경영정보학연구
제11권 제1호
2001년 3월

The Impact of Factors affecting Innovation Characteristics on EDI Implementation Success

Lee, Sang-Jae*

혁신특성의 영향요소가 성공적인 EDI의 구현에 미치는 영향

이 상 재

The evolution of EDI has opened the flexible and efficient way for business to conduct a greater portion of the routine buyer-seller business activities online. This study focuses on the role of factors that change the innovation characteristics for implementation success of EDI. Three factors promotional efforts, proactive implementation strategy, and provision of technical expertise are proposed to affect EDI implementation success, as these factors directly influence three general and most important attributes of innovation relative advantage, compatibility, and complexity respectively. Hypotheses indicate that promotional efforts, proactive implementation strategy, and provision of technical expertise directly affect EDI implementation success that is represented by three variables volume, depth, and diversity. A structural equation modeling approach (LISREL) is used to analyze data from EDI adopters. The results show that proactive implementation strategy and provision of technical expertise positively affect implementation success of EDI. Given the significant impact of the wide spread use of the EDI system, this study offers quite useful insights on the factors facilitating innovation characteristics under which EDI can be successfully diffused in organizations.

* 한양대학교, 디지털 경제경영대학, 디지털 경영학부 교수

Ⅰ. Introduction

Electronic data interchange is one type of interorganizational system that enables direct computer-to-computer communication between a business entity and its trading business partners of business data in a standard and machine readable format via the telecommunication network. EDI is expected to result in improvements in operational efficiency, lower operational costs, less paperwork, and greater accuracy [Emmelhainz, 1990; Hansen and Hill, 1989]. 20% of all US companies employ some form of EDI and about 3% of all trade documents are exchanged using EDI [Philip and Pedersen 1997]. Thousands of global retailers and manufacturers such as The Home Depot, Wal-Mart, Proctor and Gamble, Toyota have used EDI to redefine the landscape of their business. EDI is a key technology of the 1990s and based on the recent surge of interest in the Internet along with newer applications such as TCP/IP and HTTP protocols and Intranets, EDI adopters begin to use the Internet as a cost-effective channel for EDI transactions. Internet-based EDI will provide the most feasible alternative for putting online business-to-business trading within the reach of virtually any organization [Segev et al., 1997; Senn, 1998]. While no longer regarded as a new technology, EDI is becoming recognized worldwide as an essential and flexible business tool [Curtis, 1996].

An integration with IS application along with high transaction volume is necessary for EDI to be successful [Iacovou et al. 1995, Stern and Kaufmann 1985, Teo et al. 1995]. When EDI is utilized and automated to its fullest extent, the advantages from EDI increase [Ramamurthy and Premkumar, 1995; Scala and McGrath 1993]. Before an organization decides to implement EDI, however, the facilitators (or inhibitors) for innovation characteristics need to be planned in order to establish the belief that the system is effective and to increase the capability for implementation and adjustment. The major barriers to EDI implementation are difficulty in justifying the cost and benefits of EDI implementation, compatibility of infrastructure between trading partners, difference in business practices between participating firms, lack of willingness among trading partners, lack of expertise and knowledge required for EDI implementation [Ferguson and Hill, 1988]. These barriers should be overcome for the implementation success of EDI. EDI is a new way of doing business and EDI managers will fail if they consider EDI as merely a new piece of software that substitutes for existing paper documents. While it would seem that a favorable organizational context would improve the probability of EDI implementation, a positive management strategy toward these environments is more important than the environments per se, in order to fully tap the benefits of the technology.

Many IS researchers have examined IS implementation success and its determinants. However, these studies do not examine the fundamental factors that affect IS implementation through their effect on innovation characteristics Innovation characteristics are assumed to be influenced by "facilitators (or inhibitors)" for innovation characteristics. This paper examines the direct effects of "factors affecting innovation characteristics" on the implementation success of EDI. A structural equation modeling approach (LISREL) is used to validate instruments and to test the research model. A summary of empirical findings is provided at the end.

Ⅱ. Theoretical Framework

2.1 IS Implementation

Innovation can be described as an idea, practice, or object that is perceived as new by an individual or other unit of adoption [Rogers, 1995]. This study deals with the implementation of a technological innovation EDI at the organizational level. A substantial amount of research has been conducted to examine the various factors that affect IS adoption and implementation success. IS implementation is an ongoing organizational effort for diffusing information technology within an organization [Cooper and Zmud, 1990]. The full potential of IS can be realized when the IS implementation proceed comprehensively within the organization [Swanson, 1994]. This cannot be obtained by merely automating the transaction processing or communication procedures. Various extensions and enhancements to IS become more elaborate, as user's needs are newly identified and satisfied. IS should be integrated to facilitate the widespread transfer of its technology to various applications [Premkumar et al. 1994].

Kwon and Zmud [1987] suggested that five major contextual factors affect processes associated with IT implementation stages: characteristics of user community, characteristics of organization, characteristics of the technology being adopted, characteristics of the task to which the technology is being applied, and organizational environment. Tornatzky and Fleischer [1990] indicated that three elements affect the process of innovation adoption: (1) the external environmental context (e.g., government support, market uncertainty, competitive intensity), (2) the technological context (e.g., relative advantage, compatibility), and (3) the organizational context (e.g., size, formalization, centralization). A substantial number of IS implementation research commonly suggested the following important factors as being important to successful implementation [Cooper and Zmud 1990, Desanctis and Courtney 1983, Ives and Olson 1984, Premkumar et al. 1994, Sanders and Courtney 1985]: top management support, innovation characteristics, appropriate user-designer interaction, compatibility of task characteristics, extensive project definition and planning, and commitment to change and implementation efforts.

Various applications are studied in IS implementation literature: spreadsheet [Brancheau and Wetherbe, 1990], material requirement planning technology [Cooper and Zmud, 1990], computer-aided software engineering tools [Rai and Howard, 1993], open systems [Chau and Tam, 1997], and groupware [Dennis et al., 1998]. It is not possible to suggest an unifying theory of IS adoption that can be applied to all types of IS innovations. As many researchers have pointed out [Brancheau and Wetherbe, 1990; Thong, 1999; Zmud, 1982], it is necessary to refine and tailor any borrowed theory to match the context of application. Strong predictors of adoption and implementation for complex and innovative applications can be appropriately adapted from classical organizational diffusion studies [Brancheau and Wetherbe, 1990].

2.2 EDI Implementation

External services and electronic links should be expanded to realize economies of scale and to derive full benefits from the interorganizational

system (IOS) [Vitale 1985]. A wide range of factors that affect the implementation of EDI, one typical form of IOS, have been proposed by the extant literature [Grover, 1993; Premkumar et al. 1994, Ramamurthy and Premkumar, 1995; Reich and Benbasat, 1990]. The factors affecting EDI adoption include top management support, innovation characteristics (e.g., relative advantage, complexity, compatibility), commitment to change and implementation efforts, and extensive project definition and planning. Reich and Benbasat [1990] reported that customer awareness of need and support affects the adoption of customer-oriented strategic systems. Grover [1993] indicated that various environmental factors (e.g., competitive intensity, customer power), organizational factors (e.g., size, IS planning, IS infrastructure), policy factors (e.g., technology policy, role of IT, management risk position), IOS (interorganizational systems) factors (e.g., compatibility, complexity) and support factors (e.g., top management support, championship) affect the implementation of customer based IOSs. Ramamurthy and Premkumar [1995] similarly suggested innovation factors (e.g., compatibility, relative advantage), organizational factors (e.g., top management support, IS sophistication), organizational learning (elapsed time) affecting infusion of EDI. Hart and Saunders [1998] suggested the role of power and trust on the EDI use based on the sociopolitical framework for interorganizational relationship.

Despite the importance of the EDI, there is a lack of published research on the Internet phenomenon especially in Asia. In the specific context of Korean industry, a number of organizational and industry factors have been suggested. These include centralization, organizational compatibility and elapsed time (Chung et al., 1997). Other studies suggest similar factors such as decentralization, technological compatibility, top management support, and partner commitment (Kim and Chung, 1999; Kim and Lee, 1997). The studies on EDI implementation in Korean industry generally show that technological characteristics (e.g., standards, compatibility) and management policy (e.g., education, management support, controls) are important for EDI implementation.

2.3 Factors affecting Innovation Characteristics

While the influence of characteristics of innovations has been studied quite extensively [Kwon and Zmud, 1987], the studies on the effect of the facilitators (or inhibitors) that change these innovation characteristics on IS implementation are lacking. Innovation characteristics such as relative advantage, compatibility, complexity are primary determinants of innovation adoption and implementation [Tonrnatzky and Klein, 1982]. When these innovation characteristics exist, organization is motivated to take a proactive decision to adopt new systems. It is quite useful to examine the direct effects of "facilitators (or inhibitors)" for these innovation characteristics on IS implementation.

One of the major reasons for organizations to adopt a new innovation is related to the cost-benefit trade-off of adopting a particular innovation; an adoption of innovation is more likely when the new system is perceived to provide significantly better benefits than existing ones. The implementation of innovation is also encouraged when the new system is compatible with the existing work procedures and value

systems; this affects users' attitudes toward innovation and facilitates acceptance of the system and its subsequent usage. Last, the complexity of innovation represents the technical expertise required for the implementation of new system and is negatively related to the probability that the innovation is adopted.

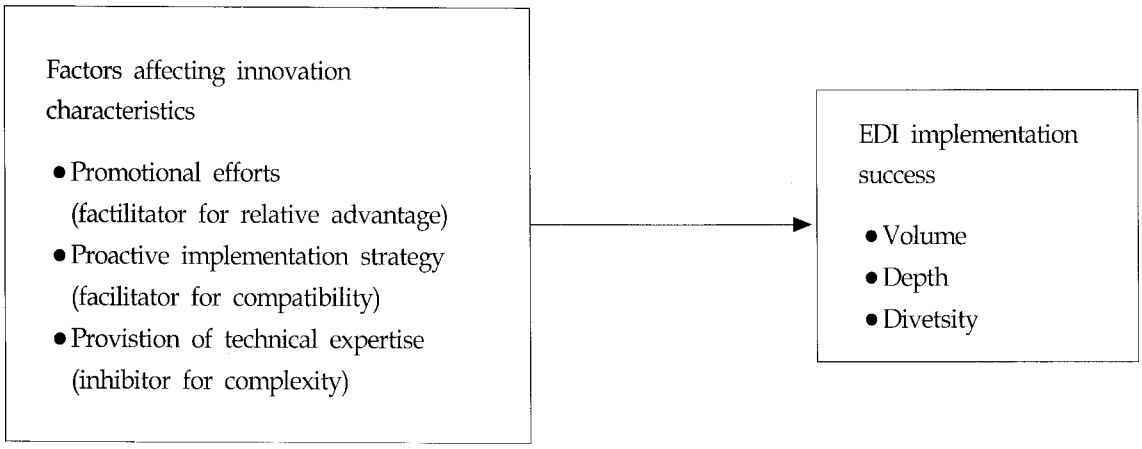
The attributes of the innovation as perceived by adopting firm influence the chance of an organization adopting an innovation. Many innovation studies have investigated the relationship between innovation characteristics, and adoption/diffusion of organizational and technological innovation (e.g., Kimberly and Evanisko [1981], Premkumar et al. [1994]). Among a number of innovation characteristics, relative advantage, compatibility, and complexity were the most important innovation characteristics [Tornatzky and Klein, 1982]. While relative advantage and compatibility positively affected adoption, complexity negatively affected adoption. This study focuses on the factors affecting these three innovation characteristics since it would be difficult to test a comprehensive model including a wide range of environmental and organizational variables [Hart and Saunders, 1998].

Ⅲ. Research Hypotheses

Three factors are found to be relevant to this study: promotional efforts, proactive implementation strategy, and provision of technical expertise. The research model is presented in <Figure 1>.

3.1 Promotional efforts

Promotion strategies to enhance the perception of the degree to which an innovation is better than the idea it supersedes may influence the adoption of an innovation. If an innovation is perceived to bring greater organizational benefits than maintaining the status quo, an innovation is more likely [Rogers, 1995]. The expected savings in time, reduced administrative cost that provide great impetus to the use of an innovation [Gatignon and Robertson, 1989; Tornatzky and Klein, 1982], is affected by the promotion of the benefits that are obtainable from EDI to various stakeholders such as trading partners, internal user departments. In many cases, organizations do



<Figure 1> Research model

not perceive the benefit that EDI technology should bring to their business operations and have reactive attitude toward the implementation of EDI. Many larger retailers have actively used promotional strategies as part of their EDI implementation plan [Booker and Fitzgerald, 1990]. A recommendation strategy that actively communicates the benefits of the technology through presentations, on-site visits, and promotional seminars, will greatly overcome the reactive attitude of EDI adopters [Iacovou et al., 1995]. A faster and more successful implementation of EDI is possible when EDI adopters have proactive approach toward EDI [Teo et al., 1995] that may be fostered by their promotional efforts.

Hypothesis 1: There is a positive relationship between promotional efforts and the extent of EDI implementation (volume, depth, and diversity).

3.2 Proactive implementation strategy

Technological innovation is more likely implemented when it is perceived as consistent with present value systems and procedures of the potential adopter [Ettlie, 1986]. In EDI, customer service is improved with the avoidance of extra paperwork and data re-entries by recipient partner organization. These improvements depend on the structured and routine processes that enable the coordination in transmission between sending and receiving computers. The extent of usage of both standardized procedures on the communication process is greatly related to the speed, accuracy, and completeness of partner communications [Stern and Kaufmann 1985]. The standardized procedures should be applied in such matters as: the method by which a message is sent; the communications transport protocol (e.g., SDLC, ASC, BISYNC); message format that contains both the data itself as well as identification and routing details; interchange control segments that indicate a set of documents transmitted between organizations at one time [Senn 1992].

Proactive implementation strategy in this study represents the efforts directed toward the implementation of the system to make EDI system as being consistent with the existing values, past experiences, and needs of the potential adopter. Many of the manual work procedures used in selling and buying goods are automated from the implementation of EDI. Significant changes in work practices and procedures occur and compatibility with existing attitudes, beliefs, value systems and IS infrastructure becomes an important issue as it ensures less resistance to the adoption, lesser risk to the adopter [Riggins and Mukhopadhyay, 1999]. Proactive management strategy that facilitate mutual adjustments and changes in business practices and IS infrastructure is necessary for most EDI adopters to further implement the technology.

Hypothesis 2: There is a positive relationship between proactive implementation strategy and the extent of EDI implementation (volume, depth, and diversity).

3.3 Provision of technical expertise

Organizational learning of knowledge and procedural know-how to use it effectively is necessary for the viability and possible exploring a new technology [Attewell, 1992]. The current

state of technical knowledge in an organizational unit is an important factor for successful implementation of organizational innovation [Kimberly and Evanisko, 1981; Meyer and Goes, 1988] and IS implementation [Kwon and Zmud, 1987; Premkumar and Roberts, 1999; Rai and Howard, 1993]. Substantial technical know-how needed to implement and operate technological innovation successfully is the major barrier to innovation adoption [Rogers, 1995]. Technical training can be offered by initiators of EDI to augment the resources of smaller partners that lack the expertise required for EDI projects [Iacovou et al., 1995]. On-site assistance is necessary to facilitate the development of internally integrated systems. For instance, as an incentive to adopt EDI, Sears provided training as part of technical subsidy and this greatly encouraged the development efforts for EDI by alleviating problems of organizational readiness and overcoming resistance because of lack of technical resources [Fitzgerald, 1990]. Provision of technical expertise may enhance the breadth and depth of knowledge possessed by EDI adopters, acts as "inhibitors" to complexity of EDI, and thereby facilitators to future EDI implementation.

Organizations, especially small ones, that may perceive EDI to be complex and may lack the technical capability to develop EDI, may especially receive benefits from technical education or training provided by their influential trading partners. The provision of technical expertise can broaden their knowledge of the interconnection arrangements of individual hardware and software components to integrate the system, thereby obtaining significant benefits from the system.

Hypothesis 3: There is a positive relationship between provision of technical expertise and the extent of EDI implementation (volume, depth, and diversity).

Ⅳ. Research Methods

4.1 Research Design

Structured interview is selected as main data collection method. The items for task characteristics and partner attributes were newly developed in this study based on EDI literature. It is necessary to ascertain whether EDI practitioners can answer the items appropriately. Information about internal EDI system that has significant strategic importance is sensitive for some companies. These questions can be better answered by the structured interview than by any other data collection method. Further, an interview gives flexibility to the respondents in their interpretation of the questions, and in determining the sequence and wording of the questions.

4.2 Participants

The companies which have comprehensively implemented EDI can answer the questions reliably, as they are likely to possess extra resources to support EDI implementation. Publicly available databases (from Chollian network service) were used to select 2000 Korean companies. Final sample was composed based on the following criteria. First, the industries which have heavily used EDI, were determined. Second, phone calls were made to the companies in those industries which are likely to have implemented EDI comprehensively and their level of EDI

implementation were examined. The companies in the sample were proposed to possess a level of knowledge about the process and state of EDI implementation, which was required to answer the questionnaire.

Nine companies refused to participate in the interview among 119 companies that are contacted. The objectives of the study were explained through a direct call to EDI managers, and the participation in the survey was solicited. In order to see if responding firms have significantly different characteristics from nonrespondents, a comparative analysis of industry membership and revenues was conducted. Response bias is not a concern in this study, as no significant differences were found.

<Table 1> presents descriptive statistics of variables. The average number of employees in the responding organizations was 5,849. The average annual sales were 1,952 billion won (or 2.44 billion American dollars). Larger companies were included in the sample more than smaller companies.

The average numbers of EDI documents and trading partners were 14 and 53 respectively and the mean volume of EDI was 50%. EDI has been used for 3.9 years on average. The title of respondents and the industry distribution of sample are indicated in <Table 2> and <Table 3>.

4.3 Measures

The measurements for promotional efforts, proactive implementation strategy, and provision of technical expertise were based on literature such as ISACA [1990], Chan et al. [1993]. They were measured using a seven point Likert-type scale (see <Table 1>). Respondents answer the extent to which they agree or disagree with each statement.

The measures for implementation success indicate the extent that the responding firm has implemented EDI, and are based on the EDI literature [Massetti and Zmud 1996, Premkumar et al. 1994, Premkumar and Ramamurthy 1995] <Table 1>. They indicate the proportion to which a firm's information exchange and processing are handled through EDI. The measures for volume represent the proportion that a company uses EDI in the five applications rather than other complementary means such as e-mail or fax. The five tasks (some companies have less than 5 tasks) can represent the characteristics of EDI applications at an organizational level, as they are believed to be more closely connected with EDI by respondents. Examples of applications are categorized as transportation trade, retail, and banking. Others applications include production, insurance engagement, and credit card usage recording. Depth indicates the integration of five application systems which respondents believe to be closely connected with EDI. Depth is measured by the extent to which EDI data can be directly processed within applications, without human intervention. Diversity is measured by the number of distinct document types an organization processes via EDI connections. It represents the number of different document types an organization handles via EDI.

4.4 Procedures

Structure interview was performed in the pilot test of the survey instrument. During the pilot test, wording, interpretation, and item importance, and

<Table 1> Descriptive statistics for research variables

Latent variables	Constructs	Mean	S.D.	Min	Max
Promotional efforts	Our management actively communicates the benefits of EDI to user departments through promotional activities (e.g. seminars, presentations, and on-site visits) (PE1).	4.64	1.43	1.00	7.00
	Our management actively communicates the benefits of EDI to trading partners through promotional activities (PE2).	3.74	1.74	1.00	7.00
	VAN service provider actively communicates the benefits of EDI to trading partners through promotional activities (PE3).	4.71	1.36	1.00	7.00
Proactive implementation strategy	Our firms restructure business processes to make it amenable to standardized rules and operation of EDI (PIS1).	4.18	1.47	1.00	7.00
	The compliance with requirements of trading partners for the products from system development stages, i.e., system design, implementation, test stages, is appropriately reviewed by trading partners (PIS2).	4.07	1.57	1.00	7.00
	The compliance with requirements of user departments for the products from system development stages, i.e., system design, implementation, test stages, is appropriately reviewed by user departments (PIS3).	4.48	1.57	1.00	7.00
	VAN service provider makes an agreement with our firm to provide capability of supporting connections with various trading partners (PIS4).	4.49	1.66	1.00	7.00
	VAN service providers supports connections with diverse environment through various protocol conversion services (PIS5).	4.45	1.66	1.00	7.00
	VAN service provider supports connections with diverse environments through providing various message standards(PIS6).	4.26	1.72	1.00	7.00
Provision of technical expertise	Our management provides technical education or training to internal user departments in order to support their usage of EDI (PTE1).	4.49	1.53	1.00	7.00
	Our management provides technical education or training to trading partners in order to support their usage of EDI (PTE2).	3.31	1.70	1.00	7.00
	VAN service provider provides technical education or training to trading partners in order to support their usage of EDI (PTE3).	4.25	1.74	1.00	7.00
	EDI staff members actively participate in seminars offered by governmental institutes and industry associations (PTE4).	4.18	1.52	1.00	7.00
Implementation success	Volume (VOL)	0.51	0.32	.01	1.00
	Depth (DEP)	5.08	1.40	1.00	7.00
	Diversity (DIV)	14.21	17.60	1.00	103.00

S.D.: standard deviation

<Table 2> Industry representation of responding companies

Name of Industry	Number of Firms	Percent
Auto/Auto Parts Manufacturing	5	4.5%
Textile Manufacturing	2	1.8%
Bank Industry	12	10.9%
Retail Industry	9	8.2%
Shipping Industry	6	5.5%
Insurance	22	20.0%
Trade Industry	16	14.5%
Food Manufacturing	16	14.5%
Credit Card Industry	2	1.8%
Steel/Metal Manufacturing	9	8.2%
Chemical Product Manufacturing	3	2.7%
Electronics Industry	4	3.6%
Transportation Industry	4	3.6%
Total	110	100%

<Table 3> Title of respondents

Title of respondents	Number	Percent(%)
Manager	18	16.3
Assistant manager	41	37.3
EDI manager	51	46.4
Total	110	100

the extent to which practitioners felt they possessed the knowledge necessary to provide appropriate responses were examined until the last draft of the questionnaire. After ten interviews with practitioners were conducted, a final review was then made by four IS professors.

A total of 110 usable responses were included in the final sample. The unit of analysis is an individual EDI adopted company. One or two EDI managers in each company simultaneously participated in the interview. These individuals were expected to have sufficient knowledge about EDI implementation. They took some questions to their colleagues in that subject area if they have not sufficient knowledge to answer them.

V. Results

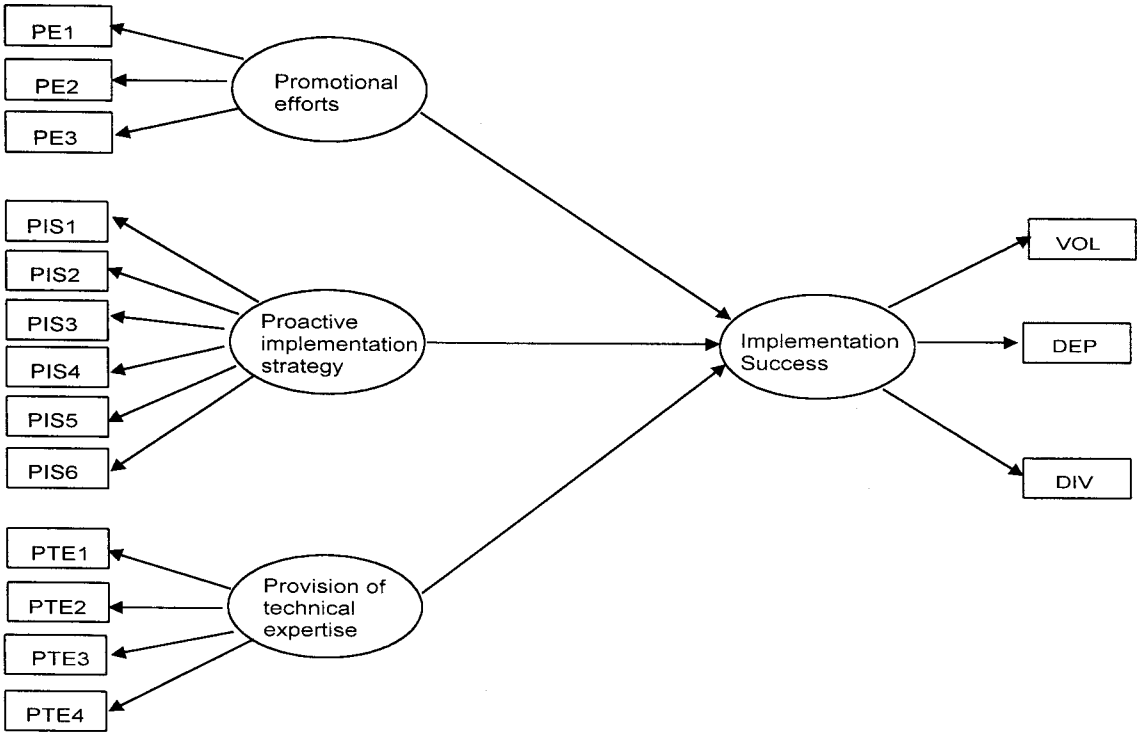
5.1 Measurement Properties

Content validity is ensured by taking extensive precautions during the previous stages of development and by pilot testing of the items with 10 IS professionals. Constructs that have been validated by other researchers were adopted.

After items and constructs for each latent variable were determined, confirmatory factor analysis was performed using LISREL (LInear Structural Relations) modeling [Jreskog, 1971; Jreskog and Srbom 1989]. Confirmatory factor analysis intends to test a priori theoretical structures against the data. The specified relationships between measures and constructs are described in measurement model. Measurement properties can be examined by testing the measurement model with four concepts. The measurement model is shown in <Figure 2>.

Reliability and validity tests are performed for each latent variable and construct (see <Table 4>). Bagozzi and Yi [1988] suggested composite reliability.

Composite reliability is the stability of the scale based on an assessment of its internal consistency of the constructs that measure the same latent variable for the collected data. The composite reliability ranges from 0.451 to 0.665 and shows moderate to high reliability. This shows that the variance of the measured variables explains a significant portion of variance in the latent



<Figure 2> Measurement and structural model

<Table 4> Reliability and validity of measures

Latent variables	Constructs	Composite Reliability	Standardized Factor Loading	Standard Error	t-value
Promotional efforts	PE1	0.665	0.888	0.095	9.354
	PE2		0.567	0.096	5.925
	PE3		0.400	0.093	4.323
Proactive implementation strategy	PIS1	0.773	0.420	0.100	4.193
	PIS2		0.602	0.095	6.362
	PIS3		0.689	0.092	7.533
	PIS4		0.738	0.090	8.232
	PIS5		0.538	0.097	5.533
	PIS6		0.605	0.095	6.386
Provision of technical expertise	PTE1	0.763	0.807	0.086	9.389
	PTE2		0.725	0.090	8.080
	PTE3		0.681	0.084	8.135
	PTE4		0.432	0.101	4.292
Implementation success	VOL	0.451	0.466	0.132	3.530
	DEP		0.498	0.134	3.722
	DIV		0.427	0.131	3.275

variable.

Construct validity is examined using convergent and discriminate validity. Convergent validity could be assessed from the measurement model by identifying whether the estimated parameters of each construct are significant [Anderson and Gerbing, 1988]. The presence of convergent validity can be suggested by the high values of reliability scores and significant parameter estimates. The parameter estimates are all significant indicating high loading for all measures. Further, average variance extracted for all latent variables exceed or are slightly below 0.5. This suggests the measures have convergent validity.

Discriminate validity refers to the degree to which a latent variable differs from other latent variables. <Table 5> shows discriminant validity of the study measures. The intercorrelations among the latent variables do not exceed the square root of average variance extracted. This suggests that the intercorrelations among the items associated with the measures are stronger than their correlations with items representing other measures and that measures are distinct and unidimensional. Hence, this generally presents that discriminant validity of all measures are satisfactory.

<Table 5> Intercorrelations among constructs
(The diagonals represent the square root of the average variance extracted.)

Latent Variables	(1)	(2)	(3)	(4)
Promotional efforts (1)	0.759			
Proactive implementation strategy (2)	0.725	0.794		
Provision of technical expertise (3)	0.680	0.728	0.737	
Implementation success (4)	0.232	0.550	0.450	0.886

5.2 Data Analysis and Results

The structural relation between controls, implementation success, and performance is tested using LISREL. LISREL provides several advantages over other multivariate techniques. First, relationships between theoretical constructs (i.e., latent variables) with multiple measuring constructs can be tested. On the contrary, the linear model by regression analysis cannot accommodate multiple measures of the same latent variable. Second, a simultaneous causation among the observed variables can be examined. Various fitness indexes including the chi-square statistic can be suggested indicating the overall fitness of models. The "best" fitting model can be determined using Chi-square difference tests, after the chi-square test statistic of alternative models such as null, saturated, theoretical, constrained and unconstrained models are compared. Third, LISREL analysis can show a causal link rather than showing just a mere empirical association among variables, which helps the development of theory [Blalock 1969]. Intricate causal links including recursive or nonrecursive relations among latent variables can be represented so as to better characterize real-world processes.

The structural model is represented in <Figure 2>. The latent variables are enclosed in circles or ellipses, while the observed variables are enclosed in squares or rectangles. A hypothesized direct effect of one variable upon another is shown by a one-way path between variables.

The chi-square is 87.56 with 76 degrees of freedom for the model. P value is 0.172. The model goodness-of-fit index is 0.919, which is a measure of the relative amount of variables and covariances jointly accounted for by the model. The

adjusted-goodness-of-fit is 0.855. The root mean square residual is 0.069, which is a measure of the average of the residuals. These measures of overall fitness indicate the explanatory power of the model.

Significant causal coefficients are found in the relation between: proactive implementation strategy and implementation success; provision of technical expertise and implementation success <Table 6>.

<Table 6> Causal effects among constructs

Causal Path	MLE of causal coefficient	Standardized coefficient	Standard error
Promotional efforts implementation success	-0.546**	-1.014	0.306
Proactive implementation strategy implementation success	0.767**	0.764	0.405
Provision of technical expertise implementation success	0.440**	0.892	0.216

MLE: Maximum likelihood estimate,
*: $p < 0.05$, **: $p < 0.01$)

These results indicate that proactive implementation strategy and provision of technical expertise are positively related to implementation success. This generally indicates that more organizational structuring of procedures and new work environment, and provision of technical expertise are needed to manage implementation as the use of new EDI increases. The trading partners and user departments need to participate in the decision to authorize new IS applications before the design of system begins [Parker 1981]. The proactive implementation strategy is critical to the formation of development process where implementation outcome (e.g., system design, reports of system testing) conforms to plans, but also insights concerning appropriate implementation planning can be suggested. Technical expertise is needed for informed technical decisions regarding planning, design implementation, and testing of EDI. Inappropriate management of implementation may cause inappropriate allocation of budgets, and out-of-control processes could then be happened, which may result in substantial losses to productivity.

The coefficient sign for promotional efforts is negative and this shows the extent of promotional efforts is expected to show a negative relationship with the EDI implementation represented by volume, depth, and diversity as firms show reactive attitude to the promotional efforts offered by their influential trading partners. For some companies, the promotional efforts by trading partners and VAN service providers are understood as external pressure to implement EDI. They do not seek to find diverse functional applications of the EDI and simply implement those applications that are likely to be imposed upon them through various promotional efforts by trading partners or VAN service providers. EDI adopters that have voluntarily initiated the implementation tend to show a more proactive attitude and develop integrated projects with internal applications. Although the adoption of EDI is related to the level of imposition to adopt the technology [Iacovou et al., 1995; Permkumar et al., 1994], the same environment does not lead to the implementation success of EDI that demands considerable resources of EDI adopters as well as the motivation to allocate the resources. Unless significant efforts are provided by trading partners, mere influence (or promotional efforts) from external industry or trading partners to

adopt EDI can not lead to the further implementation of EDI. Iacovou et al. [1995] classified EDI adopters that are strongly pressured into the decision of adoption as "Unprepared Adopters", Ready Adopters", "Coerced Adopters", and "Unmotivated Adopters." "Unprepared Adopters" and "Coerced Adopters" do not own the necessary resources to integrate the system. In addition, "Coerced Adopters" and "Unmotivated Adopters" are pressured into adopting EDI but they do not see the need for the technology. In this case, they will not allocate resources to develop integrated EDI systems that will interface with their existing computer applications.

Ⅵ. Implications and Conclusions

The results of this study have significant implications for EDI practitioners. EDI should be comprehensively implemented to allow for signficant benefits. The full potential of EDI is achieved when proactive implementation strategy and technical expertise are provided for the integration with internal applications and linkage with many trading partners communicating via diverse EDI documents. Very little guidance exists regarding the facilitators (or inhibitors) for innovation characteristics that are necessary to implement EDI systems beyond the initial decision to adopt EDI. Given the significant impact of the wide spread use of the EDI system, insight into the factors affecting EDI implementation success is quite useful. This research sheds light on these issues and offers an improved understanding of the conditions under which EDI can be successfully diffused in organizations.

Companies that plan to adopt EDI can decide whether their organizational environments are appropriate for EDI implementation. They may check their industrial, organizational, task and partner characteristics and examine whether they are favorable for EDI implementation. For instance, if conditions of EDI adopters are not appropriate for EDI implementation, they may consider the changes toward positive management strategies in promotion, implementation, and provision of technical expertise to cope with these environments. For instance, EDI adopters need to market the technology and its benefits to their trading partners in order to make them aware of the need for the technology and obtain strong commitment to the system. Since a major roadblock to integration with internal applications is due to partner's low recognition of the system, it is important to help the partners fulfill their requirements and formulate a strategy to support the implementation of the partner's system.

If internal work processes are nonrountine, they may need efforts to restructure the process to make it amenable to standardized rules and operation and consequently more routine and repetitive as part of implementation strategies. If the trading partners do not have commitment in their relations, they may provide various promotion strategies or educational services in order to increase the perceived relative advantage of the system and encourage their participation in the implementation. An organization needs to base its selection of a trading partner on how much commitment they and their partners can exert to the interorganizational relationships. The organizational practices cannot be changed in such a short time. In many cases, the difference between the present process and the ideal become

apparent only during the course of EDI implementation. Efforts need to be dedicated to the formation of strategies that encourage and promote the management of the organization and the continued growth of EDI implementation

It is necessary to provide training and education to trading partners to enhance internal recognition of the technology and provide technical assistance in implementation. High-degrees of in-house expertise in information technologies is expected to enhance the technical capability of IS department to implement EDI. A reservoir of help for problems or difficulties in the implementation as they occur, exists in the organizations with IS expertise. More professional and skilled human resources, and more technical knowledge and technical potential are available in organizations with more expertise in EDI technology. These organizations have less difficulty in experimenting with and diffusing the use of the new technology and are more likely in the forefront of EDI development.

In light of the fragmented and scant nature of the literature that addresses factors for EDI implementation, this research explicates the problem by researching various factors that lead to EDI implementation including industrial, organizational, task and partner characteristics. There may exist other variables that affect the implementation of EDI. Future research may consider these variables using a larger data base. Nevertheless, a specification of the linkages between organizational characteristics and EDI implementation can provide a useful framework for future research.

It would be meaningful to suggest other dimensions of implementation and show their relationships with organizational characteristics as the use of the EDI system becomes sophisticated. The promotional efforts, proactive implementation strategy, and provision of technical expertise have a different association with volume, depth, or diversity and this may be due to the fact that the different facets of implementation can be affected by independent variables in different ways. The measurement strategies of implementation need to suggest a comprehensive scheme to direct an organization's EDI initiative [Massetti and Zmud, 1996] and indicate how organizations will benefit from EDI by pursuing each facet of the implementation. For instance, utilization can be specifically divided into several dimensions including the proportion of total customers linked by EDI and the total number of external transactions converted to EDI, and it is possible to examine the effects of independent variables on these dimensions.

The longitudinal study of Bergeron and Raymond [1997] has shown that level of imposition does not affect EDI advantage in the long run while it is negatively associated with EDI advantage in the short run. The same variable has a negative effect on organizational context (organizational support, implementation process, and control procedures) initially but positively affects it afterwards. This indicates the possibility of a change in the relationship between promotional efforts, proactive implementation strategy, and provision of technical expertise and EDI implementation. It will be interesting to investigate how the impact of the factors affecting innovation characteristics on EDI implementation changes over time. Empirical studies of EDI implementation that have employed a longitudinal research design are rare. It is important to understand the longer-term effects of EDI on the

determinants of its implementation in view of the rapid evolution of the technology. This will provide EDI adopters with guidelines so that they may form a favorable environment in which to integrate and utilize EDI and to fully obtain the benefits from this technology.

〈References〉

[1] Anderson, J. and Gerbing, D., "Structural Equation Modeling in Practice: a Review and Recommended Two-step Approach," *Psychological Bulletin*, Vol. 103, No. 3, 1988, pp. 411-423.

[2] Attewell, P., "Technology Diffusion and Organizational Learning: The Case of Business Computing," *Organization Science*, Vol. 3, No. 1, 1992, pp. 1-19.

[3] Bagozzi, R. and Yi, Y., "On the Evaluation of Structural Equation Models," Academy of *Marketing Science*, Vol. 16, No. 1, Spring 1988, pp. 74-94.

[4] Bergeron, F. and Raymond, L., "Managing EDI for Corporate Advantage: A Longitudinal Study," *Information & Management*, Vol. 31, 1997, pp. 319-333.

[5] Blalock, H.M., *Theory Construction: from Verbal to Mathematical Formulations*, Prentice-Hall, Englewood Cliffs, NJ, 1969.

[6] Booker, E. and Fitzgerald, M., "Retailers Try EDI Hard Sell," *Computerworld*, Vol. 24, February, 1990, pp. 1-8.

[7] Brancheau, J.C. and Wetherbe, J.C., "The Adoption of Spreadsheet Software: Testing Innovation Diffusion Theory in the Context of End-user Computer," *Information Systems Research*, Vol. 1, No. 2, 1990, pp. 115-143.

[8] Chan, S., Govindan, M., Picard, J.Y. and Leschiutta, E., *EDI for Managers and Auditors*, Electronic Data Interchange Council of Canada, Toronto, Ontario, 1993.

[9] Chau, P.Y.K. and Tam, K.Y., "Factors Affecting the Adoption of Open Systems: An Exploratory Study," *MIS Quarterly*, Vol. 21, No. 1, March 1997, pp. 1-24.

[10] Chung, Y., No. Y., and Kang, J.J., "A Study on the Relationship between Organizational and Innovation Driven Characteristics and the Diffusion of Electronic Data Interchange," "*Korean Journal of MIS Research*, Vol. 7, No. 3, 1997, pp. 89-108.

[11] Cooper, R.B. and Zmud, R.W., "Information Technology Implementation Research," *Management Science*, Vol. 36, No. 2, 1990, pp. 123-139.

[12] Curtis, C., "EDI over the Internet: Let the Games Begin," *Communications Week*, Vol. 627, No. 9, September 1996, pp. 59.

[13] Dennis, A.R., Pootheri, S.K., and Natarajan, V.L., "Lessons from the Early Adopters of Web Groupware," *Journal of Management Information Systems*, Vol. 14, No. 4, Spring 1998, pp. 65-86.

[14] DeSanctis, G. and Courtney, J., "Toward Friendly User MIS Implementation," *Communications of the ACM*, Vol. 26, No. 10, October 1983, pp. 732-738.

[15] Emmelhainz, M.A., *Electronic Data Interchange: A Total Management Guide*, Van Nostrand reinhold, Multiscience Press, Inc., New York, 1990.

[16] Ettlie, J.E., "Implementing Manufacturing Technologies: Lessons from Experience," In D. Davis et al. (ed.), *Managing Technological Innovation*, San Francisco: Jossey-Bass, 1986, pp. 72-104.

[17] Ferguson, D.M. and Hill, N.C., "The State of U.S. EDI in 1988," *EDI Forum*, Vol. 1, pp. 21-29, 1988.

[18] Fitzgerald, M., "Sears Puts Foot Down, Insists on EDI Ability," *Computerworld*, July, Vol. 16, 1990, pp. 132.

[19] Gatignon, H. and Robertson, T.S., "Technology Diffusion: An Empirical Test of Competitive Effects," *Journal of Marketing*, Vol. 53, No. 1, January 1989, pp. 35-49.

[20] Grover, V., "An Empirically derived Model for the Adoption of Customer-based Interorganizational Systems," *Decision Sciences*, Vol. 24, No. 3, 1993, pp. 603-640.

[21] Hansen, J.V. and Hill, N.C., "Control and Audit of Electronic Data Interchange," *MIS Quarterly*, Vol. 13, No. 4, December 1989, pp. 403-413.

[22] Hart, P.J. and Saunders, C.S., "Emerging Electronic Partnerships: Antecedents and Dimensions of EDI Use from the Supplier's Perspective," *Journal of Management Information Systems*, Vol. 14, No. 4, Spring 1998, pp. 87-111.

[23] Iacovou, C.L., Benbasat, I. and Dexter, A.S., "Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology," *MIS Quarterly*, Vol. 19, No. 4, December 1995, pp. 465-485.

[24] ISACA, *EDI Control Guide*, Information Systems Audit Control Association, EDI Council of Australia, Sydney Chapter, 1990.

[25] Ives, B. and Olson, M., "User Involvement and MIS Success: A Review of Research," *Management Science*, Vol. 30, No. 5, May 1984, pp. 586-603.

[26] Joreskog, K.G., "Statistical Analysis of Congeneric Tests," *Psychometrika*, Vol. 36, 1971, pp. 109-133.

[27] Jreskog, K.G. and Srbom, D., *LISREL 7: A Guide to the Program and Applications*, 2nd ed., SPSS Inc., 1989.

[28] Kim, B.G. and Chung, K.S., "Determinants of EDI Implementation in Korean Companies," *Korean Journal of MIS Research*, Vol. 9, No. 1, March 1999, pp. 165-191.

[29] Kim, H. and Lee, H.J., "Factors affecting the adoption of EDI in Korean Companies," *Korean Management Science Review*, Vol. 22, No. 1, 1997, pp. 159-187.

[30] Kimberly J.R. and Evanisko, M.J., "Organizational Innovation: the Influence of Individual, Organizational, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovations," *Academy of Management Journal*, Vol. 24, No. 4, 1981, pp. 689-713.

[31] Kwon T.H. and Zmud, R.W., "Unifying the Fragmented Models of Information Systems Implementation," in Boland and Hirschheim (Eds), *Critical Issues in Information systems Research*, John Wiley, New York, 1987.

[32] Massetti, B. and Zmud, R.W., "Measuring the Extent of EDI Usage in Complex Organizations: Strategies and Illustrative Examples," *MIS Quarterly*, Vol. 20, No. 3, September 1996, pp. 331-345.

[33] Meyer, A.D. and Goes, J.B., "Organizational Assimilation of Innovations: a Multi-level Contextual Analysis," *Academy of Management Journal*, Vol. 31, No. 4, 1988, pp.

897-923.

[34] Parker, D.B., *Computer Security Management*, Reston Publishing Company, Inc., Reston, Virginia, 1981.

[35] Philip, G., and Pedersen, P., "Inter-Organizational Information Systems: Are Organizations in Ireland Deriving Strategic Benefits from EDI?," *International Journal of Information Management*, Vol. 17, No. 5, 1997, pp. 337-357.

[36] Premkumar G. and Ramamurthy, K., "The Role of Interorganizational and Organizational Factors on the Decision Mode for Adoption of Interorganizational Systems," *Decision Sciences*, Vol. 26, No. 3, 1995, pp. 303-336

[37] Premkumar, G., Ramamurthy, K. and Nilakanta, S., "Implementation of Electronic Data Interchange: an Innovation Diffusion Perspective," *Journal of Management Information Systems*, Vol. 11, No. 2, 1994, pp. 157-186.

[38] Premkumar, G. and Roberts, M., "Adoption of New Information Technologies in Rural Small Businesses," *OMEGA*, Vol. 27, 1999, pp. 467-484.

[39] Rai, A. and Howard, G.S., "An Organizational Context for CASE Innovation," *Information Resources Management Journal*, Vol. 6, No. 3, 1993, pp. 21-34.

[40] Ramamurthy, K. and Premkumar, G., "Determinants and Outcomes of Electronic Data Interchange Diffusion," *IEEE Transactions on Engineering Management*, Vol. 42, No. 4, November 1995, pp. 332-351.

[41] Reich, B.H. and Benbasat, I., "An Empirical Investigation of Factors Influencing the Success of Customer-oriented Strategic Systems," *Information Systems Research*, Vol. 1, No. 3, pp. 325-347, 1990.

[42] Riggins, F.J. and Mukhopadhyay, T., "Overcoming EDI Adoption and Implementation Risks," *International Journal of Electronic Commerce*, Vol. 3, No. 4, Summer 1999, pp. 103-123.

[43] Rogers, E.M., *Diffusion of Innovations*, New York: The Free Press, 1995.

[44] Sanders, G.L. and Courtney, J.F., "A Field Study of Organizational Factors Influencing DSS Success," *MIS Quarterly*, Vol. 9, No. 1, March 1985, pp. 77-93.

[45] Scala, S., and McGrath, R. Jr., "Advantages and Disadvantages of Electronic Data Interchangean Industry Perspective," *Information & Management*, Vol. 25, 1993, pp. 85-91.

[46] Segev, A., Porra, J., Roldan, M., "Internet-based EDI Strategy," *Decision Support Systems*, Vol. 21, 1997, pp. 157-170.

[47] Senn, J.A., "Electronic Data Interchange; the Elements of Implementation," *Information Systems Management*, Winter 1992, pp. 45-53.

[48] Senn, J.A., "Expanding the Reach of Electronic Commerce: The Internet EDI Alternative," *Information Systems Management*, Summer 1998, 7-35.

[49] Stern, L.W. and Kaufmann, P.J., "EDI in Selected Consumer Goods Industries: An Interorganizational Perspective," in R. Buzzel, *Marketing in an Electronic Age*, Boston: Harvard Business School Press, 1985.

[50] Swanson, E.B., "Information Systems Innovation among Organizations," *Management Science*, Vol. 40, No. 9, September 1994, pp. 1069-1092.

[51] Teo, H.H., Tan, B.C.Y., Wei K.K. and Woo, L.Y., "Reaping Benefits through a Pro-active

Approach," *Information & Management*, Vol. 28, 1995, pp. 185-195.

[52] Thong, J.Y.L., "An Integrated Model of Information Systems Adoption in Small Businesses," *Journal of Management Information Systems*, Vol. 15, No. 4, Spring 1999, pp. 187-214.

[53] Tornatzky, L.G. and Fleischer, M., *The Processes of Technological Innovation*, Lexington Books, Lexington, MA, 1990.

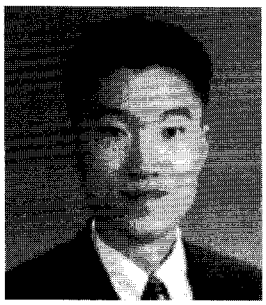
[54] Tornatzky, L.G. and Klein, K.J., "Innovation Characteristics and Innovation Adoption-implementation: A Meta-analysis of Findings," *IEEE Transactions on Engineering Management*, Vol. 29, No. 1, February 1982, pp. 28-45.

[55] Vitale, M.R., *American Hospital Supply Corp.: the ASAP System*, Harvard Business School Case Services No. 9-186-005, Harvard University, Boston, 1985.

[56] Zmud, R.W., "Diffusion of Modern Software Practices: Influence of Centralization and Formalization," *Management Science*, Vol. 28, No. 12, 1982, pp. 1421-1431.

◈ 이 논문은 2000년 3월 24일 접수하여 1차 수정을 거쳐 2001년 1월 4일 게재확정 되었습니다.

◆ 저자소개 ◆



이상재 (Lee, Sang-jae)

이상재는 한국과학기술원에서 경영정보공학으로 공학박사를 취득하였다. 한양대학교 디지털 경제경영대학, 디지털 경영학부 교수로 재직하고 있다. 그는 국제공인정보시스템감사사(CISA)이다. 주요연구분야는 Electronic Data Interchange(EDI)를 포함한 전자상거래시스템의 확산, 통제 및 감사 그리고 인공지능을 이용한 감사 및 통제제안지원시스템 등이다.