경영정보학연구
제9권 제2호
1999년 6월

환경변수가 EDI통제와 EDI구현과의 관계에 미치는 영향에 관한 탐색적 연구

이 상 재*, 한 인 구**

An Explorative Study on the Impact of Environmental Variables on the Relationship between EDI controls and EDI Implementation

Lee, Sangjae, Han, Ingoo

Electronic Data Interchange (EDI) is an important part of interorganizational electronic commerce due to the strategic impact derived from its use. In order to ensure successful implementation of EDI, EDI controls must first be developed. Because they are implemented in an environmental context, the characteristics of organizational environments have a significant impact on EDI controls. The control strategy for the EDI system - formal, informal, and automated controls - should fit certain organizational environments. A research model has been developed to depict the moderating effects of six environmental variables including industry, organizational, and task characteristics on the relationships between controls and implementation. It is shown empirically that the relationships between EDI controls and implementation are indeed affected by these factors. The results can help management design formal, informal, and automated controls in view of their own environmental contexts.

* Techno-Management Research Institute, Korea Advanced Institute of Science and Technology
** Graduate School of Management, Korea Advanced Institute of Science and Technology

Ⅰ. Introduction

Electronic Data Interchange (EDI) is an application of information technology that allows business partners to exchange electronic documents between computers in a standardized format. The implementation of EDI poses some security and integrity risks. Dependence on trading partners increases the possibility of sharing technology and databases. The domino effect caused by the mishaps of one partner within the EDI business cycle can make other trading partners vulnerable. Both parties must protect themselves from possible disclosure or alteration of transmitted messages by other partners or unauthorized third parties. As EDI expands to link diverse partners and VANs (Value Added Networks), it is necessary to see whether the trading partners or VAN service providers establish EDI controls that can detect and correct unexpected errors and failures in the system [Chan et al., 1993].

System vulnerability to EDI-related errors or failures increases with the increase of integration with internal IS, transaction volume, the number of trading documents, and trading partners Cafiero. The risks of disclosure of confidential information or to intrusion by unauthorized parties might be high in an interconnected network environment in EDI. Controls to reduce risks are important when there exist large transaction volume and processing complexity [Chan et al., 1993; Weber, 1988].

Although the security and integrity of EDI systems has become a key management issue, there are few studies on EDI controls that fit environmental contexts in order to promote the successful use of EDI. At the organizational level, organizational decline is inevitable if controls fail to match each firm's unique context [Ouchi, 1979]. The level and extent of EDI controls are contingent upon these factors. Excessive efforts by management to develop controls in view of their organizational context may lead to delays in processing or resistance from organizational members. Appropriate EDI system controls will encourage EDI practitioners to invest reasonable resources in its implementation. This will also contribute to the successful use of EDI by employing appropriate control strategies in an environmental context.

The purpose of this article is to examine the moderating role of environmental contexts in the relationship between EDI controls and EDI implementation. In order to investigate contingent control models, the study classifies EDI controls as formal, informal, and automated controls. The factors that influence EDI controls may include industry, organization, and task characteristics that affect successful innovation. In order to suggest a model of contingent controls, some EDI innovation-implementation studies and EDI control literature are reviewed. Our model was tested empirically with data collected from Korean companies that have adopted EDI. A summary of empirical findings is presented and issues for future research are suggested.

Ⅱ. EDI Controls and Implementation

EDI controls are defined in this study as the activities or processes an organization pursues to ensure security and integrity of EDI. This

study classifies EDI controls into three modes of controls: formal, informal, and automated controls. These controls can be combined collectively to achieve the organizational goal as each control gives a specific contribution to system performance (Lee et al. 1998). Formal, informal, and automated controls need each other for the enhancement of performance. An access control system using a password is one example that shows the interaction of the three controls for system performance. Formalized procedures of maintaining the user password and change control procedures for accessing control software are formal controls and they need informal controls such as user recognition of responsibility and faithfulness to the procedures in order to increase the effectiveness of the control system. Automated access control software and embedded audit routines are necessary as the access process becomes routine and repetitive. Automated control can find out and correct invalid or unauthorized accesses more accurately than manual systems in standardized and automated processes.

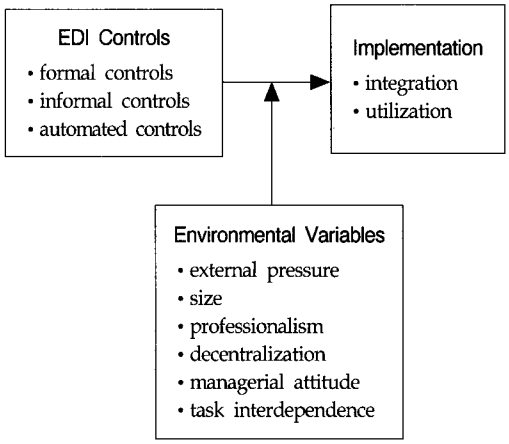
This study suggests two dimensions of EDI implementation: integration and utilization. EDI should be integrated with IS application to be effective because the key to the effective use of EDI is to integrate the information collected through EDI with internal IS applications so that the effectiveness and efficiency of the operations can be improved. Documents are received, validated, and accepted into the job-stream of the receiving computer, and immediately processed in an integrated environment. As companies increase the replacement of various communication media such as paper, face-to-face, telephone, and fax with EDI and its utilization, they must develop new EDI documents and expand network connections with external trading partners. Although it is still meaningful to consider various facets of the implementation process, the moderating effects of environmental variables on EDI controls are investigated in terms of two dimensions of implementation integration and utilization. These can be the basis for the future study of other dimensions of implementation.

As the implementation of system proceeds, tracking and control mechanisms are necessary to ensure the continuity of EDI services as the transaction volume and the speed of processing increases and human intervention reduces. "Control assurance" should be provided to various stakeholders including internal users, trading partners, and industry association as well as user departments, before the decisions regarding further implementation of system can be made (Chan et al., 1993). If sufficient security is not provided in computer use, manual work should be done for some internal applications planned for computerization. EDI implementation depends on the use of EDI controls, as the latter increase the potential for the former.

Ⅲ. Environmental Contexts for EDI Controls

External pressure, size, professionalism, decentralization, managerial attitude, and task interdependence are suggested based on a review of the literature on organizational control literature as well as organizational innovation-implementation and EDI adoption literature,

as the moderating variables in the relationship between EDI controls and implementation. The research model may be described as in <Figure 1>.



<Figure 1> Research Model

3.1 external pressures

One of the major reason for EDI adoption is external pressure from trading partners and customers [Arunachalam, 1995; Banerjee and Golhar, 1994; Iacovou et al., 1995]. Companies are more likely to adopt and implement EDI, if EDI is adopted by their trading partner which seeks operational and marketing benefits through EDI adoption. In this case, EDI should be implemented to maintain a good relationship with their partners.

When companies are influenced by other partners to implement EDI, they are likely to establish formal controls before informal controls have matured in the companies. Organizational learning takes time (e.g., to adjust to the rules and procedures and learn new ways to perform their tasks), although it has been treated as an important element in the successful usage of new technology. The formalized procedures are likely to be set up before organizational members exert their informal controls based on the recognition of responsibility and become accustomed to EDI. If there is an influential trading partner who adopts EDI, formal controls are developed to facilitate the adoption of EDI by trading partners.

Hypothesis 1-1: The positive influence of formal controls on EDI integration is greater when the extent of external pressure to implement EDI is higher.

Hypothesis 1-2: The positive influence of formal controls on EDI utilization is greater when the extent of external pressure to implement EDI is higher.

3.2 size

Large organizations have the technological expertise, trained human resources, financial resources needed to successfully implement EDI. However, problems with manual controls are compounded in large organizations. A large volume of transactions to be processed and increasing amounts of IS resources to manage are making manual controls less effective in large organizations. Large organizations need to increase the automation of controls to ensure the development of integrated and systematic controls for IS function. It is infeasible to manually control EDI in large organizations [Fullerton and Evens, 1989], as large organizations have a greater complexity of communication because of large transaction volume and more trading partners. Further, large organizations can more readily afford the high expense of

automated controls [Lawrence, 1988] and more easily provide sophisticated technical expertise required for the full implementation of automated controls than can small organizations.

Hypothesis 2-1: The positive influence of automated controls on EDI integration is greater when the size of organization is larger.

Hypothesis 2-2: The positive influence of automated controls on EDI utilization is greater when the size of organization is larger.

3.3 Professionalism

Professionals prefer their own values and beliefs to formal rules in coping with exceptions in their work and are not accustomed to standard operating procedures, formal rules or clear standards of performance [Ouchi and Maguire, 1975]. Professionals in the IS department often consult with their peers and rely on their knowledge and intuition to address unexpected problems. The efficiency and effectiveness of specialists' work would increase through the use of informal controls rather than formal procedures, as they are often engaged in jobs that demand creativity.

Automated controls such as an integrated test facility and snapshot have not yet been fully utilized because of insufficient technical ability and the complexity of its architecture [Lawrence, 1988]. Technical knowledge and expertise necessary for the introduction of automated controls can be provided by professionals to facilitate automation of controls. Thus, in specialized and professional organizations composed of experts, informal and automated controls are likely to be established.

Hypothesis 3-1-1: The positive influence of informal controls on EDI integration is greater when the level of professionalism is higher.

Hypothesis 3-1-2: The positive influence of informal controls on EDI utilization is greater when the level of professionalism is higher.

Hypothesis 3-2-1: The positive influence of automated controls on EDI integration is greater when the level of professionalism is higher.

Hypothesis 3-2-2: The positive influence of automated controls on EDI utilization is greater when the level of professionalism is higher.

3.4 decentralization

IS members including IS staff should be made aware of the importance of the faithful execution of their jobs and responsibility, as they are given more latitude to operate and manage the system. Further, as organizational decision-making authority is relegated to its members, informal controls initiated by organizational members are more effective than formal written procedures to facilitate communication of innovative and creative ideas. Centralized, mechanistic and formal organizational structures often hinder coordination and communication, as they inhibit communication of innovative ideas [Russel and Russel, 1992]. Design details must be determined though the discussion among internal departments and external partners; sharing of experience and collaboration should be encouraged to foster improvement of the system. Internal needs of user departments and requirements of trading partners should be determined to effectively integrate EDI

with internal applications; they should be encouraged to participate in system design to make it more acceptable to their partners. Informal interaction between EDI staff and IS members should be also facilitated to share their technical knowledge and skills.

Hypothesis 4-1: The positive influence of informal controls on EDI integration is greater when the extent of decentralization is higher.

Hypothesis 4-2: The positive influence of informal controls on EDI utilization is greater when the extent of decentralization is higher.

3.5 managerial attitude toward organizational change

The value of some traditional control systems may be significantly challenged, while organizational change is proceeded. Preparing for change, streamlining workflow, and planning for EDI implementation demand the efforts for the establishment of new control systems in changed organizational structure. Dependence on management-initiated formal controls in systems development and maintenance increases, if management seeks to enact organizational change while implementing EDI [Chan et al., 1993]. Management with positive attitude organizational change will increase their reliance on formal controls to monitor organizational change and the added complexity and sophistication of new EDI systems. Hence, a positive managerial attitude toward organizational change is positively related to the use of formal controls.

Hypothesis 5-1: The positive influence of formal controls on EDI integration is greater when the extent of managerial attitude toward change is more positive.

Hypothesis 5-2: The positive influence of formal controls on EDI utilization is greater when the extent of managerial attitude toward change is more positive.

3.6 task interdependence

Interdependent task environments demand the cooperation and coordination of various functional units [Otley, 1980]. There is less reliance on manual procedures to guide workflow in interdependent task environments. Controls should be enacted that properly monitor each system for the benefit of others, as the performance of each application depends on others. Internal applications linked with EDI network interact rapidly with other departments' applications to process data entered from EDI networks; interactive automated controls can monitor the complex interaction between interdependent departments. Data flow controls from one application to another Interdependent task environments should be enacted instantly before errors are propagated. Hence, automated controls are likely to be implemented in order to control interdependent processes.

Hypothesis 6-1: The positive influence of automated controls on EDI integration is greater when the level of task interdependence is higher.

Hypothesis 6-2: The positive influence of automated controls on EDI utilization is greater when the level of task interdependence is higher.

Ⅳ. Research Design and Analysis

4.1 Data Collection

Structured interviews with EDI practitioners were used to collect data. Some questions were answered by their colleagues, if these questions could be better answered by these persons who have sufficient knowledge for a response. The industries which have used EDI heavily are identified and the companies in those industries which are likely to have adopted EDI are contacted. The data used in validating the research model are gathered as part of a larger investigation concerning EDI controls (Lee et al., 1998). Using the structured questionnaire, a total of 110 interviews are made. The individual organization that has adopted EDI is the unit of analysis in this study.

The average number of employees in the responding organizations was 5,849. Average annual sales were 1,952 billion won (2.44 billion dollars) <Table 1>. EDI user firms could be expected to be larger firms, as larger firms were more easily able to invest resources to integrate and control EDI than were small firms.

<Table 1> Respondent Profiles

	Mean	Median
Number of employees in organization	5849	2076
Annual Sales (billion won)	1953	610
Number of Employees in DP dept.	86	40

Representative VANs used by respondent organizations are suggested in <Table 2>. KTENET and DACOM are the major VAN service providers and other VANs had recently started EDI services and had fewer subscribers than either KTNET or DACOM.

<Table 2> VAN of Responding Firms (* the number is larger than 110 (the number of total respondents) because one respondent may use more than one VANs)

VAN Name	Number of Responses	Percent (Total 168 Responses)
KTNET	57	33.9%
DACOM	55	32.7%
KLNET	13	7.7%
Samsung-Net	12	7.2%
LG-EDS NET	8	4.8%
Hyundai-NET	3	1.7%
POSDATA-NET	8	4.8%
KICC	2	1.2%
Others	10	6%
Total	168*	100%

4.2 Measures, Measurement Reliability, the Validity

<Table 3> represents the measures for the research variables. Environmental variables were adopted from previous literature. Based on various sources [Chan et al., 1993; Jamieson, 1994; Marcella and Chan, 1993; ISACA, 1990], items for EDI controls were newly developed. Seven-point Likert-type scales were used to measure EDI controls.

Formal controls are initiated by management and based on written procedures to be formally abided by. The items of formal controls and automated controls are based on Chan et al. (1993), ISACA (1990), Jamieson (1994), Marcella and Chan (1993). The items for informal controls

<Table 3> Items for research variables

variables	items	sources
external pressure	• influence of trading partners and government over EDI implementation (PRES1)	O'Callaghan et al. (1992)
size	• total sales • the number of employees	Runge (1985) Grover (1990)
professionalism	• the number or percentage of professional staff members with educational backgrounds (PROF1)	Daft and Steers (1986) Daft and Becker (1978)
decentralization	• the degree to which participation of subordinates in company decision making is encouraged (DEC1) • the degree to which employees can make their own decisions (DEC2) • the extent of concentration of decision making authority (DEC3)	Corwin (1975) Aiken and Hage (1971)
managerial attitude	• the degree to which top management is willing to accept changes in organizational structure (ATT1) • the degree to which top management is willing to absorb technologies with which the organization is not familiar (ATT2) • the degree to which top management is willing to commit large investments to new applications (ATT3)	Clemons et al. (1985)
task interdependence	• the degree to which performance of one task depends on other tasks (TINT1)	adapted from Goodhue and Thompson (1995)
formal control	• system change control by authorization (FC1) • integrity check of the message before processing in the applications (FC2) • transaction log for the possible errors and collapse (FC3) • appropriateness of system login procedures using password (FC4) • integrity check after generating EDI messages (FC5) • authentication of trading partners after receiving EDI messages (FC6)	adapted from Chan et al. (1993) Jamieson (1994) Marcella and Chan (1993) ISACA (1990)
informal control	• recognition of possible propagation of errors from one system to another (IC1, IC2) • recognition of the importance of their responsibility (IC3, IC4) • ability to judge peer's errors in their tasks by experience (IC5, IC6) • ability to cope with the errors effectively by experience (IC7, IC8) • interaction with seniors or peers to cope with problems in their tasks (IC9, IC10)	adapted from Jaworski (1993)
automated control	• programmed integrity check before processing in application systems (AC1) • applying access control software on critical applications and files (AC2) • automated data integrity check before transmission of EDI messages (AC3) • automated authentication of trading partners using message code (AC4)	adapted from Chan et al. (1993) Jamieson (1994) Marcella and Chan (1993) ISACA (1990)
integration	• integration with five application systems selected by respondents (INTG1)	adapted from Premkumar et al. (1994)
utilization	• utilization of EDI in five application system selected by respondents (UTIL1)	adapted from Premkumar et al. (1994) Whang (1991)

are adapted from Jaworski et al. (1993). They are based on the values, judgments and communications of organization members. Automated controls consist of automated control procedures and methods.

Implementation has two dimensions: integration and utilization. Integration is defined by the extent to which EDI data can be directly processed within applications; the integration of five application systems which respondents believe to be very closely connected with EDI is measured. They are adapted from measures of Premkumar et al. (1994). Utilization indicates the extent to which a company use EDI in the five applications; the proportion to which a firm's information exchange and processing are handled through EDI is measured.

Reliability and validity tests were performed for the collected data. <Table 4> shows the final Cronbach's alphas; one item each for professionalism, role of IS, and task routineness were deleted to increase Cronbach's Alpha. All scales indicates moderate or high reliability, as they exceeded 0.7 after deleting low-to-total correlated items were deleted, with the exception of external pressure. The coefficient alpha of external pressure was slightly lower than the guideline. As all of the items for these two variables had been validated in earlier IS studies, it was decided to include all items for these variables.

Construct validity was assessed using convergent and discriminant validity. The results of individual factor analysis for each research variable are presented in <Table 5>. The variables have high convergent validity, as all items measuring a construct cluster together to form a single construct.

Correlations among variables with cronbach alpha are compared to test the discriminant validity. If the correlation between one variable and another is not as high as each variable's coefficient alpha, it indicates a good discrimination [Gaski and Nevin, 1985]. Since the correlations between two variables are in no case as high as the coefficient alpha of each, the research variables have high discriminant validity.

<Table 4> Bivariate correlations between research variables Coefficient alpha is computed for the variables which have more than 1 item

	alpha	(1)	(2)	(3)	(4)	(5)	(5)	(7)	(8)	(9)	(10)	(11)
(1) external pressure	.6148	1.0000										
(2) size	.7701	.1720*	1.0000									
(3) professionalism	—	-.0183	.0828	1.0000								
(4) decentralization	.7553	.1832*	.2711***	.2505***	1.0000							
(5) managerial attitude	.8846	.1479	.1474	.3607***	.3946***	1.0000						
(6) task interdependence	—	.0672	.0467	.1815*	.1065	.1650*	1.0000					
(7) formal controls	.8240	.3521***	.2318**	.2651***	.2767***	.1258	.0128	1.0000				
(8) informal controls	.9070	.3568***	.2585***	.2825***	.3704***	.2640***	.0956	.5758***	1.0000			
(9) automated controls	.7517	.2403**	.3133***	.1994**	.3368***	.2783***	.0776	.5465***	.6818***	1.0000		
(10) integration	—	.0437	.1959**	.0889	.0320	.0477	.1337	.2753***	.2338**	.2778***	1.0000	
(11) utilization	—	.0434	.1580	.3206***	.0527	.0592	.0127	.0127	.2432**	.1353	.3212***	1.0000

*** p < 0.01, ** p < 0.05, * p < 0.1

<Table 5> Factor Analysis for Multiple-Item Measures
Only variables that have more than 3 item are analyzed

Variables	items	factor loadings	eign-values	percent of variance explained	cumulative percent
decentralization	DEC1	.8640	2.0195	67.3	67.3
	DEC2	.8745			
	DEC3	.7130			
managerial attitude	ATT1	.7905	2.1595	72.0	72.0
	ATT2	.8727			
	ATT3	.8792			
formal controls	FC1	.5079	3.2218	53.7	53.7
	FC2	.6681			
	FC3	.7891			
	FC4	.7556			
	FC5	.8176			
	FC6	.8096			
informal controls	IC1	.7914	5.4804	54.8	54.8
	IC2	.8429			
	IC3	.7962			
	IC4	.7957			
	IC5	.7570			
	IC6	.7523			
	IC7	.6328			
	IC8	.6934			
	IC9	.6269			
	IC10	.6807			
automated controls	AC1	.6823	2.3080	57.7	57.7
	AC2	.7315			
	AC3	.7945			
	AC4	.8223			

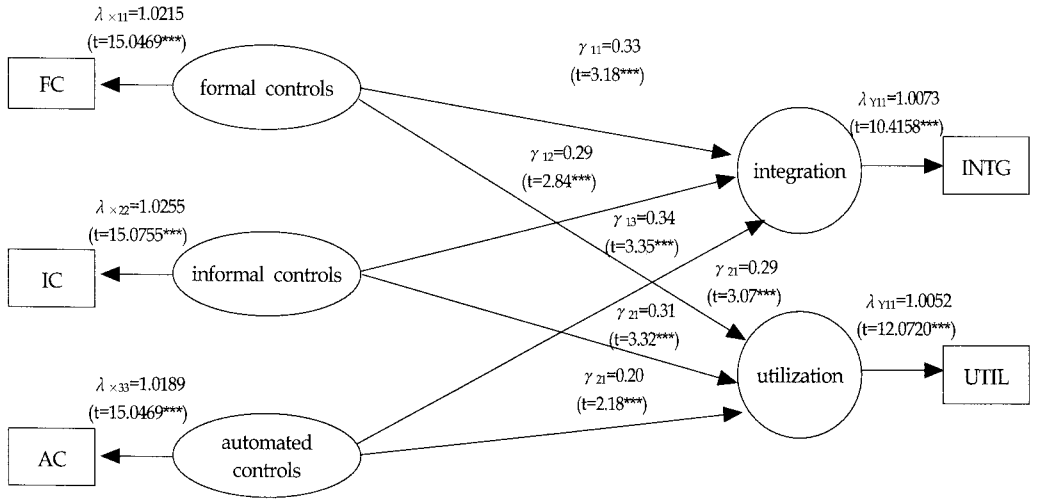
* Variables which failed to cluster together as one factor

4.3 Data Analysis and Results

One of the popular approaches for testing interaction effects is multiple regression with product terms (Cohen and Cohen 1975). Multicollinearity can be a concern, however, in the multiple regression model using multiplicative interaction terms that combines elements of independent variables when the product terms are highly correlated with component variables. This can be the case here. For example, the correlation between external pressure and external pressure×formal control is 0.8573 and the correlation between size and size×formal control is 0.9851. Multiple regression with product terms is not appropriate for testing the hypotheses.

Multi-sample analysis using LISREL (Linear Structural Relationships) can be used to test the moderating effect of environmental variables on the relationship between EDI controls and implementation. *Multi-sample analysis* can be applied to analyze data from several samples simultaneously according to LISREL models for each group where some parameter are constrained to be equal over groups. Firstly, <Figure 2> represents structural relations, standardized solutions for path coefficient, and the model fit estimated using whole sample. Formal, informal, and automated controls significantly affect integration and utilization. A summary of the model fit measures observed for the model analyzed with entire sample is shown in the lower part of <Figure 2>. These fitness indices indicate a good fit of the model and achieve the recommended values by Joreskog and Sorbom (1989).

The sample are divided into two groups (*low* and *high* groups) by the median value of each environmental variable as the dividing point, in order to use *multi-sample* analysis. Chi-square difference test is used to examine the significance of differences in the path coefficient from independent variables to dependent ones across *low* and *high* groups.



Chi-square=2.4456
Goodness of Fit Index (GFI)=0.9908
Adjusted Goodness of Fit=0.8617
Normed Fit Index (NFI)=0.9835

Non-Normed Fit Index (NNFI)=0.8956
Comparative Fit Index (CFI)=0.9896
Root Mean Square Residual (RMSR)=0.0550

<Figure 2> Structural Equation Analysis (*** p < 0.01, ** p < 0.05, * p < 0.1)

<Table 6> (a) Causal effects between controls and integration in subgroups

Causal Path	subgroup	MLE of coefficient	Standard coefficient	t-value	χ^2 difference d.f.=1
formal controls →integration	low external pressure group	0.0211	0.0210	0.1415	3.5851*
	high external pressure group	0.4085	0.4065***	3.7705	
	weak managerial attitude group	0.0349	0.0348	0.2283	2.4342
	strong managerial attitude group	0.3606	0.3597***	3.44940	
informal controls →integration	low professionalism group	-0.1075	-0.1076	-0.6269	3.2788*
	high professionalism group	0.3188	0.3192***	3.3175	
	low decentralization group	-0.0583	-0.0586	-0.4324	4.4959**
	high decentralization group	0.4051	0.4072***	3.8248	
automated controls →integration	small size group	0.1813	0.1871*	1.4160	0.2193
	large size group	0.2768	0.2856***	2.5245	
	low professionalism group	0.1707	0.1707	0.9957	0.5808
	high professionalism group	0.3423	0.3424***	3.6767	
	low interdependence group	0.0058	0.0058	0.0421	4.7977**
	high interdependence group	0.4805	0.4831***	4.1564	

(b) Causal effects between controls and utilization in subgroups

Causal Path	subgroup	MLE of coefficient	Standard coefficient	t-value	χ^2 difference d.f.=1
formal controls →utilization	low external pressure group	0.0323	0.0318	0.2197	2.2667
	high external pressure group	0.3365	0.3311***	3.0980	
	weak managerial attitude group	-0.0321	-0.0320	-0.2096	3.4962*
	strong managerial attitude group	0.3613	0.3593***	3.4704	
informal controls →utilization	low professionalism group	0.1978	0.1972	1.1824	0.2121
	high professionalism group	0.3021	0.3012***	3.1757	
	low decentralization group	0.1774	0.1787*	1.2894	0.7032
	high decentralization group	0.3616	0.3643***	3.4876	
Automated controls →utilization	small size group	-0.1958	-0.1962*	-1.4910	7.1199***
	large size group	0.3866	0.3873***	3.4282	
	low professionalism group	-0.1726	-0.1720	-1.0321	3.1599*
	high professionalism group	0.2282	0.2274***	2.3637	
	low interdependence group	-0.0687	-0.0687	-0.4938	2.3921
	high interdependence group	0.2640	0.2640**	2.1668	

(MLE:Maximum Likelihood Estimate, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$)

The results of multi-sample analysis are represented in <Table 6>. The significant improvement in χ^2 statistics in the *high* groups indicates support of the moderation hypotheses.

The results can be shown separately according to whether they are significant at the 0.05 or 0.1 significance levels. There are three hypotheses that are accepted according to the 0.05 significance level; H2-2, H4-1, and H6-1. The positive effect of informal controls on integration is significantly greater when decentralization is high. Automated controls positively affect integration significantly more when task interdependence is high, while they positively affect utilization significantly more when size is high.

Four hypotheses (i.e., H1-1, H3-1-1, H3-2-2, and H5-2) can be accepted at the 0.1 significance level. Formal controls have a greater degree of significant positive effect on integration when external pressure is high, while they positively affect utilization significantly more when managerial attitude is high. Informal controls positively affect integration significantly more when professionalism is high. Automated controls positively affect utilization significantly more when professionalism is high. The results of the testing of hypotheses are indicated in <Table 7>.

<Table 7> Results of testing hypotheses Hypothesis is rejected if p-value is greater than 0.1

Hypotheses	Results	significance
1-1	accepted	$p < 0.1$
1-2	rejected	$p > 0.1$
2-1	rejected	$p > 0.1$
2-2	accepted	$p < 0.01$
3-1-1	accepted	$p < 0.1$
3-1-2	rejected	$p > 0.1$
3-2-1	accepted	$p < 0.1$
3-2-2	rejected	$p > 0.1$
4-1	accepted	$p < 0.05$
4-2	rejected	$p > 0.1$
5-1	rejected	$p > 0.1$
5-2	accepted	$p < 0.1$
6-1	accepted	$p < 0.05$
6-2	rejected	$p > 0.1$

V. Conclusions

The contingency model of EDI controls is suggested based on technology innovation studies, innovation-implementation research, contingent control theory, and IS control studies. Environmental variables, external pressure, size, professionalism, decentralization, managerial attitude and task interdependence are suggested to affect the relationship between EDI controls and implementation-

integration and utilization. Multi-sample analysis is used; the observations were divided into two groups with the median value of each environmental variable as the dividing point and chi-square difference test is applied over these two groups. The results indicate that controls appropriate for environ- mental contexts should be strengthened to facilitate EDI implementation.

The relationship between informal controls and integration is significantly affected by decentralization. Informal controls should be enhanced for successful integration when the extent of decentralization is high. Risk recognition, sense of responsibility, experience, and interaction with their colleagues of EDI staff members are needed, according to the authority they are given in order to enhance integration.

Task interdependence is significant to the relationship between automated controls and integration. For the further integration of interdependent tasks, highly automated procedures are necessary in order to streamline and monitor interactive work processes. Preventive controls such as embedded audit routines or access controls systems become important, because the outcomes of one system can rapidly propagate into others. As integrated interdependent tasks are sequentially processed at high speeds, automated controls should be established in order to detect and correct errors as early as possible.

Company size was significant to the relationship between automated controls and utilization. Adequate IS resources are necessary for the implementation of automated controls such as integrated test facilities and concurrent audit techniques. The implementation of automated controls becomes cost-effective only when there exist large volumes of transactions. The high cost of automated controls is acceptable only when large organizations and organizations with sophisticated IS intend to increase the utilization of EDI.

Four additional hypotheses were accepted, although they were less significant (i.e., $p < 0.1$). External pressure is significant to the relationship between formal controls and integration. EDI adopters are likely to develop formal procedures to facilitate integration, when they are pressured to implement EDI. Strong support from user departments as well as from management is needed for the integration of EDI. External influence from trading partners or industry associations which emphasize the effectiveness of EDI integration strongly affects the decisions regarding the extent of integration.

Professionalism was significantly related to the relationship between informal controls and integration. When there exist a lot of specialists in organizations, informal controls should be enhanced for successful integration. Risk recognition, sense of responsibility, and experience of EDI staff members, and interaction with their colleagues are more needed if they are more

educated. EDI staff, especially highly educated members, seem to recognize the impact of sophisticated tech- nologies on security and integrity, and understand the increased vulnerability from an integrated environment to external authorized access.

Managerial attitude significantly affects the relationship between formal controls and utilization. The extent of utilization can represent management's recognition of system advantages, as utilization refers to the extent that EDI is used in exchanging messages with trading partners. Management is expedited to use of formal controls to facilitate system utilization, when management has a significantly positive attitude toward change; this indicates that they clearly perceive the relative advantages of system implementation.

Staff professionalism positively affected the relationship between automated controls and utilization. Adequate IS expertise should be available in order to successfully implement automated controls such as concurrent audit modules and integrated control routines. Organizations with highly educated IS personnel will have the expertise required to implement automated controls to increase utilization of EDI.

Professionalism and decentralization did not affect the relationship between informal controls and integration. Recognition of risks, sense of responsibility, experience of EDI staff members, and interaction among them were not affected by these two factors for EDI utilization. EDI adopters in Korea largely depend on VANs in external connections with trading partners, and the development of new documents; communication controls are provided primarily by VAN service providers when companies participate in a VAN. Commitment arising from the recognition of risk or responsibility may be low when controls are largely depended on VANs; this results in a reduced number of controls developed by EDI adopters. Commitment to individual tasks by the EDI staff members of adopting companies may be low in situations where much of the effort to implement external connection and develop new documents is made by VAN service providers.

The results of this study have significant implications for EDI practitioners. The same control mechanisms may result in different outcome (i.e., integration, utilization) according to the context in which they are used. The benefits of EDI are commensurate with the extent that it is integrated with internal applications and linked with many trading partners. Companies considering the implementation of EDI, however, should develop formal, informal, and automated controls appropriate to their environments. For example, an organization with sophisticated IS should implement automated controls and should check whether these controls are properly operating to cope with errors and manage large volumes of data processed at high speeds. The results provide insights in the design of internal EDI controls; companies can invest their resources on the modes of controls most demanded in their environmental contexts for the implementation success of EDI.

〈References〉

[1] Aiken, M. and Hage, J., "The Organic Organization and Innovation," *Sociology*, Vol. 5, 1971, pp. 63-82.

[2] Arunachalam, V., "EDI: An Analysis of Adoption, Uses, Benefits and Barriers," *Journal of Systems Management*, March/April 1995, pp. 60-64.

[3] Banerjee, S. and Golhar, D.Y., "Electronic Data Interchange: Characteristics of Users and Nonusers," *Information & Management*, Vol. 26, 1994, pp. 65-74.

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

[5] Clemons, E.K., Keen, P.W., and Kimbrough, S.O., "Telecommunications and Business Strategy: the Basic Design Variables," in Nolan, Norton & Company Managing Telecommunications for Strategic Advantage in Europe, London, referenced in Runge (1985), 1985.

[6] Cohen, J. and Cohen, P., *Applied Multiple Regression / Correlation Analysis for the Behavioral Sciences*, Erlbaum, Hillsdale, NJ, 1975.

[7] Corwin, R.G., "Innovation in Organizations: the Case of Schools," *Sociology of Education*, Vol. 4, Winter 1975, pp. 1-37.

[8] Crouse, R.J., "PC, midrange, or mainframe: choosing the right EDI platform," *EDI Forum*: The Journal of EDI, Vol. 3, 1990, pp. 117-120.

[9] Daft, L.R. and Becker, S.W., *The Innovative Organization*, New York:Elsevier, 1978.

[10] Daft, L.R. and Steers, R.M., *Organizations: A Micro/Macro Approach*, Scott, Foresman and Company, 1986.

[11] Fullerton, K.H. and Evens, M.D.,"EDI and Auditing: Opportunity and Threat," *EDI Forum*: The Journal of EDI, Vol. 2, 1989, pp. 74-77.

[12] Gaski, J.F. and Nevin, J.R., "The Differential Effects of Exercised and Unexercised Power Sources in a Marketing Channel," *Journal of Marketing Research*, Vol. 22, May 1985, pp. 130-142.

[13] Goodhue, L.D. and Thompson, R.L., "Task-technology Fit and Individual Performance," *MIS Quarterly*, Vol. 19, No. 2, 1995, pp. 213-236.

[14] Grover, V., *Variables Influencing Adoption and Implementation of Customer Based Interorganizational Systems*, Unpublished Ph.D. Dissertation, University of Pittsburgh, 1990.

[15] ISACA (Information Systems Audit and Control Association), EDI Control Guide, *EDI Council of Australia*, 1990.

[16] 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.

[17] Jamieson, R., *EDI: An Audit Approach*, The EDP Auditors Foundation, Inc., 1994.

[18] Jaworski, J.B., Stathakopoulos, V., and Krishnan, H.S., "Control Combinations in Marketing: Conceptual Framework and Empirical Evidence," *Journal of Marketing*, Vol. 57, January 1993, pp. 57-69,

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

[20] Lawrence, C.M., "Usage of Cuncurrent EDP Audit Tools," *The EDP Auditor Journal*, Vol. 3, Fall 1988, pp. 49-54.

[21] Lee, S., Han, I., and Kym, H., "The Impact of EDI Controls on EDI Implementation," *International Journal of Electronic Commerce*, Vol. 2, No. 4, 1998, pp. 71-98.

[22] Lee, S. and Han, I., "The Impact of Organizational Characteristics on EDI Implementation in Korea," Working Paper, Korea Advanced Institute of Science and Technology, 1999.

[23] Marcella, J.A. and Chan, S., *EDI Security, Control, and Audit*, Artech House Inc., 1993.

[24] O'Callaghan, R., Kaufmann, P.J., and Konsynski, B.R., "Adoption Correlates and Share Effects of Electronic Data Interchange Systems in Marketing Channels," *Journal of Marketing*, Vol. 56, 1992, pp. 45-56.

[25] Otley, T.D., "The Contingent Theory of Management Accounting: Achievement and Prognosis," *Accounting, Organization and Society*, Vol. 5, No. 4, 1980, pp. 413-428.

[26] Ouchi, W.G. and Maguire, M.A., Organizational Control: Two Functions," *Administrative Science Quarterly*, Vol. 20, December 1975, pp. 559-569.

[27] Ouchi, W.G., "A Conceptual Framework for the Design of Organizational Control Mechanisms," *Management Science*, Vol. 25, September 1979, pp. 833-847.

[28] 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.

[29] Rogers, D.A, *The Diffusion of Innovations*, 4th ed., Free Press, NY, 1995.

[30] Runge, D.A., *Using Telecommunications for Competitive Advantage*, Unpublished Ph.D. Dissertation, Oxford University, 1985.

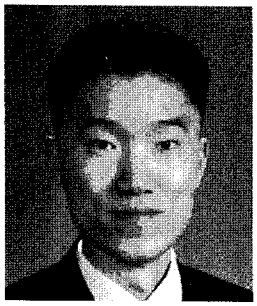
[31] Russel, D.R. and Russel, C.J., "An Examination of the Effects of Organizational Norms, Organizational Structure, and Environmental Uncertainty on Entrepreneurial Strategy," *Journal of Management*, Vol. 18, No. 4, 1992, pp. 639-656.

[32] Weber, R., *EDP Auditing: Conceptual Foundations and Practice*, McGraw-Hill, Inc., 2nd ed., 1988.

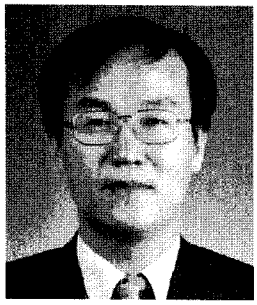
[33] Whang, K., *Evaluating the Adoption, Implementation and Impact of Electronic Data Interchange (EDI) Systems*, Unpublished Ph.D. Dissertation, New York State University, 1991.

◈ 이 논문은 1998년 9월 15일 접수하여 1차 수정을 거쳐 1999년 6월 4일 게재확정되었습니다.

◆ 저자소개 ◆



이상재(Lee, Sangjae)
공동저자 이상재는 한국과학기술원에서 경영정보공학으로 공학박사를 취득하였다. 한국과학기술원 테크노경영연구소 연구원으로 재직하고 있다. 그는 국제공인정보시스템감사사 (CISA)이다. 주요연구분야는 Electronic Data Interchange (EDI)를 포함한 전자상거래시스템의 구현, 통제 및 감사 그리고 인공지능을 이용한 감사 및 통제설계지원시스템 등이다.



한인구(Han, Ingoo)
공동저자 한인구는 서울대학교에서 국제경제학 학사를 받고 한국과학기술원에서 경영과학 전공으로 석사학위를 받고 University of Illinois at Urbana-Champaign에서 회계정보시스템을 전공하여 경영학박사학위를 취득하였다. 국민대학교 회계학과 조교수를 역임하였고 현재 한국과학기술원 테크노경영대학원 부교수로 재직하고 있다. 그는 Decision Support Systems, Expert Systems with Applications, International Journal of Intelligent Systems in Accounting, Finance and Management, International Journal of Electronic Commerce, Contemporary Accounting Research, Engineering Economist, 경영학연구, 경영정보학연구, 회계학연구 등에 논문을 발표하였다. 주요관심분야는 인공지능을 이용한 주가예측, 신용평가 및 도산예측, 정보시스템감사 및 보안등이다.