EDI-based and XML-based business-to-business integration: a statistical analysis

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Abstract

This paper analyses six factors that are expected to facilitate EDI-based or XML-based business-to-business integration. Following the technology-organisation-environment framework, the paper focuses on one technological, four organisational, and one environmental factor. An e-business framework is a standard for business documents, business processes, and messaging in business-to-business integration. Six hypotheses on the use of EDI-based or XML-based e-business frameworks are based on the literature. These hypotheses are tested using the logistic regression analysis. The data involve 3619 European companies. Large numbers of enterprise information systems and employees in the company facilitate the use of e-business frameworks. A high volume of sales and educational level of employees in the company facilitate especially the use of XML-based e-business frameworks. Moreover, if the company has primarily other companies as customers, it is more likely to use an e-business framework. The number of sites in the company has no effects on this use.

Keywords: e-business; EDI; standards; XML

Biographical notes

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1 Introduction

Since the 1960s companies have utilised *Electronic Data Interchange* (EDI) that is the interorganisational exchange of business documents in a structured machine-processable format (Emmelhainz, 1990). EDI is not limited to *business-to-business* (B2B) *electronic commerce* (e-commerce), which focuses on the use of information and communication technologies (ICT) in selling and buying activities. EDI is also employed in *electronic business* (e-business) that covers the use of ICT in all kinds of co-operative activities between business partners. *B2B integration* (B2Bi) refers to all business activities in a company that have to do with the electronic exchange of business documents between the company and its business partners (Bussler, 2003). Compared to EDI, B2Bi takes into account business processes in addition to business documents. B2Bi aims to integrate the business processes using the electronic exchange of business documents across organisational boundaries. Complexity of customer-supplier relationships is driving towards online communication (Gunasekaran and Ngai, 2004).

The necessity of B2Bi is growing with the adoption of information systems. There would be fewer problems in B2Bi if all companies used similar meanings for terms in the business documents, similar modes of operations in the business processes, and similar messaging interfaces in the information systems. If the information systems are not interoperable, human intervention is needed to prepare the input data for information systems to produce the output data. Fortunately, standards facilitate interoperability (Lyytinen and King, 2006). Finding an appropriate standard has become increasingly important in e-business. In fact, standards play an essential role in B2Bi

(Bussler, 2003; Medjahed *et al.*, 2003; Nurmilaakso and Kotinurmi, 2004; Shim *et al.*, 2000). Standardisation for B2Bi happens on two levels. A *data format* is a low-level standard that defines the data structures and data elements in general. *Accredited Standards Committee* (ASC) *X12* introduced in 1982 by American National Standards Institute, *EDI for Administration, Commerce and Transportation* (EDIFACT) introduced in 1987 by UN Economic Commission for Europe, and *Extensible Markup Language* (XML) introduced in 1997 by World Wide Web Consortium are such data formats. An *e-business framework* is a high-level standard that uses a data format to specify the data structures, data elements, and their purposes in the business context (Nurmilaakso and Kotinurmi, 2004). The e-business frameworks harmonise the meanings for terms, the modes of operations, and the messaging interfaces. B2Bi requires this kind of interoperability.

Given the growing demand for e-business, it is important to understand B2Bi and its facilitators. Despite considerable interest in e-business, the literature reveals gaps in the understanding of B2Bi (Gunasekaran and Ngai, 2004; Ngai and Wat, 2002; Power, 2005; Wareham *et al.*, 2005). Kauffman and Walden (2001) have suggested further research on the role of the XML standard for data sharing in e-business. Compared to EDI or EDI-based B2Bi (Elgarah *et al.*, 2005), the number of empirical studies of XML-based B2Bi is modest. In addition, the statistical analyses of XML-based B2Bi are rare. Empirical studies that cover XML-based B2Bi are case studies (Kärkkäinen *et al.*, 2007; Lu *et al.*, 2006; Nurmilaakso *et al.*, 2002; Yen *et al.*, 2004), or they focus on few industries or countries (Chituc *et al.*, 2008; Fu *et al.*, 2007; Legner and Schemm, 2008; Wigand and Steinfield, 2005) or on RosettaNet, an XML-based e-business

framework (Bala and Venkatesh, 2007; Chong and Ooi, 2008; Gosain *et al.*, 2003; Malhotra *et al.*, 2007).

This paper statistically analyses factors that are expected to facilitate EDI-based or XML-based B2Bi, i.e. the use of EDI-based or XML-based e-business frameworks. Following the technology-organisation-environment (TOE) framework (Tornatzky and Fleischer, 1990), this paper focuses on six factors that can characterise the users of EDI-based or XML-based e-business frameworks. First, the paper introduces EDI-based and XML-based e-business frameworks, and proposes six hypotheses based on the literature. Next, the research method, data, and models are presented. Then, logistic regression analysis (Menard, 2002) is utilised to test the hypotheses. Finally, the paper discusses limitations and further research, and presents conclusions. This paper is among the first empirical studies that provide a statistical analysis of both EDI-based and XML-based B2Bi within several industries in several countries. The paper can be referenced by the researchers of e-business or standards as well as the practitioners who develop or use B2Bi.

2 EDI-based and XML-based e-business frameworks

Although differences between organisations are often inevitable, standards bring benefits by reducing company specificity and uncertainty (Bakos 1991). Open standards ensure that larger companies can easily extend their partner communities by increasing the efficiency of their business, and smaller companies that have found proprietary technologies too complex and costly can select the level of online communication appropriate for their business (Gunasekaran *et al.*, 2002). The main purpose of standards for B2Bi is to support automated business interactions, i.e., electronic exchange of business documents in the business processes. Companies can become interoperable if

they have the same kinds of business documents, business processes, and messaging interfaces. The companies can change their information systems without any loss of interoperability as long as they use the same standards in the same way.

There is no consensus over the term for the standards for B2Bi. These standards have been called B2B interaction standards (Medjahed *et al.*, 2003), B2Bi protocols (Bussler, 2003), B2B frameworks (Shim *et al.*, 2000), e-business frameworks (Nurmilaakso and Kotinurmi, 2004), e-business interfaces (Gosain *et al.*, 2003), interorganisational business process standards (Bala and Venkatesh, 2007), and interorganisational system standards (Chong and Ooi, 2008). For example, Shim *et al.* (2000) regard the B2B frameworks as generic templates that provide functions enabling businesses to communicate efficiently. According to Medjahed *et al.* (2003), the B2B interaction standards specify communication, content, and business process layers. These layers provide protocols for exchanging messages between business partners, languages, and models to describe and organise information, and they are concerned with conversational interactions between business partners.

What are e-business frameworks? The e-business frameworks specify the business documents, business processes, and messaging for B2Bi (Nurmilaakso and Kotinurmi, 2004). For example, if a customer sends a purchase order document to a supplier, the purchase order document has to include the customer's name and address. When the supplier has received the purchase order document from the customer, the supplier has to send a purchase order response document to the customer in the order management process. In addition, the customer and supplier use certain transport, packaging, and security standards in B2Bi. The *cross-industry* e-business framework aims to serve all industries, whereas the *industry-specific* e-business framework concentrates on one or a

few industries. There are some important differences between EDI-based and XML-based e-business frameworks. ASC X12 and EDIFACT are both data formats and EDI-based cross-industry e-business frameworks. EDI-based industry-specific e-business frameworks such as EANCOM are mainly modified subsets of ASC X12 and EDIFACT. In comparison, XML is a data format but also a meta-language for electronic document management and web publishing. A number of cross-industry e-business frameworks such as Commerce XML (cXML) and Universal Business Language (UBL) and industry-specific e-business frameworks such as RosettaNet have been standardised to use the XML format. Only a few of the EDI-based e-business frameworks deal with business processes. Most of the XML-based e-business frameworks specify some extent of the business processes where business documents are exchanged.

The XML format has been regarded as more flexible and less expensive in B2Bi than the EDI formats (Goldfarb and Prescod, 2003; Gosain *et al.*, 2003; Nurmilaakso and Kotinurmi, 2004; Power, 2005; Reimers, 2001). There are also arguments that the benefits of the XML format do not outweigh its costs, and it will not replace the EDI formats in the near future (Kanakamedala *et al.*, 2003; Wareham *et al.*, 2005). EDI-based B2Bi has been traditionally implemented over value-added networks and XML-based B2Bi over the Internet (Nurmilaakso and Kotinurmi, 2004). Nowadays, EDI-based B2Bi can be implemented over the Internet (Angeles, 2000).

3 Hypotheses

3.1 Technology-organisation-environment framework

A theoretical model for B2Bi needs to take into account factors that affect the propensity to use EDI-based or XML-based e-business frameworks. The TOE

framework (Tornatzky and Fleischer, 1990) identifies three aspects that facilitate or inhibit the adoption and use of technological innovations. Therefore, the TOE framework is useful for looking at B2Bi. Technological factors describe the existing technologies in use and new technologies relevant to the company. Organisational factors such as size and scope measure the company. Environmental factors such as competitors and business partners describe the area in which the company operates. The TOE framework has empirical support in the adoption of EDI (Chwelos *et al.*, 2001; Kuan and Chau, 2001) and e-business (Hong and Zhu, 2006; Zhu *et al.*, 2003).

3.2 Technological factor

In e-business, the information systems need to work with other internal and external information systems. Companies have invested heavily in enterprise resource planning (ERP), supply chain management (SCM), and customer relationship management (CRM) systems (Falk, 2005). Companies with high technological capability tend to enjoy greater readiness for e-business (Hong and Zhu, 2006; Yasin *et al.*, 2006; Zhu *et al.*, 2003). E-business frameworks establish an ICT infrastructure that can integrate the enterprise information systems of the company with its business partners.

> **H1.** Companies that have a larger number of enterprise information systems are more likely to use EDI-based or XML-based e-business frameworks.

3.3 Organisational factors

Company size is commonly cited in ICT innovation literature (Lee and Xia, 2006). Large companies generally possess the resources that can facilitate B2Bi. The number of employees, the volume of sales, and the number of sites have been used as a measure of the company size (Child, 1973).

The literature underlines the positive influence of the number of employees on the adoption of EDI or e-business (Banerjee and Golhar, 1994; Forman, 2005; Hill and Scudder, 2002; Premkumar *et al.*, 1997; Yasin *et al.*, 2006; Zhu *et al.*, 2003). The number of employees has a direct positive effect on the benefits from EDI (Mackay and Rosier, 1996). Larger companies in terms of the number of employees tend to have more resources for the investment needed to bring B2Bi into use.

H2. Companies that have a larger number of employees are more likely to use EDI-based or XML-based e-business frameworks.

According to Sriram *et al.* (2000), larger users of EDI in terms of the volume of sales recognise both the strategic and operational benefits from EDI in greater proportions than smaller users. The users of EDI have a higher volume of sales than the non-users (Banerjee and Golhar, 1994; Hill and Scudder, 2002). Larger companies in terms of the volume of sales tend to have a higher volume of business interactions, which justifies the investment into B2Bi.

H3. Companies that have a higher volume of sales are more likely to use EDI-based or XML-based e-business frameworks.

The number of sites can be used as a proxy for the geographical scope. The scope has been found to increase the demand for ICT (Dewan *et al.*, 1998; Hitt, 1999) and to have a positive effect on the adoption of e-business (Forman, 2005; Zhu *et al.*, 2003). Companies that have business units at different addresses have to manage them simultaneously. A broader ICT infrastructure is required to integrate the business units within the company and with the business partners. A company with a wider geographical scope can benefit from the use of an e-business framework in two ways. In

addition to B2Bi with the business partners, the e-business framework can be utilised in business interactions between the business units.

H4. Companies that have a larger number of sites are more likely to use EDI-based or XML-based e-business frameworks.

The educational level of employees seems to have an important role in e-business. ICT increases the demand for highly educated employees (Bresnahan *et al.*, 2002). Highly educated employees have a comparative advantage with respect to the implementation of new technologies (Bartel and Lichtenberg, 1987). Highly educated employees who use ICT have higher productivity than other employees (Hempell, 2005). Companies whose employees have a higher education have better capabilities to B2Bi.

H5. Companies whose employees have a higher education are more likely to use EDI-based or XML-based e-business frameworks.

3.4 Environmental factor

The literature emphasises that the pressure from competitors or customers has a positive relation to the adoption of EDI or e-business (Chwelos *et al.*, 2001; Mackay and Rosier, 1996; Premkumar *et al.*, 1997; Zhu *et al.*, 2003). Customer-initiated users of EDI have greater strategic benefits from EDI than voluntary users (Sriram *et al.*, 2000) or non-users (Mukhopadhyay and Kekre, 2002). If a company has other companies instead of consumers or government organisations as its primary customers, the company is more likely to experience pressure from the outside.

H6. Companies whose primary customers are other companies are more likely to use EDI-based or XML-based e-business frameworks.

4 Research approach

4.1 Method

The paper tests six hypotheses: (H1) a larger number of enterprise information systems, (H2) a larger number of employees, (H3) a higher volume of sales, (H4) a larger number of sites, (H5) a higher educational level of employees, and (H6) other companies as primary customers facilitate EDI-based or XML-based B2Bi. The dependent variable is binary: the company knows it uses or does not use an EDI-based or XML-based e-business framework. Each independent variable represents one technological, organisational, or environmental factor. Figure 1 presents the research model.

Figure 1 Research model

In this paper, logistic regression (Menard, 2002) is used as a research method. Firstly, linear regression does not work well when the dependent variable follows a nominal scale instead of an interval scale. Secondly, logistic regression is not uncommon in e-business research (Forman, 2005; Hong and Zhu, 2006; Kuan and Chau, 2001; Zhu *et al.*, 2003).

4.2 Data

The data were based on two e-business surveys carried out by e-Business W@tch that had been launched to monitor the maturity of e-business across different sectors in 2001 by the European Commission. The second part of the e-Business Survey 2003 (e-Business W@tch, 2004) was carried out in November 2003 using computer-aided telephone interview (CATI) technology, and consisted of 4570 respondents within ten industries in 25 European countries. The first part of this survey did not cover XML-based e-business frameworks. The e-Business Survey 2005 (e-Business W@tch, 2005)

was carried out in January and February 2005 using CATI technology, and had a scope of 5218 respondents within ten industries in seven European countries. The following observations were included in the sample:

- The company has access to the Internet.
- The company does business in Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, or UK.
- The company does business in the food and beverages (NACE code 15.1-9), textile, footwear, and leather (17.1-7, 18.1-2, 19.3), publishing and printing (22.1-3), chemicals and chemical products (24.1-6, 25.1-2), machinery and equipment (29.1-5), electrical machinery and electronics (30.01-02, 31.1-2, 32.1-3), transport equipment (34.1-3, 35.1-5), construction (45), retail (52.11-12, 52.4), ICT services (64.2, 72.1-6), or business services (74.1-8) industry.

In order to ensure that each observation is sampled independently, the observation was excluded if the company did business in the textile, footwear, and leather (17.1-4, 17.6-7, 18.1-2) industry in Germany, France, Italy, Poland, Spain, or UK in 2003, or in the chemicals and chemical products (24.4-5), transport equipment (34.1-3, 35.3), or ICT services (72.1-6) industry in Czech Republic or Poland in 2003.

4.3 Models

Three models are based on three dependent and six independent variables. The dependent variable *Use* answers the question does the company use an EDI-based e-business framework such as ASC X12, EANCOM, or EDIFACT or an XML-based e-business framework such as cXML, RosettaNet, or UBL to exchange business

documents with its customers or suppliers (*Use* = 1 for a user and *Use* = 0 for a non-user). The independent variable *EDI* refers to the use of an EDI-based e-business framework (*EDI* = 1 for a user and *EDI* = 0 for a non-user). The independent variable *XML* refers to the use of an XML-based e-business framework (*XML* = 1 for a user and *XML* = 0 for a non-user).

As a technological factor, the independent variable *Systems* aggregates the number of ERP, SCM, and CRM systems (Hong and Zhu, 2006). The independent variables *Employees*, *Sales*, *Sites*, and *Education* are related to organisational factors. The variable *Employees* is the natural logarithm of the number of employees (Child, 1973; Lee and Xia, 2006; Zhu *et al.*, 2003). This logarithmic transformation is used to reduce the variance of the independent variable. The variable *Sales* is annual sales in million Euro (Child, 1973; Lee and Xia, 2006). Non-Euro sales were converted to Euro sales using exchange rates in the end of the year 2002 or 2004. The variable *Sites* is the number of sites (Child, 1973; Zhu *et al.*, 2003). Site means a business unit at a particular address. The variable *Education* measures the share of employees with a college or university degree (Bresnahan *et al.*, 2002; Hempell, 2005). As an environmental factor, the independent variable *B2B* is binary. It answers the question does a company have other companies as primary customers (*B2B* = 1). Otherwise, the company does not have primary customers, or its primary customers are consumers or government organisations (*B2B* = 0).

If all dependent variables or some independent variable had no value, the observation was removed by listwise deletion. This left 3619 usable observations. Table 1 presents descriptive statistics and Table 2 reports Pearson correlations.

Table 1 Descriptive statistics

Table 2 Pearson correlations

Some variations can be explained only if control variables are appropriately applied. In this paper, it is necessary to control the industry, country, and year effects. The control variables $Industry_i$, $Country_j$, and *Year* are binary. A company operates in the industry *i* ($Industry_i = 1$) or it does not operate in it ($Industry_i = 0$). The company operates in the country *j* ($Country_j = 1$) or it does not operate in it ($Country_j = 0$). The company was involved in either the e-Business Survey 2005 (*Year* = 1) or 2003 (*Year* = 0). In Tables 3, 4, and 5, the distribution of observations is presented according to the industries, countries, and years.

Table 3 Observations from different industries

Table 4 Observations from different countries

Table 5 Observations from different years

The logistic regression models are specified as

$$\ln\left(\frac{P(Y=1\mid Systems,..,Year)}{P(Y=0\mid Systems,..,Year)}\right)=\beta+\beta_{Systems}Systems+\beta_{Employees}Employees+\beta_{Sales}Sales+\beta_{Sites}Sites+\beta_{Education}Education+\beta_{B2B}B2B+\sum_{i=1}^{9}\beta_i^{'}Industry_i+\sum_{j=1}^{23}\beta_j^{''}Country_j+\beta_{Year}Year+\varepsilon \quad (1)$$

where $P()$ is a conditional probability, βs are coefficients, and ε is an error term. The dependent variable is $Y = Use$ in the use model, $Y = EDI$ in the EDI model, and $Y = XML$ in the XML model.

5 Analysis

The proposed hypotheses are tested by estimating the coefficients $\beta_{Systems}$, $\beta_{Employees}$, β_{Sales}, β_{Sites}, $\beta_{Education}$, and β_{B2B} in the logistic regression models (1). If the independent variable has a statistically significant positive coefficient it supports the hypothesis that the related factor facilitates B2Bi. Before the logistic regression analysis, the models must be examined for multicollinearity and goodness of fit (Menard, 2002). The

diagnostic for multicollinearity can be obtained by the linear regression model using the same variables that are used in the logistic regression model. If the variance inflation factor (VIF) of some independent variable is larger than four, high multicollinearity is a problem. The Hosmer-Lemeshow test has the null hypothesis that the logistic regression model does not predict values significantly different from the observed values. If the null hypothesis is not rejected at the 5% level, the model is well-fitted. Nagelkerke R^2 approximates R^2 in the logistic regression model. Table 6 reports the coefficients and their standard errors and statistical significances in the use, EDI, and XML model. These models were estimated using the maximum likelihood method.

The largest VIFs do not indicate high multicollinearity in the models (VIF = 1.4 ≤ 4). According to the Hosmer-Lemeshow tests, the models are well-fitted ($0.05 \leq p = 0.311$). Nagelkerke R^2s indicate that the models have a satisfactory fit. The models in Table 6 support strongly hypotheses H1 and H2, moderately hypotheses H3 and H5, and weakly hypothesis H6.

Table 6 Logistic regression models

Companies that have a larger number of enterprise information systems ($\beta_{Systems} > 0$) are more likely to use e-business frameworks. The more integrated the enterprise information systems are with the business partners the more capabilities the company has for doing e-business (Hong and Zhu, 2006). Larger companies in terms of the number of employees ($\beta_{Employees} > 0$) or the volume of sales ($\beta_{Sales} > 0$) are also more likely to use e-business frameworks. Like EDI (Banerjee and Golhar, 1994; Hill and Scudder, 2002), B2Bi has concentrated on large companies. In fact, larger companies generally adopt more ICT innovations than smaller companies (Lee and Xia, 2006). The number of sites in the company does not significantly increase the likelihood of the use

of e-business frameworks ($\beta_{Site} \approx 0$). This differs from the findings presented in the literature (Forman, 2005; Zhu *et al.*, 2003). If a company has business units at different addresses it is not necessary to use an e-business framework between these units. For example, an ERP system can be sufficient. Companies whose employees have a higher education ($\beta_{Education} > 0$) are more likely to use especially XML-based e-business frameworks. Highly educated employees have better capabilities of adopting new technologies (Bartel and Lichtenberg, 1987). Finally, other companies as primary customers increase the use of e-business frameworks ($\beta_{B2B} > 0$). This is consistent with the findings that the customers can press their suppliers to adopt EDI or e-business (Chwelos *et al.*, 2001; Zhu *et al.*, 2003). In all, companies that adopt e-business are mostly larger organisations with higher levels of ICT (Yasin *et al.*, 2006; Zhu *et al.*, 2003). The same applies to EDI-based and XML-based B2Bi.

6 Discussion

6.1 Limitations

This paper has four potential limitations. Firstly, some factors such as the value of assets, the numbers of customers and suppliers and the use of the product data management system were ignored due to the lack of data. Secondly, the data did not contain observations from some important industries such as financial services and countries such as the US. This may limit the generalisability of the results. Thirdly, the data were self-reported, which can cause reporting errors. It is unavoidable in telephone interviews that there is no ideal respondent. For example, the general manager is not always aware of the use of the enterprise information systems, and the IT manager does not necessarily know the educational level of the employees. Fortunately, a large survey sample can reduce the effects of reporting errors. Finally, the logistic regression

analysis reveals statistical associations rather than causal relationships. The evaluation of causalities is difficult without observations from the same companies before and after changes in their use of B2Bi.

6.2 Further research

For further research, there is a need for longitudinal multi-case studies and statistical analyses of B2Bi. Whether a company uses or does not use an EDI-based or XML-based e-business framework is a starting point. The volume, i.e. the extent to which a company exchanges business documents through B2Bi, breadth, i.e. the extent to which the company has established B2Bi with its business partners, as well as diversity, i.e. the number of distinct types of business documents the company handles through B2Bi, also matter (Massetti and Zmud, 1996). Which factors facilitate and which factors inhibit the volume, diversity, and breadth of the use of B2Bi? These factors should include the characteristics of the main customers, suppliers, and goods and services sold and bought In addition, it is far from certain why companies use B2Bi. There is evidence that EDI does not necessarily increase sales (Mukhopadhyay and Kekre, 2002; Venkatraman and Zaheer, 1990), but it can reduce operating costs and improve inventory turnover (Lee *et al.*, 1999; Mukhopadhyay and Kekre, 2002; Mukhopadhyay *et al.*, 1995). The key issue is the impacts of the use of B2Bi on business performance such as return on sales, return on assets, or selling, general, and administrative costs. To what extent does B2Bi improve business performance? When does XML-based B2Bi outperform EDI-based B2Bi? The research results can help non-user companies to decide whether to use EDI-based or XML-based B2Bi. User companies can utilize these results in decision making on whether to invest in the volume, diversity, or breadth of

the use of B2Bi. Finally, standards development organizations (SDO) can gain a better understanding of the limitations of their e-business frameworks.

7 Conclusions

7.1 Technology

The use of ERP, SCM, and CRM systems facilitate B2Bi. If a company integrates its enterprise information systems with the business partners, it has higher technological capabilities to do e-business. With the use of e-business frameworks, the company can gain more benefits from its enterprise information systems. On the other hand, the lack of enterprise information systems is a barrier to B2Bi.

7.2 Organisation

With regard to organisational characteristics, three of four factors were found to facilitate B2Bi. These factors are the number of employees, the volume of sales, and the educational level of employees. Especially SDOs should get worried that e-business frameworks have not reached smaller companies. This may sound naïve but it reveals a lesson not learned yet. The problems with B2Bi are no surprise if only larger companies participate in the standards development work. Although the Internet and XML can lower the costs of B2Bi (Goldfarb and Prescod, 2003; Gosain *et al.*, 2003; Gunasekaran *et al.*, 2002; Nurmilaakso and Kotinurmi, 2004; Reimers, 2001), e-business frameworks still present too high requirements for smaller companies. Secondly, if a company has a large number of business units at different addresses, there is no need to use an e-business framework in business interaction between these units. An ERP system can be sufficient for this purpose. Thirdly, if a company is involved in knowledge-intensive business, its success relies on human resources, and it may exchange very rich information with its business partners. In this situation, B2Bi can become so complex

that problems with EDI-based e-business frameworks are overwhelming. These problems with XML-based e-business frameworks are less difficult if these e-business frameworks enable more flexible B2Bi than EDI-based e-business frameworks (Goldfarb and Prescod, 2003; Nurmilaakso and Kotinurmi, 2004; Reimers, 2001).

7.3 Environment

If the primary customers are other companies, the company should be ready to B2Bi. On the one hand, the competitors can utilise e-business frameworks as a competitive weapon that forces the company to B2Bi with its primary customers. On the other hand, the users of e-business frameworks as primary customers can pressure the company towards B2Bi by rewards or threats.

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Table 1 Descriptive statistics

Variable	Obser-vations	Mean	Standard deviation	Min	Max
Use	3619	0.185	0.388	0	1
EDI	3556	0.118	0.323	0	1
XML	3561	0.103	0.303	0	1
Systems	3619	0.397	0.742	0	3
Employees	3619	3.003	1.687	0.0	9.048
Sales	3619	14.196	114.82	0.0001	6000.0
Sites	3619	2.099	6.362	1	200
Education	3619	0.294	0.32	0.0	1.0
B2B	3619	0.612	0.487	0	1

Table 2 Pearson correlations

Variable	*Use*	*EDI*	*XML*	*Systems*	*Employees*	*Sales*	*Sites*	*Education*
EDI	0.77***							
XML	0.708***	0.237***						
Systems	0.37***	0.309***	0.3***					
Employees	0.318***	0.319***	0.193***	0.393***				
Sales	0.142***	0.155***	0.126***	0.176***	0.23***			
Sites	0.138***	0.159***	0.091***	0.111***	0.242***	0.147***		
Education	0.071***	-0.041*	0.143***	0.06***	-0.176***	0.025	-0.011	
B2B	0.073***	0.042*	0.037*	0.063***	0.045**	-0.007	-0.078***	0.032

Note: * Significance at the 5% level; ** at the 1% level; *** at the 0.1% level.

Table 3 Observations from different industries

Industry	Use model	EDI model	XML model
Food and beverages	241	240	238
Textile, footwear and leather	440	436	426
Publishing and printing	197	195	195
Chemicals and chemical products	433	432	425
Machinery and equipment	244	240	242
Electrical machinery and electronics	245	240	240
Transport equipment	486	476	481
Construction	296	293	295
Retail	255	246	245
ICT services	394	377	393
Business services	388	381	381

Table 4 Observations from different countries

Country	Use model	EDI model	XML model
Austria	24	23	23
Belgium	97	97	96
Cyprus	27	24	26
Czech Republic	264	261	260
Denmark	340	334	337
Estonia	216	213	214
Finland	132	138	125
France	447	445	444
Germany	340	334	337
Greece	100	100	100
Hungary	101	98	98
Ireland	64	63	64
Italy	342	336	341
Latvia	36	34	35
Lithuania	29	29	28
Netherlands	72	71	72
Norway	59	57	54
Poland	206	197	201
Portugal	99	96	99
Slovak Republic	79	79	79
Slovenia	78	68	78
Spain	199	197	194
Sweden	207	207	201
UK	372	370	368

Table 5 Observations from different years

Year	Use model	EDI model	XML model
2003	1707	1667	1669
2005	1912	1889	1892

Table 6 Logistic regression models

Model	Use model: Non-users versus users of e-business frameworks	EDI model: Non-users versus users of EDI-based e-business frameworks	XML model: Non-users versus users of XML-based e-business frameworks
Variable	β-coefficient (standard error)	β-coefficient (standard error)	β-coefficient (standard error)
Systems	0.695 (0.066)***	0.657 (0.075)***	0.658 (0.077)***
Employees	0.378 (0.037)***	0.458 (0.045)***	0.272 (0.044)***
Sales	0.002 (0.001)*	0.001 (0.001)	0.002 (0.001)*
Sites	0.011 (0.008)	0.012 (0.008)	0.004 (0.009)
Education	0.847 (0.192)***	0.337 (0.258)	0.988 (0.23)***
B2B	0.257 (0.112)*	0.162 (0.135)	0.109 (0.141)
Largest VIF (variable)	1.4 (*Systems*)	1.4 (*Systems*)	1.4 (*Systems*)
Hosmer-Lemeshow $\hat{C}$ (p-value)	8,57 (0.38)	8,56 (0.381)	9,39 (0.311)
Nagelkerke R^2	0.308	0.302	0.292
Observations	3619	3556	3561

Note: * Significance at the 5% level; ** at the 1% level; *** at the 0.1% level.

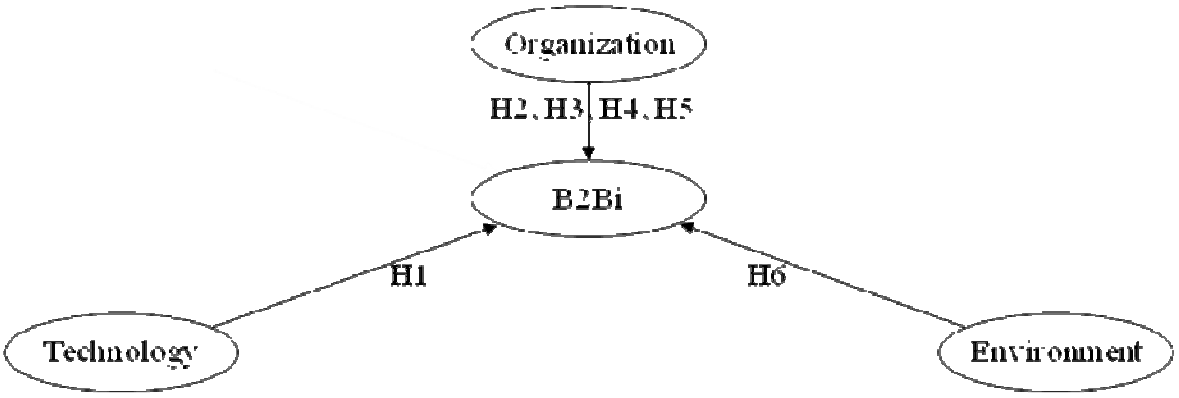

Figure 1 Research model