization; and (3) the degree to which top management effectively communicates its support for IS.

The existing state of IS diffusion within the organization can also affect the decision to adopt new IS [16][38]. IS diffusion refers to the extent to which IS are disseminated or scattered throughout the organization. An organization's decision to adopt a new information technology should be accompanied by the necessary infrastructure to successfully implement the new information technology and derive its full benefits [7]. Innovation literature strongly proposes that the adoption of any technological innovation should be based upon a firm's technological strengths [11]. The existing state of IS diffusion also appears to be an important factor in the adoption and implementation of ES, due to the fact that more ES are integrated with other IS [14][18], often making other IS more useful and easier to use [6][19]. Therefore, we hypothesize that ES adopters are likely to have a higher degree of IS diffusion than non-adopters. Based upon Sullivan [38], we examine three items of IS diffusion: (1) the degree to which IS are diffused in all parts of the organization; (2) the degree to which IS penetrate the organization in terms of importance and impact; and (3) the degree to which databases are shared for various applications, rather than having a separate database for each application.

RESEARCH METHODS

The data for this study were obtained from a survey of IS professionals within organizations from various industries in the United States. There are several reasons for aiming at IS professionals for this study. First of all, they are believed to provide the most reliable information about IS practices in their organizations, as one of our aims is to examine any associations of IS-related organizational factors with ES adoption. Also, a sample of IS professionals across organizations can represent both adopters and non-adopters of ES, as we are concerned about any differences in organizational factors between the two groups. In contrast to those surveys targeting only adopters of ES, e.g., [41][44],

this study attempts to examine the more general status of ES adoption in organizations in an effort to provide a comprehensive view of the phenomenon. Therefore, IS professionals, who presumably have more knowledge of ES technology itself as well as of the status of ES adoption in their organizations than those in other functional areas, 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 in the United States in February 1996. The mailing list was made up of different names from the member directories of the Data Processing Management Association and the Association for Systems Management, of which most members are IS practitioners. Ideally, each potential respondent should represent a distinct organization, as organizations are the unit of analysis for this study. However, it was not practically feasible to target distinct organizations because the member directories did not provide any specific information on the organizations where potential respondents were employed. Further, it would be difficult to determine the organizations which were represented by the respondents because of the anonymity of the responses. Consequently, we attempted to distribute questionnaires across distinct geographical regions covering most states and major cities where regional chapters of the associations were 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. We believe that in this way, we would be able to significantly reduce the potential bias which might be caused by multiple responses from within the same organization.

We first asked the IS professionals to choose one of the following statements that best describes the current status of their organization regarding ES adoption and implementation: (1) not planning to adopt and implement ES; (2) planning to adopt and implement ES; (3) developing ES or being engaged in pilot projects for ES; (4) using ES; and (5) had used ES but discontinued using them. Next, we asked them to classify the extent to which they agreed on the general and IS-related organizational factors of their organization. The extent of their agreement on these factors was measured using a five-point Likert-type scale. Specifically, ten questions elicited data pertaining to the three categories of general organizational factors, and ten more questions gathered information on the three categories of organizational factors related to IS practices (see Table 1). We also collected some demographic data on the respondents and their organizations and industries.

Responses were received from 141 IS professionals, representing a response rate of 23.5 percent. Fifteen responses were not usable due to lack of information. The remaining 126 responses were used as the sample for this study, representing an effective response rate of 21 percent. Table 2 shows the characteristics of this sample. The respondents include professionals in IS and other areas, with various ranks. About 69 percent of the respondents are directly involved in the IS area while the remaining 31 percent are either in other functional areas or top management. About 71 percent of the respondents are top or middle managers. This is important because we believe this seniority can enhance the credibility of the data. The organizations represented by the respondents are relatively evenly distributed with respect to industry type, thus we can generalize the findings across various industries. The sample also represents almost equally small organizations (19 percent) with sales less than $100 million, medium organizations (21 percent) with sales between $100 million and $999 million, and large organizations (19 percent) with sales of $1 billion or more. However, the sample distribution by number of employees seems skewed toward small and medium organizations with less than 10,000 employees (82 percent), which should be kept in mind when interpreting the results. Also, as noted earlier, there may be some organizations represented by more than one respondent in the sample and hence, some bias effects on the results. But we believe that our attempt to distribute questionnaires across distinct geographical regions, i.e., states and cities, reduced this potential bias significantly.

The usable 126 responses were classified into one of the two groups: adopters or non-adopters of ES. Adopters include those that are developing ES or are engaged in pilot projects for ES, those that use ES, and those that had used ES but discontinued using them. Non-adopters are those that have no plan to adopt and implement ES and those that are planning to adopt ES. Then, we conducted the Wilcoxon test to see whether or not a significant difference between adopters and non-adopters of ES can be demonstrated across the eighteen ordinal variables. The non-parametric Wilcoxon procedure associated with Mann-Whitney test was employed. The Wilcoxon procedure is distribution-free because it has a desired level of significance for a very large class of underlying distribution. Also, it is designed to be sensitive for testing differences in means between samples. For the two cardinal variables which were not included in the Wilcoxon test, sales and number of employees, multivariate Hotelling's T^2 test was performed to see whether or not there was a difference between adopters and non-adopters of ES.

Table 2. Characteristics of the Sample

Respondent Characteristics

	Top Management (%)	IS Area (%)	Other Functional Areas (%)	Total (%)
Job Title of Respondent:				
President/Owner	11.1			11.1
Senior VP		4.4	2.2	6.6
VP		6.6	4.4	11.0
Director		11.1	4.4	15.5
Manager		22.2	4.4	26.6
Analyst/Engineer		13.3	2.2	15.6
Programmer		4.4		4.4
Others		6.7	2.2	8.9
Total	11.1	68.7	19.8	

Organization Characteristics

	Frequency	Percentage
Industry Type:		
Manufacturing	15	11.9
Retailing	9	7.1
Computer/Communications	6	4.8
IS Training/Consulting/Services	24	19.0
Financial Services	18	14.3
Hospital/Healthcare	12	9.5
Utility	6	4.8
Government	18	14.3
Education	6	4.8
Others	3	2.4
Not available	9	7.1
Sales/Revenue/Budget ($):		
Less than 10 million	7	5.6
10 - 99 million	17	13.5
100 - 999 million	26	20.6
Equal to or more than 1 billion	24	19.1
Not available	52	41.3
Number of Employees:		
Less than 100	17	13.5
100 - 999	35	27.8
1,000 - 9,999	51	40.5
Equal to or more than 10,000	11	8.7
Not available	12	9.5

RESULTS AND DISCUSSION

Status of Expert Systems Adoption in Organizations

Table 3 shows the breakdown of the 126 responses by their organization's status regarding ES adoption. Of the 126 responses, 104 (83 percent) are identified as non-adopters, while only twenty-two (17 percent) are identified as adopters. Of the 104 non-adopters, 102 are not even planning to adopt ES, while only two are planning to adopt ES within a year. Of the twenty-two adopters, fourteen report current use, four report current development, and four report discontinuance of ES. Fourteen of the twenty-two adopters are involved with only one ES, while eight are involved with more than one ES. If we exclude those reporting disuse from adopters, only eighteen (14 percent) remain as adopters. Taken together, these results suggest that ES are not widely adopted in organizations, despite the promises of the technology as a useful managerial tool in decision making. It is interesting to note that the rate of ES adoption in our survey is considerably lower than in other surveys, e.g., [5][30]. As predicted by a majority of artificial intelligence practitioners [9], ES adoption might have waned in recent years. Yet the relatively high rates of ES adoption in other surveys seem due in large part to the makeup of the samples. For example, Byrd [5] surveyed knowledge engineers who are directly involved with ES projects, and Philip and Schultz [30] surveyed readers of *AI Expert* who are presumably very interested in ES technology. Unlike those surveys aimed at ES practitioners or advocates, we surveyed a broad spectrum of IS professionals across organizations and industries, thus, the results could better reflect the current state of ES adoption in the real world.

Table 4 shows the rates of ES adoption by industry type and organization size. While the overall rate of ES adoption is low, there are some variances across industrial sectors. ES adoption is highest (33 percent) in the financial services sector which include insurance, banking and investment. It was followed by manufacturing (27 percent) and IS training/consulting/services (25 percent). These three sectors are also found as major application areas of ES in a comprehensive search of literature on ES applications from 1984 to 1992 [43]. However, ES adoption seems limited in other sectors, particularly in retailing, government and education where no respondent reported adoption. Also, large organizations with sales of $1 billion or more or with 10,000 employees or more are the highest adopters of ES (33 percent and 27 percent, respectively). In comparison, ES adoption is also relatively high in small organizations with less than 100 employees (24 percent). Taken together, the results on organization size are interesting but somewhat ambivalent. Since we categorized the cardinal measures into only three or four ranges, the results might be misled. Instead, the results of multivariate Hotelling's T^2 test on these measures, which are presented below, seem less biased.

The low rate of ES adoption in this survey indicates that there exist some barriers to adopting the technology. Of the 102 responses that report no plan to adopt ES, twenty-five provided some reasons for it in their organizations. The most common reasons reported by them are (some responses provided more than one reason): satisfaction with current work practices (19 responses); lack of knowledge of ES technology (13 responses); lack of people and/or funds necessary to develop ES (9 responses); and lack of people to investigate ES technology (8 responses). We may not generalize these results due to the small number of responses, but they suggest some problems currently faced by organizations regarding ES adoption. Despite the well-publicized benefits and success stories of ES development and implementation, many organizations still do not seem motivated enough to explore the technology, as indicated by their satisfaction with current work practices and lack of knowledge of the technology. The lack of people and funds necessary to investigate and develop ES seems to further inhibit the adoption of the technology. The two main problems previously cited in regards to ES development, i.e., lack of knowledge engineers and high development costs [1][23], appear to still persist. In general, many organizations still do not appear to appreciate the benefits and advantages of ES, due in part to their satisfaction with existing management information systems and decision support systems, and lack of human and financial resources necessary to develop and adopt ES.

Organizational Differences between Adopters and Non-adopters of Expert Systems

Table 5 shows the results of comparative tests for the two groups, adopters and non-adopters of ES. Included are the mean, standard deviation and mean rank for each group, the number of cases in each group, and the observed significance level for each variable. It shows the results of non-parametric Mann-Whitney test for the eighteen ordinal variables and the results of multivariate Hotelling's T^2 test for the two cardinal variables, i.e., total sales and number of employees. A significant difference between adopters and non-adopters of ES is found for fourteen variables, while no significant difference is found for six variables.

Table 3. Breakdown of Responses by Status of Expert Systems Adoption

Status of Expert Systems Adoption	Number of Responses
Non-adopters:	104 (83%)
(1) Not planning to adopt and implement expert systems	102 (81%)
(2) Planning to adopt and implement expert systems	2 (2%)
In less than 1 year	2
In more than 1 year	0
Adopters:	22 (17%)
(3) Developing or being engaged in pilot expert system projects	4 (3%)
One expert system	3
Two to five expert systems	1
(4) Using expert systems	14 (11%)
One expert system	9
Two to five expert systems	3
More than five expert systems	2
(5) Used expert systems before but discontinued	4 (3%)
One expert system	2
Two to five expert systems	2
Total responses:	126

Table 4. Expert Systems Adoption by Industry Type and Organization Size

	Adopters	Non-adopters	Total	Adoption Rate (%)
Industry Type:				
Manufacturing	4	11	15	27
Retailing	0	9	9	0
Computer/Communications	1	5	6	17
IS Training/Consulting/Services	6	18	24	25
Financial Services	6	12	18	33
Hospital/Healthcare	1	11	12	8
Utility	1	5	6	17
Government	0	18	18	0
Education	0	6	6	0
Others	0	3	3	0
Not available	3	6	9	
Total	22	104	126	17
Sales/Revenue/Budget ($):				
Less than 10 million	1	6	7	14
10 - 99 million	2	15	17	12
100 - 999 million	6	20	26	23
Equal to or more than 1 billion	8	16	24	33
Not available	5	47	52	
Total	22	104	126	17
Number of Employees:				
Less than 100	4	13	17	24
100 - 999	5	30	35	14
1,000 - 9,999	9	42	51	18
Equal to or more than 10,000	3	8	11	27
Not available	1	11	12	
Total	22	104	126	17

Table 5. Comparison of Organizational Factors: Adopters vs. Non-Adopters of Expert Systems

Variable	ES Adoption Status	Mean	Standard Deviation	Mean Rank	Cases	Significance
General organizational factors:						
CENT1	Non-adopters	3.5534	1.235	58.88	103	0.0041
	Adopters	4.4091	0.503	82.27	22	
CENT2	Non-adopters	3.0680	1.301	60.19	103	0.0540
	Adopters	3.6818	1.041	76.16	22	
CENT3	Non-adopters	3.5049	1.028	60.08	103	0.0391
	Adopters	4.0000	0.816	76.68	22	
CENT4	Non-adopters	3.2039	1.224	59.18	103	0.0091
	Adopters	3.9091	0.426	80.43	22	
RISK1	Non-adopters	3.2500	1.130	57.88	104	0.0001
	Adopters	4.2727	0.767	90.05	22	
RISK2	Non-adopters	3.8654	1.107	63.51	104	0.9946
	Adopters	4.0000	0.617	63.45	22	
RISK3	Non-adopters	3.1538	1.328	60.37	104	0.0315
	Adopters	3.7727	0.685	78.30	22	
SIZE1	Non-adopters	340593340	1.0131E+10		57	0.1480
	Adopters	195170600	2628100000		17	
SIZE2	Non-adopters	7121	19786		93	0.0630
	Adopters	3196	4901		21	
SIZE3	Non-adopters	3.3571	1.169	60.99	98	0.7375
	Adopters	3.2727	1.202	58.22	22	
IS-related organizational factors:						
ISPL1	Non-adopters	3.3232	1.177	56.84	99	0.0043
	Adopters	4.0909	0.750	79.73	22	
ISPL2	Non-adopters	3.2233	0.959	58.25	103	0.0008
	Adopters	3.9545	0.653	85.25	22	
ISPL3	Non-adopters	3.3592	1.212	58.66	103	0.0027
	Adopters	4.1818	0.664	83.34	22	
ISPL4	Non-adopters	3.3107	0.990	58.05	103	0.0006
	Adopters	4.1364	0.889	86.18	22	
TOPS1	Non-adopters	3.9320	1.231	62.46	103	0.7004
	Adopters	4.2727	0.456	65.55	22	
TOPS2	Non-adopters	3.7670	1.262	61.62	103	0.3303
	Adopters	4.2273	0.429	69.45	22	
TOPS3	Non-adopters	3.1275	1.318	58.20	102	0.0029
	Adopters	4.0455	0.575	82.45	22	
ISDF1	Non-adopters	3.7573	1.052	64.56	103	0.2566
	Adopters	3.5909	0.959	55.68	22	
ISDF2	Non-adopters	3.8155	0.837	60.66	103	0.0893
	Adopters	4.1364	0.468	73.98	22	
ISDF3	Non-adopters	3.3010	1.274	59.66	103	0.0213
	Adopters	4.0000	0.873	78.64	22	

All four variables of centralization display a significant difference between adopters and non-adopters of ES. These results suggest that ES adopters are likely to have a more decentralized decision-making structure than non-adopters. In particular, as indicated by the big difference in mean ranks of CENT1 and CENT4, ES are more likely to be found in organizations where subordinates are encouraged to participate in organizational decision making and decisions on the adoption of new policies than in organizations where they are not encouraged. In such a decentralized decision-making structure, decisions on ES adoption can be made locally and immediately. Furthermore, since continuous involvement of users is essential in ES projects, the decentralized, participative decision-making structure seems more appropriate to adopting ES which have a strong user orientation.

Concerning the risk propensity of top management, a significant difference is found for RISK1 and RISK3 between adopters and non-adopters of ES. These results suggest that top management of ES adopters is likely to be more willing to accept organizational changes resulting from a decision and commit large investments to new IS applications, whereas top management of non-adopters is likely to be reluctant to take these risks. The organization's position regarding financial risks is important to ES activities, because the adoption and subsequent implementation of ES often requires a large investment in capital and time. Also, the organizational risks must be addressed through the changes in organizational methods, procedures, and skills. However, no significant difference is observed for RISK2 between adopters and non-adopters of ES, suggesting that top management's willingness to absorb unfamiliar technology, hardware and software is not associated with ES adoption. As indicated by a wide variety of ES shells and tools currently available for conventional hardware and software platforms (see [37]), ES technology may be already mature at least to the extent that it does not require unfamiliar technology, hardware and software and hence, little technological risk is associated with it.

Concerning organization size, a significant difference is found for SIZE2 between adopters and non-adopters of ES, suggesting that ES adopters are likely to have a larger number of employees than non-adopters. This result may not be generalizable to large organizations with 10,000 employees or more, as they are under-represented (9 percent) in the sample (see Table 2). Yet no significant difference is observed for SIZE2 and SIZE3 between adopters and non-adopters of ES, indicating that both sales and organization size relative to the relevant industry are not associated with ES adoption. The result on SIZE2 also suggests that our previous contention that larger organizations in terms of sales are more likely be ES adopters than smaller organizations (see Table 4), may be misled by categorizing the cardinal measure into several ranges. Taken together, the results on organization size are somewhat conflicting. Although ES adopters tend to have a larger number of employees than non-adopters, the operationalization of organization size as a factor associated with ES adoption appears to have much room for latitude.

A significant difference is found between adopters and non-adopters of ES in all four variables of links between IS and business planning. These results suggest that ES adopters tend to have a higher degree of strategic IS planning than non-adopters. Specifically, ES are more likely to be found in organizations where IS management is actively involved in business planning, IS plans are aligned with the organization's business strategy, top management is actively involved in IS planning, and where there is a continuous assessment of new information technology in IS planning. Gaining a competitive advantage is one of the most important motivations for adopting and implementing ES in organizations, as perceived by knowledge engineers [5]. When ES plans are closely linked with those of the business strategy as a whole, ES have better chances for successful adoption and implementation and hence, competitive advantages.

Concerning top management support for IS, a significant difference is found for TOPS3 between adopters and non-adopters of ES, suggesting that top management's effective communication of its support for IS is associated with ES adoption. But no significant difference is observed for TOPS1 and TOPS2, indicating that top management's encouragement of IS use and consideration of the importance of IS in the organization are not associated with ES adoption. In this regard, top management's consideration and encouragement of ES alone is not likely to have much impact on the adoption of the technology. Instead, when top management support is clearly articulated and effectively communicated to all parts of the organization, it can result in provision of adequate resources such as people, time and funding, and thus have positive effects on ES adoption.

No significant difference is found for ISDF1 between adopters and non-adopters of ES, suggesting that the existing state of IS diffusion within the organization is not associated with ES adoption. But a significant difference is found for both ISDF2 and ISDF3, indicating that deep penetration of IS in terms of importance and impact and extensive sharing of databases for various applications are associated with ES adoption. Diffusion of IS in terms of importance and impact seems more important to ES adoption than just dissemination of IS in absolute terms. Also, organizations that share databases among various applications

are probably more technologically advanced and innovative, and thus they are more likely to adopt new technology like ES. Further, extensive sharing of databases among various applications can provide the data necessary to meet the needs of many ES applications.

CONCLUSION

Using the data from a survey of IS professionals across organizations, we have attempted to examine the current status of ES adoption in organizations and identify important organizational factors which may be associated with ES adoption. The results regarding the status of ES adoption suggest that ES are not widely adopted in organizations, despite the many benefits and successes previously reported in the press and literature. It seems that many organizations merely "talk the talk" of ES implementation, not being motivated enough to adopt the technology themselves. Some reasons for the low adoption of ES may include: satisfaction with current work practices, lack of knowledge of ES technology, and lack of human and financial resources necessary to develop ES. These findings on the status of ES adoption would be useful to those in the field in planning for the future. Also, the results of comparison of adopters and non-adopters of ES suggest that there are some differences in organizational factors between the two groups. Importantly, ES adoption tends to be associated with organizations which have a decentralized decision-making structure and practice strategic IS planning. The findings on organizational factors are well worth trying to understand, as they could provide guidance concerning organizational conditions and practices which are most appropriate to adopting ES. For example, such a guide could be used by IS managers in assessing the appropriateness of their organizations to ES adoption, as well as by vendors of commercial ES products in searching out potential customers. Taken together, the findings of this study are expected to contribute to increasing our understanding of ES adoption in organizations and associated organizational factors.

There are several limitations to this study. First, we have considered only a restricted set of organizational factors in delineating adopters and non-adopters of ES. These organizational factors are certainly not comprehensive, although some of them are found as being associated with ES adoption. Second, there might be multiple responses from same organizations in the sample and hence, some bias effects on the results. But the distribution of questionnaires across distinct geographical regions (i.e., states and cities) is believed to have reduced the potential bias significantly. Third, the results, which are based upon the perceptions of a sample of IS professionals, are subject to the problems related to perceptual studies. If we had targeted managers and users in functional areas, the results might have been different but the response rate might have been much lower. Given the importance of IS professionals' perceptions and attitudes in the decision process of IS adoption, however, this study can provide some meaningful insights into the organizational conditions and practices that may be most associated with ES adoption. Finally, we have not systematically examined any causal relationships between the organizational factors and the adoption status, largely because of the mediating nature of the organizational factors on the adoption. Thus, we may not draw any prescriptive conclusions from this study and the results do not necessarily indicate that the existence of certain organizational conditions and practices would lead to ES adoption. These limitations are certainly not exhaustive but rather important ones. Obviously, these limitations suggest several possibilities for future research.

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