

In Search of an Efficient EDIcebreaker

Use of Electronic Marketplaces for the Diffusion of EDI Among SMEs

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Abstract: Although EDI is considered to be an old technology, many firms have invested considerable resources in EDI. During the last decades, SMEs have implemented EDI in order to meet the demands of their business partners. However, the SMEs do not derive the full benefit of their investments because they use EDI with too few business partners. One problem in this context is that the EDI users are invisible and isolated to each other. With the common use of the Internet among businesses, electronic marketplaces become increasingly accessible. This paper suggests that a solution to the problem of the isolated EDI users can be found within electronic marketplaces. As for the bilateral EDI arrangements and the multilateral electronic marketplaces they have two characteristics in common: (1) both are based on electronic data transactions over telecommunication networks, and (2) both have so far proven to be most suitable for commodities and standardized products.

1. INTRODUCTION

Previous research has recognized that the use of IT in organizations can reduce coordination costs and reduce transaction risks (Clemons, et al., 1993). In a broad sense the use of IT for transaction coordination has been referred to as interorganizational information systems (IOIS). One specific IOIS tool is EDI (Electronic Data Interchange). EDI allows business partners to make commercial transactions by sending and receiving digital documents over telecommunication networks (Raymond and Bergeron, 1996). Several studies have found that EDI gives the opportunity of short transaction time for messages, high data quality, and integration of data (Jones and Beatty, 1998; Cox and Gnoneim, 1996; Arunachalam, 1995). One aspect in regard to EDI that has to be stressed in this context is that as a natural consequence of

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the perpetual development of IT better, smarter, and cheaper business-to-business e-commerce solutions have without doubt been developed. However, many companies have invested a large amount of resources in EDI and, therefore, they are interested in getting some payoff from these investments. This paper will concentrate on those investments made in the particular technologies supporting EDI transactions.

EDI is, similar to other interactive media, a medium from which benefit is derived only if there is broad access. A critical mass is essential (Jones and Beatty, 1998; Premkumar et al., 1997; Iacovou et al., 1995). Universal access is optimal (Markus, 1987) but not necessary; however, the more users the EDI community consists of the greater benefits (Mukhopadhyay et al., 1995). Literature has identified that especially small companies do not derive the benefits from EDI because they still have to maintain their traditional paper-based routines, since they only exchange EDI messages with a few customers (Ramamurthy et al., 1999).

Large companies, which have implemented EDI, often become known in the EDI landscape by different degrees of power. Power, in the context of interorganizational relationships, can be defined as "the capability of a firm to exert influence on another firm to act in a prescribed manner" (Hart and Saunders, 1997). Distinctions can be made between persuasive and coercive power (Hart and Saunders, 1998) and between competitive pressure and imposition by trading partners (Iacovou et al., 1995). Some industries such as the automotive industry have succeeded in forcing the majority of their suppliers to use EDI (Tuunainen, 1998; Mukhopadhyay et al., 1995).

However, the benefits of power are not available to small and medium sized companies (SMEs). Although they want to achieve gains from their EDI investments, they are not in a position to exert power toward their business partners and less so toward their customers, where an assertion of power would be essentially useless. In order to examine whether small companies are ready and willing to exchange EDI messages with other small companies, data was collected among the customers of one such small firm. The data shows that one out of four respondents is both ready and willing to start an EDI partnership. Consequently, we deduce from the data that there is a lack of knowledge among the firms regarding whether or not their business partners already use EDI. In this paper, we will address this phenomenon as *the invisibility problem*. Although research has shown that small companies gain from establishing EDI connections with EDI champions (Lee et al., 1999), it can be questioned whether the EDI investments could be utilized more efficiently in the small companies.

With the increased use of the Internet among businesses, electronic marketplaces might offer a solution. An electronic marketplace is an interorganizational information system that allows the participating buyers

and sellers to exchange information about process and product offerings (Bakos, 1991). With focus on the steel industry some existing electronic marketplaces are examined in order to find out what they offer to buyers and sellers. The purpose of the examination is to predict the suitability of the existing electronic marketplaces for SMEs that use EDI. Based on literature within information systems research on EDI, the paper will discuss the incentive for SMEs that have already invested in EDI to move to the electronic marketplace.

The organization of the paper is as follows: The next section presents data from a survey that aimed at investigating the willingness among SMEs to use EDI with each other. From data it is deduced that there is an invisibility problem. Along with the presentation of data, a short presentation of the company is given and a description of the data collection methodology. The following section gives an overview of basic concepts and theory of electronic marketplaces. A section follows which presents the link between EDI and electronic marketplaces. The next section describes elements of some existing electronic marketplaces for steel and machinery. Finally, a conclusion and directions for further research is outlined.

2. THE INVISIBILITY PROBLEM FOR SMEs IN THE EDI LANDSCAPE

Regardless of whether their core activity is manufacturing or wholesale, SMEs will typically have hundreds of suppliers and even more customers. Prior studies have shown that the adopters of EDI often have very few EDI links (Horluck, 1996) even when the EDI transactions are based on a global standard such as EDIFACT (Andersen et al., 2000). However, the implementation of EDI is a large investment both in direct purchases, such as hardware and software, and in terms of human resources and training of employees (Ramamurthy et al., 1999; Arunachalam, 1995). When the SME only uses EDI with a few business partners, the investment in technology and training is underutilized.

If a global standard for EDI (e.g. EDIFACT) is used in a company, the economic cost of including other business partners is relatively low. However, how is the company to know whether a particular business partner already uses EDI, and if it is the case whether the company is interested in exchanging EDI messages? As mentioned above, we refer to this issue as *the invisibility problem* because nobody really knows who is using EDI (even within a business sector that has a limited number of participants).

3. DATA COLLECTION AND RESEARCH METHODOLOGY

3.1 Background for the data collection

During the summer of 1999, an EDI connection was established between a small subsidiary company and its parent company. The subsidiary company is a wholesaler of products to the steel and machinery industry. Fifty-six people are employed in the company. To this firm the implementation of EDI with the supplier was motivated by the prospect of administrative savings, since 40% of all purchase orders and invoices are exchanged with the holding company. After overcoming minor initial obstacles from integrating the EDI messages with the SAP/R3 system, the EDI traffic runs without problems. So far the exchange of EDI messages includes orders, order confirmations, and invoices. The company does not yet exchange EDI messages with other business partners; however, the intention is to extend EDI to their customers as a next step.

3.2 Research methodology

During October 1999, a survey was performed among 139 of the company's key customers which, the company for strategic, economic or other reasons would like to keep a business-relationship with. The selection of key-customers was based on two criteria: a) large-scale purchases during the last year; or b) a strong potential for large-scale purchases in the future. The aim was to find out if the preferred customers already used EDI and (if they did) whether they were interested in exchanging EDI based on the EDIFACT standard. We also asked whether those business partners who did not yet use EDI were interested in exchanging EDI messages.

One hundred thirty-nine questionnaires were mailed to the preferred customers. The receiving company's name was printed on the questionnaire. Along with the questionnaire was a letter describing why and how the company would like to use EDI based on the EDIFACT standard with the customer. The only means for response suggested on the questionnaire was fax. The questionnaire, which had six questions, consisted of only one page. Before the questionnaire was distributed among the customers it was discussed among a few people internal in the organization.

Fifty-nine of the 139 questionnaires were returned, all by the means of fax; 58 of the returned questionnaires were valid. Since all the questionnaires could be identified from the name printed on the questionnaire itself, it was possible to add data from the SAP/R3 database regarding exact number of

order lines purchased during the last year and the total value of purchases between the company and the respondent. The variable on the number of order lines is in relation to EDI of greater interest than the value of purchases, because one of the benefits of EDI is to be found in the volume of exchanged messages. Volume, or number of order lines exchanged, is a measure of the tactical value of the improvements of an organizations business process (Massetti and Zmud, 1996). These data combined with data from questionnaires are the foundation for the further analysis.

3.3 Findings

Following is a summary analysis of some basic business transactions for the preferred customers. For all the preferred customers, the company supplied the yearly number of order lines and the total value of all orders from their SAP/R3 database. The average value per order line was also calculated.

Table 1. Number of order lines versus respondent

| Responded questionnaire | # | Mean number of order lines | Median number of order lines |
|-------------------------|----|----------------------------|------------------------------|
| YES | 55 | 272,109 | 172,000 |
| NO | 80 | 114,388 | 35,000 |

Table 2. Value of orders in DDK versus respondent

| Responded questionnaire | # | Mean value of order | Median value of order |
|-------------------------|----|---------------------|-----------------------|
| YES | 55 | 1,034,000 | 509,689 |
| NO | 79 | 302,521 | 132,421 |

There is a statistical significant difference between respondents and the non-respondents with respect to the number of order lines (Kruskal-Wallis H = 16.4 with a p-value of 0.000051) and also with respect to the value of purchases (Kruskal-Wallis H = 21.0 with a p-value of 0.000005).

Table 3. Average value per order line in DDK versus respondent

| Responded questionnaire | # | Mean average value per order line | Median average value per order line |
|-------------------------|----|-----------------------------------|-------------------------------------|
| YES | 55 | 5,915 | 3,183 |
| NO | 79 | 7,182 | 1,945 |

A test of difference between respondents and non-respondents with respect to the average value per order line resulted in a Kruskal-Wallis $H = 4.0$, giving a p-value of 0.05. The difference in average value per order line is DKK 1270.00 (about USD 160) and although this difference is statistically significant at the 5% level, it is not considered to be of any practical importance.

Approximately one out of four of the respondents replied in the survey that they were interested in exchanging EDI messages with the company.

Table 4. The interest among respondents to exchange EDI messages

| Interested in exchanging EDI | Frequency | Percentage | Cumulative |
|------------------------------|-----------|------------|------------|
| YES | 13 | 22.4 | 22.4 |
| NO | 45 | 77.6 | 100.0 |
| Total | 58 | 100.0 | |

This survey reveals that presently at least 13 and maybe as many as 31 of the company's preferred customers are interested in exchanging EDI messages with the company. It is our belief that although there is a statistically significant difference between respondents and non-respondents regarding the average value per order line, the difference has no practical importance. Therefore, it is plausible that there are as many non-respondents that are interested in exchanging EDI messages as there are among the respondents ($0.224 * 139 \approx 31$.) These 13 to 31 companies have so far been invisible to this specific company.

Though the sample is small, it is our belief that these data reflect a general problem within SMEs. The SMEs have invested in EDI in order to fulfill demands from their business partners, but they do not use EDI in an optimal way because most of their customers and suppliers do not know that it is possible to exchange EDI messages with them. SMEs therefore often only exchange EDI messages with a few business partners. Some kind of transparency is needed to solve this problem of invisibility in the EDI landscape.

It is clearly not an efficient solution that all companies within a business sector distribute hundreds of questionnaires to their business partners in order to find out whether they use EDI, and if so are they then interested in exchanging EDI messages. A survey using a questionnaire is in most cases a very inefficient, impractical, and expensive way of obtaining that kind of information. Therefore, a more general solution to the problem of invisibility has to be found that holds the possibility of creating transparency for all potential EDI users. One solution to the problem of invisibility could be to move towards electronic marketplaces. Though the electronic marketplaces do not directly solve the invisibility problem they do hold the possibility of breaking the isolation and they do create an opportunity for SMEs to utilize their investments in EDI with a larger number of customers and suppliers.

4. ELECTRONIC MARKETPLACES

Through the 1990s, the improvements of the electronic communication tools such as the Internet have supported the idea of electronic marketplaces. This has led to a new era for businesses (Bakos, 1997) where it is affordable and relatively easy for SMEs to join the electronic marketplaces. The idea of electronic marketplaces was inspired by the concepts embodied in transaction cost theory. The terms *electronic markets* and *electronic hierarchies* were first introduced by Malone et al. in 1987 (Malone et al., 1987).

Building on the substantial work of Coase (1937) and Williamson (1975) on transaction cost theory, Malone et al. suggested that technological progress within information systems had made electronic interconnection, and thereby electronic markets, possible. They argued that the use of electronic interconnections was a result of three forces: (1) the electronic communication effect, which is facilitated by the technologies that have reduced both the time and cost of communicating information; (2) the electronic brokerage effect, where many different buyers and sellers are connected through a central database; and (3) the electronic integration effect, where the information technology is used to reuse data in different business processes, e.g. the use of EDI (Steinfeld et al., 1995). Malone et al. found it likely that these three forces would lead to a decrease in the unit cost of coordination. They suggested that the benefits of electronic markets are most favorable when both asset specificity and the complexity of product descriptions are low and when there is, in principle, access for an unlimited number of sellers and buyers; that is, when the only restriction on the market is the law of supply and demand (Williamson, 1975).

5. ARE ELECTRONIC MARKETPLACES OF ANY RELEVANCE TO EDI USERS?

A distinction has been made between bilateral and multilateral interorganizational information systems (Choudhury, 1998). In bilateral systems, individual links are made between customer and supplier. An EDI link is an example of a bilateral system. In multilateral systems, firms get access to a large or unlimited number of trading partners. An electronic marketplace is an example of a multilateral system. Traditionally when firms have established EDI connections it has been to gain operational benefits such as fewer errors and shorter lead times (Arunachalam, 1995). However, the strategic benefits have also played a considerable role, including benefits such as the establishment of long-lasting business relations and closer ties with customers (Fearon and Philip, 1998; Dearing, 1990). In some cases, the implementation of EDI has locked in users, especially if a proprietary EDI standard has been used. These strategic benefits of EDI raise the question of whether SMEs will be interested in moving from a bilateral system to a multilateral system; that is, from close EDI connections with few well-known business partners to an open electronic marketplace.

Because of the considerably high cost of establishing EDI connections, e.g. investments in timely negotiations on EDI protocols (Hart and Saunders, 1998), long-term business relations characterize most EDI connections. In general, IT investments for the purpose of coordination will be made with long-term suppliers for at least three reasons: (1) time to recoup investments, (2) learning curve effects, and (3) incentives to support long-term contracts (Clemons et al., 1993). The cost of establishing the connection itself to an electronic marketplace is insignificant. (See next section).

We have however, not established a connection between EDI users and electronic marketplaces. Bilateral systems and close long-term business relations characterize EDI connections whereas multilateral systems and isolated transactions characterize electronic marketplaces. However, EDI and electronic marketplaces have two important characteristics in common: (1) both are based on electronic data transactions over telecommunication networks, and (2) both have so far proven to be most suitable for commodities and standardized products. Based on these two characteristics it is our claim that a link between EDI and electronic marketplaces can be established. And it is therefore our belief that electronic marketplaces are of relevance to those EDI users that are invisible and thereby isolated to other EDI users.

Open telecommunications networks, such as the Internet, are a prerequisite for electronic marketplaces (Steinfeld et al., 1995). As shown in the section below, electronic marketplaces use the Internet as a means of

establishing and sustaining networks. EDI allows business partners to make commercial transactions by sending and receiving digital documents over telecommunication networks (Raymond and Bergeron, 1996). Until recently, one of the major problems for establishing networks based on EDI has been that the company in most cases had to subscribe to a costly Value Added Network (VAN). However, over the past few years the Internet has proved to be a less-costly and less-complicated alternative (Hart and Saunders, 1998; Muller, 1998). As a consequence it must be expected that in the future companies will choose to perform their EDI transactions via the Internet instead of via a VANs-operator or a direct connection.

There are a number of often cited examples in the literature of the kinds of goods traded on electronic marketplaces, including aircraft parts (Choudhury et al., 1998), airline tickets (SABRE) (Bakos, 1991), different types of procurement such as MROs (Berryman et al., 1998), and hospital supplies (Steinfeld et al., 1995). A common characteristic of these examples is that they are commodities or standardized products. Malone et al. (1989) have put it in a very straightforward way, "One way sellers can decide if electronic markets are likely to be useful in their industries is to consider whether customers can make purchase decisions based on information in a computerized database." As for EDI, messages have to be machine readable and data has to be unambiguous in relation to content, meaning, and format (Horluck, 1994). This requirement of highly structured protocols (Kalakota and Whinston, 1997) limits the beneficial area for EDI transactions to commodities and standardized products. Research has especially shown broad implementation of EDI in the automotive industry (Tuunainen, 1998; Mukhopadhyay et al., 1995), and in the grocery sector (Andersen et al., 2000). Commodities and standardized products characterize both these sectors. Even though EDI is useful for exchanging business information regardless of whether the item is a commodity or highly specified literature and practice have so far only concentrated on the commodities. Probably due to the above mentioned limitations on content, meaning and format.

In most companies the electronic connection is already there. A survey among Danish companies reveals that 87 percent of the companies had an Internet connection in 1999 (Ministry of Research and Technology, 2000). It also seems as if the target is the same for both the electronic marketplaces and EDI usage: commodities and standardized products. Thus the electronic marketplaces should be a good place for the invisible EDI users to go in order break the isolation and achieve a broader use of their EDI investments.

6. EXAMPLES OF ELECTRONIC MARKETPLACES WITHIN THE STEEL INDUSTRY

To get an overview of the support and services some of the electronic marketplaces offer to sellers and buyers, four electronic marketplaces for raw steel and steel products in USA and Denmark are presented in the following section.

The selection of the sites was based on the criterion that the site be a marketplace for raw steel and steel products. The list is by no means exhaustive. Nonetheless, the sample gives an idea of what activities the electronic marketplace for steel supports. All data are obtained from information available on the respective web sites and the links within the web sites. All data were collected during April 2000.

Table 5. Electronic marketplace sites in the steel and machinery industry

| Name of marketplace | URL | Established | Type of market place |
|---------------------|-------------------|----------------|-----------------------|
| MetalSite | Metalsite.com | August 1998 | Neutral third party |
| e-STEEL | Esteel.com | September 1999 | Neutral third party |
| Metalexplorer | Metalexplorer.com | January 2000 | Neutral third party |
| Industrilink | Industrilink.dk | 1989 | Controlled by sellers |

In table 6 below, some features for the four electronic marketplaces are described. The information is broken into three segments: (1) on-line transactions, (2) requirements for entering the marketplace, and (3) price for performing a transaction on the electronic marketplace.

1. An electronic marketplace supports one or more of the following market-making functions: identification, selection, and execution (Choudhury et al., 1998). The information on degree of support is chosen to show the extent of information generated during the process on the electronic marketplace. If a site only serves as a broker, electronic data is necessarily not generated in the process; at least not in the regime of the electronic marketplace. If, on the other hand, the parties negotiate, generate a purchase order, and arrange shipping and payment valuable electronic data is generated that is then suitable for the IOISs of the seller and buyer.
2. The information on requirements for entering the electronic marketplace site is included in order to measure the actual cost of entering, which must be expected to be relevant, especially for SMEs.

3. The argument for including the cost of performing transactions in the marketplace is to document that using electronic marketplaces is not free. Although using the electronic marketplace reduces the transaction costs, the cost of operating at the marketplace has to be considered.

Table 6. Content of electronic marketplace sites in the steel and machinery industry

| Site | MetalSite | e-STEEL | Metalexplorer | Industrilink |
|----------------------|---|---|--|--|
| On-line transactions | Find product Find customer Negotiate Buy Send purchase order Arrange shipping Track order Payment Online purchase orders delivered by e-mail, EDI or fax. | Initiate Specify Target Negotiate Close - - - Steeldirect: Provides the ability to target specific groups for online business. | Initiate Specify Negotiate Complete the transaction. | Send purchase order via WWW EDI The electronic infrastructure for EDI and e-commerce is provided. |
| Requirements | Membership required. There are no membership or application fees. | Membership required. There are no membership or application fees. | Membership and use is free of charge if you subscribe as a Buyer member. Subscription as a Seller member gives unlimited access and no transaction fees. Membership fee is Euro 590/quarter. | Membership required. There are no membership or application fees for buyers. Sellers have to have EDI connections. Initially fee is Euro 270/month.* |
| Cost of Transaction | Free to buyers. Charges the seller from ¼ % up to 2%, for each sale that is completed online. | Free to buyers. Charges the seller a fixed transaction fee of 0.875% of the value of the transaction. | None. | n.a. |

* To become a seller of Industrilink.dk an e-commerce strategy has to be made within six months and implemented within twelve months. Until an e-commerce strategy is implemented the monthly fee for sellers is Euro 270.

Data from the web sites of four electronic marketplaces for raw steel and steel products shows that the sites to a large extent support business transactions. Two of the sites make it explicit that the data generated in the business process is available in EDI format. Regarding the requirements, none of the sites charge buyers anything to become members, but all the sites require that buyers go through an application procedure. The two Danish sites charge sellers a fee to join the marketplace. The Industrilink-site places considerable demands on the sellers. The sellers have to make up an e-commerce strategy that has to be implemented within one year. So far Industrilink.dk has 14 sellers connected to the site. The two U.S. sites charge sellers a percentage fee for each transaction. No data were available for Industrilink.dk regarding transaction fees. Metalexplorer.com does not charge a transaction fee.

7. CONCLUSION AND DIRECTIONS FOR FURTHER RESEARCH

The electronic marketplaces and EDI have common characteristics that should be utilized in the future: both have so far mostly been used for commodities and standardized products and they both base their transactions on electronic data via telecommunication networks. Data supports the argument that the EDI users are invisible and thereby isolated in the business environment. They do not, therefore, get an optimal return on investment in their EDI systems, because the number of business partners with whom they exchange EDI messages are limited to a few. The electronic marketplaces offer an open marketplace with the possibility of many players. The electronic marketplaces have a high level of business support regarding services of all kinds, including EDI support. The efficient EDIcebreaker could therefore be found within the electronic marketplaces. Turning to the theory of diffusion of innovations it is likely to predict that the move is possible.

The diffusion of innovations is a process where “an innovation is communicated through certain channels, over time, among the members of a social system” (Rogers, 1995). According to Rogers the innovation can be an idea, practice or object, which is perceived as new among the group of users. To EDI users who are used to bilateral interorganizational information systems it would be a new practice if they included the multilateral electronic marketplaces in their business-performance. In determining whether it is likely that the change will take place the five perceived attributes of innovations; relative advantage, compatibility, complexity, trialability, and observability can be considered.

Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 1995). The relative advantage can be divided into tangible benefits and intangible benefits (Premkumar et al., 1994). The adoption of electronic marketplaces within organizations that use EDI has the possibility of gaining tangible benefits if business can be performed to a higher degree via electronic means. Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of the potential adopter (Rogers, 1995). If the use of electronic marketplaces is compatible with the sociocultural values, previous introduced ideas, and the company's need for innovation then the move is possible. Data can support the argument that an increased use of the EDI systems in the organizations is relevant, and that the company is willing to adopt the innovation. Complexity is the degree to which an innovation is perceived as relatively difficult to understand and use (Rogers, 1995). As mentioned previously do most companies have an Internet-connection already, and are therefore familiar with the media that host the electronic marketplaces. Those companies that have implemented EDI have without doubts already spend a substantial amount of effort in training employees. Trialability is the degree to which an innovation may be experimented with on a limited basis (Rogers, 1995). In the case of electronic marketplaces there is a rich opportunity to try out the innovation on a limited basis. As shown in table 6 there is close to free access to the electronic marketplaces within the steel and machinery industry. Observability is the degree to which the results of an innovation are visible to others (Rogers, 1995). It is questionable if the move to an electronic marketplace is observable to others. In most cases the pool of actors within the electronic marketplace is hidden. Though the move to the electronic marketplace is not directly observable among the EDI users it is never the less hard to neglect the fact that the four previously mentioned determinants for adoption of an innovation are highly represented in the case of EDI users entering the electronic marketplaces.

However, the move from a pure EDI environment towards a mix of EDI and electronic marketplaces is not only a question of fit to existing organizational structures and willingness to innovation, common modes of transportation, and goods that are easy to categorize; strategic considerations also play a vital role. As pointed out earlier, the implementation of EDI among business partners can serve as a lock-in mechanism. When moving from a close EDI partnership towards open markets, the strategic advantage of closer ties to business partners disappears. An important task for future research is therefore to look at whether the operational advantages of EDI

are of greater importance than the strategic advantages, especially in the context of electronic marketplaces.

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