

EDI 시스템의 도입에 관한 연구

황 경 태¹⁾

Evaluating The Adoption of EDI Systems

This study investigates a special class of Inter-Organizational Systems, Electronic Data Interchange (EDI) systems. The major objective of this research is to identify the factors that facilitate or inhibit the adoption of an EDI system. A research model is developed to investigate the research questions identified. The adoption of EDI systems is assumed to be affected by four contextual factors: 1. general characteristics of the industry in which a firm operates, 2. EDI-related industry characteristics, 3. general characteristics of the firm, and 4. information technology (IT) related firm characteristics. The findings of this study provide strong supporting evidence that most of the variables proposed and tested in the study are important factors affecting the adoption of EDI systems.

1) 동국대학교 경상대학 정보관리학과

I. INTRODUCTION

With the proliferation of telecommunication technologies, the traditional internal focus of information systems (IS) has shifted to entities beyond the organization's boundaries, such as customers, suppliers and even competitors. This type of IS is described as an inter-organizational system (IOS). The IOS plays a vital role in changing industry structure and potentially providing competitive advantages to the adopting firm [Porter and Millar, 1985].

Electronic Data Interchange (EDI) systems are a special class of IOS. While it has been predicted that the use of EDI systems will increase, very little is known about the successful deployment of such systems. Particularly there is a lack of information about the factors that facilitate or inhibit the adoption of EDI systems.

This paper first reviews the research on EDI systems. Based on previous studies in the area as well as related area in IS deployment, it then builds a research model. The research design, methodology, and variables in the model, hypotheses to be tested and the data collection method are then presented. Test results of the research model are detailed next. This

paper concludes with a summary of major findings and implications of the study for both research and managerial practice.

II. ELECTRONIC DATA INTERCHANGE (EDI) SYSTEMS

2-1. Definition of EDI

EDI has been defined in numerous but similar ways in the literature [Benjamin, et.al., 1990; Davis, 1988; EDI Research, Inc., 1989; Hinge, 1988]. Hinge [1988], for example, defined EDI as intercompany, computer-to-computer exchange of business documents in standard formats. Almost all the definitions of EDI contain a few common key words such as intercompany, standard or structured format and computer-to-computer communication. These key words will be explained further in order to clarify the concept and to differentiate EDI from other electronic communication applications.

First, intercompany communication indicates that data transfer occurs between two separate companies and cooperation between the two is required to make the system work properly. A company that initiates the development of the EDI system

and prompts its trading partner firms to adopt the system is called a "hub company" [Langner, 1990; Payne, 1989].

Second, standard format communication implies that information to be transmitted must be formatted according to a predefined layout so that a computer can process the information without human assistance. According to Hinge [1988], four types of EDI standards exist: proprietary, industry-specific, cross-industry and international standard. A proprietary standard is set by one company which has enough leverage to ensure that all trading partner firms use its standard. An industry-specific standard is set by an industry trade group and promotes industry-wide electronic communication. Due to the industry specific growth of EDI, multiple industry-specific standards exist. Examples are Uniform Communication Standard (UCS) in the grocery industry, Transportation Data Coordinating Committee (TDCC) standard in transportation, and Warehouse Information Network Standard (WINS) in warehousing to name a few. These separate standards issues are now beginning to be resolved by a cross-industry standard, called X.12, which was developed by American National Standards Institute. At the international level, a stan-

dard, called EDIFACT (EDI for Administration, Commerce and Transport), was developed by the United Nations. Typically, a company chooses an EDI standard that will facilitate communications with the maximum number of trading partners.

Finally, computer-to-computer communication refers to the fact that information flows directly from a hub company's application system to the trading partner's application system or vice versa without human intervention. For computer-to-computer transmission to be possible, a communication network must be established to interconnect both companies' computer systems. There are basically two ways to develop an EDI network: 1. establish one's own network and 2. use a third-party value-added network. Large EDI users are more likely to set up their own communications networks because of the sheer number of communication links involved [Belitsos, 1988; Stix, 1987]. Advantages of private EDI networks include additional security and the possibility of using proprietary EDI standards to exert more control over trading partner firms [Belitsos, 1988]. However, for most but the very largest corporations, a third-party network is a more feasible solution

[Stix, 1987]. Popular third-party EDI network providers in the U.S. are General Electric Information Services (EDI*Express), McDonnell Douglas Integrated Business Systems Division (EDI*Net), Control Data Corp. (REDINET), Sterling Software, Inc. (ORDERNET) and IBM Corp. (IBM Information Network).

2-2. Benefits of EDI

Many authors have documented expected benefits from the use of EDI. Hinge [1988] classified benefits into direct and indirect. Direct benefits come from reducing the cost directly associated with handling paper transactions. They include elimination of keyboard data entry, improved order entry procedures, eliminated manual sorting, matching, filing, reconciling, mailing, decreased paper materials, reduced need for overnight couriers, reduced telephone costs, reduced need for paper storage space and elimination of data entry facilities. Indirect benefits include effective use of data received electronically for better inventory management, streamlined manufacturing operations, and enhanced customer-supplier relationships.

3-3. Status of EDI Usage

According to recent studies [EDI, Spread the Word!, 1990; Langner, 1990], about 12,000 U.S. companies currently use EDI. The number of users of EDI has grown 45% annually and is expected to grow continuously.

With regards to industry, some are well established in EDI utilization, such as the automotive, grocery, transportation and chemical industries. They have established their industry-specific standards and are actively using EDI. Others, such as healthcare, insurance, telecommunications and electronics, are beginning to use EDI [Langner, 1990; Skagen, 1989].

Most companies adopt and implement EDI because their customers demand it [Boudette, 1989]. However, in a few industries such as pharmaceutical and healthcare industries, demands for EDI are coming from suppliers rather than customers [Gardner, 1989].

2-4. Previous Studies of EDI

Wrigley [1991] has examined the literature and some of the current research on EDI. According to him, well over 900 articles on EDI appeared in English-lan-

guage journals and other publications worldwide between 1986 and 1991. However, only 32 articles of these 900 articles even mentioned the word "research" and the majority of them referred to data published in market and user surveys. He pointed out a pressing need for more research activity, focused specifically on EDI.

A few studies in this area have relied on anecdotal information and on information based on a small number of case studies [Bebjamin, et. al., 1990]. It is dangerous to generalize the conclusions from a relatively small sample. Therefore, this study employs a large sample size survey-based methodology to investigate the adoption of EDI systems.

III. RESEARCH DESIGN AND METHODOLOGY

3-1. Research Model

Based on the primary fields of literature in information technology (IT) research: implementation, and innovation studies, a research model (shown in Figure 1) was developed. The model posits that a number of factors affect the adoption of EDI systems. The factors include 1. general

characteristics of the industry in which a firm operates, 2. EDI-related industry characteristics, 3. general characteristics of the firm, and 4. IT related firm characteristics. The model presented and tested in this study draws from and synthesizes work done by Runge [1985], Reich and Benbasat [1990]. and Grover [1990] among others, and draws heavily on the propositional inventory of Kraemer and Dutton [1989]. Many of the variables detailed in the model have been used in previous studies on IT, but none have thus far been used in the context of EDI technology.

The general form of the research model is similar to models seen in Liang [1986] where contextual factors impact DSS usage. The associations proposed by Reich and Benbasat [1990] are also comparable—industry, customer, and technological factors influence adoption of customer oriented strategic systems. Thus, there is broad support in the literature for the research model used in this study.

The various constructs of the factors in the research model are summarized in Figure 1. In operationalizing the constructs, the study adopts measures which have been used and validated by previous research. Many of measures in this study

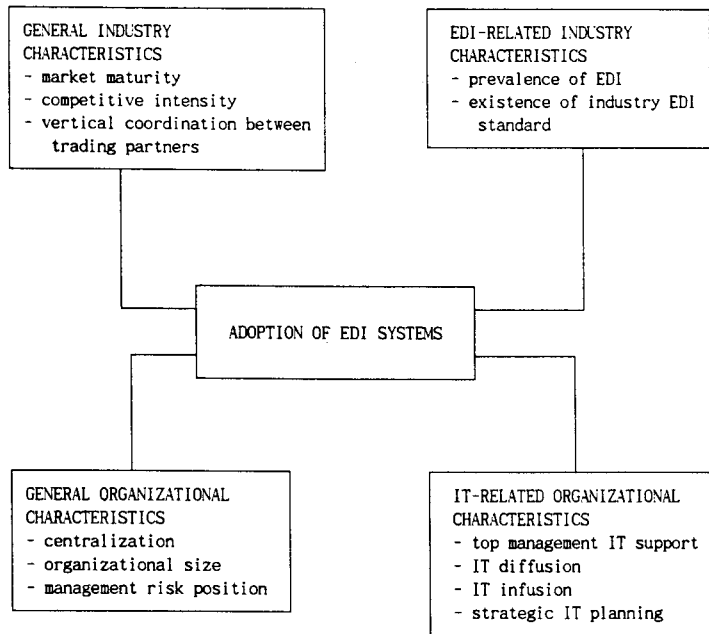


Figure 1. Research Model

are drawn from past studies with minor modifications required for the adoption of EDI systems. Most measures used in this study are based on a 5-point Likert type scale where 1 denotes “strongly disagree” and 5 denotes “strongly agree”. A few measures are composed of either categorical or open-ended questions.

Justification and measurement of and research hypotheses related to all the variables described in the model are discussed below.

3-1-1. General Industry Characteristics

This study assesses the effect of such salient environmental variables on the

adoption of EDI systems as market maturity, competitive intensity and vertical coordination between supplier and customer.

Market Maturity

A number of studies in the adoption of IOS [Grover, 1990; Runge, 1985] have found that IOSs exist in mature industries which tend to encourage the innovative use of IS. The studies postulate that mature industries are likely to represent an environment which will tend to encourage the innovative use of IS in general and IOS in particular. EDI systems, a special type of IOSs, are also likely to be found in mature industries.

(H1: EDI adopters have more mature products/services than non-adopters.)

A one-item categorical measure adopted from Runge [1985] and Grover [1990] is used to assess the maturity of an industry or a market. The questionnaire item asks which of the following phases of the life cycle major product/services of the respondent company is in: introduction, growth, maturity or decline.

Competitive Intensity

The literature on innovations has reported a strong relationship between competitive intensity and adoption of innovation. The relationship has been explained by the fact that high competitive intensity will lead to greater resource allocation for innovation and consequently greater innovation [Robertson and Gatignon, 1986; Utterback, 1974]. Therefore, it can be hypothesized that EDI systems are adopted more in industries where there is strong competition.

(H2: Adopters are in more competitive industries than non-adopters.)

Intensity of industry competitiveness is measured by the two-item measure [Grover, 1990]. The two items measure

the degree of competition based on price and product/service quality in the respondent industries.

Vertical Coordination Between Supplier and Customer

A number of studies have indicated that customer and supplier organizations which have a high degree of vertical dependence will coordinate and develop an interlocking relationship [Palmer, 1983; Robertson and Gatignon, 1986]. A close relationship between trading partner organizations is expected to facilitate the adoption of EDI systems.

(H3: Adopters are in industries where a higher degree of vertical coordination between customers and suppliers exists.)

A modified version of Grover's [1990] one-item measure is used to assess the degree of collaboration and cooperation between firms in the respondents' industry and their trading partners. The questionnaire item measures the degree of strong collaboration and coordination between the firms in the respondent industry and their customers (or suppliers).

3-1-2. EDI-Related Industry Characteristics

5 Also assessed is the effect of EDI-related variables on the adoption of EDI systems such as prevalence of EDI systems in the industry and existence of EDI industry standards.

Prevalence of EDI in the industry

Many studies in the innovation area have reported a positive relationship between adoption of an innovation and the number of firms in the industry that have adopted the innovation [McGinnis and Ackelsberg, 1983; Utterback, 1974]. Grover [1990] also found similar results in the IOS context. Therefore, it can be hypothesized that more EDI systems will be found in industries where EDI systems are prevalent.

(H4: Adopters have more operational EDI systems in their industries than non-adopters.)

A one-item measure used by Grover [1990] and Runge [1985] is modified to measure the spread of EDI systems usage in the respondent firms' industry group. The open-ended questionnaire item asks for an estimate of the actual percentage of firms using an EDI system in the respondent firm's industry.

Existence of EDI Industry standards

Benjamin et. al. [1990] identified the state of industry-wide EDI standards development as one of the factors that influence an organization's ability to develop effective EDI applications. The state of standards development differs among industries. Therefore, it can be hypothesized that more EDI systems are likely to be found in industries which already have established EDI standards.

(H5: Adopters are in industries where an EDI document standard exists.)

A one-item categorical measure is constructed to determine whether there is a widely-accepted EDI standard within the respondent firm's industry.

3-1-3. General Organizational Characteristics

The general organizational characteristics incorporated in the investigation of EDI adoption are centralization, size and management risk position.

Centralization

Organizational structure is one of the most frequently tested variables in innovation process research. Hage and Aiken [1969] categorize organizational structure

into three major dimensions: centralization, formalization and complexity. Among three dimensions, centralization has been found to be negatively related to the adoption of IOS [Grover, 1990; Runge, 1985]. Therefore, adopters of EDI systems are likely to be more innovative and tend to be less centralized.

(H6: Adopters have more decentralized structures than non-adopters.)

This construct is measured by four items originally adopted from Hage and Aiken's [1969] study. The measure consists of the following four items: the degree to which 1. participation of subordinates in company decision making is encouraged; 2. no action can be taken until a superior approves a decision; 3. a person who wants to make his or her own decisions will be quickly discouraged here; and 4. there is frequent participation of subordinates in decisions on the adoption of new policies.

Firm size

Size of organization has been well tested in innovations research even though the results have been contradictory. Studies of IOS have revealed that IOS has been found in larger firms [Grover, 1990; Runge, 1985]. Because larger firms have the exist-

ing IS infrastructure required to implement an IOS. EDI systems also need many IT components and larger firms are therefore more likely to adopt EDI systems.

(H7: Adopters are larger in size than non-adopters.)

The size of firm is measured along four dimensions; total sales in terms of dollar amount, total number of employees, number of employees directly reporting to IS department and firm size relative to the respective industry.

Management Risk Position

Many Studies have suggested that level of risk a firm is willing to take will influence the adoption of IS projects [Clemons, et. al., 1984; McFarlan, 1981]. A firm's position regarding these risks will be reflected in the decisions it makes regarding the adoption of innovative uses of IS. Therefore, the level of risk management is willing to take is likely to affect the EDI adoption decision.

(H8: Top management of adopters have a high risk-taking propensity than non-adopters.)

The extent of risk orientation of top management is measured by a three-item

measure [Grover, 1990] originally drawn from Clemons et. al. [1984]. According to Clemons et. al. [1984] risk can be classified into three broad categories: organizational, managerial and financial. The three-item measure assesses all three categories risks. The measure consists of the following three items: the degree to which 1. top management is willing to accept changes in organizational structure, work force composition, skills, etc. that may result from a decision; 2. top management is willing to absorb technologies, hardware and software, with which the organization is not familiar; and 3. top management is willing to commit large investments to new applications or network design.

3-1-4. IT-Related Organizational Characteristics

IT-related characteristics of firms, including top management support for IT, extent of strategic IT planning, IT diffusion and IT infusion, are considered in evaluating the adoption of EDI systems.

Top Management Support for IT

Top management support has been unequivocally recognized as a prerequisite to the success of IS implementation [Arthur

Young, 1989; Information Week, 1986]. In IOS studies also, top management support has been found to be positively related to the adoption and successful implementation of the systems. Therefore, it is believed that firms with greater top management support for IT are more likely to adopt EDI systems.

(H9: Adopters have more top management support for IT than non-adopters.)

A three-item measure is developed based on Raymond [1985] and Weill [1989] to operationalize the degree of top management support for IT. The three items of the measure are: the degree to which 1. top management encourages use of information technology; 2. top management considers information technology important to the company; and 3. top management considers information technology has effectively communicated its support for information technology.

IT diffusion and IT infusion

IT infusion and IT diffusion [Sullivan, 1985] will also affect the decision to adopt EDI systems. IT infusion is defined as the degree to which IT has penetrated the company in terms of importance, impact

or significance. IT diffusion refers to the degree to which IT has been disseminated or scattered throughout the company. As mentioned earlier, implementation of EDI systems require existing IS infrastructure and many IT components. Therefore, it is expected that firms with a higher degree of IT infusion and diffusion are more likely to adopt EDI systems.

(H10: Adopters have a higher degree of IT diffusion than non-adopters.

H11: Adopters have a higher degree of IT infusion than non-adopters.)

A three-item measure is constructed based on Sullivan [1985] and Grover [1990] to assess how much IT is diffused the respondent's organization. The measure is composed of the following three questions: the degree to which 1. information technology is considerably diffused or scattered in almost all parts of the respondent's company; 2. there is broad based implementation of telecommunications technology in the respondent's company; and 3. databases are extensively shared for various applications, rather than having a separate database for each application.

A one-item measure derived from Sullivan [1985] is constructed to measure the

importance of IT in the respondent's firm. The one item measures the degree to which information technology is considered important in the respondent's company.

Extent of Strategic IT Planning

Links between IS business plans are particularly important for IS activities to be important to competitive strategy [McFarlan and McKenny, 1982]. Strategic IT planning is found to be an important factor in the adoption of IOS [Grover, 1990; Runge, 1985]. Therefore, it is expected that sophistication of IT planning is positively related to the adoption of EDI.

(H12: Adopters perform a higher degree of IT planning than non-adopters.)

The degree of strategic IT planning is measured by four items [Benson and Parker, 1985]. The four items measure the degree to which 1. information systems management is actively involved in business planning; 2. IS plans are aligned with our company's business strategy; 3. top management is actively involved in IS planning; and 4. there is a continuous assessment of new information technologies in IS planning.

3-1-5. Adoption/Non-Adoption of EDI

Firms are classified into one of the following two: adopter or non-adopter. Adopters are firms that 1. currently use the system (operational stage), 2. have decided to adopt the system and are implementing the system (implementation stage) or 3. have decided to adopt the system and are engaged in the pilot project (pilot stage). Non-adopters are firms that have no plan to adopt the system.

3-2. Data Collection Method

Data for this study have been obtained from primary sources through a mail survey. The survey was intended to obtain information about the adoption of EDI systems, and general and IT-related characteristics of the respondent's organization and industry. Therefore, target respondents to the questionnaire must have general business knowledge as well as information about the EDI system. The target respondents for adopter firms were people in the highest managerial position, who had been involved in implementation of EDI systems. For non-adopter firms, chief information systems executives were targeted.

Commercial mailing lists were used to

identify both groups of respondents. Mailing lists for EDI related personnel in adopter firms were obtained from EDI, Spread the Word!. Lists for the chief IS executives for non-adopter firms were prepared from the Directory of Top Computer Executives. Names of respondents for the non-adopter firms were randomly selected from all the available names in manufacturing and service industries listed in the Directory of Top Computer Executives, but not listed in the EDI lists. It was assumed that the EDI lists are comprehensive and unbiased as to which firms are included, and that if a firm is not listed in the EDI list, it does not have an EDI systems and, therefore, is a non-adopter.

Based on the operationalization method outlined in section 3-1, a survey instrument was constructed. The questionnaire was then pre-tested by three IS executives of firms located in the Buffalo area. After the pretesting, a total of 1,308 questionnaires were mailed out (924 to the adopter firms and 384 to non-adopters). Of those, a total of 314 usable responses (280 adopters and 34 non-adopters) were returned, representing a response rate of 24%. More than 70% of the respondents wanted to receive a summary report from the study and attached their business card.

The perceived importance of the topic was substantiated by the considerably high response rate and respondents' interest in receiving the report.

IV. DESCRIPTIVE RESULTS

This section presents a broad picture of the respondent companies and respondents including information about respondent firms' industries, 1989 sales revenues, number of total employees, number of employees directly reporting to IS department and job titles of the respondents.

4-1. Industry Representation of Respondent Companies

Table 1 illustrates the industry groupings of the respondent companies classified by adopters and non-adopters. As can be seen, the response sample represents a

wide variety of industries. About 60% of the firms in the sample of both groups are in various manufacturing industries while the remainder are in several service sector industries. This ratio of manufacturing/service is fair representation of the nature of the total population.

As far as EDI utilization is concerned, the adopter response sample also covers diverse industries. Companies in the industries known to be well established in EDI utilization comprise about 40% of the adopter response sample. About 10% of the adopter response sample are from the industries beginning to use EDI, such as telecommunications and electronics.

4-2. Characteristics of Respondent Companies

Below follows information about 1989 sales of both adopter and non-adopter

Table 1. Industry Grouping of Respondent Companies

Industry	adopters		Non-Adopters	
	No.	%	No.	No.
Household and Food Products	30	10.7	0	0
Heavy Manufacturing	137	48.9	21	61.8
Transportation, Communications and Utility	49	17.5	3	8.8
Wholesale, Retail, and other Services	59	21.1	10	29.4
Not Reported	5	1.8	0	0
Total	280	100	34	100

respondent companies. In case of adopter firms, 85 companies (38% of the sample) have sales of more than \$1 billion. These companies can be classified as large to very large organizations. Seventy two companies (33%) are in the medium range with sales of over \$100 million but under \$1 billion. Another 64 companies (29%) are in the small to very small range with sales less than or equal to \$100 million. Small, medium and large organizations are equally distributed across the adopter sample. Non-adopter firms are mostly small (19 companies, 63%) to medium (11 firms, 47%) ones.

Information about the number of employees of respondent companies revealed that 34% of adopter firms, which can be regarded as large and very large organizations, have more than 10,000 employees. Another 28% of the sample in the medium range have more than 1,000 employees but less than 10,000 employees. In case of non-adopter firms, 24 companies (70%) belong to small and the remaining 30% to medium firms.

4-3. Characteristics of Respondents

Job titles of the respondents revealed that 41 respondents (15% of all the

respondents) are at the level of Vice President (VP) and above. Among them, 16 respondents are from IS department having the title of VP-IS or Chief Information Officer. The remaining 25 respondents consists of President, CEO, GM, Controller, and VPs of diverse departments such as administration, customer service, operations, sales, procurement, etc.

About 80% of the respondents (218 respondents) are from the IS department with various titles such as systems analyst, supervisor, manager or director of IS, or EDI. It can be noted that 69 respondents (more than 25% of the respondents) have the title with the word "EDI" specified. Among the titles, 'Managers of EDI' are the most common (24 respondents), followed by 'EDI Coordinator' (20 respondents). Other titles include 'EDI Administrator', 'EDI Planner', 'EDI Specialist'.

About 8% of the respondents (23 respondents) are manager, supervisor or director of the department other than IS. They are from the department of logistics (or transportation), purchasing (or procurement), customer service, distribution, accounting, marketing and sales.

V. ANALYSES

5-1. Overview

The main objective of the study was to examine the differences of the contextual variables between adopter and non-adopter companies. Several analyses were performed using different sets of adopter companies.

Adopters of EDI systems were composed of companies in three different adoption stages: 1. operation, 2. implementation and 3. pilot stage. First, analysis was performed to compare the differences between non-adopters and adopters in general. In this case, the three different groups of adopters were pooled into one category. Secondly, non-adopters were compared with adopters of comparable size. Size was controlled in order to determine whether the overall results were solely caused by the bigger size of the adopter organizations. Finally, the differences between the various categories of adopters and non-adopters, and the different groups of adopters themselves were examined.

Differences in means for the variables of two different groups were tested using t-tests. All t-tests in this study were based

on t-statistics computed using either the pooled or separate estimates of variance. The separate estimate was used when the probability of equal variances as indicated by their F ratio was less than 0.05. One variable of the industry characteristics factor, existence of industry EDI standard, was dichotomous in nature. For this variable, a Chi-square test was performed to examine the independence of the variable and the adoption of EDI systems.

5-2. Comparison between Adopters and Non-Adopters

Table 2 and 3 summarize the results of the t-tests and Chi-square test for all the variables between non-adopters and adopters of EDI systems. Two hundred and eighty adopter companies were compared with 34 non-adopters. Adopters consisted of 235 firms in operation, 26 in implementation, and 19 in pilot stage. From the 12 hypotheses tested, all but two were strongly supported (at least at the 0.05 level) by the analyses. Market maturity and competitive intensity were found not statistically different between adopters and non-adopters.

The supported hypotheses follow below:

1. Adopters of an EDI system have a higher degree of vertical coordination

Table 2. T-test of Differences between EDI Adopters and Non-Adopters

	Adopters (N=280)		Non-Adopters (N=34)		Significance of T-value
	Mean	S.D.	Mean	S.D.	
<u>Industry Characteristics</u>					
Market Maturity	2.650	0.58	2.676	0.73	-0.235
Competitive Intensity	4.406	0.76	4.250	0.69	1.137
Vertical Coordination	3.485	1.04	3.058	0.84	2.281 **
Prevalence of EDI	42.533	31.96	8.173	8.90	12.189***
<u>General Organizational Char.</u>					
Decentralization	3.529	0.84	3.166	0.72	2.395 **
<u>Size</u>					
Sales (millions)	4,290	10,723	196	242	5.669**
No. of Employees	21,142	60,854	1,457	2,263	5.168***
No. of IS Employees	171	345	16	18	6.648***
Relative Size	3.785	1.25	3.088	1.11	3.089***
Management Risk Position	3.464	0.87	2.794	0.81	4.249***
<u>IT-Related Organization Char.</u>					
Top Management IT Support	3.959	0.92	3.421	0.85	3.228***
Strategic IT Planning	3.651	0.84	3.000	0.77	4.279***
IT Diffusion	3.460	0.90	2.794	0.74	4.128***
IT Infusion	4.078	0.94	3.470	0.86	3.567***

* : significant level 0.1

* * : significant level 0.05

* * * : significant level 0.01

Table 3. Chi-square Analysis of Differences between Adopters and Non-Adopters
With or without Industry EDI Standard

	NON-ADOPTERS	ALL ADOPTERS	ADOPTERS OF COMPARABLE SIZE
NO EDI STANDARD	27(79%)	66(26%)	28(20%)
EDI STANDARD	7(21%)	214(77%)	111(81%)
TOTAL	34(100%)	280(100%)	139(100%)

	Non-Adopters vs. All Adopters	Non-Adopters vs. Adopters of Comparable Size
Chi-square	45.351**	45.252***
Likelihood Ratio Chi-square	41.183***	42.111***

* * * : significance level 0.01

with their trading partners than non-adopters (significant at the 0.05 level).

2. Adopters have more operational EDI systems in their industries than non-adopters (significant at 0.01).
3. Adopters have more decentralized structures than non-adopters (significant at 0.05).
4. Adopters of EDI system are larger in each of the four aspects of size than non-adopters (significant at 0.01). Measures of size include sales revenue, number of total employees, number of IS employees and relative size.
5. Top management of adopters have a high risk-taking propensity than non-adopters (significant at 0.01).
6. Adopters perform a higher degree of IT planning than non-adopters (significant at 0.01).
7. Adopters have a higher degree of IT diffusion than non-adopters (significant at 0.01).
8. Adopters have a higher degree of IT infusion than non-adopters (significant at 0.01).
9. Adopters have more top management support for IT than non-adopters (significant at 0.01).
10. Adoption of an EDI system is not in-

dependent of existence of the industry EDI standard (significant at 0.01).

5-3. Comparison between Adopters and Non-Adopters of Comparable Size

In this analysis, non-adopters were compared with adopters of comparable size. The purpose of this analysis was to examine whether the strongly supportive results of the first analysis were purely caused by the bigger size of the adopter companies. In order to control the size of the two groups, adopters in this analysis were chosen from companies with sales amount less than the median value of all adopters, which is \$164 million. Therefore, a total of 139 adopter companies was compared with 34 non-adopters. The results of the tests are summarized in Tables 3 and 4.

Sales revenue was not statistically different between the two groups nor were total number of employees and relative size. However, one aspect of the size variable, number of IS employees, was found to be significantly different (significant at 0.01) between the two groups. Adopters had notably more IS employees than non-adopters even though other facets of the size were not different.

From this analysis, all but one

Table 4. T-test of Differences between EDI Adopters and Non-Adopters of Comparable Size

	Adopters (N=139)		Non- Adopters (N= 34)		Significance of T-value
	Mean	S.D	Mean	S.D.	
SALES (millions)	164	179	196	242	-0.658
NO. OF EMPLOYEES	8,740	64,102	1,457	2,263	1.235
NO. OF IS EMPLOYEES	50	121	16	18	2.890***
RELATIVE SIZE	3.407	1.31	3.088	1.11	1.300
<u>Industry Characteristics</u>					
Market Maturity	2.610	0.57	2.676	0.73	-0.569
Competitive Intensity	4.416	0.77	4.250	0.69	1.138
Vertical Coordination	3.532	0.98	3.058	0.84	2.579 **
Prevalence of EDI	39.741	30.63	8.173	8.90	9.179***
<u>General Organization Char.</u>					
Decentralization	3.347	0.86	3.166	0.72	1.130
Management Risk Position	3.468	0.89	2.794	0.81	4.015***
<u>IT-Related Organization Char.</u>					
Top Management IT Support	3.940	0.94	3.421	0.85	2.909***
Strategic IT Planning	3.559	0.88	3.000	0.77	3.368***
IT Diffusion	3.302	0.91	2.794	0.74	2.995***
IT Infusion	4.021	0.97	3.470	0.86	3.020***

* : significant level 0.1

** : significant level 0.05

*** : significant level 0.01

hypothesis supported by the first analysis were confirmed again. One hypothesis not supported by this analysis was the one regarding centralization. Even though adopters had more decentralized structure, degree of centralization was not statistical-

ly significant. In summary, results of the first analysis were generally confirmed even after controlling for the size of the two groups. Hence the prior results are not solely caused by the bigger size of the adopter organizations.

Table 5. T-test of Differences between Early-Adopters and Late-Adopters

	Early-Adopters (N=235)		Late-Adopters (N=45)		Significance of T-value
	Mean	S.D	Mean	S.D.	
<u>Industry Characteristics</u>					
Market Maturity	2.654	0.56	2.622	0.68	0.361
Competitive Intensity	4.437	0.74	4.250	0.82	1.524
Vertical Coordination	3.500	1.03	3.413	1.14	0.512
Prevalence of EDI	45.171	32.56	27.558	23.55	3.771***
<u>General Organization Char.</u>					
Decentralization	3.536	0.84	3.492	0.84	0.319
Size					
Sales(millions)	4,500	10,765	3,275	10.543	0.640
No. of Employees	22,607	65,823	14,394	27,888	1.344
No. of IS Employees	182	366	122	224	1.383
Relative Size	3.839	0.87	3.511	1.23	1.606
Management Risk Position	3.490	0.87	3.333	0.88	1.114
<u>Related Organization Char.</u>					
Top Management IT Support	4.025	0.91	3.623	0.93	2.727***
Strategic IT Planning	3.688	0.86	3.467	0.74	1.621
IT Diffusion	3.517	0.92	3.173	0.75	2.372**
IT Infusion	4.162	0.91	3.652	0.99	3.402***

* : significant level 0.1

* * : significant level 0.05

* * * : significant level 0.01

5-4. Comparison between Early-Adopters and Late-Adopters

Adopter of EDI systems were composed of companies in three different adoption

stages: operation, implementation and pilot stage. Final analyses were performed to examine the differences between the different categories of adopters and non-adopters, and the different groups of

Table 6. T-test of Differences between Late-Adopters and Non-Adopters

	Latey- Adopters (N=45)		Non- Adopters (N=34)		Significance of T-value
	Mean	S.D	Mean	S.D.	
<u>Industry Characteristics</u>					
Market Maturity	2.622	0.68	2.676	0.73	-0.339
Competitive Intensity	4.250	0.82	4.250	0.69	0.000
Vertical Coordination	3.413	1.14	3.058	0.84	1.522
Prevalence of EDI	27.588	23.55	8.173	8.90	4.360***
<u>General Organization Char.</u>					
Decentralization	3.492	0.84	3.166	0.72	1.813*
<u>Size</u>					
Sales(millions)	3,275	10,543	196	242	1.799*
No. of Employees	14,394	27,888	1,457	2,263	3.132***
No. of IS Employees	122	224	16	18	3.071***
Relative Size	3.511	1.23	3.088	1.11	1.571
Management Risk Position	3.333	0.88	2.794	0.81	2.786***
<u>IT-Related Organization Char.</u>					
Top Management IT Support	3.623	0.93	3.421	0.85	0.991
Strategic IT Planning	3.467	0.74	3.000	0.77	2.726***
IT Diffusion	3.173	0.75	2.794	0.74	2.231**
IT Infusion	3.652	0.99	3.470	0.86	0.854

* : significant level 0. 1

* * : significant level 0.05

* * * : significant level 0.01

adopters themselves.

Companies in the pilot or implemenation stage were classified as late-adopters while organizations which already had operational systems were classified as early-

adopters. There were 235 early-adopters and 45 late-adopters.

Results of the differences between early-adopters and late-adopters are summarized in Tables 5 and 6. Early-adopters

and late-adopters were not different in all of the general industry and general organizational characteristics, such as market maturity, competitive intensity, degree of vertical coordination, degree of decentralized structure, size and risk propensity of top management. They differed only in the IT-related organizational characteristics and industry characteristics associated with the EDI systems, including prevalence of EDI systems, existence of industry EDI standard, degree of top management support for IT, and extent of IT diffusion and infusion.

5-5. Comparison between Late-Adopters and Non-Adopters

In this analysis, late-adopters were compared with non-adopters of EDI systems. Tables 6 and 7 show the results of the analyses. In this case, seven hypotheses out of 12 tested were supported. All the hypotheses of the general organization characteristics were clearly supported. They were hypotheses concerning centralization, size, and top management risk propensity. Differences were found in two of the four IS-related characteristics including the degree of strategic IT planning and degree of IT diffusion. Among industry characteristics, only EDI related character-

istics, such as prevalence of EDI systems and existence of industry EDI standard, were found to be statistically different between the two groups.

VI. CONCLUSIONS

6-1. Summary of Major Findings

The major objective of this research was to identify the factors that facilitate the adoption of an EDI system. A research model was developed to investigate the research questions identified.

Various constructs in the models were operationalized by using modified measures, drawn from past studies, required for studying the adoption of EDI systems and by following suggestions from the relevant literature. The model was then empirically tested using data gathered by a survey methodology.

Twelve hypotheses were tested for comparing differences of the contextual variables such as general and EDI-related industry characteristics, and general and IT-related organizational characteristics between adopter and non-adopters. Several analyses were performed by using different sets of adopter companies such as adopters in general, adopters with comparable sizes

as non-adopters, early-adopters, and late-adopters.

Ten of 12 hypotheses tested were supported in the comparison of adopters with non-adopters. Two hypotheses not supported were related to competitive intensity and maturity of the industry. The results were generally confirmed after controlling for the size of the two groups. All but one hypothesis regarding decentralization were supported. In the comparison of non-adopters with late-adopters, seven hypotheses were supported. The seven hypotheses related to three general organizational characteristics (decentralization, size, and management risk position), two of the IT-related organizational characteristics (IT planning and IT diffusion), and two of the EDI related industry characteristics (prevalence of EDI systems and existence of industry EDI standard). Both the EDI related industry characteristics and the IT-related organizational characteristics were also effective in distinguishing early-adopters from late-adopters.

In conclusion, the analyses performed for the research model provide strong supporting evidence that most of the variables proposed and tested in the study are appropriate factors affecting the adoption of

EDI systems. Some implications based on the results are presented below.

6-2. Implications

Most studies in the EDI area have been case studies relying on anecdotal data. This study developed a research model and tested the model by the empirical data gathered through survey-based methodology. The model provides a simple framework for understanding the process for adopting EDI systems and offers a foundation for further empirical testing for refinement of the model.

On a practical level, this research delineated factors most significant to managers in the adoption of EDI systems. That is, it provides managers with guidance concerning situations which are most appropriate to deploying EDI. Specific implications based on the results of the study are summarized below.

Industry Characteristics

It was found that competitive intensity of industry and maturity of products or services do not affect the adoption of EDI systems. This suggests that the adoption of EDI system is motivated by other considerations than competitive intensity or matur-

ity of products or services. However, a higher degree of coordination between the trading partners was found to have a positive relationship with the adoption of EDI systems. It clearly suggests that cooperation between the related parties is required to facilitate the adoption of IOS in general and EDI system in specific.

EDI Related Industry Characteristics

It was found that adopters of EDI systems are in industries which have many operational EDI systems and industry-wide EDI standards. The results emphasize the importance of the established EDI document standard that will facilitate communication with the maximum number of trading partners in the adoption of EDI systems. Both factors were also found to be effective in distinguishing early-adopters from late-adopters.

General Organizational Characteristics

Adopters of EDI systems were found to have more decentralized decision making structure, to be larger in size, and to have a higher risk-taking propensity of top management than non-adopters. Adoption and subsequent implementation of EDI systems require a large investment in capital as well as time and organizational

change. Willingness of top management to take organizational, managerial, and financial risk and to adopt a more participative decision making process certainly increases the likelihood of EDI systems adoption. The results also indicate that larger firms in general have the existing IS infrastructure required to adopt and implement an EDI system.

IT-related Organizational Characteristics

It was found that adopters perform a higher degree of IT planning and have a higher level of IT diffusion than non-adopters. The results suggest that existing broad based implementation of telecommunication technology and extensive databases, and close links between IS and business plan facilitate the EDI system adoption.

6-3. Suggestions for Future Research

The EDI systems defined and included in the analyses of this study were more traditional ones. That is, this study focused on inter-organizational use of EDI system, specifically utilization of EDI systems between customer and supplier organizations. Therefore, excluded are intra-organization systems and systems that link to

trading partners other than customers and suppliers. Therefore, one possibility for further research is to revalidate the research model and findings from this study using such EDI systems.

This study assumed the decision to adopt the EDI system is rational. Therefore, only four contextual factors, i.e., general and IT-related organizational characteristics, and general and EDI-related industry characteristics, are included in evalu-

ating the differences between adopters and non-adopters. The other approach possible for future research is to examine other than rational views such as political ones.

A limitation of this study pertains to collecting data about characteristics of firm and industry as well as EDI adoption from a single individual. The appropriateness of this strategy can be explicitly evaluated by future studies through the use of multiple respondents or objective measures.

참 고 문 헌

Arthur Young, *The Landmark MIT Study: Management in the 1990s*, Arthur Young, 1989, Report # M189-1733 189-qg-1868-30M.

Belitsos, B., "EDI Becomes a Necessity", *Computer Decisions*, October 1988, pp. 38-40.

Benjamin, R.I., de Long, D.W. and Scott Morton, M.S., "EDI: How Much Competitive Advantage?", *Long Range Planning*, Vol. 23, No. 1, February 1990, pp.29-40.

Benson, R. and Parker, M., *Enterprise-Wide Information Management—An Introduction to the Concept*, IBM Los Angeles Scientific Center, 1985.

Boudette, N.E., "EDI: A Leap of Faith", *Industry Week*, Vol. 238, No. 15, August 7, 1989, pp. 52-55.

Clemons, E.K, Keen, P.G.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, 1984.

Davis, H.A., *Electronic Data Interchange and Corporate Trade Payments*, Financial Executives Research Foundation, 1988.

EDI Research, Inc., *Respondent Report for the State of U.S. EDI: 1989*, EDI Research, Inc.,

1989.

EDI, Spread the Word!, *EDI Yellow Pages International*, EDI, Spread the Word!, Dallas, Texas, 1990.

Gardner, E., "A Direct Line Between Buyer and Supplier", *Modern Healthcare*, Vol, 19, No. 11, March 17, 1989, pp. 26-28.

Grover, V., *Factors Influencing Adoption and Implementation of Customer Based Inter-Organizational Systems*, Unpublished Ph.D. Dissertation, University of Pittsburgh, 1990.

Hage, J and Aiken, M., "Relationship of Centralization to Other Structural Properties", *Administrative Science Quarterly*, June 1969, pp. 72-92.

Hinge, K.C., *EDI: From Understanding to Implementation*, AMA Membership Publications Division, American Management Association, 1988.

Information Week, "The Strategic Use of Information: Seizing the Competitive Edge", May 26, 1986, pp. 26-92.

Kraemer, K. and Dutton, W., "Survey Results in the Study of Management Information Systems", in *The Information Systems Research Challenge*, ed Izak Benbasat, Havard Business School, Boston, Mass, 1989.

Langner, M., "Sought-for EDI Revolution is Still Mainly Evolution", *Network World*, Vol. 7, No. 50, December 10, 1990, pp. 52-56.

Liang, T. P. "Critical Success Factors of Decision Support Systems: An Experimental Study" *Data Base*, Winter 1986, pp. 3-15.

McFarlan, F.W., "Portfolio Approach to Information Systems", *Harvard Business Review*, September-October 1981, pp. 109-119.

McGinnis, M.A. and Ackelsberg, R.M., "Effective Innovation Management: Missing Link in Strategic Management", *The Journal of Business Strategy*, Summer 1983, pp. 59-66.

Palmer, D., "Broken Ties: Interlocking Directorates and Intercorporate Coordination", *Administrative Science Quarterly*, Vol. 28, 1983, pp. 40-55.

Payne, R.A., "EDI Implementation: A Case Study", *Journal of Systems Management*, March 1989, pp. 14-20.

Porter, M.E and Millar, V.E., "How Information Gives You Competitive Advantage", *Harvard Business Review*, July-August 1985, pp. 149-160.

Raymond, L., "Organization Characteristics and MIS Success in the Context of Small Business", *MIS Quarterly*, Vol. 9, No. 1, March 1985, pp. 37-

52.

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, September 1990, pp. 325-347.

Robertson, T.S. and Gatignon, H., "Competitive Effects on Technology Diffusion", *Journal of Marketing*, Vol. 50, July 1986, pp. 1-12.

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

Skagen, A., "Nurturing Relationships Enhancing Quality with EDI", *Management Review*, Vol. 78, No. 2, February 1989.

Stix, G., "EDI: Not Just Do-It-Yourself", *Com-*

puter Decisions, Vol. 19, No. 6, March 23, 1987, pp. 20, 24 and 28.

Sullivan, C.H., "Systems Planning in the information Age", *Sloan Management Review*, Winter 1985, pp. 3-11.

Utterback, J.M., "Innovation in Industry and the Diffusion of Technology", *Science*, Vol. 183, February 1974, pp. 620-626.

Weill, P. and Olson, M., "Managing Investment in Information Technology: Mini Case Exmaples and Implications", *MIS Quarterly*, Vol. 13, No. 1, March 1989, pp. 3-18.

Wrigley, C.D., "Research on EDI: Present and Future", *Proceedings of the 4th International Electronic Data Interchange Conference*, Yugoslavia, June 10-11, 1991.

◇ 저자소개 ◇



저자 황경태는 연세대학교 상경대학 응용통계학과를 졸업하고 미국 Washington D.C.의 George Washington 대학에서 경영학 석사학위를 취득하고 State University of New York at Buffalo에서 MIS로 박사학위를 취득하였다. 현직에 오기 전에 약 2년동안 삼성데이터 시스템 컨설팅팀에서 근무하였고 현재는 동국대학교 경상대학 정보관리학과에 재직하고 있다. 주요 관심분야는 EDI 시스템을 포함한 통신관련 정보시스템, 정보기술의 경제적 가치, 정보전략등이고 *Information and Management*, *Journal of Systems Management*, *Journal of Information Systems*, *Information Systems Journal* 등에 논문을 발표한 바 있다.