

**AN EMPIRICAL ANALYSIS OF BENEFITS OF ELECTRONIC
DATA INTERCHANGE (EDI) IMPLEMENTATION:
IMPLICATIONS FOR NEW IT IMPLEMENTATION**

Deepak Khazanchi
University of Nebraska at Omaha
khazanchi@unomaha.edu

ABSTRACT

This paper reports that the benefits accrued from implementing and integrating Electronic Data Interchange (EDI) within small and medium-sized enterprises (SMEs) can be conceptualized into two factors. First, firms derive operational/tactical benefits by predominantly focusing on increasing internal utility of this technology. Second, firms derive strategic benefits from EDI in the form of better external relationships and alliances with trading partners and an enhanced ability to compete in their market. Among other significant findings, there are clear indications from the correlation statistics reported here that experience with EDI, industrial category of a firm and the level of EDI integration have a significant influence on the ability of a firm to obtain long-term (strategic) benefits from such IT projects. These results also have significant implications for SME managers/stakeholders considering new interorganizational IT initiatives.

INTRODUCTION

According to forecasts published by Giga, a private research firm, Electronic Data Interchange (EDI) transactions in the United States alone were about \$2.7 billion in 1997 and are estimated to grow to \$3.8 billion by 2002 (Wilson, 2000). Vollmer (2001), a research director of B2B integration at Giga Information Group asserts:

“During the past several years, it has been all too common to hear “experts” denigrate the potential of EDI in favor of some new solutions just around the corner. However, it is no coincidence that both ebXML and BizTalk Server-leading XML-based initiatives to build widespread e-business functionality-are supporting existing EDI transactions. After a lengthy review of available options, the sponsoring organizations came to the same conclusion-- EDI is the only practical e-business standard that makes sense for basic functionality at this time.”

The Giga report challenges the popular notion that traditional EDI transactions will be widely replaced by emerging Web alternatives. In supporting the analysis presented in this report,

Jack Relch, the E-commerce director of National Gypsum states: "I don't know of a single company in our industry, for all the hoopla, that's exchanging documents via the Web in XML format... Many of the large players have used traditional electronic data interchange for years. We've had good success with EDI over the Web as a cost-saving alternative.¹" Clearly, though a shrinking percentage of the total business-to-business (B2B) electronic commerce pie, EDI continues to be "alive and kicking" and an important element of the future landscape of global B2B e-commerce (Ibid.).

Electronic Data Interchange

Electronic Data Interchange (EDI) is the computer-to-computer interchange of business transactions that conforms to specified standards over a communications network that includes at least two *trading partners*. These interactions include the interchange of common commercial information typically consisting of purchase orders, shipping notices, invoices, related acknowledgements, funds transfer with banks, etc. (Zorfass & Michel, 1992). EDI automates the slow, labor-intensive exchanging of transactional documents in paper form via fax and/or regular mail. The EDI enterprise is the hub of activities. Hubs represent the accumulation point for transactions from multiple trading partners. For example, Wal-Mart is a hub with more than 5000 electronic hook ups with its vendors. The trading partners can be viewed as spokes. Spokes (vendors, customers, etc.) become part of the extended EDI enterprise. Larger spokes can be hubs of their own supplier, customer networks. Most SMEs tend to be spokes for large hub organizations.

EDI requires five key elements (Arunachalam, 1995; Pfeiffer, 1992):

- Electronic mail for rapid personal (administrative) communications;
- On-line networks for rapid communications such as third party or value added networks (VANs) and Virtual private networks (VPNs);
- At least two organizations conducting joint business transactions electronically (trading partners);
- Standard protocols for file and message transfers. This is accomplished with trading partner agreements regarding data coding and formatting rules. Standard EDI message formats can be those developed by industrial organizations (e.g., TDCC/EDIA, VICS, WINS), proprietary (e.g., General Motors), national (ANSI X12) or International (UN/EDIFACT).
- Data processing task(s) at both (all) organizations pertaining to a transaction are supported by independent application systems.

There are three generic approaches to implementing EDI links. The first approach uses a direct EDI link between vendor and customer using a modem and telephone line. Many large hub organizations own and operate a private network service (e.g., Wal-Mart, GE) that all business partners are required to use. Trading partners establish communications using a dial-up link to the hub's network. While a majority of these hubs do not charge for their network service, trading partners do have to pay all phone charges. The second approach revolves around indirect EDI links through value-added networks (VAN) or "third party electronic clearing houses." These independent EDI networking vendors provide all the necessary software and communications services and essentially perform the function of an electronic post office for numerous business partners. Trading partners place their business documents in "electronic envelopes" identifying the sender and receiver. The document is mailed to the VAN after setting up a dial-up link via phone lines. The VAN will either forward the document to the hub organization's computer automatically or place it in the receiver's mailbox for pickup at a later time. Major costs associated with this EDI transmission option

¹ "EDI in XML Envelope", <http://www.internetwk.com/> (Apr 23rd, 2001).

will include expenses relating to VAN setup, telephone lines, and monthly transaction fees. Third, with the development of better Internet browsers and compatible EDI software that incorporates adequate security measures including encryption, the robust and cheaper Internet has become the medium of choice for transmitting electronic documents and messages globally. This approach is essentially similar to the direct communications link except that the Internet access charges are substantially lower than the other options.

RESEARCH RATIONALE AND QUESTIONS

New business practices such as Just-In-Time (JIT) manufacturing and quick response retailing (QR) rely on the transfer of transaction data to gain a competitive advantage in the market place. Pickett and Udo (1994) assert that "the numerous benefits of doing business using electronic data interchange (EDI) have caused large companies to accept EDI as a way of life." In a longitudinal study of Chrysler's adoption of EDI, Mukhopadhyay, Kekre, and Kalathur (1995) report substantial dollar savings due to improved information exchanges between Chrysler and its suppliers that result from EDI. They also assert that, not unlike many major hub enterprises, Chrysler made EDI a necessary condition for suppliers doing business with their assembly centers. However, most small companies at the receiving end of this EDI mandate do not take complete advantage of this strategic technology through appropriate consideration of costs/benefits and internal and external integration (Khazanchi, 1995). Furthermore, some research studies have found that businesses (small or large) that voluntarily initiate EDI have better success integrating it within internal functions and consequently realizing both operational and strategic benefits (Raymond & Bergeron, 1996; Swatman, Swatman & Fowler, 1994; Swatman & Swatman, 1991). For EDI to be a successful and efficient means of electronic trading, whatever ultimate form the technology itself takes, a better understanding of the business impact of EDI and similar interorganizational information systems on small- to medium-sized enterprises (SMEs) is essential.

Impact of EDI on Organizations

Impact of EDI refers to the actual benefits EDI adopters receive from utilizing EDI. EDI benefits can be categorized into Indirect and Direct Benefits (Iacovou, Benbasat, & Dexter, 1995). The following definitions are culled from the work of Pfeiffer (1992), Banerjee and Golhar (1993), Swatman et al. (1994), Iacovou et al. (1995), Arunachalam (1995), and Benjamin, de Long, and Michaeli, (1990).

Indirect benefits such as improved customer service, increased operational efficiency, improved trading partner relationships, and increased competitiveness are obtained by organizations that are proactive, have excellent organizational support, and their business applications are seamlessly integrated with EDI. Essentially such organizations view EDI as a strategic technology and a necessary tool for doing business.

Whereas, *direct benefits* such as higher quality of information, reduced transaction costs, improved cash flows, and reduced inventory levels are obtained by organizations in the form of financial savings as a result of EDI adoption.

This description of indirect and direct benefits is consistent with the conclusion reached by authors such as Cash and Konsynski (1985), Porter (1985), Porter and Millar (1985), Malone, Yates, and Benjamin (1987), Johnston and Vitale (1988), and Benjamin, et al. (1990) that information in general and interorganizational information systems such as EDI in particular have allowed some firms to improve operational efficiency and coordination with trading partners and create and sustain a significant competitive advantage in the marketplace.

Table 1: Summary of Key EDI - SME Research Studies

	<i>Author/Work</i>			
	<i>Raymond and Bergeron (1996)</i>	<i>EDI World Institute (1995)</i>	<i>Iacovou et al. (1995)</i>	<i>Carter et al. (1987)</i>
Research Objective	Assess success factors that have allowed SMEs to obtain advantages from EDI	Impact of EDI on SMEs	Factors influencing EDI adoption and impact of EDI	Assess education & training needs for successful implementation of EDI
Research Variable(s)	Organizational context (organizational support, implementation process, & control procedures), integration level, imposition level, EDI advantages (operational, managerial, strategic)	N/A	Perceived benefits, Organizational readiness, External pressure, EDI adoption & integration EDI impact	N/A
Research Design	Field study/Survey	Survey	Multiple-case study	Descriptive study using survey & follow-up interviews
Sampling Frame (Sample)	500 Canadian SMEs from various sectors in Quebec and Ontario provinces (39 responses with < 250 employees)	Manufacturing SMEs in North American, Europe, Australia (149 responses)	Small firms in Canada	25 firms from various sectors
Key Research Findings	Quality of organizational context of EDI is crucial to the attainment of benefits; Low imposition level (voluntary adoption) has a significant impact on the quality organizational context.	SMEs had <=100 employees with \$1-\$20 million in annual sales; 9 of 10 implemented EDI at the request of a customer; Over half increased revenues & profits; Majority reduced document cycle time, improved accuracy of information	Pre-adoption awareness of EDI benefits is low; Overall readiness of small firms is low; Need for financial, technological, managerial support; Small firms are reluctant to integrate EDI into operations because of high costs.	Conclusions: Use education & training to Gain commitment of EDI system; training programs should be designed to suit intended audience; understanding expected (actual) operational impediments; education & training must be state of the art & begin early in the adoption process.

Impact of EDI on SMEs

Small firms that have a favorable organizational context (i.e., top management support, personnel training, collaboration between functional areas, etc.) and are seeking to achieve high-levels of internal and external integration have a better chance of obtaining many operational and strategic benefits of EDI. A summary of key research on the experience of SMEs with EDI implementation is provided in Table 1.

The results of EDI impact studies on SMEs are clearly indicative of the fact that small businesses can potentially accrue the same level of benefits as large firms if the following conditions are satisfied. In addition to being proactive to the changes in the business-technology environment, a business must have adequate organizational support, some degree of technological sophistication, adequate planning mechanisms in place, a sustained plan for the internal and external integration of EDI, and an awareness of the potential impact of EDI (i.e., direct and indirect benefits).

Research Questions

Based on the previous discussion, the purpose of this paper is to investigate two main questions. First, what is the nature and structure of benefits obtained by SMEs through EDI implementation? Second, what is the influence of various firm demographics and other variables (elicited from *a priori* research) on the EDI benefits construct? To address the latter question, the influence of variables such as "extent of trading partner support", "stage of EDI integration," "volume of EDI documents (messages)", "nature of cost/benefit analysis", "perceived benefits of EDI", etc. on EDI benefits is evaluated. These variables were previously identified by various researchers (e.g., Carter, Monczka, Clauson, & Zelinski, 1987; Monczka & Carter, 1988; Pfeiffer, 1992; Swatman & Swatman, 1991; Iacovou, et al., 1995) as having an impact on EDI adoption and integration and in consequence on the ability to realize potential benefits of EDI implementation.

RESEARCH METHOD

In the context of a larger study of the impact of EDI on SMEs in the Commonwealth of Kentucky, the previous two research questions were also addressed. The sampling frame was limited to Kentucky because this project was partially supported by a grant from the Kentucky Cabinet for Economic Development. A survey research design was used to elicit data about SMEs and their experiences with EDI implementation.

Data Collection

In late 1997, the survey was mailed to 353 SME-capable firms identified from the 1997 *EDI Yellow Pages* (Phillips Business Information, Inc., 1997) and from two local hub companies and a State Government agency. Since high non-response rate² (>60%) can dilute the ability to statistically generalize to the larger EDI user population, various measures to reduce nonresponse rates were taken resulting in an effective response rate of 24.3% or 86 useful responses. However, McDaniel and Gates (1993) report that higher response rates are a means to reducing nonresponse bias. They also report that "...of all the studies that have looked for differences between nonrespondents and respondents (or early or later respondents) of mail surveys, none has been reported that found meaningful, practical differences between

² It is well established that the possibility of a high non-response rate is a major problem with questionnaires (Sproull, 1988).

respondents and the entire sample or between early respondents and respondents as a whole" (pp. 233, emphasis added).

Instrumentation

EDI impact was measured in terms of *relative benefits* realized by SMEs through EDI adoption and integration. For convenience and readability of the survey instrument, EDI benefits were initially categorized into indirect and direct benefits as explained in the previous section of this paper.

EDI Benefits Realized by Responding Firms

In order to explore the nature of benefits realized by Kentucky SMEs, responding firms were asked to assess the impact of EDI implementation on their organization by indicating the *extent to which each listed benefit had been obtained by the firm* (refer column 1, Table 2 for the list of items). Thus, responding firms rated the extent to which various benefits were obtained by their enterprise³. This was assessed with a 5-point Likert-type scale with verbal labels ranging from a score of 1, "substantially deteriorated (or decreased)," to 3 or "no change," to 5, "substantially improved (or increased)." Thus checking a 5 would indicate that a firm had obtained a substantial improvement (or increase) in a specified benefit because of EDI implementation, whereas checking a 1 would indicate that a firm had observed a substantial deterioration (or decrease) in a specified benefit item.

RESULTS AND DISCUSSION

Profile of Survey Participants

Industrial Sector and Range of Products

All 86 responding firms provided information about their industrial sector. Table 2 profiles the sampled-firms by industry category.

Table 2: Industry Category (N=86)

Industry Category	Frequency	% of Responses
Manufacturing	49	57%
Wholesale Trade	23	27%
Retail Trade	6	7%
Services (e.g., computer, accounting, TV repair)	2	2%
Transportation and Public Utilities	1	1%
Mining	1	1%
Other	4	5%

In the manufacturing sector, participating firms make a diverse range of products including everything from industrial parts and supplies to candy and cheesecakes. In the wholesale trade sector, firms deal in products ranging from industrial parts and supplies to food and pharmaceuticals. The remaining firms are involved in retail trade such as office furniture and

³ The exact phrasing of the question was as follows: Please evaluate the impact of EDI implementation in your organization by indicating the extent to which each of the following benefits have been obtained by your enterprise. Select a response by assessing the change observed in the listed EDI benefit.

power tools, services such as health and lab analysis, and other business activities such as hauling freight, warehousing, logistics management, and computer systems value added reselling (VAR).

Respondent's Position (Job Title)

An equal number (43) of responding individuals belong to the non-technical, managerial or administrative ranks (e.g., Treasurer, Owner/Major Stakeholder/President, Business Manager/General Manager) as those from the information systems branch (e.g., EDI Specialist/EDI Supervisor, IS Manager/EC Manager, Systems Analyst) completed the survey for sample-organizations.

Organizational Size

The sample is uniformly distributed by organizational size when size is measured in terms of the "number of full-time employees" (as displayed in Table 3).

Table 3: Number of Full-Time Employees (N=86)

Number of full-time employees	Frequency	% of Responses
Fewer than 5 employees	5	6%
5 to 10	10	12%
11 to 20	7	8%
21 to 50	9	10%
51 to 100	11	13%
101 to 250	24	28%
251 to 500	7	8%
More than 500	13	15%

Another popular measure of organizational size is "sales volume" and is displayed in Table 4 below. A large number (nearly 70%) of responding firms had gross sales over \$1 million in 1997 with more than half (47%) generating over \$10 million in sales.

Table 4: Estimated 1997 Gross Sales (N=86)

1997 Gross sales (Estimated)	Frequency	% of Responses
Less than \$10,000	1	1%
\$10,000 to \$50,000	3	3%
\$50,001 to \$100,000	4	5%
\$250,001 to \$500,000	3	3%
\$500,001 to \$1 million	3	3%
\$1 million to \$5 million	12	14%
\$5 million to \$10 million	8	9%
More than \$10 million	40	47%
Don't know	12	14%
Total	86	100%

EDI Experience

The utility a firm draws from EDI can also be gauged by its relationship with the length of EDI utilization or amount of experience gathered with this technology. Organizations with

EDI experience of less than or equal to 12 months, make up nearly 10% of the sample, while 56% of the sampled-firms have more than one year and less than 5 years experience. Finally, organizations with more than 5 years of experience make up nearly 34% of the sample. Apparently, a majority of the firms in the sample report being substantially experienced with EDI.

EDI Benefits

Descriptive Analysis of EDI Benefits Realized by Responding Firms

Each one of the benefits listed in Table 5 is significantly different from the middle scale value of 3.00 ("no change") when a one-sample t-test was applied at the 95% confidence level. In other words, on the average, survey-respondents reported achieving a small but statistically significant positive change in each of the listed benefits due to the implementation of EDI in their organization. It should be noted that "inventory levels" and "transaction costs" are reverse-coded and therefore, a deterioration (or decrease) in them has a positive influence on realized benefits.

As shown in Table 5, the mean scores for all the individual EDI benefits clearly support this conclusion. However, it is surprising to note that none of the listed benefit categories has a mean score that falls in the slightly to substantially improved (or increased) or slightly to substantially deteriorated (or decreased) range⁴. Of course, there are individual firms in the sample that report having achieved substantial benefits from EDI, but on the average this is obviously not true.

Table 5: Change in EDI Benefits--Descriptive Statistics (N=78)

Potential EDI Benefits Realized ⁵	Mean	Standard Deviation
Quality of Information	3.83	.93
Relationship with Trading Partners	3.83	.80
Customer Service	3.61	.80
Ability to Compete	3.59	.70
Operational Efficiency	3.55	.89
Cash Flows	3.33	.70
Transaction Costs (reverse coded ⁶)	2.69	1.04
Inventory Levels (reverse coded ⁶)	2.76	.51

Factor Analysis of EDI Benefits

The "EDI benefits" items were further analyzed using the data reduction technique⁷ of "principal components analysis (varimax rotation with Kaiser Normalization)." This

⁴ These are equivalent to the ratings of 4 and 5 on the five point Likert-type "benefits" scale.

⁵ Respondents were asked to assess the impact of EDI implementation on their organization by indicating the extent to which each listed benefit had been obtained by the firm. A 5 point Likert-type scale with verbal labels was used with respondents indicating whether a benefit had "substantially deteriorated or decreased" (coded as a 1), "slightly deteriorated or decreased" (coded as a 2), "no change" (coded as a 3), "slightly improved or increased" (coded as a 4), and "substantially improved or increased" (coded as a 5).

⁶ Lowering transaction costs or reducing inventory levels has a positive impact on accruing benefits from EDI implementation.

exploratory factor analysis was used to identify any underlying factors that constitute the "EDI benefits" construct and for further understanding its relationship with previously identified variables. A two-factor structure was found, explaining nearly 58% of the sample variance. All the "EDI benefits" scale items had a loading greater than 0.5 on the factor to which they were attributed. Nunnally (1978) recommends a 0.5 threshold to achieve an adequate level of reliability for each factor in exploratory work. Communalities for the two factors range from 0.51 to 0.69 with one exception at 0.39. This result is another strong indication of the validity of the latent factor structure.

Table 6: Factor Loadings for 'EDI Benefits' Construct⁸

Potential EDI Benefits Realized	Operational/ Tactical Benefits (BENEFIT1) ⁹	Strategic Benefits (BENEFIT2) ⁹
Cash Flows (e.g., Improve cash flows by faster processing and exchange of information between trading partners)	.74	
Inventory Levels (e.g., Reduce inventory levels by shortening order cycle, reducing ordering costs)	-.71	
Operational Efficiency (e.g., Reduce lead time and costs, better information management, avoid re-keying of data)	.64	.44
Transaction Costs (e.g., Lower costs by eliminating paperwork, postage, faxing, and saving on labor)	-.62	
Customer Service (e.g., Improve customer service by shorter lead times, timely information regarding transaction status)	.62	.51
Quality of Information (e.g., Improve quality by increasing timeliness, accuracy, and accessibility of information)	.57	.44
Ability to Compete (e.g., Increase ability to reach new markets, provide better service at lower costs)		.82
Relationship with Trading Partners (e.g., Enhance trust by sharing information, reduce errors, enable JIT/QR programs)		.81
Eigenvalues	2.59	2.04
% of Total Variance Explained (Cumulative)	32.41%	57.91%

The two categories of potential EDI benefits realized by the surveyed organizations found by the factor analysis shown in Table 6 can be conceptually described as follows.

- Factor 1 can be named "operational/tactical benefits," and it relates to the change in benefits associated with the impact of EDI in engendering improved cash flows, reduced inventory levels, increased operational efficiency, lowering transaction costs, and improving quality of information.
- Factor 2 can be named "strategic benefits," and it relates to the change in benefits associated with the impact of EDI in increasing a firms' ability to compete and enhancing relationships with trading partners.

As noted previously in the background section of this paper Iacovou et al. (1995) categorized EDI benefits obtained by SMEs into indirect and direct benefits. They supported their conceptualization with seven case studies. The factor analysis reported above is based on a

⁷ SPSS/PC version 8.0 was utilized for statistical analysis.

⁸ Rotation converged in 3 iterations. The extraction method used was Principal Component Analysis and varimax rotation with Kaiser normalization.

⁹ Cross-loadings between factors below 0.25 are not shown.

sample size of 86¹⁰ and clearly does not support their conceptualization of EDI benefit categories. Notwithstanding this finding, the individual benefit items identified from *a priori* research by Iacovou et al. are useful indicants of the EDI benefits construct.

Table 7: Relationship of SME Characteristics & EDI Benefits^{11,12} (N=78)

	Industry Category	EDI Experience	1997 Gross Sales (Est.)	# Full-Time Employees	# Temporary or Part-Time Employees
Operational/ Tactical Benefits (BENEFIT1)	.120 (.294)	.123 (.285)	.036 (.756)	.122 (.289)	.098 (.393)
Strategic Benefits (BENEFIT2)	.271* (.017)	.348** (.002)	-.055 (.633)	.150 (.191)	.112 (.328)

Relationship of SME characteristics with EDI Benefits

Table 7 summarizes the correlation statistics between variables that are useful in classifying surveyed-SMEs and the two EDI Benefit factors derived in the previous section of the paper. The data is consistent with the notion that firms with EDI experience can obtain greater strategic benefits from EDI implementation. On the other hand, experience with EDI does not seem to have a significant relationship with operational/tactical EDI benefits or benefits that accrue from improving the efficiency of internal operations and reducing cash flows. Interestingly, data analysis shows that the 'EDI benefits' realized by SMEs are not significantly related to firm size measured in terms of either gross sales or number of employees (full or part-time). Finally, although industrial sector of sample firms has no significant relationship with the ability of a firm to obtain operational/tactical benefits from EDI implementation, it is significantly related with a firm's potential to realize strategic benefits from EDI implementation.

Relationship of Other Key Variables¹³ to 'EDI Benefits' Factors

A number of other research variables have previously been identified by various researchers (e.g., Pfeiffer, 1992; Swatman & Swatman, 1991; Premkumar, Ramamurthy, & Nilakanta, 1994; Iacovou, et al., 1995) as having an impact on EDI adoption and integration and in consequence on the ability of firms to realize potential benefits of EDI implementation. Table 8, 9 and 10 summarize the correlation statistics between these research variables and the two "EDI Benefits" factors.

¹⁰ Actually the factor model was derived using 78 cases only. The remainder were excluded because of missing values.

¹¹ ** Correlation is significant at the 0.01 level (2-tailed; 99% confidence); * Correlation is significant at the 0.05 level (2-tailed; 95% confidence).

¹² Pearson correlation coefficients with significance levels in parenthesis are shown.

¹³ These variables have previously been identified by various researchers (e.g., Pfeiffer, 1992; Swatman & Swatman, 1993) and Iacovou et al., 1995) as having an impact on EDI adoption and integration and in consequence on the ability to realize potential benefits of EDI implementation.

Table 8:
Relationship of Key Determinants of EDI Benefits with Operational/Tactical Benefits Factor (Benefit1) and Strategic Benefits Factor (Benefit2)¹⁴

		<i>Nature of Cost/Benefit Analysis by SME Prior to Adopting EDI</i>	<i>Volume of EDI Documents (Messages) Exchanged¹⁵</i>	<i>Current Stage of EDI Integration</i>
BENEFIT 1	Pearson Correlation	.261*	.122	.456**
	Sig. (2-tail)	.022	.157	.000
BENEFIT 2	Pearson Correlation	.108	.200*	.210***
	Sig. (2-tail)	.348	.020	.074
N		77	78	78

		Extent of Trading Partner support					
		<i>Hard-ware</i>	<i>Soft-ware</i>	<i>Education & Training</i>	<i>Telecommuni-cation costs</i>	<i>Maintenance</i>	<i>Implemen-tation</i>
BENEFIT 1	Pearson Correlation	.188***	.336**	.209***	.148	.127	.138
	Sig. (2-tail)	.103	.003	.066	.197	.268	.138
BENEFIT 2	Pearson Correlation	-0.026	-.102	-.055	.002	-.017	-.079
	Sig. (2-tail)	.824	.374	.634	.984	.885	.491
N		76	78	78	78	78	78

Nature of Cost/Benefit Analysis

Conducting a cost-benefit analysis prior to EDI implementation could provide firms an appreciation of whether EDI would be advantageous to them while understanding its inherent costs. Survey respondents were asked to identify the nature of cost/benefit analysis conducted by them prior to adopting EDI. A majority of the responding firms did not conduct any cost/benefit analysis at all (73%) while nearly 12% report doing a rough estimate, 6% estimate costs only, 7% estimate tangible benefits and costs only, and the remaining estimate costs, tangible and intangible benefits. This result is consistent with other research studies on SMEs. Apparently, either SMEs do not give much importance to the financial consequences associated with implementing new technologies or a majority view the need for such technologies as EDI to be a foregone conclusion. The latter conclusion is also validated by the lack of influence of economic factors on the EDI adoption decision and the great importance attached to customer demands with regards to this decision.

As illustrated in Table 8, the nature of cost/benefit analysis conducted by organizations has a significant influence on the ability of a firm to obtain operational/tactical EDI benefits and

¹⁴ * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed); *** Correlation is significant at the 0.10 level (2-tailed).

¹⁵ This variable has a complex relationship (i.e., it is not linear) with the 'EDI benefits' factors and in consequence the correlation coefficient shown in the table are the nonparametric Kendall's Tau statistic.

does not correlate with strategic EDI benefits (Benefit2). This result is partly consistent with past research findings reported by Pfeiffer (1992).

Volume of EDI communications

Greater the volume of messages (documents) exchanged with EDI technology more likely it is for a firm to achieve substantive savings from EDI implementation. The data shows that "volume" is significantly correlated with firms achieving strategic benefits and has no relationship with operational/strategic benefits.

Current Stage of EDI Integration

EDI integration is the process during which a firm alters its business practices and applications so that they interface with its EDI application. In this regard, the level of *internal integration* reflects the variety of applications interconnected with EDI, such as order-entry/purchasing, accounting, production scheduling (MRP), shipping, etc. Another way of defining the level of internal integration is to describe it in terms of stages of integration. Swatman and Swatman (1991), Swatman et al. (1994) have constructed a *four-stage model for EDI integration* and validated it for large firms. At the lowest level of integration (coded as "1") firms use EDI to print out messages and documents and then re-key data into internal systems. On the other hand, at the highest level of integration (coded as "4") firms use EDI as a strategic technology that links systems throughout the value chain. Obviously, the greater the level of EDI integration the better the opportunity to obtain long-term benefits from this type of technology.

The study results (refer Table 8) confirm that the stage of EDI integration is positively correlated with the strategic benefits (ability to compete or forge relationships with trading partners) obtained by sampled-firms.

Extent of Trading Partner Support

Many authors advocate the use of incentives and subsidies to entice smaller firms to begin using EDI and to expand its use further. This advice has not been always heeded. The trading partners of Kentucky small firms have not heeded this advice as well. Respondents from the sample firms were asked to rate the *level of support received* from their trading partners for hardware, software, education & training, telecommunication costs, maintenance and implementation. Respondents used a 3-point Likert-type interval scale to rate each of these categories, with "1" indicating that "no support was received" and "3" indicating that "substantial support was received." Sampled-organizations reported receiving moderate to no support from trading partners in all support categories. The average "support received" score is the highest for EDI implementation (1.76) and Education and Training (1.64). This is consistent with past research and with the fact that "hub" trading partners tend to provide some education/training support and also do pilot testing of new EDI transactions.

Intuitively it can be argued that greater trading partner support would translate into higher benefits of EDI implementation for firms. The study data indicates that this assertion is only partly correct. Apparently, at the 95% level of confidence, trading partner support for EDI "software" is the only variable that had a significant positive relationship on operational/tactical EDI benefits (Benefit1) achieved by sampled-firms. Other variables such as trading partner support for "hardware" and "education & training" significantly influence operational/tactical benefits at the 90% level of confidence. All other "support" variables did not have any significant correlation with two 'EDI benefits' factors (refer Table 8).

Perceived Reasons for Adopting EDI or EDI Decision Criterion

Another set of variables that could determine the accrual of EDI benefits relate to the perceived reasons why firms adopt EDI (Iacovou et al., 1995). Two key reasons often touted as highly influential factors for the adoption of EDI in firms are as follows: (Influence of) Customer or Supplier's demand and competitive environment. The correlation results illustrated in Table 9 indicate a different story. On the average, the influence of customer or supplier's demand has no significant relationship with achieving EDI benefits. On the other hand competitive pressures (remaining competitive, pressure from competitors, meeting industry standards) are significantly related to the accrual of strategic benefits in small firms.

Table 9: Relationship of 'EDI Adoption Criterion' with Operational/Tactical Benefits Factor (Benefit1) and Strategic Benefits Factor (Benefit2)^{16,17}

EDI Decision Criterion ¹⁸	BENEFIT 1	BENEFIT 2
Customer or supplier's demand	-.043 (.707)	.067 (.557)
Remain competitive	.131 (.252)	.435** (.000)
Pressure from competitors	.100 (.383)	.287* (.011)
Meeting industry standards	.074 (.522)	.420** (.000)
Improves customer service	.440** (.000)	.314 ** (.005)
Makes Just-In-Time manufacturing possible	.203*** (.075)	.079 (.494)
Forges strong business relationships with partners	.023 (.841)	.326** (.004)
Increases sales revenues/Increases profits	.414** (.000)	.244* (.032)
Decreases transaction costs	.527** (.000)	.263* (.020)
Decreases administrative costs	.540** (.000)	.260* (.022)
Decreases manufacturing costs	.340** (.002)	-.015 (.897)
Decreases procurement costs	.458** (.000)	.075 (.512)
Reduces number of employees	.455** (.000)	.065 (.576)
Reduces inventory & carrying costs	.507** (.000)	.042 (.715)
Quicker response and access to information	.373** (.001)	.337** (.003)
Improves accuracy of information	.331** (.003)	.372** (.001)
Improves communication with trading partners	.186** (.102)	.465** (.000)
Improves ability to control & coordinate data	.369** (.001)	.379** (.001)
Reduces paperwork	.357** (.001)	.200 (.079)
Ease of processing for order entry	.473** (.000)	.224* (.049)
Aids in accounting, billing, production scheduling	.335** (.003)	.229* (.043)
Ease of tracking shipments/Ease of tracking orders	.441** (.000)	.217 (.056)
Improves efficiency of business operations	.501** (.000)	.155 (.176)

¹⁶ Pearson correlation coefficients with significance levels in parenthesis are shown. The useful sample size varies between 77-78 depending on a specific item with the majority of the items having an N of 78.

¹⁷ * Correlation is significant at the 0.05 level (2-tailed; 95% confidence); ** Correlation is significant at the 0.01 level (2-tailed; 99% confidence).

¹⁸ Respondents were asked to assess EDI decision criterion on a 4 point Likert-type scale with verbal labels. Respondents indicated with a check whether a criterion had "no influence at all" (coded as a 1), "minor influence" (coded as a 2), "moderate influence" (coded as 3), and "major influence" (coded as 4).

Table 10: Relationship of Key 'EDI Implementation Impediments' with Operational/Tactical Benefits Factor (Benefit1) and Strategic Benefits Factor (Benefit2)^{19,20}

EDI Implementation Impediments²¹	BENEFIT1	BENEFIT2
Low volume or frequency of orders	-.144 (.212)	-.189 (.100)
Impersonal nature of EDI	-.111 (.342)	-.153 (.187)
Maintaining one system for EDI capable & another for non-EDI capable partners	-.127 (.271)	-.029 (.804)
Translating customer/supplier data for direct use in internal applications	-.079 (.490)	-.055 (.632)
Complexity of the technology	-.177 (.122)	-.156 (.173)
Selecting means for communications with trading partners	-.054 (.640)	-.041 (.724)
Determining appropriate internal applications to apply EDI	-.189 (.100)	-.223* (.051)
Ability to seamlessly integrate EDI with existing internal applications	-.220* (.052)	-.040 (.727)
Absence of uniform EDI standards	.068 (.556)	.219 (.054)
Implementing multiple trading partners	-.138 (.231)	-.016 (.888)
Integrating multiple EDI systems and/or VAN connections	-.162 (.158)	.221* (.053)
Dealing with multiple EDI formats	.032 (.781)	.273* (.015)
Selecting the hardware to run EDI software	-.253* (.025)	-.024 (.832)
Changing business processes	-.291** (.010)	-.032 (.782)
Small size of business	-.313** (.006)	-.190 (.101)
Increased responsibility for employees	-.152 (.187)	-.017 (.884)
Gaining management/stakeholder commitment	-.024 (.835)	-.178 (.121)
Overcoming resistance to change	-.035 (.765)	.010 (.929)
Availability of managerial time to expand EDI use	-.155 (.180)	-.063 (.587)
Addressing legal issues (e.g., electronic orders, signatures, legal agreements)	-.008 (.944)	-.063 (.589)
Exposure to ever-changing customer/supplier requirements about EDI system	-.046 (.692)	-.036 (.756)
Managing data and transmission security and auditability	.155 (.178)	.097 (.401)
High startup costs	-.078 (.499)	.144 (.209)
Availability of financial resources	-.092 (.425)	.106 (.355)
High cost of integration and expansion of EDI use	-.094 (.412)	.171 (.135)
Availability of technological resources	-.123 (.282)	-.068 (.554)
Learning new technology and methodology	-.181 (.114)	-.076 (.506)
End users and customers' continued reliance on paper-based transaction	-.038 (.739)	.073 (.527)
Obtaining general information about EDI	-.226* (.047)	-.222* (.051)
Considering EDI as a natural extension of pre-existing internal operations	-.303** (.007)	-.051 (.656)
Understanding potential benefits of EDI	-.211 (.066)	-.181 (.116)

¹⁹ Pearson correlation coefficients with significance levels in parenthesis are shown. The useful sample size varies between 77 and 78 depending on a specific item with the majority of the items having an N of 78.

²⁰ * Correlation is significant at the 0.05 level (2-tailed; 95% confidence); ** Correlation is significant at the 0.01 level (2-tailed; 99% confidence).

²¹ This is measured on a 3 point Likert-type "seriousness of challenge" scale with verbal labels. A rating of "1" indicates that an item is "not serious at all", "2" indicates that an item is a "somewhat serious challenge", "3" indicates that an item is an "extremely serious challenge." Respondents have the option of indicating that an item is "not an impediment for us" coded as a "0".

Impediments to EDI Adoption and Integration

The greater the seriousness and challenge of various impediments to EDI adoption and integration, the lower the chances of increasing or improving the level of benefits after EDI implementation or integration. Table 10 illustrates the correlation between most common impediments to EDI adoption and integration and the two EDI benefits factors. Although the individual SME owners have told this author that having the "right" volume or frequency of orders is an important challenge, the data in this study indicates that on the average there is no significant relationship between low volume or frequency of orders and the EDI benefits. In fact, most of the more critical challenges that negatively impact EDI benefits have to do with the business process reengineering (BPR) aspect of the technology and the difficulties associated with understanding, modifying or customizing EDI for the adopting firm. Particularly, the difficulty of "selecting the hardware to run EDI software", "changing business processes", "small size of business", "obtaining general information about EDI", "understanding potential benefits of EDI", and "considering EDI as a natural extension of pre-existing internal operations" have a significant negative influence on obtaining operational/tactical (direct) EDI benefits.

CONCLUDING REMARKS

Limitations of the Study

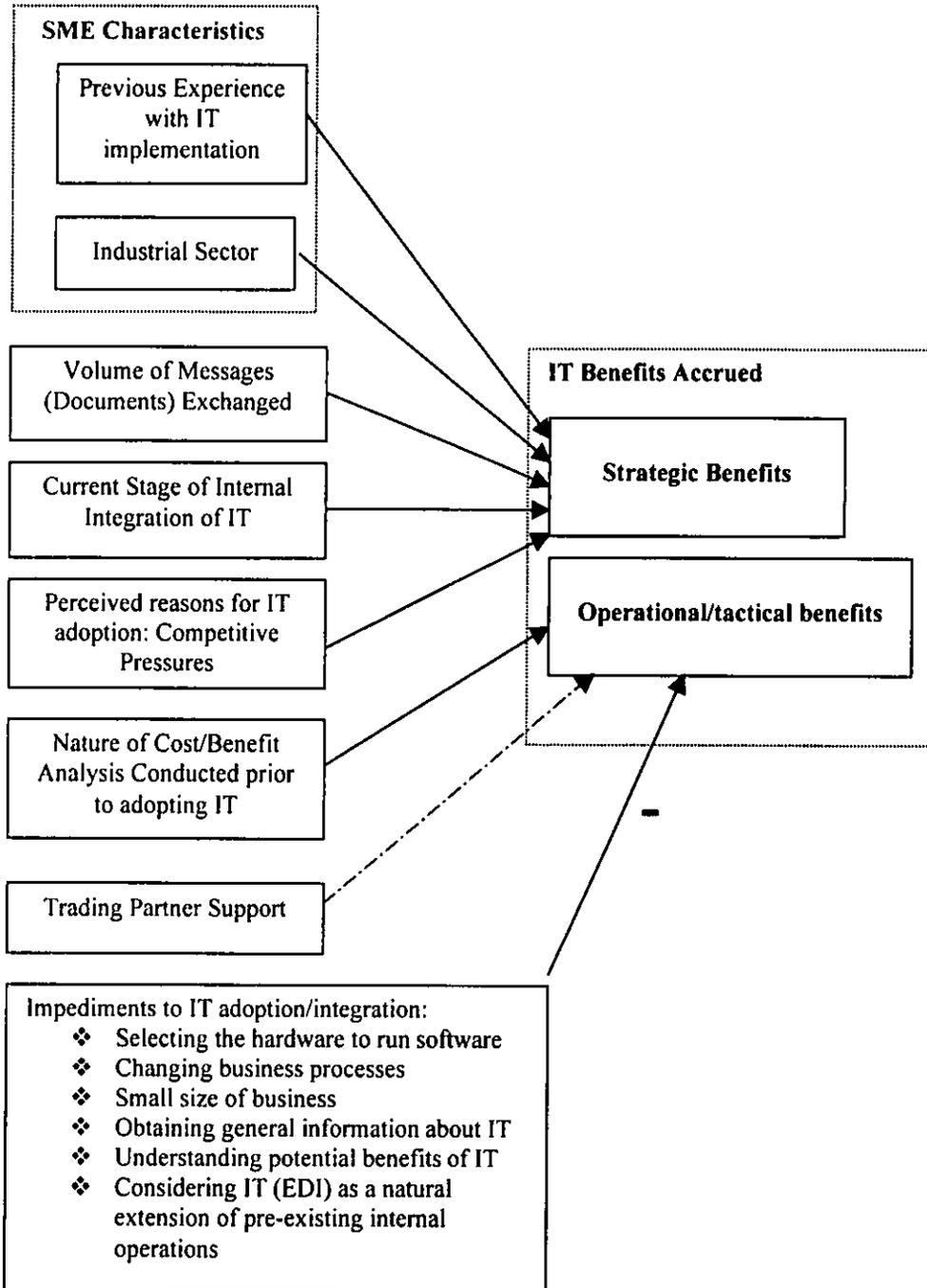
As with most research endeavors, this project has some potential limitations. Since the research method used for this study is nonexperimental²² in nature, study results are not necessarily generalizable to all SMEs. However, results could be generalized to the industries and organizational sizes represented by the sample. Further, no cause and effect conclusions have been drawn; results are useful for deriving conclusions about relationships and characteristics of EDI use in Kentucky SMEs and similar firms in the larger context. Even though all efforts were taken to reduce nonresponse bias and other errors, inferences, conclusions, recommendations from this type of research strategy are generally supported with lesser confidence than true experimental research (Sproull, 1988).

Implications for Practice and Research

The results reported in this paper have critical implications for both practice and future research. As suggested in the introduction of this paper, notwithstanding technological developments such as eXtensible Markup Language (XML) and web-based ordering systems, EDI will continue to be a major technological standard for conducting B2B or business-to-business electronic commerce around the globe. The results reported in this study provide some useful guidance for small firms to truly realize benefits in the short- and long-term from investments in organization-transforming information technologies such as EDI. Thus, for example, this study demonstrates that regardless of firm size, it is possible to obtain strategic benefits from implementing newer information technologies (IT) such as EDI and that they will not occur in the immediate term (refer Figure 1). Further, firms need to give critical consideration to the level of internal integration of the IT being implemented, which has a strong bearing on accruing strategic benefits. In addition, in order to achieve operational/tactical benefits from IT implementation, firms need to better prepare for and understand how they can overcome impediments relating to modifying business processes and choosing the technology itself.

²² An experimental variable (e.g., EDI use or non-use) is neither introduced nor controlled in non-experimental research designs.

Figure 1: Significant Findings—Determinants of Relative Impact of IT on SMEs Implications for new Interorganizational IT Implementation²³



²³ All relationships shown are positive unless otherwise specified.

Finally, the results of this study provide mixed support for earlier findings by researchers on EDI implementation in small and large firms. The results of this study also show that there are some important determinants and inhibitors of strategic benefits that can be realized by SMEs. Thus, as illustrated in Figure 1, significant variables such as the nature of cost/benefit analysis conducted, extent of trading partner support, IT adoption criterion, impediments to adoption/integration, and stage of internal integration and their relationship to strategic benefits accrued from IT implementation in general, and business-to-business commerce technologies in particular, are of clearly of interest to researchers and practitioners alike and warrant further investigation.

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Deepak Khazanchi is Professor and Chairperson of the Department of Information Systems and Quantitative Analysis in The Peter Kiewit Institute (PKI) -- College of Information Science & Technology (IS&T) at the University of Nebraska in Omaha (UNO). He has given seminars and advised firms on setting up IS/T project management best practices and previously worked as a Project/Design Engineer in the construction industry. His current research interests include philosophical and pedagogical issues in IS, B2B EC control & assurance, and impact of pervasive IT on service quality. Deepak's recent research has been published in the *Communications of the Association of Information Systems (CAIS)*, *Journal of the Association of Information Systems (JAIS)*, *Decision Support Systems*, *Information Systems Management*, *Journal of Information Technology Management*, and *DATA BASE for Advances in Information Systems*.