

## Key obstacles to EDI success: from the US small manufacturing companies' perspective

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### Abstract

This study first empirically investigated key EDI obstacles experienced by US small manufacturing firms and, then, examined the relationships between the identified obstacles and their realized EDI benefits. This research revealed the following important findings. First, four dimensions of obstacles were derived: lack of managerial leadership/organizational readiness, lack of integration of EDI with internal/external computer systems, potential technical concerns, and security/legal concerns. Second, the lack of integration of EDI with internal/external computer systems turned out to be the most significant barrier to achieving the overall EDI success and three key EDI benefits, such as reduced administrative/transaction costs, improved information accuracy, and enhanced competitiveness in the marketplace. Third, the "lack of managerial leadership/organizational readiness" and "technical concerns" dimensions were found to be the second and third most significant obstacles to the reduction of administrative/transaction costs, respectively. Finally, the security/legal concerns dimension is considered a significant barrier to the overall EDI success.

### Introduction

As many companies in an extremely competitive environment are implementing just-in-time (JIT), vendor-managed inventory techniques and, recently, supply chain management, the strategic significance of the information systems, such as electronic data interchange (EDI), Internet-based EDI, and the Internet, has intensified. Some researchers (e.g. Barber, 1997) predict that the Internet will completely replace EDI soon as an inter-organizational system (IOS), by pointing out the rapidly growing Internet users and the unique capabilities of the Internet for conducting business-to-business transactions.

However, many others (e.g. Larson and Kulchitsky, 2000; Sliwa, 2000; Tingle, 2000) claim that EDI will continue to be used as an important communication medium by many business organizations for years to come because of the following major reasons.

First, since many large firms across industries, including the electronics, automotive, retailing, and transportation and logistics industries, have already invested millions of dollars on EDI systems and have achieved strategic benefits from this technology, they do not have a strong enough motivation to switch to the Internet (Larson and Kulchitsky, 2000). Second, the Internet is still viewed by many top managers as a vulnerable and insecure vehicle for electronic commerce (Ratnasingham, 1998). Finally, the EDI-capable firms can utilize the recently developed software that integrates the Internet into existing EDI systems and benefit from the speed and flexibility of the Internet without losing their EDI investment.

Currently, the active role of EDI as an IOS is evidenced in some industries, such as the automotive, retailing, and transportation and

logistics industries. For example, GM has been using EDI, connected with its more than 6,000 suppliers, and has recently adopted the international EDIFACT as a new standard for EDI systems to improve its global supplier communications (Zuckerman, 1999).

Despite the great potential of EDI for enhancing competitiveness in the marketplace, the adoption of electronic linkages between companies is not as uncomplicated, or as profitable as has been expected. Rather, disappointing results have materialized and these can be attributed to many factors, including lack of trust between trading partners and lack of organizational readiness for EDI. Particularly, many small businesses still view EDI as a cost of doing business and often use non-integrated, standalone EDI systems, attaining only minimal benefits.

Therefore, the specific objectives of this research were to first, assess the small firms' perceptions of key EDI benefits and the overall EDI success; second, identify key dimensions of obstacles to EDI success as perceived by the small firms; third, examine the relationships of the derived dimensions with the key EDI benefits and the overall EDI success; and fourth, present managerial implications and recommendations for EDI success.

The rest of this paper discusses relevant literature, research questions, research method, analyses and results, and discussion and conclusions.

### Literature review

#### Potential benefits of EDI

EDI can be defined as the computer-to-computer exchange of standard business documentation in machine-processable form (Hart and Saunders, 1998; Marcussen, 1996).



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This system enables companies to achieve various types of operational and strategic benefits.

Specifically, the reported EDI benefits can be largely categorized into six areas:

- 1 decreased administrative and transaction costs by reducing paperwork and lowering costs for both coordinating and processing transactions (Murphy and Daley, 1999);
- 2 reduced inventory levels and inventory costs by enhancing integration between trading partners' information systems, which allows shorter order cycles and higher inventory turnovers (Dröge and Germain, 2000; Iacovou *et al.*, 1995; Philip and Pedersen, 1997);
- 3 improved accuracy of information and error reduction by eliminating the need for re-keying data (Murphy and Daley, 1999);
- 4 improved cash flows, i.e. funds are not tied up in a company's accounts payable or accounts receivable for long periods of time (Murphy and Daley, 1999);
- 5 better customer service by reducing order cycles time and providing timely information about transaction status (Angeles *et al.*, 1998; Murphy and Daley, 1999); and
- 6 enhanced competitiveness through a win-win partnership fostered by EDI linkages, such as more timely responses to market changes (Iacovou *et al.*, 1995; Murphy and Daley, 1999).

However, most of the previous studies have primarily focused on large firms in examining the realized EDI benefits. Little research has investigated this issue from the small firms' perspectives.

#### **Obstacles to EDI success**

Based on a review of the EDI and IOS literature, the authors identified various types of barriers to EDI success and then, classified them into the following seven categories: managerial leadership, costs and benefits, technical, human resources management, trading partner relationships, security, and legal issues:

- *Managerial leadership issues.* Top and middle managements' understandings of EDI and their strong support play a crucial role in successful EDI implementation, since EDI would influence an organization's interactions with its trading partners, change business processes, and impact the competitive position of this firm in the industry (Monczka and Carter, 1988; Premkumar and Ramamurthy, 1995).
- *Perceived costs and benefits issues.* Often a concern to businesses is the costs of implementing EDI versus the benefits to be received. The EDI implementation requires substantial financial resources for the system itself, additional hardware and software to enhance communication links, and ongoing expenses during usage (Iacovou *et al.*, 1995). Thus, the high costs involving EDI implementation could appear to be prohibitive to many small firms. Another important concern for small businesses is the high volume of transactions that EDI requires before benefits are obtained, since most small firms cannot easily gain economies of scale that would warrant their investment in the costs of EDI.
- *Technical issues.* The technical obstacles associated with EDI include difficulty in integrating existing computer systems with EDI, proliferation of standards, and risk of system instability. The full integration of EDI with an organization's internal computer systems and with those of trading partners is considerably a difficult task, primarily due to the incompatibilities between EDI software and in-house applications, and the existence of several standards for information exchange of protocols, procedures, and data forms (Hendon *et al.*, 1998). In addition, the system stability issues, such as data backup, disaster recovery, and error recovery, are the utmost concerns of most business organizations.
- *Human resources management issues.* Since the effectiveness of any technology primarily depends on time and effort to learn and use it, insufficient education and training for the managers and users can be a critical barrier to EDI success (Banerjee and Golhar, 1994). In addition, new technology often brings behavioral and organizational changes to an organization, as a result incompatibility of EDI with existing organizational culture, value, and work practices can occur and become one of the greatest barriers to EDI success (Premkumar and Ramamurthy, 1995).
- *Trading partner relationships issues.* A critical obstacle to EDI success may arise from the difficulty in getting trading partners to use EDI and the problems in reaching an agreement on trading terms associated with EDI use.
- *Security issues.* Security issues, such as the disclosure of messages, modification of message contents, modification of message sequence, sender masquerade,

and repudiation of message origin or receipt, are a serious concern for current and future EDI users. When the EDI audit and control procedures fail to detect such security risks, this failure could severely damage the communication and partnerships between trading partners (Banerjee and Golhar, 1993).

- *Legal issues.* The legal disputes associated with EDI may present potential challenges to business organizations. Thus, EDI partners together need to clearly make an agreement on all terms and conditions related to EDI use, including shipment location of scheduled delivery, duration of the contract, designation of who pays for network charges, and the obligations of sender and receiver, in case the document is intercepted by an unauthorized third party or only a part of the document is transmitted (Aggarwal *et al.*, 1998; Monczka and Carter, 1988).

As discussed earlier, a wide range of obstacles to EDI success have been identified by prior research. Yet, little research has empirically investigated the underlying key barriers faced, particularly by small firms.

#### **Key obstacles and EDI benefits**

Not all barriers to EDI success have the same negative effect on attaining EDI benefits. It is thus important to examine which obstacles are most significantly associated with the failures of gaining the maximum benefits of EDI. In investigating the relative importance of various types of EDI barriers, a number of researchers conducted field studies. For example, Reekers and Smithson (1994) noted that the variety of standards and the integration of EDI into the existing system are the most widespread difficulties for EDI users in Germany and the UK. Ramaseshan (1997) surveyed manufacturers, distributors, wholesalers, and retailers, and found that the most frequently mentioned obstacle is top management support, followed by threats to security of information, potential legal problems due to the lack of paper documentation, implementation costs, and technical problems.

Philip and Pedersen (1997) discovered major problems associated with EDI in Northern Ireland. Their findings were, in descending order of importance, difficulty in quantifying the return on EDI investment, high volume of transactions needed to benefit from EDI, high implementation costs, lack of top management commitment, selection of a message standards, impacts on the organization, and legal issues.

Murphy and Daley (1999) examined the EDI barriers perceived by international freight forwarders (usually small businesses) and their customers (usually large ones).

According to their study, the small service providers consider high setup costs as the most critical barrier, followed by:

- incompatibility of hardware/software;
- lack of standard formats;
- customer sophistication, and awareness of EDI benefits;
- customer education/training;
- customer resistance to change; and
- corporate culture.

On the other hand, large business customers deemed incompatibility of hardware/software as the most important barrier, followed by:

- lack of standard formats;
- high setup costs;
- lack of customer sophistication;
- lack of awareness of EDI benefits;
- corporate culture;
- customer education/training; and
- customer resistance to change.

Tuunainen (1998) examined the small businesses in the automotive industry and pointed out the following key obstacles:

- lack of EDI awareness;
- confounding standards;
- too high costs;
- low transaction volume;
- technical complexity; and
- data security concerns.

Recently, Angeles and Nath (2000), using a sample of 64 dyads (buyer-supplier), examined the relationships between key EDI implementation factors and EDI success. They found that EDI success is most strongly associated with the availability of clear guidelines for EDI transaction agreements, and commitment and sense of ownership of the cross-functional EDI team.

As discussed earlier, many studies have attempted to identify the relationships between EDI obstacles and its success. Yet, relatively few studies have investigated the issue within the context of small manufacturing firms.

#### **Research questions**

The specific research questions derived from the relevant literature review were as follows:

- RQ1.* To what extent do small firms perceive to have attained key EDI benefits (for EDI adopters) or expect to attain the key benefits from EDI (for non-adopters)? What would be



the EDI-adopters' and the non-adopters' assessment of the overall EDI success?

- RQ2. What do small firms perceive to be key obstacles to EDI success?
- RQ3. Which obstacles, of the key obstacles identified, have the most significantly negative impact on attaining key EDI benefits and the overall EDI success?

### Research method

In this inquiry, a small firm was defined as one with less than 400 employees. As a sampling frame for this study, a total of 640 firms meeting this size criterion were identified from the two two-digit SIC codes listed in *Disclosure: The Financial and Business Information on the US Publicly Traded Companies* (Disclosure, 1999). There are 262 firms in the industrial machinery and equipment industry (SIC 35) and 378 firms in the electrical and electronic equipment industry (SIC 36). These specific industries were selected because they have a long history of industrial buyer-supplier partnerships relationships and are characterized by firms of various sizes working in a competitive environment. Thus, these industries appear to offer fertile ground for investigating the issues related to the EDI implementation of small manufacturing firms.

A total of 400 companies were drawn from the sampling frame and a self-administered questionnaire was mailed to the presidents or information systems managers of the selected US small manufacturing companies. A second copy of the questionnaire was sent three weeks after the initial mailing. A total of 102 surveys were obtained, 17 of which were returned as undeliverable. Thus, a total of 85 usable responses were included in this study, resulting in a 22.2 per cent response rate. Given the total number of firms in the sampling frame, the obtained number of responses is considered adequate. To assure whether there was any non-response bias, comparisons were made between responses to the first mailing and those to the second mailing on each study variable (Armstrong and Overton, 1977). This test revealed statistically no differences in mean responses.

### Characteristics of the responding companies

Table I presents a summary of the characteristics of the responding firms. Of the 85 responding companies, 27 (32 per cent)

were EDI adopters and the remaining 58 (68 per cent) were non-adopters. Of the adopters, 85 per cent were implementing EDI for more than three years. Concerning the annual sales revenue, 79 per cent of the responding firms showed less than \$50 million and the remainder revealed between \$50 million and \$300 million. As to the number of employees, 27 per cent reported to have less than 50 employees; 60 per cent, from 50 to 299; and the remaining 13 per cent, from 300 to 399.

Approximately 72 per cent of the responding firms reported to have long-term, strategic alliances with their customers, suppliers, or both. Regarding the issue of a trading partner's imposition on the EDI adoption decision, 66 per cent of the EDI user firms indicated that they were forced to adopt EDI by their trading partners. Concerning the EDI partner firms (multiple answers were allowed for this item), 73 per cent of the EDI adopters were linked with customers, followed by suppliers (35 per cent), government agency (23 per cent), and financial institutions (19 per cent). Finally, while 50 per cent of the EDI adopters were implementing a JIT manufacturing approach, only 29 per cent of non-adopters were employing the approach.

### Measures

The relevant literature review revealed a total of seven broadly-defined EDI obstacles, such as:

- 1 managerial leadership;
- 2 costs and benefits;
- 3 technical;
- 4 organizational;
- 5 trading partner relationships;
- 6 security; and
- 7 legal issues.

The authors developed appropriate scale items for measuring those obstacles. Two EDI consultants then reviewed the initial items and various alterations were undertaken based on their inputs.

As a result, a three-page questionnaire was constructed. The first part of the questionnaire addressed the characteristics of the responding firms. In the second part, a total of 20 scale items pertaining to the seven categories of EDI obstacles were listed (see the Appendix for scale items). The respondents were requested to assess the extent to which each of the 20 specific obstacles is present in their organizations, based on a Likert-type five-point scale, ranging from 1 = "not an obstacle at all" to 5 = "an obstacle to a very great extent".

**Table I**  
 Characteristics of responding companies

Classification	Number	Percentage
<b>Number of employees (n = 85)</b>		
< 50	23	27
50-299	51	60
300-399	11	13
<b>Annual sales revenue (\$m) (n = 81)</b>		
< 50	64	79
50-300	17	21
<b>EDI adoption (n = 85)</b>		
Adopters	27	32
Non-adopters	58	68
<b>Having strategic alliances (n = 82)</b>		
With customers only	13	16
With suppliers only	5	6
Both customers and suppliers	41	50
No strategic alliances	23	28
<b>Using a just-in-time (JIT) manufacturing approach (n = 81)</b>		
<b>EDI adopters (n = 26)</b>		
Yes	13	50
No	13	50
<b>Non-adopters (n = 55)</b>		
Yes	16	29
No	39	71
<b>Number of years in EDI use (n = 26)</b>		
≤ 3	4	15
> 3	22	85
<b>EDI imposed by trading partners (n = 26)</b>		
Yes	14	54
More or less	3	12
No	9	35
<b>Organizations interacting via EDI (multiple answers allowed) (n = 26)</b>		
Customers	19	73
Suppliers	9	35
Financial institutions	5	19
Government agencies	6	23
Transportation companies	2	8
Others	2	8

In addition, the informants were requested to respond to seven items, using a 1 = "very unsuccessful", 3 = "no change", and 5 = "very successful scale". The first six items were to measure six individual EDI benefits, respectively, and the last item was to assess the overall EDI success. The six individual benefits were:

- 1 reduced administrative/transaction costs;
- 2 decreased inventory levels/inventory costs;
- 3 improved information accuracy;
- 4 improved cash flows;
- 5 better customer service; and
- 6 enhanced competitiveness in the marketplace.

In responding to the seven items, EDI adopters were asked to rate the items based on their perceptions of actual EDI benefits and overall success, while non-adopters were

requested to rate the items based on their expectations under the assumption of EDI implementation.

## Analyses and results

### Perceived benefits of EDI

The first research question focused on the small firms' perceptions of actual (for EDI adopters) or expected (for non-adopters) benefits of EDI. Table II presents the means and standard deviations for the six individual EDI benefits identified earlier. The EDI adopters reported that they achieved, via EDI, some improvement in their customer service ( $m = 3.56$ ; where 3 = no changes and 5 = very successful), information accuracy (3.37), and competitiveness in the marketplace (3.15), while they experienced no improvement in

**Table II**

Results of MANOVA and *t*-tests between two groups regarding key EDI benefits and the overall success

Key EDI benefits	EDI adopters		Non-adopters		t-tests		Two-group total		MANOVA		
	Mean	SD <sup>a</sup>	Mean	SD	t	p	Mean	SD	Wilks' λ	F	p
Reduced administrative and transaction costs	3.00	1.27	3.37	0.94	-1.472	0.145	3.24	1.07			
Reduced inventory levels and inventory costs	2.67	1.04	3.13	1.16	-1.766	0.081	2.97	1.13			
Improved information accuracy	3.37	1.36	3.50	1.06	-0.467	0.642	3.46	1.16			
Improved cash flows	2.78	1.19	3.15	0.89	-1.581	0.118	3.03	1.01	0.875	1.141	0.214
Better customer service	3.56	1.01	3.59	0.90	-0.146	0.884	3.58	0.93			
Enhanced competitiveness in the marketplace	3.15	1.20	3.18	1.09	-0.105	0.916	3.17	1.12			
Overall EDI success	3.46	1.47	3.05	1.46	1.575	0.119	4.46	1.47			

Note: <sup>a</sup>SD: standard deviation

their administrative/transaction costs (3.00), cash flows (2.78), and inventory levels/inventory costs (2.67). They also reported a relatively low level of overall EDI success (3.46).

In the case of non-adopters, the respondents appeared to have some positive expectations regarding EDI adoption. This group showed mean scores between three and four for all the six EDI benefits. Of the six benefits, they expected to have the largest improvement in their customer service (3.59), followed by information accuracy (3.50) and administrative/transaction costs (3.37). They did not expect much progress in the areas of inventory levels/inventory costs (3.13), cash flows (3.15), and competitiveness in the marketplace (3.18). Regarding the overall EDI success, the non-adopters predicted that EDI implementation would bring almost no changes to their organizations (3.05). This mean score was somewhat lower than that of EDI adopters.

The results of the multivariate analysis of variance (MANOVA) and subsequent *t*-tests indicated that there were no statistically significant differences between the two groups on each of the six EDI benefits and on the overall EDI success (see Table II). This finding indicates that the two groups have a strong agreement on their assessment of EDI benefits and overall success.

#### Underlying key obstacles to EDI success

The second research question concentrated on identifying key obstacles to EDI success as perceived by small manufacturing firms. Before deriving key dimensions, the MANOVA test was performed on the data collected from the two groups: EDI adopters and non-adopters. The MANOVA test failed to reject the null hypothesis that the two

groups have equal means with respect to the 20 scale items for measuring EDI obstacles ( $F = 1.141$ , Wilks'  $\lambda = 0.875$ ,  $p = 0.214$ ). This indicated that there was a highly significant agreement between the two groups in their perceived importance of EDI obstacles. Subsequently, *t*-tests were undertaken for each of the 20 items and only two items (Cb2 and Hr3) were shown to have a significant dissimilarity between the two groups.

Therefore, the MANOVA and *t*-tests results warranted that the data on each group could be merged and used to derive key dimensions of obstacles as perceived by the responding firms, regardless of their status of EDI adoption. Thus, the merged data were subjected to the principal components factor analysis with a varimax rotation. Factoring was stopped according to the criterion of a minimum eigenvalue of one and a four-factor solution emerged.

These exploratory factor analysis results are presented in Table III. As shown in Table III, the results from the four-factor solution indicated that 16 out of 20 scale items were loaded 0.55 or more on one of the four factors, but not on any other. To minimize problems due to multicollinearity, this study did not use the four scale items with significant cross-loadings for further analysis.

Reliability analysis produced Cronbach alphas for the generated factors. All of the multi-item measures had Cronbach's alphas greater than 0.75, an indication of sufficient reliability for the exploratory nature of this study. The extracted four factors together accounted for 67 per cent of the total variance. The first factor, lack of managerial leadership/organizational readiness, explains 38 per cent of the variance. This dimension was followed by lack of



**Table III**  
 Results of factor analysis on perceived importance of EDI obstacles

Factors	Loading			
	1	2	3	4
<b>1 Managerial leadership/organizational readiness</b>				
MI1 <sup>a,b</sup>	<b>0.74</b>	0.24	-0.07	0.10
MI2	<b>0.81</b>	0.13	0.21	0.08
Cb1	<b>0.75</b>	0.28	-0.05	0.08
MI3	<b>0.71</b>	0.08	0.24	0.23
Hr1	<b>0.76</b>	0.05	0.21	0.25
Hr2	<b>0.58</b>	0.36	-0.10	0.10
Hr3	<b>0.55</b>	0.10	0.43	0.02
Hr4	<b>0.60</b>	0.05	0.25	0.38
<b>2 Integration of EDI with internal/external computer systems</b>				
Cb3	0.14	<b>0.62</b>	-0.14	0.44
Tp1	0.30	<b>0.60</b>	0.40	0.04
Te3	0.15	<b>0.84</b>	0.14	0.02
Te4	0.11	<b>0.82</b>	0.24	0.10
<b>3 Technical concerns</b>				
Te5	0.10	0.31	<b>0.84</b>	0.12
Te2	0.12	0.06	<b>0.75</b>	0.30
<b>4 Security/legal concerns</b>				
SE1	0.15	0.04	0.37	<b>0.82</b>
LE1	0.20	0.20	0.11	<b>0.85</b>
Percentages of variance explained	<b>37.99</b>	<b>11.69</b>	<b>10.32</b>	<b>7.00</b>
Cronbach's alpha	<b>0.88</b>	<b>0.79</b>	<b>0.78</b>	<b>0.83</b>

Notes: <sup>a</sup>For notations, please see the Appendix; <sup>b</sup>Of 20 original scale items, four items were unused (MI4, Cb2, Cb4, Te1)

integration of EDI with internal/external computer systems (12 per cent), potential technical concerns (10 per cent), and security and legal concerns (7 per cent).

- *Lack of managerial leadership/organizational readiness.* This factor was defined by eight scale items drawn from three of the original seven categories: four items from human resource management, three from managerial leadership, and one from costs and benefits issues.

The lack of managerial leadership/organizational readiness dimension refers to the concept that to be successful in EDI implementation, first, an organization should provide its managers and EDI users with training programs, in which they can improve their understanding of EDI and develop their technical expertise in the information systems; second, top management should show a strong commitment and allocate sufficient financial resources to EDI implementation; and third, top management should provide a strong leadership in developing adequate organizational culture, structure, procedures, and controls that fit into the electronic business transaction environment.

- *Lack of integration of EDI with internal/external computer systems.* This factor was constructed by four scale items pertaining to three original categories: two from technical issues, one from costs and benefits, and one from trading partner relationships. The full integration of EDI with internal/external computer systems, which is one of the important prerequisite conditions for obtaining maximum benefits of EDI, requires high initial capital investment and maintenance costs and, particularly, close cooperation and trust between trading partners.
- *Technical concerns.* This factor consisted of two items drawn from the original technical concerns category: first, poor back-up, disaster recovery, and error recovery; and second, lack of audit trails.
- *Security/legal concerns.* This factor comprised two scale items, one from the original security issues category and the other from the legal concerns. This dimension refers to the potential security and legal problems involving EDI use.

#### Perceived key obstacles and EDI benefits

The third research question was concerned with assessing the impacts of the generated four dimensions of obstacles on each of the

six individual EDI benefits and the overall EDI success. Separate regression analyses were performed for each of the total seven dependent variables. To control for the effects of the responding companies' characteristics, the variables such as annual sales revenue were also entered as independent variables in the seven regression equations.

The results of the regression analyses are summarized in Table IV. The overall model fit for each regression equation was assessed by  $F$  statistics. Of the seven regression models, the models for the four dependent variables, such as reduced administrative/transaction costs, improved information accuracy, enhanced competitiveness, and the overall EDI success, were statistically significant at  $p < 0.05$ .

On the other hand, the models for the remaining three dependent variables, such as reduced inventory levels/inventory costs, improved cash flows, and better customer service, turned out to be statistically insignificant at  $p < 0.05$ .

- *Reduced administrative/transaction costs.* As shown in Table IV, the regression equation, measuring the relationships between the extracted four dimensions of EDI obstacles and the reduction of administrative/transaction costs, explained 42.2 per cent of the dependent variable ( $F = 3.707$ ,  $p = 0.011$ ).

The lack of integration of EDI with internal/external computer systems dimension was significantly and negatively associated with the reduction of administrative/transaction costs, whereas the lack of managerial leadership/organizational readiness and the technical concerns dimensions were significantly and positively related to the dependent variable.

Considering the beta coefficient of each independent variable in terms of absolute values, the lack of integration of EDI with internal/external computer systems dimension is the most significant barrier to the reduction of administrative/transaction costs, followed by the lack of managerial leadership/organizational readiness, and technical concerns dimensions.

- *Improved information accuracy and enhanced competitiveness.* The two generated regression models for the improved information accuracy and the enhanced competitiveness accounted for 43.3 per cent and 55.5 per cent of the variance of the respective dependent variables ( $F = 3.841$ ,  $p < 0.009$ ;  $F = 5.636$ ,  $p = 0.001$ ). Only one independent variable,

“the lack of integration of EDI with internal/external computer systems”, was significantly and negatively associated with each of the two dependent variables.

- *Overall EDI success.* The regression model for the overall EDI success accounts for 48.0 per cent of the variance of the dependent variable ( $F = 4.428$ ,  $p = 0.005$ ); two independent variables, such as “the lack of integration of EDI with internal/external computer systems” and “security/legal concerns”, had significant and negative relationships with the overall EDI success. Between the two, the lack of integration of EDI with internal/external computer systems dimension is a more significant variable with a larger beta coefficient, in terms of absolute values.

## Discussion and conclusions

It has been widely accepted that EDI allows organizations to improve their performance on purchasing, manufacturing, and customer service, and helps them to enhance a competitive advantage in the marketplace. However, empirical studies found that EDI initiators (usually larger and dominant firms) often obtain more benefits from EDI than EDI followers (usually smaller and weak firms) (e.g. Reekers and Smithson, 1994; Whang and Seidmann, 1995).

This trend was partially supported by this study, which found that both EDI adopters and non-adopters indicated modest improvements on customer service and information accuracy, and no or little change on reduced administrative/transaction costs, decreased inventory levels/inventory costs, improved cash flows, and enhanced competitiveness in the marketplace.

Particularly, many of the non-adopters do not appear to be convinced of the value of EDI adoption and use, considering their mean score ( $m = 3.05$ , where 1 = very unsuccessful, 3.0 = no change, 5 = very successful) on the overall EDI success,

Since EDI systems involve the creation of inter-organizational automated systems, close cooperation and collaboration between trading partners inherently have a strong impact on the extent of EDI benefit gained by them. It is, thus, essential for EDI initiators to clearly understand what obstacles are facing their EDI followers.

This research examined the key barriers to the widespread acceptance and maximum use of EDI in the small businesses context. The results of ANOVA and  $t$ -tests indicated that the EDI adopter and non-adopter groups



**Table IV**  
 Results of regression analyses<sup>a</sup>

Benefits	Factors												Overall Model F	p	Adj. R <sup>2</sup>	
	Managerial leadership/ organizational readiness			Integration of EDI with internal/external computer systems			Technical concerns			Security /legal concerns						
	$\beta$	t	p	$\beta$	t	p	$\beta$	t	p	$\beta$	t	p				
Reduced administrative and transaction costs	0.565	2.338	0.030*	-0.989	-3.591	0.002***	0.455	2.203	0.040*	-0.245	-1.398	0.178	7	3.707	0.011*	0.422
Reduced inventory levels and inventory costs	0.521	1.942	0.067	-0.777	-2.541	0.020*	0.490	2.133	0.046*	-0.202	-1.039	0.312	7	2.489	0.054	0.286
Improved information accuracy	0.377	1.576	0.132	-0.832	-3.053	0.007**	0.311	1.520	0.145	-0.019	-0.110	0.913	7	3.841	0.009**	0.433
Improved cash flows	0.302	0.944	0.357	-0.666	-1.824	0.084	0.290	1.057	0.304	-0.167	-0.718	0.481	7	0.936	0.502	-0.018
Better customer service	-0.104	-0.359	0.723	-0.607	-1.836	0.082	0.475	1.914	0.071	0.075	0.356	0.725	7	1.746	0.158	0.167
Enhanced competitiveness in the marketplace	0.397	1.873	0.077	-0.964	-3.991	0.001***	0.312	1.719	0.102	-0.284	-1.847	0.080	7	5.636	0.001***	0.555
Overall EDI success	0.291	1.272	0.219	-0.792	-3.031	0.007**	0.317	1.618	0.122	-0.366	-2.197	0.041*	7	4.428	0.005**	0.480

Notes: <sup>a</sup>Independent variables: four EDI obstacles; Dependent variables: six EDI benefits and overall EDI success; \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; \*\*\*\* $p < 0.0001$

have a strong agreement in their perceived importance of EDI obstacles. A total of four dimensions of obstacles to EDI success were derived from an exploratory factor analysis.

The extracted dimensions:

- 1 were lack of managerial leadership/organizational readiness;
- 2 lack of integration of EDI with internal/external computer systems;
- 3 technical concerns; and
- 4 security/legal concerns.

Next, this study investigated the relationships of the four obstacles with the six individual EDI benefits and the overall EDI success. Multiple regression analyses results revealed the following major findings.

First, the lack of integration of EDI with internal/external computer systems, of the four EDI obstacles, turned out to be the most significant barrier to achieving the overall EDI success and three specific EDI benefits to the fullest extent, such as:

- 1 reduced administrative/transaction costs;
- 2 improved information accuracy; and
- 3 enhanced competitiveness.

This dimension has a significant and negative relationship with each of the four dependent variables. The results indicated that small companies, which neither experienced serious problems in integrating EDI with internal/external computer systems (EDI adopters) nor considered the task as a significant obstacle (non-adopters), tended to perceive their present or future EDI use as more successful. Those successful EDI users might either possess sophisticated information technology or believe to receive strong financial and technical support from their large trading partners.

This finding is consistent with many previous studies (e.g. Hendon *et al.*, 1998; Jun *et al.*, 2000; Reekers and Smithson, 1994; Tuunainen, 1998), in which to gain the full potential of EDI, trading partners need to fully integrate the EDI into their respective internal application systems. However, it should be noted that the computer-to-computer system integration via EDI could be achieved mainly through a strategic alliance between two trading partners, in which both parties can easily share sensitive information, such as product design specifications, demand forecasts, and manufacturing schedules. Since many small firms lack the financial and technical resources required for effectively using EDI, it would be difficult for them to achieve such a high depth of EDI integration on their own efforts.

Second, two dimensions, lack of managerial leadership/organizational

readiness and technical concerns, were found to be important obstacles to decreasing administrative/transaction costs. These two obstacles were significantly and positively associated with the dependent variable, i.e. managers, who considered "lack of managerial leadership/organizational readiness" and "technical concerns" to be more important obstacles, tended to achieve or expect lower administrative/transaction costs.

One possible explanation for this finding is that EDI adopters, who recognized the two obstacles as significant, have instituted changes to overcome the obstacles by providing sufficient training to their managers, developing desirable organizational culture and procedures, and maintaining appropriate audit trails and system stability. In the case of non-adopters, who also recognized those barriers as significant, they might believe that they could bring necessary changes to their organizations on their own efforts. In contrast, no such changes were made in firms where those two dimensions were not recognized as obstacles.

This explanation is consistent with the conclusions of previous authors who noted that such factors as top management strong commitment and leadership, appropriate organizational culture and procedures, training programs, and system stability are critical to maximum efficiency of intra- and inter-organizational business processes and related information transactions (Monczka and Carter, 1988; Philip and Pedersen, 1997; Ramaseshan, 1997).

Finally, the security/legal concerns dimension has a significant and negative relationship with the overall EDI success, i.e. managers who perceived security/legal concerns to be a less important obstacle tended to achieve (or expect) a higher level of EDI success. As argued by Tuunainen (1998), Philip and Pedersen (1997), and Banerjee and Golhar (1993), it is important to note that security and legal problems could ruin good relationships between trading partners and cause severe losses. Thus, small firms need to take precautionary measures against potential security and legal problems.

In conclusion, to attain the full potential of EDI, it is recommended that top managers of trading partners should pay special attention to integrating EDI with their respective internal computer systems. In doing so, it is essential that those managers should demonstrate strong leadership in developing an appropriate organizational infrastructure and building intimate relationships with their trading partners. In addition, the

managers need to make every effort to eliminate the potential negative effects of the technical and security/legal problems by taking precautionary measures such as a contractual mechanism.

Regarding the future trend on the IOS use, many large organizations, which have already invested millions of dollars on the EDI infrastructure and are satisfied with the security of VAN-based EDI systems, are reluctant to abandon their current systems (Sawabini, 2001; Tingle, 2000). Moreover, as mentioned by Dröge and Germain (2000) and Ratnasingham (1998), since large VAN suppliers, such as General Electric and Sterling Commerce, are constantly improving their Internet-based EDI technologies with enhanced security measures and cheaper cost structures, the EDI diffusion rate will be greatly increased by joining smaller organizations into the EDI camp. Therefore, it is highly likely that EDI and Internet-based solutions will coexist for years to come (Lankford and Johnson, 2000; Sawabini, 2001).

Major limitations of this study are in the limited scope of target industries and the relatively small sample size. To validate these research findings and to enhance the generalizability of them, it is recommended that future research collect data from a larger number of samples across industries and analyze them by employing more rigorous research methods, such as structural equation modeling. It is also suggested that future research investigate the adoption and implementation issues of Internet-based EDI or other Internet-based IOS, such as extranets.

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#### Appendix. Questionnaire items

##### Managerial leadership issues

M1: Lack of top management support and commitment

M12: Inadequate leadership  
M13: Failure to understand EDI and its potential benefits  
M14: Lack of functional management support and commitment

##### Costs and benefits issues

Cb1: Lack of financial resources  
Cb2: The high volume of transactions that EDI requires before benefits are obtained  
Cb3: High initial and maintenance costs  
Cb4: Lack of exploration of new opportunities for EDI to help maximize profits

##### Technical issues

Te1: Proliferation of standards  
Te2: Poor back-up, disaster recovery, and error recovery  
Te3: Lack of integration with internal computer systems  
Te4: Lack of integration with trading partners and other organizations  
Te5: Lack of audit trails

##### Human resource management issues

Hr1: Insufficient education and training of managers and EDI users  
Hr2: Lack of people with technical expertise  
Hr3: Human resistance to change  
Hr4: Inadequate organizational culture, structure, procedures, and controls

##### Trading partner relationships issues

TP1: Lack of assistance and cooperation from trading partners

##### Security issues

SE1: Security issues

##### Legal issues

LE1: Legal issues