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An Empirical Investigation into Factors Relating to the Adoption of Executive Information Systems: An Analysis of EIS for Collaboration and Decision Support*

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ABSTRACT

This study focuses on the organizational adoption of Executive Information Systems (EIS). A distinction is made between two related, complementary EIS capabilities—EIS for collaboration support (EIS_c) and EIS for decision support (EIS_d). EIS_c is relatively standardized and replicable, while EIS_d has to be developed in situ given the specific characteristics of the user and task. The adoption process is conceptualized as an initial transition from a state of nonadoption to adoption (adoption status) and subsequent internal propagation of the technology (adoption level). Data collected from a national survey are used to test hypotheses between identified contextual variables and the adoption status and adoption level of EIS_c and EIS_d. Adopters and nonadopters of both EIS_c and EIS_d do not differ in their organization size, suggesting that the traditional paradigm of "EIS as a technology for large firms" is no longer true. Environmental uncertainty is found to promote the transition from a state of nonadoption to adoption of both EIS_c and EIS_d while continuing to catalyze the internal propagation of EIS_d. While no differences are observed in IS department size between adopters and nonadopters of EIS_c, our results suggest that larger IS departments provide the resource base to explore the less standardized of the two capabilities, EIS_d. IS support is also found to be critical for the subsequent internal propagation of EIS_d. Furthermore, the adoption level of both EIS_c and EIS_d are found to be promoted by top management support. Implications of these results are discussed for the organizational adoption of EIS.

Subject Areas: Adoption of Innovations, Collaboration Support, Decision Support, and Executive Information Systems.

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INTRODUCTION

Emergent Perspective of EIS

Advances in information technology provide organizations with an opportunity to redesign traditional, and often archaic, work processes. Executive Information Systems (EIS) are a product of these rapid developments in information technology. EIS can be defined as computer-based information systems designed to support the managerial work activities of executives (Elam & Leidner, 1995). In fact, the evolution of EIS has led to a shift in the attributes of these systems and in the support that these systems can potentially offer executives. Table 1 compares the traditional and emergent perspective of EIS along four dimensions.

While traditional EIS supported only a few top executives, the emerging view is that EIS can spread horizontally across and vertically down to other organizational managers (Belcher & Watson, 1993). Thus, the emerging trend is to view EIS "as technology for information delivery to all business end users . . . " (Volonino, Watson, & Robinson, 1995, p. 106). It was also believed that EIS were likely to be developed in the context of large firms (Rockart & DeLong, 1988; Watson, Rainer, & Koh, 1991). The underlying rationale was that EIS were expensive and predominantly resource-rich firms could afford them. Moreover, the complexities of operating larger organizations made them better candidates for EIS. However, EIS vendors now offer products such as Lightship and Paradigm, which are targeted specifically at small and midsized firms. Traditional EIS focused primarily on internal information sources to provide monitoring support through "drill down" applications for top-level executives. Today, EIS allow for convenient access to both internal and external data/information sources (Watson, Watson, Singh, & Holmes, 1995; Rainer & Watson, 1995; Volonino et al., 1995). As a result, while traditional EIS provided limited support (typically in the form of control-oriented information for a handful of top executives), today's EIS incorporate technologies such as electronic mail, voice mail, computer conferencing, electronic calendaring, tickler files, data analysis tools, vertical and horizontal "drill-down," modeling/simulation capabilities, etc., to provide substantial support for executive work. Some researchers have also suggested that as EIS evolve, they are likely to have a significant impact on the organization's planning and control systems (Mitchell, 1988; Fried, 1991; Shoebridge, 1988; Gulden & Ewers, 1989; Rockart & De Long) and lead to higher levels of organizational effectiveness (Paller & Laska, 1990). Recent empirical evidence indicates that EIS can enhance mental models of executives (Vandenbosch & Higgins, 1995) and lead to faster responses in decision situations (Leidner & Elam, 1993).

Objectives and Motivation

Despite touted organizational benefits, few have been successful in developing EIS (Watson et al., 1991). Several explanations have been forwarded for this lack of EIS growth. First, substantial financial resources are needed to develop EIS. It was reported that the "cost of a typical private sector system varies between $1 million to $2 million for the hardware, software tools, and development effort" (Mohan, Holstein, & Adams, 1990, p. 435). However, a recent survey suggests

Table 1: EIS—Traditional and emergent perspectives.

EIS-Related Attributes	Traditional Perspective	Emergent Perspective
1. Users	Few top-level executives	Executives at all levels
2. Organization Size	Large firms	Large and small firms
3. Data/Information Sources	Internal	Internal and external
4. Type of Support	Control	Communication, coordination, control, and planning

that, on average, EIS can cost about $325,000 (Watson et al., 1995). Although, the price of acquiring EIS has decreased over the years, the current tag may well be out of reach for some firms. Second, developers have often found it difficult to identify user requirements since the clientele they are dealing with (i.e., executives) often face uncertain environments (Watson & Frolick, 1993). While several strategies have been suggested to facilitate user information requirements determination for EIS (Wetherbe, 1991), there is little empirical work aimed at understanding EIS adoption patterns.

In lieu of the emerging role of EIS and its increasing penetration among executive and managerial ranks at all levels, it is imperative to understand why EIS are adopted and which attributes facilitate EIS adoption levels in organizations. Some researchers suggest that the decision to adopt an EIS may simply be an outcome of the decision maker's style, decision environment, and the time frame for decision making (Elam & Leidner, 1995). Managers with analytical or directive decision styles and facing greater time pressures are likely to adopt EIS to a greater extent than others. On the other hand, it has been suggested that internal and external pressures often force firms to adopt EIS (Watson et al., 1991). The importance of such internal and external contextual factors in promoting or inhibiting the adoption of information technology has been examined in past studies (Zmud, 1982, 1984a, 1984b; Rai & Patnayakuni, 1996). Thus, contextual factors may be important determinants of EIS adoption.

Our study focuses on the contextual factors that are likely to impact EIS adoption and does not examine EIS from an outcome perspective. Although some contextual attributes of EIS adoption have been explored in case studies (Houdeshel & Watson, 1987; Rees-Evans, 1989; Wallis, 1989; Armstrong, 1990; Fireworker & Zirkel, 1990; Cottrell & Rapley, 1991; Gunter & Frolick, 1991; Joslow, 1991), they represent isolated incidents of varying adoption levels in single firms. While such case studies capture the nuances and details of context, and improve understanding of the forces underlying the phenomenon, they have limited generalizability (Harrigan, 1983). Jenkins (1990) observed that the usefulness of these case studies can only be extended if researchers agree to share frameworks, constructs, variables, and relationships to facilitate comparisons across studies.

The emergent perspective of EIS incorporates two related, complementary, but distinct facets of information technology support. First, collaboration technology is

directed at supporting managerial processes of communication and coordination. We refer to this as EIS for collaboration support (EIS_c). Second, decision support technology is targeted at supporting the informational needs for planning and control. We refer to this as EIS for decision support (EIS_d). This distinction between collaboration support technology and decision support technology has been made in the recent IS literature (Turban, McLean, & Wetherbe, 1996). A similar distinction has also been made in the context of computer-based support for executives (Rockart & DeLong, 1988). Making such a distinction in the case of EIS may result in interesting insights about differences in adoption-related issues pertaining to these two facets of EIS.

Furthermore, organizations may explore EIS and even decide to commit resources at some point in time; the benefits accrued are likely to be enhanced if EIS are adopted to support most executives. The organization innovation and IS adoption literature streams make an important distinction between defining and understanding the transition from a state of nonadoption to initial adoption, and the subsequent propagation of the innovation across the population of potential adopters within a given organization (Zmud, 1982; Rai, 1995). Accordingly, the objectives of this paper are to:

- Profile the current adoption of EIS_c and EIS_d in U.S. organizations,
- Investigate contextual differences between adopters and nonadopters of EIS_c and EIS_d, and
- Investigate the relationships between contextual factors and the adoption levels of EIS_c and EIS_d.

The remainder of our paper is organized as follows. First, we present the theoretical foundations of the study and outline the conceptual framework. Second the research model is presented along with the research hypotheses. Third, we provide the details of our empirical study and statistical analysis. Fourth, we interpret our results and discuss their implications. Finally, we conclude by suggesting some grounds for future research.

THEORETICAL FOUNDATIONS

Dependent Variables: Adoption Status and Adoption Level

Innovation theory has been a popular theoretical basis for researchers investigating the adoption of information technology (IT) in organizations (Zmud, 1982, 1984a, 1984b; Huff & Munro, 1985; Grover, 1993; Grover & Goslar, 1993; Rai, 1995). The process of organization innovation can be defined as the adoption of an internally generated or purchased device, system, policy, program, process, product, or service that is new to the adopting organization (Daft, 1982; Damanpour & Evans, 1984). In general, adopters and nonadopters are differentiated using a binary measure that assesses whether or not any resource commitments have been made towards the innovation. We define an organization as having adopted EIS_c or EIS_d if these systems have been developed and installed for at least one executive. Nonadopters of EIS_c and EIS_d do not support any of their executives with these

systems. The adoption status of EIS_c and EIS_d classifies an organization as either an adopter or nonadopter.

Examining the discontinuity from nonadoption to adoption can provide useful insights about the factors that trigger initial adoption. It is necessary to complement this by understanding why adopter organizations differ in their levels of adoption. Some organizations may have one or a few executives supported by EIS_c and EIS_d capabilities, while other organizations may have a significant majority of their executives supported by these technologies. The level of adoption of EIS_c and EIS_d is defined as the proportion of executives supported by these systems.

Independent Variables: Selection of Contextual Variables

Several variable categories have been proposed to influence organizational adoption of innovations. Based on their synthesis of the past literature, Kwon and Zmud (1987) identified five variable categories that should influence IT innovations. These include user characteristics, environmental characteristics, organizational characteristics, technology characteristics, and task characteristics. We focus specifically on environmental characteristics and organizational characteristics, and include an additional factor called IS characteristics.

Past studies in organizational innovation (Utterback, 1974; Kimberly & Evanisko, 1981), strategic management (Miller & Friesen, 1982), information systems (Lederer & Mendelow, 1990), and diffusion of IT innovations (Grover & Goslar, 1993) emphasized the importance of studying the impact of the environment on key organizational capabilities. Organizations operating in different environments have to manage information of differing natures and complexity. It is conceivable that environmental characteristics create a "pull" for EIS, and we specifically examine the relationship between environmental uncertainty and EIS adoption. The underlying rationale is that uncertain environments are likely to require more effective and efficient management of information. Given the focus of EIS, it could be viewed as more useful by organizations operating in such contexts.

Organizational factors are believed to influence innovations in organizations. Popular variables in this category include centralization, formalization, specialization, information sources, leadership, and organization size. However, conclusive results were most likely obtained only when "researchers extended diffusion theory to account for new factors specific to the IT context under study" (Fichman, 1992, p. 195). We focus on top management support and organization size. Top management support may well be among the critical factors that influences the level of EIS adoption within organizations. Innovation studies have reported a positive association between top management support and innovation behavior observed in organizations (Kimberly & Evanisko, 1981; Meyer & Goes, 1988). Top management support may be important from a resource standpoint. Further, political support from top management can ameliorate resistance from vested interest groups. Similarly, a majority of past studies in innovation suggest that organizational size should positively influence the capability of organizations to adopt innovations. The common rationale provided is that larger organizations typically have "more" resources to absorb the costs associated with the adoption

of innovations. The EIS literature also suggests that larger organizations are more likely to adopt EIS as compared to smaller organizations (Rockart & DeLong, 1988). Therefore, we also examine the relationship between organization size and the level of EIS adoption.

We include an additional category of IS factors that are likely to influence EIS adoption behavior. There is some empirical support that IS factors are critical for the propagation of IT innovations (Grover & Goslar, 1993). The two IS factors considered here include IS support and IS department (ISD) size. Appropriate support from internal sources, such as competent in-house IS staff can accelerate learning processes and rapidly reduce knowledge barriers associated with the deployment of complex information technology innovations (Attewell, 1992). In the context of EIS, IS support can assist in the propagation of EIS (Watson et al., 1995). As in the case of organization size, ISD size may well determine the availability of technical resources that can create a momentum for EIS adoption in organizations.

Thus, we focus on five contextual variables in investigating organizational adoption of EIS. Three of these variables, namely, environmental uncertainty, organization size, and ISD size are proposed to differ between adopters and nonadopters and promote the level of EIS adoption. The remaining two variables, top management support and IS support, are proposed to influence EIS adoption levels.

RESEARCH MODEL AND HYPOTHESES

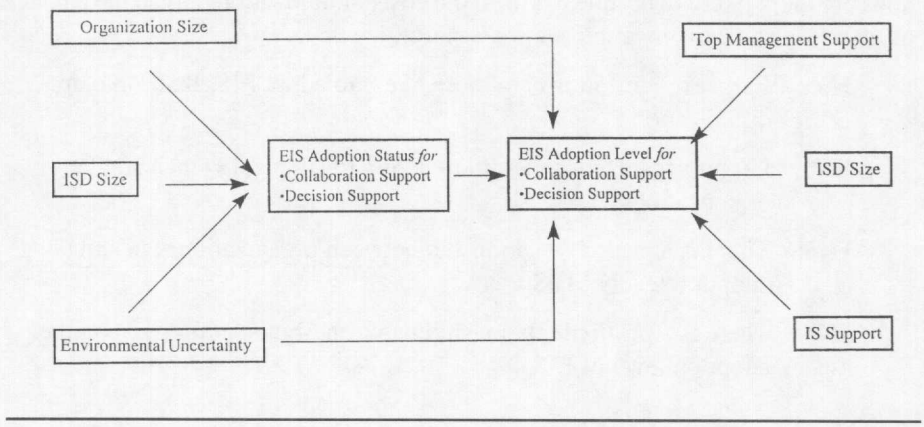
Based upon the above discussion, the research model is shown in Figure 1. The dependent variables are the adoption status and adoption levels of EIS_c and EIS_d. The contextual variables considered include environmental characteristics (uncertainty), organizational characteristics (top management support, organization size), and IS characteristics (IS support and ISD size).

Environmental Uncertainty

Environmental uncertainty exists due to forces in the firm's external environment. Miller and Friesen (1982) identified three external forces that contribute to environmental uncertainty. These include: dynamism, heterogeneity, and hostility. Dynamism refers to the turbulence in an organization's external environment; heterogeneity refers to the complexities in the environment; and hostility refers to the competitive pressures faced by the organization. In one of the earlier efforts to study computer-based information systems for executives, Rockart and Treacy (1982) claimed that computer-based support for executives was increasing because "volatile competitive conditions heighten the desire among top executives for ever more timely information and analysis." Seven years later Gulden and Ewers (1989) noted that EIS were:

> becoming key tools in the executive arsenal. In this era of reorganization, mergers and acquisitions, turbulent markets and increasing competition, managers now more than ever need more effective ways to understand their markets and their competition and guide their operations and their people. (p. 91)

Figure 1: The research model.



Watson et al. (1991) noted that competitive environments, rapidly changing external environments, and the need to be proactive in dealing with the external environment, are among the main reasons for developing EIS. As the researchers suggest, the external pressures for EIS usually come from changing raw material costs, increased competition, and increased regulatory pressures from the government.

Accordingly, we hypothesize that:

H1a: Firms that have adopted EIS_c face a higher level of environmental uncertainty than nonadopters.

H1b: Firms that have adopted EIS_d face a higher level of environmental uncertainty than nonadopters.

H2a: There is a positive relationship between environmental uncertainty and the adoption level of EIS_c.

H2b: There is a positive relationship between environmental uncertainty and the adoption level of EIS_d.

Organizational Characteristics

Organization Size

The effect of organization size on the propagation of IT innovations has produced inconclusive results. Some researchers have suggested that organization size has a positive impact on IS success (Ein-Dor & Segev, 1978; Raymond, 1990). In other instances, no direct relationship has been found between organization size and IS success (Gremillion, 1984; Raymond, 1985). However, for the most part, the EIS literature seems to suggest a positive relationship between organization size and adoption of the technology (Rockart & De Long, 1988; Paller & Laska, 1990). The rationale provided include: (1) larger organizations have more executives, who are spatially dispersed, thereby leading to a greater need for a sophisticated information technology infrastructure for communication and coordination, (2) the complexity

of larger organizations leads to a greater need for information infrastructures that can improve managerial control and planning systems, and (3) larger organizations are more likely to be able to afford the costs of innovation. Given the balance of literature and existing evidence we hypothesize that:

H3a: Larger organizations are more likely to adopt EIS_c than smaller organizations.

H3b: Larger organizations are more likely to adopt EIS_d than smaller organizations.

H4a: There is a positive relationship between organization size and the adoption level of EIS_c.

H4b: There is a positive relationship between organization size and the adoption level of EIS_d.

Top Management Support

Top management support refers to the extent to which EIS efforts are promoted by the top/corporate management of the firm. The importance of top management support for MIS implementation is widely accepted in the literature. As Jarvenpaa and Ives (1991) stated: "Few nostrums have been prescribed so religiously and ignored as regularly as executive support in the development and implementation of management information systems (MIS)" (p. 205).

The importance of top management support for EIS adoption has been voiced by both practitioners and researchers. Major suggestions include locking in support from a politically secure senior executive in the early phases of development, involving senior executives in information requirements specification phases (Rinaldi & Jasterzembski, 1986a, 1986b), and obtaining commitment from a member of the top management who is willing to oversee development activities (Houdeshel & Watson, 1987; Rockart & De Long, 1988). McNamara, Danziger, and Barton (1990) also noted that top management must get involved in EIS efforts to avoid development of unrealistic applications. Thus, we hypothesize that:

H5a: There is a positive relationship between top management support and the adoption level of EIS_c.

H5b: There is a positive relationship between top management support and the adoption level of EIS_d.

IS Characteristics

ISD Size

The relationship between ISD size and adoption of IT innovations has not received much attention among IS researchers. Nevertheless, ISD size is likely to have a significant impact on the adoption of emerging IT innovations. For example, Rai (1995) found that ISD size had a significant impact on the propagation of CASE technology in U.S. organizations. Since large ISDs present more options for organizing innovation efforts by drawing upon their resources and technical skills

(Fuller & Swanson, 1992), they are likely to better support EIS innovation efforts. Therefore, we hypothesize that:

H6a: Organizations with larger ISDs are more likely to adopt EIS_c than organizations with smaller ISDs.

H6b: Organizations with larger ISDs are more likely to adopt EIS_d than organizations with smaller ISDs.

H7a: There is a positive relationship between ISD size and the adoption level of EIS_c.

H7b: There is a positive relationship between ISD size and the adoption level of EIS_d.

IS Support

IS support refers to the extent of involvement of the IS function in an organization's EIS efforts. Rockart and De Long (1988) observed that appropriate IS staff can play an important role in facilitating EIS adoption and suggested that:

> If systems (EIS) are to be used by a broad range of executives and have wide impact on the organization, their chances for success are greater when developed by a mainstream IS team working with a strong operating sponsor. (p. 175)

However, Rockart and De Long also noted that all EIS need not be developed with high involvement from the mainstream IS function of the organization. Others have reported that an increasing number of ISDs are getting involved in the development of EIS by actively communicating the potential benefits of such systems to senior executives (Volonino & Drinkard, 1989). In some organizations, IS personnel are, in fact, taking a lead role in developing EIS for executives (Watson et al., 1991). Involvement of IS personnel in EIS efforts is also critical as important technical expertise is needed for applications development, integration of fragmented and heterogenous databases (Barrow, 1990), and application systems maintenance (Moad, 1988; Fried, 1991). This leads us to hypothesize that:

H8a: There is a positive relationship between IS support and the adoption level of EIS_c.

H8b: There is a positive relationship between IS support and the adoption level of EIS_d.

THE EMPIRICAL STUDY

The Sample

A survey design was adopted for the study and questionnaires were sent to the top computer executives in 1423 randomly selected organizations (*Directory of Top Computer Executives*, 1992). A cover letter explained the purpose of the study, sought cooperation for participation, and requested that the questionnaire be completed by the person most knowledgeable about EIS efforts in the organization. A

follow-up questionnaire along with a reminder letter was mailed two weeks after the initial mailing.

A total of 238 questionnaires were received from 13 key industries in 42 states of the U.S., resulting in a response rate of 16.7%. Of these, 28 were discarded due to insufficient data. Table 2 shows the EIS adoption profile across the industries represented in our sample and Table 3 highlights the respondent position profile and reported status of EIS adoption. A majority of respondents (64%) held top management positions (both IS and corporate combined), 32% were middle managers (both IS and functional management combined), and 4% belonged to lower management levels (IS and functional combined).

Of the 210 usable responses, 140 organizations (66.7%) had not adopted EIS. These respondents were not required to answer questions relating to top management support, IS support, and organizational adoption level, but did provide information on demographic and environmental variables. Seventy organizations (33.3%) had adopted some EIS capabilities to support one or more of their executives.

Response Rate and Nonresponse Bias

A low response rate of 16.7% raises concerns of possible response bias. There can be several reasons for the low response rate in our study. First, the instrument was rather long and some questions required factual responses. Second, EIS are still in the early stages of macro-adoption across the population of potential adopters. Organizations with little or no use for EIS may have found the questionnaire "early" in timing and disregarded it for this reason. Third, the questionnaire may not have been targeted directly to the executives most knowledgeable about EIS efforts, and our request for redirection to such individuals could have resulted in misplaced surveys. Finally, our national survey approach may have lowered the response rate.

To investigate this further, we decided to compare our response rate and sample profile with other EIS studies.Toward this end, six empirical studies were identified (Watson et al, 1991; Watson, Rainer, & Frolick, 1992; Fitzgerald, 1992; Benard & Satir, 1993; Leidner & Elam, 1993; Watson & Frolick, 1993). Even though a selective sampling methodology was adopted for each of these studies, the response rates and adoption profiles of our database are comparable with past studies with the added advantage of being obtained from a large-scale national survey. Furthermore, our sample includes both adopters and nonadopters of EIS.

We also checked for commonly suggested elements of nonresponse bias in our sample. A chi-square test suggested no significant differences between the proportionate makeup of the surveys sent out and those received by industry and regional classification ($\alpha = .05$). A comparison of responses was also conducted between "early" and "late" respondents and no significant differences in the mean values of the study variables were observed between the two groups.

Measurement

The lack of reliable and valid measures is a source of concern with MIS empirical research (Jarvenpaa, Dickson, & DeSanctis, 1984; Straub, 1989; Sethi & King, 1991).

Table 2: Respondent industry profile.

Industry	Total Mailed	Returned (%)	Nonadopters	Adopters: EIS_c or EIS_d
Banking	61	4 (1.9)	3	1
Diversified Finance	43	7 (3.3)	3	4
Education	144	30 (14.3)	23	7
Government				
Federal	63	7 (3.3)	2	5
State	53	8 (3.8)	3	5
Local	95	15 (7.1)	10	5
Health Services	84	14 (6.7)	10	4
Insurance	59	11 (5.2)	5	6
Manufacturing	680	90 (42.9)	66	24
Retail	62	8 (3.8)	6	2
Transport	21	2 (1.0)	1	1
Utilities	41	12 (5.7)	8	4
Others	17	1 (0.5)		1
		1 (0.5)*		1*
Totals	1423	210 (100)	140	70

*One respondent from an EIS-adopting organization did not provide industry information.

Using guidelines suggested by Straub and Sethi and King, a three-phase instrument development process was undertaken. In the first phase, a thorough review of the innovation, IT implementation, and EIS literatures was conducted to identify studies in which similar variables had been theoretically dealt with or operationalized. Where existing measures were not available, a list of items characterizing the variable under investigation was generated using the literature reviewed. Table 4 shows the relevant references from the literature for each of our study variables.

In the second phase, a group interview was conducted with the executive sponsor at a leading computer leasing firm where EIS is used by several executives, and with faculty members actively involved in EIS research. The discussion was semistructured and focused on whether items formulated in the first phase appropriately measured the study variables. Based on the input received, some modifications were made to the instrument.

As part of the third phase, which can be characterized as the pilot study, key members of the EIS development team in six organizations were contacted and asked to participate in an interview. All six agreed and interviews were conducted with these individuals at their respective organization sites. On average, each interview lasted for about an hour. Participants were asked to provide comments on the appropriateness and clarity of questionnaire items. Appropriate changes were made prior to the national mailing. The questionnaire items for each of the multi-item

Table 3: Respondent position profile.

Respondent Position	$N = 207$	Nonadopters	Adopters: EIS_c or EIS_d
IS Top Management (VPs, Directors)	114	78	36
IS Middle Management (Managers)	60	36	24
IS Lower Management (Programmers & Analysts)	6	2	4
Corporate Management (Presidents, CEOs, VPs)	18	15	3
Functional Middle Management (Managers)	7	5	2
Lower Management (Branch managers, etc.)	2	1	1

scales are included in the Appendix. We now describe each of the operational measures used, including a discussion of their reliability and validity.

Dependent Variables

Respondents were asked to indicate the proportion of key executives/managers for whom EIS applications had been developed and installed to support each of the four managerial functions of communication, coordination, control, and planning. The proportion of executives/managers were ordinally anchored on a 5-point scale as follows: 0 (*none*), 1 (*one*), 2 (*few*), 3 (*many*), and 4 (*most*). Popular applications that support each of these functions were included as illustrative examples. Responses to these questions (shown in the Appendix) were used as a basis to compute the scores for each of the dependent variables. Table 5a summarizes the measures for each of the dependent variables.

Adoption Status

Dichotomous measures were defined to classify organizations as adopters and nonadopters of EIS_c and EIS_d . Each organization was assigned scores to represent its adoption status for EIS_c (1 [*adopter*] and 0 [*nonadopter*]) and EIS_d (1 [*adopter*] and 0 [*nonadopter*]). An organization was classified as an adopter of EIS_c if it had installed applications to support communication or coordination functions for at least one of their executives. Similarly, organizations that had installed applications to support control and planning functions for one or more executives were classified as EIS_d adopters.

Adoption Level

Variations in the EIS-adoption level among organizations was captured using two measures. The first measure assessed the adoption level for EIS_c and the second gauged the adoption level for EIS_d. EIS_c adoption level was assessed as the sum of the indicated proportion of executives for whom EIS applications had been developed and installed to support communication and coordination. Similarly, EIS_d adoption level was measured by summing the indicated proportion of executives

Table 4: Relevant references for research model constructs.

Constructs	References
Environmental Uncertainty	Miller and Friesen (1982); Sabherwal and King (1992); Grover and Goslar (1993)
Top Management Support	Garrity (1963); Bean, Neal, Radnor, and Tansik (1975); Vanlommel and De Brabander (1975); Kimberly and Evanisko (1981); Meador, Guyote, and Keen (1984); Sanders and Courtney (1985); Rinaldi and Jasterzembski (1986); Houdeshel and Watson (1987); Meyer and Goes (1988); DeLone (1988); Rockart and De Long (1988); McNamara et al. (1990); Reich and Benbasat (1990); Jarvenpaa and Ives (1991)
IS Support	Rockart and De Long (1988); Moad (1988); Volonino and Drinkard (1989); Paller and Laska (1990); Barrow (1990); Watson et al. (1991); Fried (1991)
Organization Size	Utterback (1974); Ein-Dor and Segev (1978); Kimberly and Evanisko (1981); Gremillion (1984); Raymond (1985, 1990); Rockart and De Long (1988); Meyer and Goes (1988); Paller and Laska (1990); Watson et al. (1991)
ISD Size	Fuller and Swanson (1992); Rai (1995)

for whom EIS applications had been developed and installed to support control and planning.

A factor analysis of EIS adoption levels for each of the four managerial functions resulted in a two-factor solution (Table 5b). EIS adoption levels for managerial communication and coordination loaded on one factor, while EIS adoption levels for managerial control and planning loaded on the second factor. This two-factor solution corroborates our conceptual distinction between EIS for collaboration support (Factor 1) and EIS for decision support (Factor 2).

Independent Variables

Environmental Uncertainty

Miller and Friesen's (1982) view of an organization's external environment properties was adopted to measure environmental uncertainty. Specifically, dynamism, heterogeneity, and hostility of an organization's environment were assessed using a total of 14 items. As all respondents provided information on environmental uncertainty, 210 observations were used to validate the factor structure of these items. Nunnally (1978) suggested that items should be dropped if they exhibit low item-total correlations as these items reduce the internal consistency of the measurement scale. Three items had low item-total correlations and were accordingly dropped from further analysis. One item was part of the dynamism scale, while the other two items were part of the hostility scale.

Stewart (1981) suggested that Bartlett's test of sphericity and the Kaiser-Meyer-Olin measure of sampling adequacy (MSA) should be examined to assess

Table 5: Definition and measures of EIS adoption.

a. Measures of EIS adoption.

	EIS for Collaboration Support	EIS for Decision Support
Adoption Status	Dichotomous measure. Organizations that had developed and installed EIS applications to support communication or coordination for one or more executives classified as adopters. The others are classified as nonadopters.	Dichotomous measure. Organizations that had developed and installed EIS applications to support control or planning for one or more executives classified as adopters. The others are classified as nonadopters.
Adoption Level	Ordinal measure with a range of 2-10. Sum of the indicated proportion of executives for whom EIS applications had been developed and installed to support communication and coordination.	Ordinal measure with a range of 2-10. Sum of the indicated proportion of executives for whom EIS applications had been developed and installed to support control and planning.

b. Factor analysis results of EIS adoption level.

Factors and Items ($N = 70$)	Loadings
Factor 1: Adoption Level of EIS for Collaboration Support (Eigenvalue = 1.71)	
1. Applications supporting communications	.85
2. Applications supporting coordination	.83
Factor 2: Adoption Level of EIS for Decision Support (Eigenvalue = 1.14)	
1. Applications supporting control	.86
2. Applications supporting planning	.79

whether or not a set of variables are appropriate for factor analysis. Bartlett's test assesses whether the correlation matrix comes from a population of variables that are independent. As expected, the null hypothesis of variable independence for the 11 items was rejected at a level of significance of .000. MSA provides a measure of the extent to which variables belong together. Kaiser and Rice (1974) provided a calibration of the MSA measure, and they classified a value of .90+ as "marvelous" and .80+ as "meritorious." Our MSA measure was .884 and suggested that the 11 items were appropriate for factor analysis.

A principal component factor analysis followed by a varimax rotation was conducted on the 11 items. This resulted in the expected three-factor structure (Table 6a) suggested by Miller and Friesen (1982) and recently validated by Sabherwal and King (1992) and Grover and Goslar (1993). A second-order factor analysis was conducted using the item means for the dynamism, hostility, and heterogeneity scales, and the expected one-factor solution representing environmental uncertainty was obtained (Table 6b). This factor captures approximately 70% of the total variance represented by the three items. The

Table 6: Factor analysis result of external environment uncertainty.

a. First-order factor analysis.

Factors and Items (N = 199)	Loadings
Factor 1: Environment Dynamism (Eigenvalue = 5.02)	
1. Changes in marketing practices	.70
2. Rate of product/service obsolescence	.66
3. Prediction of competitor actions	.60
4. Prediction of demand and consumer tastes	.74
5. Changes in product/service technology	.71
Factor 2: Environment Heterogeneity (Eigenvalue = 1.07)	
Differences among product/services due to:	
1. Customer buying habits	.84
2. Nature of competition	.82
3. Market dynamism and uncertainty	.74
Factor 3: Environment Hostility (Eigenvalue = 1.01)	
Threat of survival due to:	
1. Tough price competition	.68
2. Competition in product quality	.76
3. Dwindling markets for products	.71

b. Second-order factor analysis.

Factors and Items (N = 199)	Loadings
Factor 1: Environmental Uncertainty (Eigenvalue = 2.12)	
1. Environment Dynamism	.85
2. Environment Heterogeneity	.85
3. Environment Hostility	.82

Cronbach's alpha measure for internal consistency was computed to be .78 for environmental uncertainty.

Top Management Support

The three-phase instrument development process yielded a six-item measure for top management support. A 7-point Likert type scale, ranging from *strongly disagree* to *strongly agree*, was used for each of these items. Bartlett's test for sphericity led to a rejection of the null hypothesis of variable independence at a level of significance of .000. The measure of sampling adequacy was computed to be .79 and suggested that the items were appropriate for factor analysis. Principal component factor analysis resulted in a one-factor solution that explained 61% of the total variance represented by the six items (see Table 7).

The item-total correlations indicated no sudden drops providing evidence of homogeneity among the items and a Cronbach's alpha value of .87 reveals a high level of internal consistency among the measurement items.

Table 7: Factor analysis of top management support and IS support variables.

Factor and Items	Loadings
Top Management Support (Eigenvalue = 3.6645, $N = 68$)	
1. Executive sponsor(s) participation in EIS development	.7385
2. Top management contact with sponsor on EIS-related issues	.8019
3. Resource support for EIS	.7340
4. Top management perception of importance of EIS	.8209
5. Top management's constructive feedback on EIS application	.7881
6. EIS regarded as high priority by top management	.8015
IS Management Support (Eigenvalue = 3.8696, $N = 65$)	
1. IS executive participation in EIS development	.7647
2. IS cooperation in identifying data sources	.8535
3. IS cooperation in resolving technical problems	.9203
4. IS accept accountability for EIS	.6621
5. Communication between IS and top management on role of EIS	.8154
6. High IS involved in development	.7786

Organization Size

The number of employees was used as a measure of organization size. This measure has been used in other studies on organizational innovation (Kimberley & Evanisko, 1981; Meyer & Goes, 1988) and IS innovation (Zmud, 1982; Rai, 1995). Given large variations in organization size and consistent with previous studies, the z scores of the natural logarithm of organization size were computed and used in subsequent analysis.

ISD Size

One objective item was used to assess the number of full-time employees as a measure of ISD size. Similar measures have been used by Nilakanta and Scamell (1990), Fuller and Swanson (1992), and Rai (1995). As with organization size, the z scores of the natural logarithm of ISD size were computed and used in subsequent analysis.

IS Support

The three-phase instrument development process yielded a six-item measure for IS support. As with top management support, a 7-point Likert type scale that ranged from *strongly disagree* to *strongly agree* was used for each of the items. Bartlett's test for sphericity led to a rejection of the null hypothesis of variable independence at a level of significance of .000. The measure of sampling adequacy was computed to be .85 and suggested that the items were appropriate for factor analysis. Principal component factor analysis resulted in a one-factor solution that explained 64.5% of the total variance represented by the six items (see Table 7). There were no sudden drops in the item-total correlations and a Cronbach's alpha

value of .89 suggests a high level of internal consistency among measurement items.

Summary of Psychometric Properties

Venkatraman and Grant (1986) recommended that survey instruments used for research should use scales (1) with multiple, higher level items rather than single, nominal items, (2) that are internally consistent, and (3) that are valid. The measures for environmental characteristics were adopted from previous research, while the measures for top management support for EIS and IS support were developed for this study. Interviews with practicing senior managers and the subsequent pretest ensured the appropriateness of measurement items employed for each of the variables. Factor analysis of measurement items resulted in expected factor structures providing evidence of measurement validity. The intercorrelations between independent variables and their reliability values are summarized in Table 8.

ANALYSIS AND RESULTS

Differences between Adopters and Nonadopters

Table 9 presents some demographic data about respondents. Fifty-nine organizations had adopted EIS_c for one or more of their executives, while 54 organizations had adopted EIS_d. Analysis of variance was used to test hypothesized differences in the mean values for environmental uncertainty across adopter and nonadopter groups for both EIS_c and EIS_d. Given the low correlation between organization size and environmental uncertainty and no significant correlation between ISD size and environmental uncertainty, it was appropriate to use ANOVA as opposed to MANOVA. The results of the ANOVA tests summarized in Table 10 provide strong support for differences in environmental uncertainty between adopters and nonadopters, suggesting that organizations that have adopted EIS_c or EIS_d face higher levels of environmental uncertainty than their nonadopting counterparts. The risk of a Type I error is .031 for differences in environmental uncertainty between adopters and nonadopters of EIS_c and .02 for EIS_d.

The bivariate correlation matrix (see Table 8) shows a moderate correlation between organization size and ISD size. We would have liked ideally to use MANOVA to examine differences in size-related variables between adopting and nonadopting organizations. However, missing data on one variable leads to a loss of the entire case. We did not consider it appropriate to use approaches such as mean substitution for missing data as these approaches are typically less conservative. While 53 and 40 organizations had missing values for organization size and ISD size, respectively, 80 organizations had missing data on at least one of these variables. Given the nature of this missing data, we would have faced significant sample attrition if we decided to proceed with the use of MANOVA. Accordingly, ANOVA was used to test size-related differences between adopters and nonadopters of EIS_c and EIS_d.

The mean differences in organization size and ISD size between adopters and nonadopters, as detected by ANOVA analysis and directional *t* tests, are also

Table 8: Descriptive statistics and intercorrelations.

Independent Variables	*n*	Mean	*SD*	Standard Alpha	Environmental Uncertainty	Natural Logarithm Organization Size	Natural Logarithm ISD Size	Top Management Support	IS Support
Environmental Uncertainty	201	15.17	4.16	.78	1.00				
Organization Size (Employees)	157	5482	172267						
Natural Log of Organization Size	157	7.01	1.75		.21*	1.00			
ISD Size (Employees)	172	53.06	75.51						
Natural Log of ISD Size	170	3.26	1.22			.41**	1.00		
Top Management Support	65	27.17	8.84	.87				1.00	
IS Support	65	32.65	8.01	.89			-.27*	.41**	1.00

*$p<.10$ (two-tailed levels of significance)
**$p<.05$

Table 9: Sample profile—Adopters and nonadopters.

	Applications Developed and Installed		
Type of EIS Support	No	Yes	Missing
EIS_c (Collaboration Support)	145	59	6
EIS_d (Decision Support)	151	54	5

Table 10: Mean comparisons between adopters and nonadopters.

	Adopters vs Nonadopters of EIS for Collaboration Support			Adopters vs Nonadopters of EIS for Decision Support		
	F	*p**	*n*	*F*	*p*	*n*
Environment Uncertainty	3.52	.031	204	9.97	.002	205
Natural Log of ISD Size	1.85	.085	165	4.26	.020	165
Natural Log of Firm Size	.05	.415	152	.24	.313	153

*As we have developed directional hypotheses, the reported significance values are for one-tailed, directional *t* tests.

summarized in Table 10. Organization size was not found to significantly differ between adopters and nonadopters for either EIS_c or EIS_d. While ISD size was not found to significantly differ between adopters and nonadopters of EIS_c, significant differences were observed between adopters and nonadopters of EIS_d. Organizations adopting EIS_d were found to have significantly larger ISDs than nonadopting organizations.

Relationships between Contextual Variables and Adoption Level

The measures of adoption level for EIS_c and EIS_d assess the proportion of executives who have been provided collaboration support and decision support capabilities. These measures are designed to assess the degree of propagation of these technologies within organizations classified as having "adopted" them. Table 11 shows that the mean adoption level for EIS_c is significantly higher than that for EIS_d, providing evidence that the propagation of EIS_d may be facing greater challenges, and possibly different challenges than the propagation of EIS_c.

Table 12 summarizes the bivariate correlations between the adoption levels of EIS_c and EIS_d and each of the contextual variables. Three of the independent variables (environmental uncertainty, top management support, and IS organization support) correlated significantly with the adoption level of EIS_c. All five contextual variables correlated significantly with the adoption level of EIS_d.

Multiple regression analyses were used to test the hypotheses associating the contextual variables with the adoption levels of EISc and EISd. As discussed earlier, missing data constrained us from including organization size and ISD size as part of the regression models. For each of the two regression analyses, violations of linearity, normality, and homoscedasticity were carefully examined. Standardized

Table 11: Sample profile: Level of adoption.

	Descriptive Statistics				
Type of EIS Support	Range	Mean	*SD*	Min	Max
EIS_c (Collaboration Support) [*n*=59]	1-8	5.83	1.90	2	8
EIS_d (Decision Support) [*n*=54]	1-8	4.13	1.83	1	8

Table 12: Zero-order correlations: Independent with dependent variables.

	EIS Adoption Level:			
Independent Variables	(Collaboration Support)		(Decision Support)	
Environment Uncertainty	.19*	(59)	.27**	(54)
Natural Log of Organization Size	n.s.	(46)	.28**	(43)
Natural Log of ISD Size	n.s.	(45)	.33**	(42)
Top Management Support	.29**	(58)	.22**	(53)
IS Support	.25**	(58)	.17*	(53)

*$p \leq .10$
**$p \leq .05$
n = Numbers in parentheses

residuals plots and case-wise outlier statistics (Mahalonobis distance, Cook's D, and leverage) suggested that some observations were leading to significant violations of these assumptions. Accordingly, problematic observations were deleted and the remainder of the sample closely met the required assumptions for regression analysis. In the regression analyses for both EIS_c and EIS_d, there were adequate observations as both models have three independent variables.

Table 13a summarizes the results of the regression analysis between adoption level of EIS_c and environmental uncertainty, top management support, and IS support. The overall model is found to be significant with a low risk of a Type I error (p= .0003). An adjusted *R*-square of 29% suggests that variations in levels of adoption of EIS_c are substantially explained by the model. Interestingly, top management support is the only independent variable that emerges as significant. The regression results provide strong support for the importance of top management support in propagating the level of EIS_c adoption within an organization.

Table 13b summarizes the results of the regression analysis between adoption level of EIS_d and environmental uncertainty, top management support, and IS support. The overall model is again found to be significant with a low risk of a Type I error (p=.0004). The model has an adjusted *R*-square of 34% suggesting that variations in levels of adoption of EIS_d are substantially explained by the three independent variables. All three independent variables emerge as highly significant.

The regression analyses support the hypotheses associating top management support with the adoption level of EIS_c and EIS_d. Our analyses also supported the hypotheses associating environmental uncertainty and IS support with the adoption

Table 13: Regression analysis results.

a. Adoption level of EIS_c.

	d.f.	Sum of Squares	Mean Square
Regression	3	39.12	13.04
Residual	46	78.10	1.70

$F = 7.68$ Significance of $F = 0.0003$

Independent Variables	Standardized Beta	*T*	$p <$
Environment Uncertainty	.12	.93	.18
Top Management Support	.53	4.02	.00
IS Support	.04	.32	.37

R-Square: 0.33 Adjusted *R*-Square = 0.29

b: Adoption level of EIS_d.

	d.f.	Sum of Squares	Mean Square
Regression	3	40.79	13.60
Residual	37	63.99	1.73

$F = 7.86$ Significance of $F = 0.0004$

Independent Variables	Standardized Beta	*T*	$p <$
Environment Uncertainty	.40	3.09	.002
Top Management Support	.28	2.04	.024
IS Support	.29	2.14	.020

R-Square: 0.39 Adjusted *R*-Square = 0.34

level of EIS_d. However, the hypotheses associating environmental uncertainty and IS support with the adoption level of EIS_c are not supported.

Although size-related hypotheses could not be included in the regression analyses due to reasons mentioned earlier, the bivariate correlations between the independent variables and adoption levels of EIS_c and EIS_d (see Table 12) indicate that both organization size and ISD size correlated significantly with level of adoption of EIS_d. Thus, there is support for hypotheses associating organization size and ISD size with level of adoption of EIS_d and no support for hypotheses associating organization size and ISD size with level of adoption of EIS_c. As we did not include the size-related variables in the multiple regression analyses, we do not assess whether ISD size and organization size are significantly related to adoption level of EIS_d in the presence of other contextual variables

Statistical Interpretation of Insignificant Results

Cohen (1988) noted a broadly prevalent problem in the application of classical statistical inference by researchers in many fields. The lack of significance is often interpreted as lack of any effect and the researcher springs into a trap of de facto

sustaining the null hypotheses. Baroudi and Orlikowski (1989) forcefully reiterated this in the context of MIS research and pointed out that most empirical studies in the field have made similar erroneous conclusions. In addition to the probability of a false positive (a Type I error), it is important to guard against false negatives or the probability of a Type II error.

Given that statistical analysis for large effects is purely a process of "statistical sanctification" (Cohen, 1988), we examined the power of our insignificant results under assumptions of small and medium effects. The same standards of small and medium effect sizes suggested by Cohen and used by Baroudi and Orlikowski (1989) to evaluate the power of MIS empirical research were adopted.

Since we are dealing with unequal samples, the harmonic mean was used as the effective sample size in power computations for the insignificant ANOVA results. The level of significance was fixed at .10 for these directional tests. Our values for power, under assumptions of small or medium effects, compare favorably with those compiled and reported by Baroudi and Orlikowski (1989). The mean of organization size was insignificant between adopters and nonadopters of both EIS_c and EIS_d. ISD size was insignificant between adopters and nonadopters of EIS_c. These three tests have high power levels (> .80) at the .4 and .5 effect size levels. While we cannot state that adopters and nonadopters do not differ in these aspects, we are in a position to state that if size differences do exist between these groups, they are, in fact, small.

Correlation analyses were used to assess the relationships between ISD size and organization size with the adoption levels of EIS_c and EIS_d. No significant correlations were detected between either of the size variables and the adoption level of EIS_c. The power of these two tests have high values ranging from .67 for a medium effect size (.3) to .98 for a large effect size (.5). Here again, we are in a position to state that if the two size-related variables correlate with the adoption level of EIS_c, the strength of these associations are, in fact, very small.

Only top management support was found to be significant in the regression model associating the contextual variables and adoption level of EIS_c. Accordingly, we assessed the power of the F test which compared the variation in EIS_c explained uniquely by environmental uncertainty and IS support relative to top management support. Essentially, we partialed out the variance in the adoption level of EIS_c explained by top management support and then assessed the additional variance in adoption level of EIS_c explained by environmental uncertainty and IS support. The power of the test rejecting additional variance explanation by IS support and environmental uncertainty is greater than .95 when the risk of a Type I error is fixed at .05.

DISCUSSION

Based on a review of the literature, we observed that there were two different facets of EIS support, and accordingly, it was considered useful to make a distinction between EIS applications targeted at providing collaboration support (EIS_c) and decision support (EIS_d). This section is organized to address the three objectives of the study. First, we focus on the current adoption profile of EIS_c and EIS_d in U.S. organizations. Second, we focus on the differences in environmental, organizational,

and IS factors between adopters and nonadopters of EIS_c and EIS_d. Third, we discuss the relationships between environmental, organizational, and IS factors and the levels of adoption of EIS_c and EIS_d.

Adoption Profile

Our results suggest that EIS have not been widely adopted. Overall, only a third of our sample had adopted either EIS_c or EIS_d. Fifty-nine firms had adopted EIS_c while 54 firms had adopted EIS_d to support at least one of their executives. Our analysis suggests that the adoption levels of EIS applications vary significantly, with EIS_c being more widely adopted than EIS_d. Determining the information requirements for managerial decision making is complex and difficult to identify. Rapley (1993) observed that current EIS efforts in organizations may not be based on an understanding of the complex information needs of executives. Developments in technology and development approaches should better align the capabilities of EIS_d systems with the information characteristics of managerial decision-making environments.

Differences between Adopters and Nonadopters

Table 14 shows the summary of results and the hypotheses that were supported by our statistical analyses. Strong support was found for hypotheses (H1a and H2a) relating increases in environmental uncertainty with the transition from a state of nonadoption to one of adoption for both EIS_c and EIS_d. Environmental uncertainty increases the velocity, variety, and intensity of information that organizations, including executives, need to process. Thus, organizations in more uncertain environments are more likely to face a greater "pull" for EIS, because it could be viewed as a possible means to enhance the information-processing capabilities of their executives.

H3a and H3b were not supported as no significant differences in firm size were detected between adopters and nonadopters of either EIS_c or EIS_d. The traditional notion that EIS were suitable for large firms seems to be waning. Clearly, the evolution of EIS from a control-oriented technology to one that encompasses collaboration and decision support capabilities makes the technology a viable option for large, midsized, and small organizations. The emergence of relatively inexpensive products have made EIS more accessible to smaller firms.

While no significant differences were detected in ISD size between adopters and nonadopters of EIS_c, adopters of EIS_d had larger ISD size than nonadopters. Thus, hypothesis H6a is not supported, while H6b is supported. Why is it that significant differences were detected between adopters and nonadopters of EIS_d but not between adopters and nonadopters of EIS_c? We suggest that EIS_d is likely to require intensive IS resources for requirements determination, data integration from disparate, functional databases, systems development, enhancement and maintenance. The technology for EIS_c is relatively standardized, and minimal in situ development of the technology needs to be undertaken.

Table 14: Summary of statistical analyses.

	Mean Comparisons Between Adopters and Nonadopters		Correlation Analyses*** Level of Adoption		Regression Analyses Level of Adoption	
	EIS_c	EIS_d	EIS_c	EIS_d	EIS_c [Adj. R^2=.29]	EIS_d [Adj. R^2=.34]
Environment Uncertainty	H1a**	H1b**	*	**	H2a (n.s.)	H2b**
Organization Size	H3a (n.s.)	H3b (n.s.)	H4a (n.s.)	H4b**	Missing Data—Variables not included in regression analyses	
ISD Size	H6a*	H6b**	H7a (n.s.)	H7b**		
Top Management Support	N/A		**	**	H5a**	H5b**
IS Support			**	*	H8a (n.s.)	H8b**

n.s. = not significant
*$p \leq .10$
**$p \leq .05$
***We use correlation analyses to assess the relationships between size-related variables and adoption levels of EIS_c and EIS_d. Due to the nature of missing data, these variables were not included in the multiple regression analyses.

Level of EIS Adoption

Our analysis suggests a significant relationship between environmental uncertainty and the level of adoption of EIS_d, but not with the adoption level of EIS_c, thereby providing support for H2b and no support for H2a. Thus, environmental uncertainty provides the impetus to shift from a state of nonadoption to adoption for both EIS_c and EIS_d, and promotes the propagation of EIS_d though the organization. It appears that organizations operating in uncertain environments will provide (or will be demanded by their executives to provide!) EIS_d capabilities to a larger number of their executives so as to improve their access to timely and accurate information. Information search tools incorporated in an EIS can alert executives to specific situations, and by identifying patterns of activities, executives can be better supported to respond to changing conditions in the environment.

Significant relationships between top management support and level of adoption of EIS_c and EIS_d were detected, thereby supporting H5a and H5b. The literature strongly supports the notion that top management support is critical for successful EIS efforts (Rinaldi & Jasterzembski, 1986a, 1986b; Houdeshel & Watson, 1987; Rockart & De Long, 1988). As noted by Rainer and Watson (1995): "The most important variables affecting the (EIS) development process are those that the executives provide through their leadership and continued involvement in the development process" (p. 97). EIS_c capabilities help executives to better communicate with stakeholders and coordinate their activities with others. EIS_d capabilities allow executives to aggregate and disaggregate information, explore relationships between different operational variables, and present information in meaningful formats. Such capabilities can assist executives to enhance their mental models of their organization's activities. It is not very surprising, therefore, that EIS efforts strongly supported by top management will lead to higher levels of organizational adoption.

Our regression analyses suggest that IS support is positively related to the adoption level of EIS_d but not EIS_c. Thus, H8b was supported while H8a was not supported. The relative standardization of collaboration technologies may make it easier to spread across executives in comparison with applications targeted at supporting decision processes of executives. Decisional information needs vary significantly across an organization. This leads to significant variations in the data sources, internal and external, that need to be integrated, models that need to be developed, and user interface characteristics that need to be provided. Each application has to be tailored to a great extent to the executive and the decision at hand. This clearly calls for significant IS support to spread these systems across the cadre of executives at all levels.

CONCLUSIONS

Can executives actually receive effective support from EIS? The nature of their information-processing tasks marks one important structural aspect of higher levels of management (Rai, Stubbart, & Paper, 1994). As organizations get larger and more diversified, the complexity of information that managers need to deal with

increases as well. Similarly, as an organization's environmental uncertainty increases, so does the variety, complexity, and ambiguity of executive information. Today, both large and small firms face increasing levels of environmental uncertainty. These factors clearly create a need for a technology that can be used to better manage executive information. This is prompting organizations, large and small, to explore EIS to support the informational needs of their executives.

The need for improvements in executive information management is further enhanced by one long-standing, but often overlooked factor. The basic constraints of human cognition apply to executives as well. While the need for information-processing support seems apparent, the low level of EIS adoption suggests a lack of enthusiasm among organizations to invest in present technology. A significant majority of surveyed organizations have not installed EIS support for either collaboration or decision making for even one of their executives. Furthermore, those that have started the adoption process have not progressed very far in spreading the technology across their executives. However, the relative spread of EIS_c is greater than that of EIS_d in these organizations.

Enhancing collaboration support requires developing a technology infrastructure that increases the "reach" of executives. With such capability, executives can distribute information and interact with others, possibly in real time, even if they are geographically dispersed. It is evident that the need to establish such an information technology infrastructure is also driven by the uncertainties in the firm's external environment. Turbulent environments create a need to communicate more effectively and to better coordinate organizational activities. However, once initiated, the critical issue for the internal spread of such systems appears to be top management support. Providing resource support and designing and implementing corporate policies such as the use of electronic messaging systems, scheduling systems, and document management systems may propagate the internal spread of these systems. Furthermore, the advent of value-added networks and collaboration software environments are making the development of such infrastructures less of an "internal" IS development issue.

EIS applications targeted at providing decision support have been adopted to relatively lower levels than applications providing collaboration support. Traditional EIS applications have focused on monitoring critical business activities. The information delivered was typically internal and well structured. The dominant logical challenge is to identify and provide relevant information to support executive decisional roles. Information supporting executive decision making tends to be unstructured, and includes information from both internal and external sources. The challenge rests not in merely providing access to these sources, but in actually integrating and transforming data, and presenting information in a suitable form for executive decision making. Providing decision support to executives requires a detailed understanding of their information requirements in specific problem situations. Questions such as "Have we identified information that will build, challenge, or reinforce executive mental models in specific problem-solving situations?" need to be posed during application development and evolution. Recent empirical evidence suggests that competitive advantage can be achieved if EIS can build the mental models of executives (Vandenbosch & Higgins, 1995).

The IS organization and its data administration function can face a formidable task in semantically and technologically integrating fragmented databases. It is incumbent on executives to provide necessary political and resource support. They can also significantly influence the quality of EIS by participating in requirements determination and providing feedback on the appropriateness of information content delivered and the form of delivery.

Given the current state of EIS adoption, can emerging technologies help promote the growth of EIS in U.S. organizations? The picture appears promising. Emerging information technologies have the capabilities to expand the "reach" of EIS applications providing collaborative support. The advent of wireless LANs, cellular technologies, multimedia, and notebook computers, coupled with dropping hardware prices, has enhanced the portability of EIS applications in the workplace (Volonino et al., 1995). The barriers of physical boundaries to accessing data, sharing information, and enhancing collaboration are being systematically ameliorated. As noted by these researchers: "Mobile technologies eliminate the common acceptance barrier that exists when information delivery is limited to the desktop from which executives are often trying to break away" (p.112).

Similarly, advances in large-scale textual databases, data and information warehouses, data analysis and reporting tools (DARTs), knowledge-based systems, and group support systems individually, but even more so collectively, represent significant promise for EIS. For example, multiple expert systems can be integrated and interfaced with EIS to improve environmental scanning and provide intelligent support in problem identification and decision making (Chi & Turban, 1995). At the same time, group support system capabilities incorporated into EIS can promote greater collaboration between executives.

While EIS capabilities are likely to be greatly enhanced by emerging technologies, the organizational and IS context necessary to introduce and assimilate EIS applications is critical. Environmental factors do influence the introduction of EIS capabilities in organizations. More volatile information environments provide a catalyst for exploring EIS. Such environments also catalyze the spread of EIS among executives for decision support, all of whom are conceivably trying to make better decisions in complex information environments. It also appears that organizations of all sizes, small and large, will need to focus on improving information management for their executives.

A firm arguably has little control over its environment. However, there are factors that a firm has some control over. These include ISD size, IS support, and top management support. Given the relative standardization of collaboration support capabilities, it appears that internal IS resources are unlikely to play a critical role in determining whether or not they are explored. On the other hand, availability of internal IS resources is more likely to enable exploration of EIS for decision support. IS support is also critical in propagating the adoption level of such systems across executive and problem contexts. Furthermore, top management support is of paramount importance in internally propagating both types of EIS capabilities examined here. [Received: May 8, 1996. Accepted: March 6, 1997.]

REFERENCES

Armstrong, D. A. (1990). How Rockwell launched its EIS. *Datamation*, *36*(5), 69-72.

Attewell. P. (1992). Technology diffusion and organizational learning: The case of business computing. *Organization Science*, *3*(1), 1-19.

Baroudi, J. J., & Orlikowski, W. (1989). The power of statistical power in MIS research. *MIS Quarterly*, *13*(1), 87-106.

Barrow, C. (1990). Implementing an executive information system: Seven steps for success. *Journal of Information Systems Management*, *7*(2), 41-46.

Bean, A. S., Neal, R. D., Radnor, M., & Tansik, D. A. (1975). Structural and behavioral correlates of implementation in U.S. business organizations. In R. L. Schultz & D. P. Slevin, (Eds.), *Implementing operations research/ management science*. New York: Elsevier North-Holland, 77-132.

Belcher, L. W., & Watson, H. J. (1993). Assessing the value of Conoco's EIS. *MIS Quarterly*, *17*(3), 239-253.

Benard, R., & Satir, A. (1993). User satisfaction with EISs: Meeting the needs of executive users. *Information Systems Management*, *10*(4), 21-29.

Chi, R. T., & Turban, E. (1995). Distributed intelligent executive information systems. *Decision Support Systems, 14*(2), 117-130.

Cohen, J. (1988). *Statistical power for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cottrell, N., & Rapley, K. (1991). Factors critical to the success of executive information systems in British Airways. *European Journal of Information Systems*, *1*(1), 65-71.

Daft, R. L. (1982). Bureaucratic versus nonbureaucratic structure and the process of innovation and change. *Research in the Sociology of Organizations*, *1*, JAI Press, Inc.

Damanpour, F., & Evans, W. M. (1984). Organizational innovation and performance: The problem of organizational lag. *Administrative Science Quarterly*, *29*(3), 392-409.

DeLone, W. H. (1988). Determinants of success for computer usage in small business. *MIS Quarterly*, *12*(1), 51-61.

Directory of top computer executives. (1992). Phoenix, AZ: Applied Computer Research, Inc.

Ein-Dor, P., & Segev, E. (1978). Organizational context and the success of management information systems. *Management Science*, *24*(10), 1064-1077.

Elam, J. J., & Leidner, D. G. (1995). EIS adoption, use, and impact: The executive perspective. *Decision Support Systems*, *14*(2), 89-103.

Fichman, G. R. (1992). Information technology diffusion: A review of empirical research. *Proceedings of the Thirteenth International Conference on Information Systems*, Dallas, TX, 195-206.

Fireworker, R. B., & Zirkel, W. (1990). Designing an EIS in a multidivisional environment. *Journal of Systems Management, 41*(2), 25-31.

Fitzgerald, G. (1992). Executive information systems and their development in the U.K.: A research study. *International Information Systems, 1*(2), 1-35.

Fried, L. (1991). Decision-making prowess. *Computerworld, 25*(9), 59-60.

Fuller, M. K., & Swanson, E. B. (1992). Information centers as organizational innovation: Exploring the correlates of implementation success. *Journal of Management Information Systems, 9*(1), 47-68.

Garrity, J. T. (1963). Top management and computer profits. *Harvard Business Review, 41*(4), 6-12, 172-174.

Gremillion, L. L. (1984). Organization size and information system use. *Journal of Management Information Systems, 1*(2), 4-7.

Grover, V. (1993). An empirically derived model for the adoption of customer-based interorganizational systems. *Decision Sciences, 24*(3), 603-640.

Grover, V., & Goslar, M. D. (1993). The initiation, adoption, and implementation of telecommunication technologies in the U.S. *Journal of Management Information Systems, 10*(1), 141-163.

Gulden, G. K., & Ewers, D. E. (1989). Is your ESS meeting the need? *Computerworld, 23*(28), 85-89.

Gunter, A., & Frolick, M. (1991). The evolution of EIS at Georgia Power Company. *Information Executive, 4*(4), 23-26.

Harrigan, K. R. (1983). Research methodologies for contingency approaches to business strategy. *Academy of Management Review, 8*(3), 398-405.

Houdeshel, G., & Watson, H. J. (1987). The management information and decision support (MIDS) system at Lockheed-Georgia. *MIS Quarterly, 11*(1), 127-140.

Huff, S. L., & Munro, M. C. (1985). Information technology assessment and adoption: A field study. *MIS Quarterly, 9*(4), 327-340.

Jarvenpaa, S. L., Dickson, G. W., & DeSanctis, G. L. (1984). Methodological issues in experimental IS research: Experiences and recommendations. *Proceedings of the Fifth International Conference on Information Systems*, Tucson, AZ, 1030.

Jarvenpaa, S. L., & Ives, B. (1991). Executive involvement and participation in the management of information technology. *MIS Quarterly, 15*(2), 204-224.

Jenkins, A. M. (1990). Executive education and executive information systems: Problems, solutions and research. *Research issues on information systems: An agenda for the 1990s*. Dubuque, IA: William C. Brown Publishers, 153-172.

Joslow, S. (1991). Case study: Building an EIS. *Information Center Quarterly*, Winter, 6-9.

Kaiser, H. F., & Rice, J. (1974). Little jiffy mark IV. *Education and Psychological Measurement, 34*(2), 111-117.

Kimberley, J., & Evanisko, M. (1981). Organizational innovation: The influence of individual, orgnizational, and contextual factors on hospital adoption of technological and administrative innovations. *Academy of Management Journal*, *24*(4), 689-713.

Kwon, T. H., & Zmud, R. W. (1987). Unifying the fragmented models of information systems implementation. In R.J. Boland & R. Hirschheim (Eds.), *Critical issues in information systems research*. New York: John Wiley.

Lederer, A. L., & Mendelow, A. L. (1990). The impact of the environment on the management of information systems. *Information Systems Research*, *1*(2), 205-222.

Leidner, D. & Elam, J. J. (1993). Executive information systems: Their impact on executive decision making. *Journal of Management Information Systems*, *10*(3), 139-155.

McNamara, B., Danziger, G., & Barton, E. (1990). An appraisal of executive information and decision support systems. *Journal of Systems Management*, *41*(5), 14-18.

Meador, C. L., Guyote, M. J., & Keen, P. G. W. (1984). Setting priorities for DSS development. *MIS Quarterly*, *8*(2), 117-129.

Meyer, A. D., & Goes, J. B. (1988). Organization assimilation of innovations: A multilevel contextual analysis. *Academy of Management Journal*, *31*(4), 897-923.

Miller, D., & Friesen, P. H. (1982). Innovation in conservative and entrepreneurial firms: Two models of strategic momentum. *Strategic Management Journal*, *3*(1), 1-25.

Mitchell, R. (1988, June). How top brass is taking to the keyboard at Xerox. *Business Week*, 86.

Moad, J. (1988). The latest challenge for IS is in the executive suite. *Datamation*, *34*(10), 43-52.

Mohan, L., Holstein, W. K., & Adams, R. B. (1990). EIS can work in the public sector. *MIS Quarterly*, *14*(4), 435-448.

Nilakanta, S., & Scamell, R. (1990). The effect of information sources and communication channels on the diffusion of innovation in a data base environment. *Management Science*, *36*(1), 24-40.

Nunnally, J. C. (1978). *Psychometric theory*. New York: McGraw-Hill.

Paller, A., & Laska, R. (1990). *The EIS book*. Homewood, IL: Dow Jones-Irwin.

Rai, A. (1995). External information source and channel effectiveness and the diffusion of CASE innovations: An empirical study. *European Journal of Information Systems*, *4*, 93-102.

Rai, A. & Patnayakuni, R. (1996). A structural model for CASE adoption behavior. *Journal of Management Information Systems*, *13*(2), 205-234.

Rai, A., Stubbart, C. S, and Paper, D. (1994). Can executive information systems reinforce biases? *Accounting, Management and Information Technologies*, *4*(2), 87-106.

Rainer, R. K., & Watson, H. J. (1995). What does it take for successful executive information systems? *Decision Support Systems*, *14*(2), 147-156.

Rapley, K. (1993). A plausible impossibility: Supporting top executives with information systems. In D. Avison & J.E. Kendall (Eds.), *Human, organization, and social dimensions of information systems development.* IFIP North Holland Proceedings, 375-380.

Raymond, L. (1985). Organizational characteristics and MIS success in the context of small business. *MIS Quarterly*, *9*(1), 37-52.

Raymond, L. (1990). Organizational context and information systems success: A contingency approach. *Journal of Management Information Systems*, *6*(4), 5-20.

Rees-Evans, H. (1989). Top management transformed as EIS arrives. *Accountancy*, *103*(1148), 143-144.

Reich, B. H., & Benbasat, I. (1990). An empirical investigation of factors influencing the success of customer-oriented strategic systems. *Information Systems Research*, *1*(3), 325-347.

Rinaldi, D., & Jastrzembski, T. (1986a). Executive information systems put strategic data at your CEO's fingertips. *Computerworld*, *20*(43), 37-50.

Rinaldi, D., & Jastrzembski, T. (1986b). Golden rules: EIS installation. *Computerworld*, *20*(43), 51.

Rockart, J. F., & De Long, D. W. (1988). *Executive Support Systems.* Homewood, IL: Dow Jones-Irwin.

Rockart, J. F., & Treacy, M. E. (1982). The CEO goes on-line. *Harvard Business Review*, *60*(1), 82-88.

Sabherwal, R., & King, W. R. (1992). Decision processes for developing strategic applications of information systems: A contingency approach, *Decision Sciences*, *23*(4), 917-943.

Sanders, G. L., & Courtney, J. F. (1985). A field study of organizational factors influencing DSS success. *MIS Quarterly*, *9*(1), 77-89.

Sethi, V., & King, W. R. (1991). Construct measurement in information systems research: An illustration in strategic systems. *Decision Sciences*, *22*(3), 455-472.

Shoebridge, A. (1988). EIS: Friend or foe. *Accountancy*, *102*(1142), 150-151.

Stewart, D. W. (1981). The application and misapplication of factor analysis in marketing research. *Journal of Marketing Research*, *18*(1), 51-62.

Straub, D. W. (1989). Validating instruments in MIS research. *MIS Quarterly*, *13*(2), 147-165.

Turban, E., McLean, E., & Wetherbe, J. (1996). *Information technology for management: Improving quality and productivity*. New York: John Wiley.

Utterback, J. M. (1974, February). Innovation in industry and the diffusion of technology. *Science*, *183*(2), 620-626.

Vandenbosch, B., & Higgins, C. A. (1995). Executive support systems and learning: A model and empirical test. *Journal of Management Information Systems*, *12*(2), 99-130.

Vanlommel, E., & De Brabander, B. (1975). The organization of electronic data processing (EDP) activities and computer use. *The Journal of Business*, *48*(3), 391-410.

Venkatraman, N., & Grant, J. H. (1986). Construct measurement in organizational strategy research: A critique and proposal. *Academy of Management Review*, *11*(1), 71-87.

Volonino, L., & Drinkard, G. (1989). Integrating EIS into the strategic plan: A case study of Fisher-Price. *Transactions of the Ninth International Conference on Decision Support Systems*, Providence, RI, 37-45.

Volonino, L., Watson, H. J., & Robinson, S. (1995). Using EIS to respond to dynamic business conditions. *Decision Support Systems*, *14*(2), 105-116.

Wallis, L. (1989). Power computing at the top. *Across the Board*, *26*(1-2), 42-51.

Watson, H. J., & Frolick, M. (1993). Determining information requirements of an EIS. *MIS Quarterly*, *17*(3), 255-269.

Watson, H. J., Rainer, R. K., & Frolick, M. N. (1992). Executive information systems: An ongoing study of current practices. *International Information Systems*, *1*(2), 37-56.

Watson, H. J., Rainer, R. K., Jr., & Koh, C. E. (1991). Executive information systems: A framework and a survey of current practices. *MIS Quarterly*, *15*(1), 12-30.

Watson, H. J., Watson, R. T., Singh, S., & Holmes, D. (1995). Development practices for executive information systems: Findings of a field study. *Decision Support Systems*, *14*(2), 171-184.

Wetherbe, J. C. (1991). Executive information requirements: Getting it right. *MIS Quarterly*, *15*(1), 50-65.

Zmud, R. W. (1982). Diffusion of modern software practices: Influence of centralization and formalization. *Management Science*, *28*(12), 1421-1431.

Zmud, R. W. (1984a). The effectiveness of external information channels in facilitating innovation within software groups. *MIS Quarterly*, *7*(2), 43-58.

Zmud, R. W. (1984b). Examination of "push-pull" theory applied to process innovation in knowledge work. *Management Science*, *30*(6), 727-738.

APPENDIX

Instruction for Respondents

This questionnaire relates to your organization's environment and your Executive Information Systems (EIS) efforts. We refer to EIS as "Computer-based applications that support communication, coordination, controlling, and planning functions of key executives/managers." EIS are believed to have the potential to improve executive productivity and organizational performance. As part of a major effort to understand more about EIS success, we need your cooperation by responding to this survey, which should take a maximum of 10 minutes. Your responses are extremely important and will be *strictly confidential.*

Environmental Characteristics

The following items relate to your primary industry that accounts for the largest percentage of your sales. Please circle the number in each scale that best approximates the actual conditions in it.

How rapid or intense is each of the following in your primary industry?

Our organization/division rarely changes its marketing practices to keep up with the market and competitors.	1	2	3	4	5	6	7	Our organization/division must change its marketing practices extremely frequently.
The rate at which products/services are getting obsolete in the primary industry is very slow.	1	2	3	4	5	6	7	The rate of product/service obsolescence is very high.
Actions of competitors are quite easy to predict in our primary industry.	1	2	3	4	5	6	7	Actions of competitors are unpredictable.
Demand and consumer tastes are fairly easy to forecast in our primary industry.	1	2	3	4	5	6	7	Demand and tastes are almost unpredictable.
The production/service technology is not subject to very much change.	1	2	3	4	5	6	7	The modes of production/service change often and in a major way.
The environment causes a great deal of threat to the survival of our organization/division.	1	2	3	4	5	6	7	Environment causes very little threat to the survival of our organization/division.

Are there great differences among the products/services you offer, with regard to:

About same for all our products	1	2	3	4	5	6	7	Varies a great deal from line to line
customer buying habits	1	2	3	4	5	6	7	
the nature of the competition	1	2	3	4	5	6	7	
market dynamism & uncertainty	1	2	3	4	5	6	7	

How severe are the following challenges:

This is not a substantial threat	1	2	3	4	5	6	7	This is a very substantial threat
tough price competition	1	2	3	4	5	6	7	
competition in product quality	1	2	3	4	5	6	7	
dwindling markets for products	1	2	3	4	5	6	7	
scarce supply of labor/ material	1	2	3	4	5	6	7	
government interference	1	2	3	4	5	6	7	

Organizational EIS Efforts

Please circle the responses that indicate the proportion of key executives/managers for which EIS applications have been installed.

	1 none	2 one	3 few	4 many	5 most
Communication support like email, voice mail, etc.	1	2	3	4	5
Coordination support like electronic calendaring, file ticklers, computer conferencing, etc.	1	2	3	4	5
Controlling support like monitoring critical success factors, variance reporting, horizontal & vertical "drill-down," etc.	1	2	3	4	5
Planning support like Newswire & Dow Jones access, "what if" analysis, trend analysis, etc.	1	2	3	4	5

Organizational Support Factors

Please circle the appropriate response that best describes your EIS efforts.

SD	D	DS	N	AS	A	SA
Strongly Disagree	Disagree	Disagree Slightly	Neutral	Agree Slightly	Agree	Strongly Agree

a. Executive Sponsor(s) personally participates in EIS development on a regular basis.	SD	D	DS	N	AS	A	SA

b. Top/corporate management's contact with the Executive Sponsor(s) on EIS-related issues has been frequent.	SD	D	DS	N	AS	A	SA
c. Top/corporate management provides sufficient resources for EIS.	SD	D	DS	N	AS	A	SA
d. Top/corporate management perceives EIS to be important.	SD	D	DS	N	AS	A	SA
e. Top/corporate management usually provided constructive feedback on the appropriateness of EIS applications.	SD	D	DS	N	AS	A	SA
f. EIS is regarded as a high priority by top/corporate management.	SD	D	DS	N	AS	A	SA
g. Information System (IS) executives participate in meetings concerning EIS development.	SD	D	DS	N	AS	A	SA
h. IS personnel cooperate in identifying data sources for EIS applications.	SD	D	DS	N	AS	A	SA
i. IS personnel cooperate to resolve technical problems encountered in EIS development.	SD	D	DS	N	AS	A	SA
j. IS personnel accept accountability for EIS.	SD	D	DS	N	AS	A	SA
k. There is active two-way communication between IS executives and top/corporate management on the role of EIS.	SD	D	DS	N	AS	A	SA
l. IS function is highly involved in EIS development.	SD	D	DS	N	AS	A	SA

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