The adoption and impact of EDI in Dutch SME's

van Heck, E.; Ribbers, P.M.A.

Published in:
Proceedings of the HICSS

Publication date:
1999

The Adoption and Impact of EDI in Dutch SME's

Eric van Heck
Erasmus University Rotterdam
Rotterdam School of Management
Rotterdam, The Netherlands
Email: e.heck@fac.fbk.eur.nl

Pieter M. Ribbers
Tilburg University
Center for Economic Research
Tilburg, The Netherlands
Email: P.M.A.Ribbers@kub.nl

Abstract

This paper tests a recent model, developed by Iacovou et al. (1995), of the adoption and integration of Electronic Data Interchange (EDI) systems. Their model includes three factors as determinants of EDI adoption: perceived benefits, organizational readiness, and external pressure. Factors were measured in 137 small businesses in the Netherlands. Measuring instruments were developed and used in structured interview sessions with the managers of these small businesses. The responses from the 83 non-adopters support the validity of the model in predicting intent to adopt EDI. All three factors were found to be significant in the predicted direction. The responses from the 54 EDI adopters showed that the factors expected benefits and external pressure could significantly explain the adoption of EDI. However, external pressure seems to be the dominant factor to explain the adoption of EDI by small businesses. The results of the EDI adopters show also that there was no significant relationship between the level of integration of EDI (internally and externally) with the actual benefits adopters received from utilizing EDI. More integrated systems did not offer higher direct and indirect benefits.

1. Introduction

There has been a constant growth of the use of information technology to support the exchange of information both within and between organizations. Especially the application of technology to the exchange of information between organizations has been an important area of growth. Electronic Data Interchange (EDI) is a way of conduction inter-organizational transactions electronically (O'Callaghan & Turner, 1995). UN/EDIFACT defines EDI as: "the electronic transfer from computer to computer of commercial or administrative transactions using an agreed standard to structure the transaction or message data" (United Nations, 1993). The key components of this definition are: the electronic transfer of data; the use of standards; and the exchange of data with (or with minimal) human intervention. Due to some event in a company's operational processes, for example a sales order, a computer application generates an electronic message which is sent to, received and processed by another computer application. This message will trigger another event in the receiving organization, e.g. the delivery of products. Enabled by standardi-zation of the message exchange, this communication takes place without human intervention. The organizations involved have to agree on contents, grammar, and organizational actions resulting from the message exchange.

With the introduction of EDI the following benefits are expected:
- faster exchange of data without errors, reducing the communication costs;
- streamlining logistic processes, resulting in reduction of lead times, on time delivery and inventory reductions;
- improving the competitive position, e.g. by creating new kinds of services.

So, different reasons may lead to the application of EDI. Still many organizations are reluctant to implement EDI (Hoogeweegen, 1997). The Dutch coordination center for EDI, Ediforum, reports that in the Netherlands, around 25.000 companies are

0-7695-0001-3/99 $10.00 (c) 1999 IEEE

currently using EDI, out of a potential 400.000 companies. Compared to 1994, the number of users has grown by 10.000 companies; but despite this relatively high growth in the number of EDI users, the current number still falls short of expectations. The same holds for the rest of the world; for the USA, for instance Oakie (1997) reports that only 100.000 out of a potential 1.9 million companies are currently participating in EDI. So, the adoption and implementation of EDI hampers. There are different reasons for this slow down of the adoption process of EDI. One of the difficulties in EDI adoption is that full benefit can be reached only if enough critical mass is achieved. To transact EDI messages one needs to have partners who also are willing to adopt EDI.

Central questions of this research are:

- What are the factors responsible for the adoption and integration of EDI in small businesses?
- What is the impact of integrated EDI systems in small businesses?

The objective of this research is to empirically validate factors affecting the adoption and implementation of EDI in small businesses. This research builds on the work of Iacovou, Benbasat and Dexter (1995). They developed a model of EDI adoption by small business. They empirically demonstrated their model by using the results of seven case studies. In this research we go one step further and empirically validate the EDI adoption model. Factors were measured in 137 small businesses in the Netherlands. Measuring instruments were developed and used in structured interview sessions with the managers of the small businesses.

2. Adoption Model of EDI

The starting point of the research is the model developed by Iacovou et al. (1995). They did an extensive analysis on the EDI research literature. Out of their analysis they came up with the following important factors: perceived benefits of EDI, organizational readiness for EDI, and external pressure to adopt EDI. The Iacovou model was extended. We introduce a fourth factor: the availability of an EDI standard.

Perceived Benefits of EDI

Perceived benefits refer to the level of recognition of the relative advantage that EDI technology can provide the organization (Iacovou et al., 1995). Higher managerial understanding of the relative advantage of EDI increases the likelihood of allocation of the managerial, financial, and technological resources necessary to implement an integrated EDI system (Benbasat et al., 1993). It is therefore expected that small firms with management that recognizes the benefits of EDI will be more likely to adopt EDI and enjoy higher impacts compared with firms with management that do not recognize the benefits of EDI.

Organizational Readiness for EDI

Organizational readiness refers to the level of financial and technological resources of the firm (Iacovou et al., 1995). Usually, small businesses lack the resources that are necessary for EDI and interorganizational redesign. Furthermore, the relatively low level of computerization makes the integration of EDI systems difficult, necessitating costly expenditures. Financial readiness refers to the financial resources available for EDI to pay for the development, implementation and usage of the EDI system. Usually, small businesses with available financial resources will be better equipped to implement integrated EDI systems and, therefore, obtain higher benefits from the use of such EDI systems. The second dimension is technological readiness and deals with the level of sophistication of IT usage and IT management in a firm. Sophisticated firms already use in an advanced way (internal) information systems (hardware, software, etc) with advanced users and developers. It is expected that small firms with higher organizational readiness for EDI will be more likely to be adopters and more likely to enjoy higher benefits than firms with lower levels of readiness (Iacovou et al., 1995).

External Pressure

External pressure to adopt refers to the influences from the firm's environment. The two main sources of external pressure to adopt are the competitive pressure and the imposition by trading partners. As more competitors and trading partners become EDI-capable, small firms are more inclined to adopt EDI in order to maintain their own competitive position. Such impositions are especially prevalent in the case of EDI because of its network nature. So, it is expected that small businesses that encounter pressure either by their

partners or from the competition will adopt EDI more frequently than those that do not encounter such pressure.

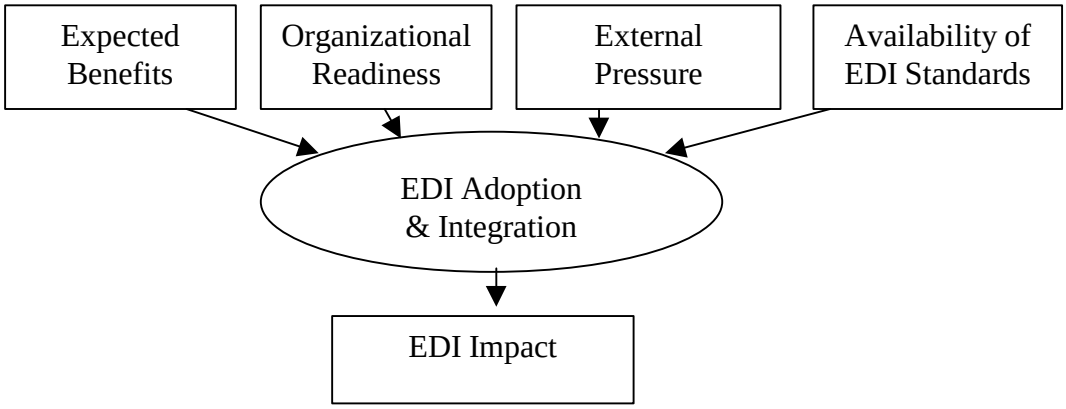

Figure 1: Conceptual Model; extended from Iacovou et al. (1995)

Availability of EDI Standards
One of the critical factors is the availability of EDI standards. Krcmar et al (1995:322) state that the use of a commercially available standard reduces the development costs and time and decreases the risk linked to the new EDI application. Moreover, a widespread message format offers the advantage to increase adoption among potential EDI partners. So, it is expected that small firms will adopt EDI if EDI message formats are available and decreases the risk linked to the new EDI standard reduces the development cost and time

EDI Adoption and Integration
EDI adoption is the process during which the small business becomes capable of transacting via EDI, usually through a front-end, PC-based EDI server. EDI integration is the phase during which a firm alters its business practices and applications so that they interface with its EDI applications internally with other applications and externally with other trading partners (suppliers, customers, governmental organizations, and financial institutions) with which the firm can transact business through EDI (Bergeron & Raymond, 1992)

EDI Impact
Impact of EDI refers to the actual benefits adopters receive from utilizing EDI. It is assumed that the level of integration of EDI is positively related to the benefits an adopter can receive given its EDI capability. Usually, non-integrated EDI systems will offer adopters direct benefits only, such as reduced transaction costs and higher information quality. Integrated systems, on the other hand, will offer both high direct benefits and the ability to take advantage of indirect benefits, such as increased operational efficiency, better customer service, and improved interfirm relationships (Iacovou et al, 1995). This more complete integration, which requires interorganizational design and policies, is essential to achieve performance improvements and full beneficial impact of EDI (Clark and Stoddard, 1994).

Hypotheses
So, the following hypotheses are developed, see figure 1.

H1: Higher perceived benefits of EDI will lead to greater intent to adopt and integrate EDI.

H2: Higher organizational readiness will lead to greater intent to adopt and integrate EDI.

H3: Higher external pressure will lead to greater intent to adopt and integrate EDI.

H4: Higher availability of EDI standards will lead to greater intent to adopt and integrate EDI.

H5: Higher integration of EDI will lead to higher impacts.

It was also tested that the combination of factors would lead to greater intent to adopt and integrate EDI.

H6: Higher perceived benefits, higher organizational readiness, and higher external

pressure will lead to greater intent to adopt and integrate EDI.

3. Research Methodology

To investigate the EDI adoption model, an empirical study of small businesses was undertaken in the period between November 1997 and February 1998. Accordingly with the definition used by the Dutch Office of Statistics, in this study a small business is defined to be a firm with less than 100 employees.

VARIABLE NAME	*VARIABLE*	*CRONBACH'S a*
NGPERBEN	Perceived Benefits Non-adopter	0,9099
NGORREAD	Organizational Readiness Non-adopter	0,7882
NGEXPRE	External Pressure Non-adopter	0,7421
NGSTAND	Availability of EDI standards Non-adopter	0,3528
NGADIN	EDI-Adoption & Integration Non-adopter	0,7166
GPERBE	Perceived Benefits Adopter	0,7524
GORREAD	Organizational Readiness Adopter	0,6784
GEXPRE	External Pressure Adopter	0,6508
GSTAND	Availability EDI Standards Adopter	0,5157
GADIN	EDI-Adoption & Integration Adopter	0,7551
GIMPAC	EDI Impact Adopter	0,8147

Table 1: Cronbach's Alpha of variables for Non-adopters and Adopters

Sample
A sample of Non-adopters and Adopters of EDI was provided by Ediforum, the Dutch national EDI organization. According to Ediforum the list represented the Dutch situation with regard to EDI adoption. A total number of 380 small businesses were on the list. A letter by Ediforum was sent to these businesses to explain the purpose of the research and to ask for participation in the research. Representatives of the businesses were telephoned to ask if they would participate. At the end, 139 of the 380 small businesses agreed to participate. Out of the 139 firms, one firm turned out not to be a small firm and one firm didn't fill in the questionnaire. So, the total of investigated firms was 137 and therefore the response rate was 36%.

Data collection
The main data collection method was face-to-face, structured interviews with the managers of the small businesses. However, when necessary telephone interviews with other employees in the firms were conducted. Questionnaires were used for all interviews. Two forms of the questionnaire were developed: one for the Non-EDI-adopter and one for the EDI-adopter. The questionnaires included closed format questions and some open format questions. The questionnaires were based upon the interview guides developed by Iacovou et al. (1995). However, the interview guides in this study were mostly with closed format questions. Therefore, statistical analysis of the answers was possible. The questionnaires are in Dutch and available upon request. The interviews were done by students of Erasmus University Rotterdam and Tilburg University. These students were doing in their graduate study a minor in EDI and were trained to execute interviews.

Measuring Instruments
Measuring instruments were developed for each of the variables of the EDI adoption model. These measuring instruments were developed for Non-EDI-adopters and for EDI-adopters.

Data Analysis
The interview data were analyzed with the help of SPSS. Single and multiple regression analysis were used for testing the hypotheses.

Reliability
The reliability of the variables was measured by Cronbach's Alpha. In table 1 the Cronbach Alpha's for each of the variables is presented. For this type of research Cronbach's Alpha levels of around 0.7 are appropriate. Therefore, the measuring

instruments of the availability of EDI standards, both for non-adopters and adopters (NGSTAND and GSTAND) is not reliable and is not taken account in the analysis of the results.

SBI no	Industry	Percentages Respondents	Percentage SME's in the Netherlands (1997)[1]
01-02	Agriculture	3,2	16,7
05	Fishery	1,1	0,1
15-37	Manufacturing	13,8	6,8
45	Construction	10,6	7,8
50-52	Repair & Trade	29,8	25,1
60-64	Trade	1,1	3,8
65-67	Financial	20,2	1,8
70-74	Leasing	13,8	16,0
85	Health Care	1,1	6,4
90-93	Environment & Recreation	5,3	5,9

Table 2: Distribution of investigated SME's over industries

Function	Amount
Director/Owner	69
General Manager	14
IT Manager	17
Marketing Manager	2
Production Manager	2
Other	33
Total	*137*

Table 3: Frequencies of the functions of the respondents

Characterization of investigated firms

Firstly, the characteristics of investigated small percentages of the respondents over the different industries are presented in table 2. Compared with the distribution of SME's over the different industries in the Netherlands, the agricultural industry and the health care industry were less represented in the investigated group. The manufacturing industry, the construction industry, and the financial industry were more represented.

Finally, in table 3 the functions of each of the respondents are presented. Most of the respondents are the owners of the small business.

4. Empirical Findings

This section presents the results of the analysis of the data with regard to the empirical testing of the EDI adoption model. We will first discuss the results of the Non-EDI-adopters. Second, we will discuss the results of the EDI-adopters.

Non-EDI-Adopters

Due to the fact that the measuring instrument of the availability of EDI standards was not reliable the variable Availability of EDI standards could not be taken into account. Therefore, hypothesis 4 could not be tested.

Single and multi-regression analysis was used to analyze the data of the Non-EDI-Adopters. The results of the analysis are that H1, H2, and H3 were not rejected, see table 4. Expected benefits, organizational readiness, and external pressure both have a significant relationship with the intent to adopt EDI. Also the combination of the three variables (hypothesis 6) explains 58.5 % of the measured variance of the dependent variable.

[1] Source: Dutch Central Office of Statistics (CBS)

Independent Variable	Dependent Variable	B	SE B	Beta	R^2	F	P	N
Expected Benefits	EDI Adoption & Integration	.809 (.854)	.90 (.284)	.707	.500	80.924	.000	83
Organizational Readiness	EDI Adoption & Integration	.634 (1.529)	.56 (.442)	.411	.169	16.439	.000	83
External Pressure	EDI Integration & Adoption	.565 (2.607)	.205 (.447)	.292	.085	7.569	.007	83
Expected Benefits + Organizational Readiness + External Pressure	EDI Integration & Adoption	.722 .319 .362 (-.496)	.086 .118 .143 (.426)	.630 .207 .187	.585	37.162	.000 .008 .013	83

Table 4: Results regression analysis for Non EDI-adopters.

Independent Variable	Dependent Variable	B	SE B	Beta	R^2	F	P	N
Expected Benefits	EDI Adoption & Integration	.431 (.325)	.208 (.821)	.276	0.076	4.293	.043	54
Organizational Readiness	EDI Adoption & Integration	.0099 (1.900)	.210 (.679)	.020	.000	.020	.887	54
External Pressure	EDI Adoption & Integration	1.038 (-.388)	.172 (.415)	.642	.412	36.405	.000	54
EDI Adoption & Integration	EDI Impact	5.774E -02 (3.283)	.080 (.187)	.099	.010	.518	.475	54
Expected Benefits + Organizational Readiness + External Pressure	EDI Adoption & Integration	.225 .111 1.001 (-1.522)	.170 .162 .176 (.871)	.144 .073 .619	.438	13.001	.190 .496 .000	54

Table 5: Results regression analysis for EDI-adopters.

EDI-adopters

Due to the fact that the measuring instrument of the availability of EDI standards was not reliable the variable Availability of EDI standards could not be taken into account. Therefore hypothesis 4 could not be tested. Single and multi-regression analysis was used to analyze the data of the EDI-Adopters. The results of the analysis are that H2 was rejected. There is no significant relationship between organizational readiness and EDI adoption and integration. Hypothesis H1 and H3 were not rejected. Expected benefits explain 7.6 % of the measured variance of EDI adoption and integration. External pressure explains 41.2% of the measured variance of EDI adoption and integration, see table 5. The combination of the three variables (hypothesis 6) was rejected. The relationship between EDI Adoption & Integration and EDI Impact was investigated. The results of the analysis of hypothesis 5 was that H5 was rejected. The results are not significant within the 0.05 range.

Categories of EDI Adopters

As Iacovou et al (1995) describe that 'The relative proportions of organizational readiness, external pressure, and perceived benefits in a firm influence different levels of EDI adoption and impact for the organization'. Derived from this conceptual model they distinguish six categories of EDI adopters: the unprepared adopters, the ready adopters, the coerced adopters, the unmotivated adopters, the

EDI initiators, and the non-adopters. We categorize the research population of our study according to the categorization of Iacovou et al. (1995).

Table 6 presents the results for the Non-EDI-adopters. It is interesting to see that:

- 20 small businesses out of the total of 83 firms can be categorized as EDI initiators (although at the moment they did not adopt EDI). Many small businesses have a low external pressure and therefore they don't adopt EDI although expected benefits and organizational readiness are high. Again, it is a sign that from a theoretical point of view all three factors are important to adopt EDI - as was also empirically validated with the regression results.
- 50 small businesses can be categorized as non-adopters, which they are. However, 26 small adopters expect a high impact if they adopt EDI.

Table 7 represents the results of the EDI-adopters. The following conclusions can be formulated:

- Most of the EDI-adopters indicate high real impacts of EDI.
- 22 of the investigated EDI-adopters out of a total of 54 can be categorized as EDI initiators.
- 24 of the investigated EDI adopters are categorized as non-adopters.
- There are some differences between the theoretical impacts and real measured impacts for several groups (the unprepared adopters and the unmotivated adopters).

Group	Exp. Benefits	Org. Readiness	External Pressure	Theoretical Impact	Expected Impact (number of cases)
Unprepared Adopters	**High**	**Low**	**High**	**Low**	**5 (1)**
Ready Adopters	**High**	**High**	**High**	**High**	**4 (2)**
Coerced Adopters	**Low**	**Low**	**High**	**Low**	**4 (1)**
Unmotivated Adopters	**Low**	**High**	**High**	**Low**	**- (0)**
EDI Initiators	**High**	**High**	**Low**	**High**	**3,5 (20)**
Non-Adopters	**High**	**Low**	**Low**	**N/A**	**3,35 (26)**
Non-Adopters	**Low**	**Low**	**Low**	**N/A**	**1,2 (20)**
Non-Adopters	**Low**	**High**	**Low**	**N/A**	**3 (4)**

Table 6: Categories of Non-EDI-Adopters (For expected impact: 5=high; 1=low)

Group	Exp. Benefits	Org. Readiness	External Pressure	Theoretical Impact	Real Impact (number of cases)
Unprepared Adopters	**High**	**Low**	**High**	**Low**	**3,38 (3)**
Ready Adopters	**High**	**High**	**High**	**High**	**3,8 (4)**
Coerced Adopters	**Low**	**Low**	**High**	**Low**	**- (0)**
Unmotivated Adopters	**Low**	**High**	**High**	**Low**	**2,9 (1)**
EDI Initiators	**High**	**High**	**Low**	**High**	**3,57 (22)**
Non-Adopters	**High**	**Low**	**Low**	**N/A**	**3,43 (20)**
Non-Adopters	**Low**	**Low**	**Low**	**N/A**	**1,55 (2)**
Non-Adopters	**Low**	**High**	**Low**	**N/A**	**2,54 (2)**

Table 7: Categories of EDI-Adopters (For real impact: 5=high; 1=low)

5. Conclusions

In this article there are two central questions.

- What are the factors responsible for the adoption and integration of EDI in small businesses?

From the analysis of data of 137 Dutch small business it can concluded that for the Non-EDI-adopters all three factors do have a significant and strong effect on the EDI adoption process (Hypothesis 6).

For the group of EDI-adopters the factor organizational readiness do not significantly affect the EDI adoption process. Only perceived benefits and especially external pressure force small businesses to adopt EDI. External pressure by dominant suppliers or clients seems to be a very important and significant factor explaining the adoption by small businesses in the Netherlands. Small businesses adopt EDI because they have to do that for their main suppliers or clients.

- What is the impact of integrated EDI systems in small business?

For the EDI-adopters in the investigated group of Dutch small businesses there was no significant relationship between EDI adoption and integration and EDI impact. The assumption was that the level of integration of EDI is positively related to the benefits an adopter could receive given its EDI capability. This assumption could not be empirically be validated. One reason for this might be that small businesses are forced to implement EDI by their main supplier or client and that the real benefits of EDI, despite real integrative EDI systems, will go to the main supplier or client and not to the small business. Therefore small businesses will not receive the expected benefits of EDI.

Small businesses can be assisted in the adoption and implementation process in the following way. Firstly, the results of this research can be discussed with them. One can focus on the results with regard of the power of external pressure with regard to the adoption and implementation of EDI. Most small businesses are forced to implement EDI. The second part of the story is that also most of the benefits are not distributed to the small businesses and therefore they have to develop strategies to implement EDI systems that also create value for themselves. Value creation strategies can be developed by reshaping customer and supplier relationships with EDI (Van Heck & Ribbers, 1997).

Finally, the article shows the importance and relevance of the management of technologies for SME's. EDI is an example of an electronic integration technology and a complicated business tool for most SME's. SME's are reluctant to use such business tools. In most economies around the world 95% of the firms are SME's. Therefore, if most SME's do not adopt these technologies the move from traditional economies to information economies will hamper.

Acknowledgements

We would like to thank the participating 137 SME's, the students who collected the data, Arie van Bellen (Ediforum) for providing the sample, Marc Dekker (Erasmus University Rotterdam) and Edwin van Hooft (Tilburg University) for assisting with the empirical research, and Virpi Tuunainen (Helsinki School of Economics and Business Administration) for her comments on a previous version of this article.

References

1. Benbasat, I., Bergeron, M. and Dexter, A.S. (1993), Development and Adoption of Electronic Data Interchange Systems: A Case Study of the Liquor Distribution Branch of Britisch Columbia, *Proceedings of Administrative Sciences Association of Canada Twenty First Annual Conference*, Lake Louise, Alberta, Canada, May 1993, pp. 153-163.

2. Bergeron, F. and Raymond, L. The Advantages of Electronic Data Interchange, *DataBase (*23:4), Fall 1992, pp.19-31.

3. Clark T.H. and Stodddard D.B., *Interorganizational Business Process Redesign: The Procter and Gamble Case*, Working Paper 94-077, Harvard Business School, Boston, MA, 1994.

4. Hoogeweegen, M. (1997), *Modular Network Design: Assessing the Impact of EDI*, PhD Dissertation, Erasmus University Rotterdam.

5. Iacovou, C.L., Benbasat I. & Dexter A.S., Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology, *MIS Quarterly*, December 1995.

6. Krcmarc, H., Bjørn-Andersen, N. & O'Callaghan, R., *EDI in Europe: How It Works in Practice*, John Wiley & Sons Ltd, Chichester, 1995.

7. Oakie, S. (1997), Making money on the Internet- The Myths, The Facts, The Truth, *EC World*, February 1997, pp.12-13.

8. O'Callaghan R. and J.A. Turner (1995), Electronic Data Interchange: Concept and Issues, in: Krcmarc, H., Bjørn-Andersen, N. & O'Callaghan, R., *EDI in Europe: How It Works in Practice*, John Wiley & Sons Ltd, Chichester, 1995.

9. United Nations (1993), ISO CD 9735:1993(E), *Electronic Data Interchange for Administration Commerce, and Transport (EDIFACT)* – Application level syntax rules, 1993.

10. Van Heck E. and P.M. Ribbers (1997), Value-creation by Reshaping Customer and Supplier Relationships with EDI; The Case of Technische Unie in the Netherlands, in: R. Galliers et al. (eds), *Proceedings of the 5th European Conference of Information Systems*, Cork, Ireland, vol. 3, pp 1234-1250.