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Analysis of EDI success implementation factors and their interrelationship with the level of EDI implementation within Swedish companies

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Abstract

This thesis concerns the electronic data interchange (EDI) which is being used for transferring information between organisations in the supply chain.

The benefits and barriers of using EDI are highlighted throughout the introduction stage of our research work. In spite of the evident advantages of the EDI system, it has been emphasised by many researches and practitioners that the implementation of the EDI system can result in both positive and negative effects for the companies. A proper implementation of the EDI system may eliminate or at least minimise its disadvantages and improve the effectiveness of the EDI system.

In the theoretical framework stage, we are focusing on different factors that might affect the successful implementation of EDI. Looking through different EDI-related literature, it has been identified that there are 13 factors that are contributed to being very successful in the implementation of the EDI system.

In order to identify the importance of the selected factors, their rank has been calculated in the analysis part. The next stage of our analysis deals with measuring the correlation between the criticality degrees of 13 success factors and changes in the level of EDI implementation. Only 3 out of 13 success factors have been defined as sensitive to the improvements in EDI level. An additional result from our research was that the level of EDI implementation significantly predicts perceived overall success of the EDI network. By expanding our research, an analysis of the criticality of the EDI implementation success factors for the companies from manufacturing and service sector has been provided.

As a final point of our study, we would like to mention that the findings of this study should be of value for practitioners as well as for academics. For practitioners these results can be used as a guideline in reaping the benefits of EDI technology. For academics it provides a starting-point for further research in this area, and especially to the successful EDI implementation at the international level.

Keywords: EDI, Electronic Data Interchange, Electronic Network

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TABLE OF CONTENTS

I. INTRODUCTION

1.1. Background

Today, business environments operate in an extremely competitive relationship. In order to be successful on the market place, many new strategies have been implemented by the organisations. Varied in focus, most of these strategies have been based on one key element – information. The acquisition and use of information becomes essential in the intensely competitive business environment, since better and effective use of information are considered critical to the success. Supply chains today are increasingly dependent on effective and efficient information exchange between the value chain partners. As information becomes a critical resource in managing marketing channel operations, accurate exchange of that information becomes of principal concern to them.1

Supply chain management is characterised by an inter-organisational coordination in which companies work in cooperation with their customers and suppliers to integrate activities along the supply chain to effectively supply products to customers. Information technology assures the successful channel operations and trading relationships between the supply chain partners. It generates a systematic integration of channel relationship by allowing more efficient and automatic information flow. Thus, the integrated channel relationship between the value chain partners is characterised by a more standardised and automatic inter-organisational relationship. These types of

[1] Williams et al (1998); Tayur et al (1999); Nakayama (2003)

interrelationship between the organisations result in an improved data processing efficiency, reduced costs and limited errors of data interchange.2

In our academic research, we are going to focus on electronic data interchange (EDI), an important class of information technology (IT) used for transference of information between organisations in the supply chain. The underlying drive towards choosing this topic has been motivated to us by Professor Göran Bergendahl.

EDI is a form of electronic communication with a comprehensive set of standards and protocols that allow the exchange of business transaction data and documents in a computer understandable format (Bidgoli, 1999). EDI originated in the 1980s as a device for large businesses to communicate multi-line ordering and accounting information between the backend resource planning systems of trading partners.3 The investments in this technology, and its usage, correspond to the reorganisation of the business process and communication infrastructure that flow between trading partners. As pointed out by King et al (2002), an implementation of EDI is a process in which two or more organisations determine how to work together more effectively. Thus, EDI has often been considered as an enabler for the achievement of quick response and just-in-time stock.

In spite of evident advantages of the EDI system, it has been emphasised by many researches and practitioners that the implementation of the EDI system can result in both positive and negative effects for the companies. On the one hand, EDI facilitates the improvement of in-company operations and strengthens the relationship between trading partners. On the other hand, some problems or disadvantages relating to EDI implementation can occur unavoidably, i.e., required large initial investment. As pointed out by Angeles

[2] Hill and Scudder (2002); Tayur et al (1999); Nakayama (2003)
[3] Chen and Williams (1998); Computer Weekly (10/31/2002)

et al (2001), in order to benefit in full from the potential of EDI technology, a considerable amount of attention has to be paid to its implementation. A proper implementation of EDI may eliminate or at least minimise some of its disadvantages and improve the effectiveness of the system by increasing its value (Bidgoli, 1999).

Looking through different EDI-related literature, our attention has been narrowed to the researches done by Angeles et al (1998) and Angeles et al (2001) in which the implementation of EDI success factors for U.S. firms has been investigated. Keeping the same idea for our study, we decided to investigate different factors of EDI successful implementation, and to find their criticality with regard to the level of EDI implementation in companies that operate in Sweden.

The organisation of the thesis is as follows. We begin in section 1.2 by presenting general information about EDI technology. Also, benefits and problems related to the implementation of EDI system are discussed in this chapter. In section 2, the methodology of our study is presented. In section 3.1, review of similar previous studies is outlined. According to our literature findings, in section 3.2 the potential factors that might influence the successful implementation of EDI are emphasised and their detailed description is presented. The profile of our research sample is analysed in section 4.1. We present our research framework and findings in section 4.2. The concluding remarks are presented in section 5.

1.2. General information about EDI

The distinctive characteristic of the EDI system consists of the opportunity that it offers to trading partners to exchange business information/documents electronically, instead of hardcopy documents. This leads to a new way of

doing business known as electronic commerce. (Rahman and Raisinghani, 2000)

In the specialised literature EDI has been defined in different ways. Thus, Neef (2001) defines EDI as "a dedicated electronic connection, usually between buyers and their largest selling partners, used for transfer of purchasing information". According to Chesher et al (2003) EDI is "the electronic transfer of structured commercial data using agreed message standards between computer applications". Williams (1994, p.173) defines it as "the inter-organisational exchange of business documentation in a structured, machine-processable form". Mackay and Rosier (1996, p.62) defined EDI as "the paperless transmission of business documents between trading partner application systems, via a computer and communications network, in a standard message format". According to the definition given by UN/EDIFACT4 in ISO 9735:1993 standard, EDI is defined as "the electronic transfer from computer to computer of commercial or administrative transactions using agreed standard to structure the transaction or message data"5.

Based on our literature findings, we are going to define EDI for this study as:

> *...the electronic movement of repetitive business information/documents such as purchase orders, invoices, payments, bills, shipping-manifests, and delivery schedules, between the computer systems of trading partners that are based on a standardised and structured messages.*

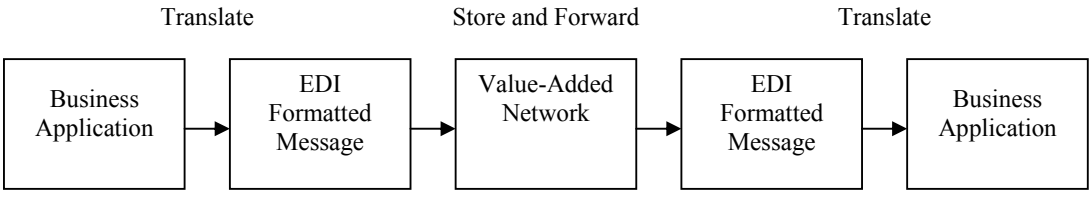
In the specialised literature, it is possible to find the following special characteristics of EDI system: [6]

[4] UN/EDIFACT – United Nations / Electronic Data Interchange for Administration Commerce and Transport
[5] http://www.unece.org/trade/untdid/welcome.htm
[6] King et al (2002); Rahman and Raisinghani (2000); Chen and Williams (1998)

- ***Business transactions messages.*** EDI system is used to transfer electronically repetitive business transactions. These include purchase orders, invoices, payments, bills, shipping manifests, and delivery schedules, confirmations, and so on.
- ***Data formatting standards.*** Since EDI messages are repetitive, it is reasonable to use some formatting standards. Standards can shorten the length of the messages and eliminate data entry errors, since data entry occurs only once.
- ***EDI translators.*** An EDI translator converts data from proprietary formats into standard formatted message, the process being reversed at the receiving end.

In Figure 1 an inter-organisational interchange of electronic messages has been schematically presented, using EDI system. Thus, EDI seeks to take a form of a business application, translate that data into a standard electronic format, and transmit it using secure telecommunication links. At the receiving end, the standard format is retranslated into a format that can be read by the recipient's application. Consequently, output from one application becomes input to another through the computer-to-computer exchange of information.[7]

Figure 1: Sketch of Electronic Data Interchange (by King et al, 2002, p. 259)



The EDI has been widely accepted as an essential business tool used to facilitate inter-organisational transactions, and sometimes for improving

[7] Kalakota and Whinston (1996); King et al (2002)

internal operations by integrating internal and external systems in order to obtain competitive advantage.8 It is claimed that EDI saves as a catalyst and a stimulus to improve business process and communication infrastructure that flow between organisations. EDI enables organisations to redesign their processes significantly because of its three main capabilities: high speed, reliability, and ease in getting the data. 9

The EDI has often been considered as an enabler for achieving quick response and just-in-time stock. The increased investments in this technology and its usage correspond with the changes in the logistics and product delivery functions. Massive investments in information technology have been made by manufacturers, suppliers and logistics providers with the hope of achieving a successful quick response and just-in-time implementation in their supply chains. (Tayur et al, 1999)

The EDI system has changed the idea of businesses, triggering new definitions and key success factors of entire industries. Well-known retailers, like 'The Home Deport', 'Toys R Us' and 'Wal-Mart', would operate differently today without EDI, since it is an integral and essential element of their business strategy. Global manufacturers, like Johnson and Johnson, Levi Strauss, Toyota, Volvo and Unilever, have used EDI to redefine relationships with their customers and suppliers through such practices as quick-response retailing and just-in-time manufacturing. These highly noticeable impacts of EDI applications by large companies have been extremely successful. (King et al, 2002)

[8] Chen and Williams (1998); King et al (2002)
[9] Hoogeweegen et al (1998); King et al (2002)

1.2.1. Benefits of EDI implementation

Many researchers point out specific benefits that can be obtained by the organisations through the implementation of the EDI system.

Thus, Laage-Hellman and Gadde (1996) have analysed the implementation of EDI in the Swedish construction industry. In their study it has been pointed out that the implementation of EDI has direct and indirect effects on company cost-savings. *Direct cost-saving effects* arise from the information flow itself, through simplification of information handling processes, improvement of information quality and its rapid transmission. It has been indicated by them that to process a typical invoice within the construction company costs at least SEK 300 (approx. US$45). This cost can be reduced by 90% by taking advantage of the possibilities offered by the EDI system. *Indirect cost-saving effects* emerge from the changes EDI allows a business to make in its own operations. Thus, the higher speed and frequency of transmission will affect the company's physical flow in several ways. For example, improved delivery planning will result in shorter lead times. In turn, this means decreasing inventories and a reduction in the amount of capital employed.

Mackay and Rosier (1996) analysed the impact of EDI implementation in the Australian automotive industry. It has been argued by them that EDI was one of those communication and information technologies that was capable of assisting an industry/ companies in improving efficiency and becoming more competitive. According to their study, implementation of EDI technology has brought about a number of benefits to the industry/companies, including: improved productivity, clerical staff savings, increased data accuracy and customer service, reduction of administrative costs and inventory level.

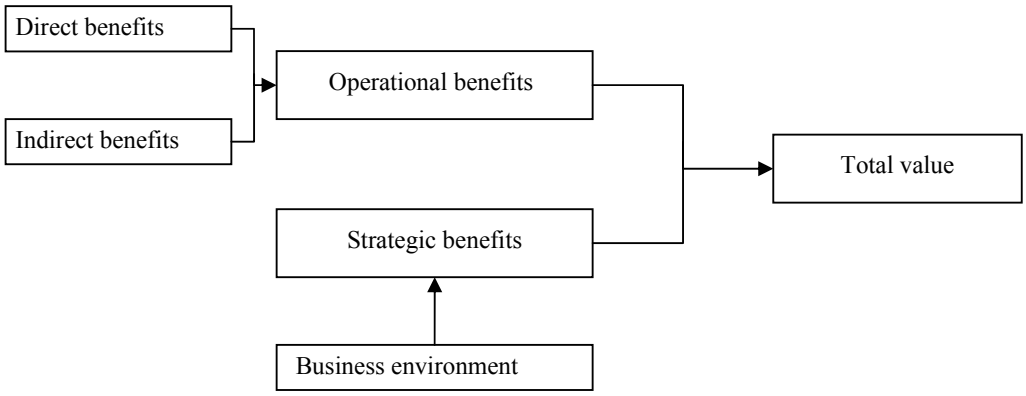
Mukhopadhyay and Kekre (2002) in their field study of customer – supplier relationship, classified EDI benefits as operational and strategic. *Operational*

benefits are derived from a reduced need for manual processing, greater accuracy of data processing, cost savings of administrative expenses, expedite payments etc. *Strategic benefits* arise from the long-term gains that an organisation makes by developing closer relationships with trading partners, and by using EDI to improve its competitive position.

In 1988, Ferguson et al (1990) have made a telephone survey of 1094 U.S. firms that were currently using or were planning to use EDI technology. There was an open question that allowed the respondents to express their own viewpoint regarding the implementation of the EDI system. The results of this survey emphasised the following main benefits of EDI technology: (1) 'quick response and access to the information' was mentioned more than twice as often as any other (47,1%); (2) 'cost efficiency' was 20,4%, followed closely by (3) 'customer request' (19,2%); (4) 'the effect of EDI on paper work' was mentioned by 12,4% of the respondents and (5) the 'accuracy' by 9,8%.

In the study carried out by Bidgoli (1999), it has been mentioned that EDI can enhance the organisation competitiveness by expediting the delivery of information and reducing costs. In this study he outlined some additional benefits of EDI technology, such as: (1) promotion of true partnership relationships between the companies; (2) improvement of quality through improved record-keeping, fewer errors in data entry, reduced processing delays, less reliance on human interpretation of data, and minimised unproductive time; (3) acceleration of the order-invoice-payment process from days or weeks to hours or minutes; (4) delivery of sales information to manufacturers, shippers, and warehouses in real time; (5) improvement of organisation's competitiveness; (6) provision with timely and accurate data for decision-making; (7) improvement of the internal operations of a firm by reducing the process-cycle time.

Figure 2. Graphical categorisation of EDI benefits



According to our literature findings, the benefits of EDI technology can be categorised as presented in Figure 2. As has been pointed out in a lot of EDI-related works, an adequate implementation of the EDI system can give companies operational and strategic advantages over their competitors. As follows, the operational benefits obtained by the companies improve its internal operations by having direct and indirect effects. The strategic benefits that an organisation can derive from EDI technology depend upon the business environment and organisation's capability to exploit this environment to its benefits. In this way, it is necessary to mention that the benefits of the EDI technology are different for different organisations and different situations.

1.2.2. Barriers of EDI implementation

In spite of the actual widespread cooperation between the companies and evident benefits of the EDI system, the use of EDI in practical applications is still very limited. There seem to be a number of barriers and problems that, in various ways, slow down the rate at which EDI applications are extended through the businesses.

King et al (2002) notified that despite the tremendous impact of the EDI system among industry leaders, the set of EDI adopters represent only a small fraction

of its potential users. Thus, for example, in USA several million businesses participate in commerce every day, but fewer than 100,000 companies have adopted the EDI system for inter-organisational relationship. Moreover, most of the companies have had only a small number of their trading partners on EDI, mainly due to its high costs. Consequently, the authors concluded that the major factors that didn't allow to many companies to benefit from EDI, are the following: (1) significant initial investment is required; (2) business processes reorganisation is necessary in order to fit EDI requirements; (3) a long start-up time is needed; (4) use of expensive, private Value Added Networks (VAN) are necessary; (5) the operating costs of EDI are high; (6) lack of standard EDI formats may require one company to use several standards; (7) the system is complex to use; (8) a converter is required to translate business transactions to EDI code.

Ferguson et al (1990) in their survey of 1094 U.S. firms emphasised that designing and marketing successful EDI products require managers to understand perceived and/or real barriers that impede firms from entering or expanding the implementation of the EDI system. As a result of their conversations with respondents, the authors of the article concluded that the EDI growth is severely constrained by the lack of knowledge about EDI technology and its benefits. As they have mentioned in the article, even among EDI users and planners a significant percentage of respondents do not understand the capabilities of EDI VANs and EDI translation software. The results of the survey indicated that the most significant barrier mentioned by respondents was the 'perceived high cost of setting up' a trading partner (18,4%). The second essential barrier was the 'compatibility of software with hardware' (12,4%), followed by the 'lack of awareness of benefits' (10,6%). Other barriers included the problems associated with 'non-sophisticated trading partners' (8,9%) that may not understand the value of EDI or may not be able

to implement the technology. This was followed by the need for 'customer training/education' (8,3%).

In the study realised by Bidgoli (1999) it is emphasised that an EDI system may include some disadvantages compared with traditional non-EDI system, but a proper implementation of EDI may eliminate or at least minimise some of these disadvantages. The following disadvantages of the EDI system has been mentioned by him: (1) concentration of control; (2) data processing, application, and communications errors; (3) potential loss of management and audit trails; (4) reliance on third parties; (5) reliance on trading partner's system; (6) total systems dependence; (7) unauthorised transactions and fraud.

In the study of EDI implementation in the Swedish construction industry, carried out by Laage-Hellman and Gadde, the barriers of successful EDI implementation has been categorised in five basic groups. Thus, the four potential barriers of EDI implementation lie in different technical or organisational aspects, which are distinctive both at the company level and industry level. A fifth factor to consider is related to the way companies are doing business with each other. According to their study, the technical barriers at the industry level are mostly related to the lack of certain standards, which has impeded a rapid introduction of EDI. However, these barriers have successively diminished in importance. According to the Swedish study, the major technical obstacle at industry level is now the lack of modern computer applications that are adapted to EDI. As organisational barriers to rapid EDI implementation at industry level can be the limited number of EDI users. Since there are not so many customers or suppliers to link up with, a lot of companies prefer to postpone their EDI investments until a critical mass of users exists. The technical aspects at company level have to do with the internal EDI systems and their way of functioning as well as with the EDI competence of the company. According to this study, most inhibitors today are the organisational

aspects at company level, and the changing characteristics of business relationships, because EDI is a mechanism that enables companies to redesign work flows and business processes within and between companies, in order to increase the efficiency and effectiveness of the entire production and distribution chain.

As pointed out by several writers, EDI failed to live in small and medium enterprises. In all these studies most of the small companies indicated that they were forced to adopt EDI by larger trading partners. In a certain sense, implementation of EDI was a prerequisite for them to stay in business. Most of the small companies reported difficulties and dissatisfaction with EDI in particular: the number of transactions is too low to ensure EDI; tasks often need to be duplicated as a result of the installation of EDI technology; there are few willing partners to assure the use of EDI; cost of EDI rank over the benefits; there are problems attributable to standards incurred when EDI was being used. These studies show that many small and medium enterprises have had difficulties arising through lack of technical, financial or administrative resources. These problems have been discussed by a number of authors: for instance, MacGregor & Bunker[10], or Mackay & Rosier (1996).

1.3. Problem definition

Notwithstanding prevalent cooperation between trading partners from the supply chain and huge amount of information and material flows between companies, the use of EDI in practical applications is still very limited. There seems to be a number of problems and barriers that somehow hold back the application of EDI technology through the businesses. King et al (2002) notified that despite the tremendous impact of the EDI system among industry leaders, the set of EDI adopters represent only a small fraction of its potential

[10] look in: Rahman and Raisinghani (2000) p. 126-170

users. Thus, for example, in USA several million businesses participate in commerce every day, but fewer than 100,000 companies have adopted the EDI system for inter-organisational relationship. Moreover, most of the companies have had only a small number of their trading partners on EDI, mainly due to its high costs. Different EDI-related literature has pointed out that factors such as, considerable EDI initial investment, unavoidable necessity of business process reengineering, long start-up time, use of expensive private VANs, high operating costs and lack of EDI industry standard do not allow many companies to benefit from usage of EDI technology.

Since a huge investment is involved in the adoption, implementation and maintenance of the EDI system, companies should be concerned in putting into practice a successful EDI project. Consequently, in order to benefit in full from the potential of EDI technology, a considerable amount of attention has to be paid to its implementation (Angeles et al, 2001). A proper implementation of EDI may eliminate or at least minimise its disadvantages and improve the effectiveness of EDI system by increasing its value (Bidgoli, 1999). These arguments determined our interest in investigating the importance of different factors that lead to successful implementation of EDI across the different sectors of Swedish industries. Additionally, a limited number of studies associated with the key factors in successful implementation of EDI have been conducted (Angeles et al, 2001).

Taking into consideration the above mentioned issues, we assume that it is worthwhile to build up a conceptual model that contains all the possible factors that might lead to successful implementation of EDI. Besides, we are aiming to evaluate the degree of criticality of each factor and their relationship to the level of EDI implementation in the organisations. We believe that this investigation will make it possible to ascertain the priority of the success factors for different levels of EDI implementation. In this way, the results of

this research may help companies to manage their resources in a better way, in order to obtain a higher payback from the huge investments in EDI technology.

Another interesting statement that has been found by us in the literature is that a more advanced EDI implementation between trading partners leads to significantly higher benefits for all participating firms in the supply chain network. This statement is quite a logical one, and explains the reason of why companies are interested in enhancement of their EDI implementation level and improvement of their relationships with trading partners. The estimation of getting greater benefits form the implementation of the EDI system, serves as a drive towards a highly integrated execution of electronic data interchange in the logistics field and supply chain management (Angeles et al, 1998). However, a big concern for us is to determine if the adaptation of the more advanced relationship with trading partners through the EDI system will lead to a higher perception of EDI value for the companies. In other words, we would like to investigate if the investment in a higher level of EDI leads to a greater perception of benefits from this system or not.

Thus, by doing this research we are attempting in our thesis to answer to the following research questions:

1. Which factors might influence the successful implementation of EDI across different industries?
2. What is the correlation between the degree of criticality of EDI implementation factors and the level of EDI implementation?
3. What is the correlation between EDI level of implementation and the perceived overall success of EDI network?

Thus, the results of this research will present the most important factors that should be taken into account for achieving the prosperous results in implementation of the EDI system.

In accordance with the "Index för Elektroniska Affärer" written by Anna Johansson (2002), 62% of big Swedish companies are using electronic purchasing that is equivalent to 1.102 companies. On the sales side, 42% of Swedish companies are using electronic transaction, which is equivalent to 747 companies. As realised from this statistic, the use of inter organisational information technology such as EDI and web-based business-to-business (B2B) e-commerce system has considerably increased in Sweden. Thus, we have realised that there is a common interest among the Swedish companies – either the ones who have already implemented EDI system or the ones who are interested in adoption of EDI – to realise the higher benefits such as strategic and operational benefits through successful implementation of EDI.

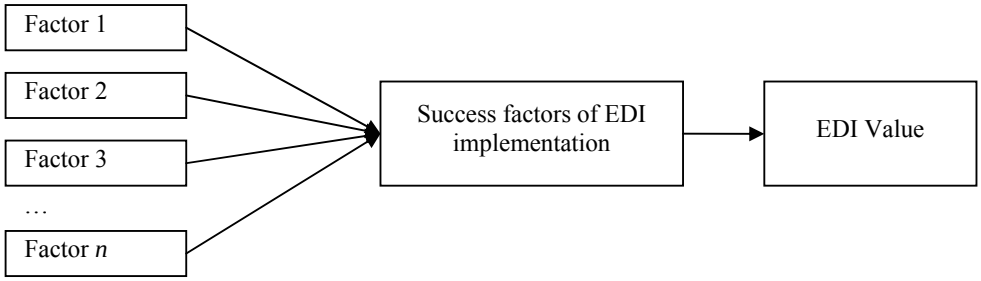
1.4. Purpose

The purpose of this study is to empirically validate factors affecting successful implementation of EDI in Swedish companies. The idea of this study has been taken from studies done by Angeles et al (1998) and Angeles et al (2001) in which the implementation of EDI success factors for U.S. firms has been investigated.

Pursuing the purpose of the study, our research can be divided into following steps: (1) investigation and analyse of different factors that might affect the degree of success in implementation of EDI system; (2) finding out to what extent these factors can be critical in relation to the changes in the level of EDI implementation; (3) investigation of the overall success of EDI system in correlation with the level of EDI system implementation.

In order to achieve the purpose of this study, we are going to build up a model (see Figure 3) including all the possible factors that contribute to the most perceived EDI value.

Figure 3: The preliminary model of EDI adoption and implementation factors



Thereafter, we will look closely to companies that operate in Sweden and who already have implemented EDI system. By making a survey through companies, we will define and rank the most important factors which have to be taken into consideration during implementation of EDI.

On the whole, the results of this study can be applied as a guideline for Swedish companies to succeed reaping the potential benefits of EDI technology.

According to our investigations, no similar studies have been made in Sweden. This finding makes our study more interesting.

1.5. Limitations

Our analysis on evaluating the critical factors relating to the implementation of the EDI system will be completely based on the survey questionnaire and set-up interviews. Although we are going to apply statistical analysis into the answered questionnaire, the result of our thesis is mostly quantitatively oriented.

Given the limited time, resources and difficulties in accessing required data, we are going to narrow down the scope of our investigation by selection of different factors that might influence the implementation of EDI from reviews of EDI-related literature, and not from the companies' interviewed as was supposed at the beginning of our survey. In addition, our research sample is restricted to medium and large companies that operate in Sweden.

In order to expand our research of the EDI implementation success factors, we are going to investigate the degree of criticality of these factors and their correlation to the level of EDI implementation for the manufacturing (60% of our research sample) and service (34% of our sample) sectors. The financial sector will not be analysed, since there are only three companies from this sector in our research sample. The results of such a small sample size cannot be generalised across all companies from the same industry. Furthermore, such a small samples size is not statistically significant, and is not able to provide valuable results.

II. METHODOLOGY

2.1. Method Description

There are many procedures for gathering information required for developing and completing academically or practically oriented thesis. The two most popular and useful methods are either interviews and document collection which are well known as primary data and secondary data source, respectively.

2.1.1. Primary data [11]

Collecting primary data can be done in two ways, either from the personal conversation and interviews or from the telephone interviews and e-mail. There are both upsides and downsides when using each of these methods.

The upside of applying the personal conversation and interview method are the great satisfaction and quality in receiving responses, since there are opportunities for the interviewer to continuously present spontaneous and complementary questions related to the subject in question. The interview method will reduce the degree of misinterpretation of respondents due to the fact that the interview process can be more controlled. Besides, more complicated questions can be raised which in turn leads to high precision in the received feedback. As downsides of using this method, the difficulties in arranging interview times and subjective responses can be pointed out. Since the responses obtained from the interface communication are based more on the individual thought and values rather than the viewpoints of all persons within organisation, it can result in that the responses from the interviews become more subjective.

[11] Wiederheim P. and Eriksson T. (1991); Merriam S. (1998); Dahmström K. (1995)

As mentioned above, the second alternative for collecting primary data can be done through telephone interviews and e-mail. On the one hand, telephone interviews would contribute to a higher frequency of answers as well as facilitating the process of follow-up questions. On the other hand, the transparency of questions related to telephone interviews should be taken into consideration, since there are no slides for presentation nor any features of bodily communication in order to get the respondent to completely understand the subject in question.

E-mail can be considered as a good way of collecting information when the available questionnaire contains many alternative answers. E-mail can also be applied as a follow-up method in combination with a telephone interview.

2.1.2. Secondary data

The concept of secondary data implies the collection of information through the literatures, case studies, articles, web sites and other historical and documentary records related to the description of the case at issue. Secondary data sources cover both empirical and theoretical researches in relation to the subject of thesis. Accessing to the required information through using both primary data and secondary data sources might also be interesting. (Dahmström K., 1995)

However, there are some downsides of using secondary data sources for analysing the case at issue. For instance, the purpose of the thesis may not match up completely to that of past or current research. Being exposed to the risk of getting old or out-of-date information from these data sources can be pointed out as another downside of this method. (Dahmström K., 1995)

2.2. Choice of Our Method

2.2.1. Data Collection

The underlying drive towards choosing the topic of thesis related to "Electronic Data Interchange" has been motivated by Professor Göran Bergendahl. Thereafter, we started looking for the relevant literatures and articles available in the library and different databases. We used keywords like "E-Commerce", "Management Information System", "Information Technology", and "Electronic Data Interchange" for searching information. Too many articles and books were found, but we tried to sort out those which were directly related to the topic at issue. After reading carefully through these articles, we found some of them quite interesting and worthwhile in order to get help for developing the idea of our thesis. In the first phase of data collection, we have used secondary data for building up the research model and questionnaire. The model includes all underlying success factors for implementation of EDI, which have been derived from a variety of literatures and articles.

By searching through Swedish homepages and using keywords "Elektroniska Handel", we found "Index för Elektroniska Affärer" written by Anna Johansson. This report was dealt with the statistical analysis relating to electronic trading among the different sectors of Swedish industries. Since the topic of our thesis and Anna's report was in the same area, we assumed that it was possible to use the same source of information as Anna Johansson did. We were hoping to get a list of companies and contact persons who were involved with EDI from Anna Johansson. She refused to disclose the contact persons' information, due to some secrecy issues. Thus, the only help which we got from Anna Johansson was accessing a list of Swedish companies ranging from small to large that were carrying out electronic transaction.

In the second phase of the data collection, primary data has been applied to our investigation, since we carried out an interview and questionnaire survey.

2.2.2. Selection of companies

The list of Swedish companies, which Anna Johansson mailed to us, contains two different categories. The first category, which amounts to 600 companies, is related to large Swedish companies and the second category, which amounts to 300 companies, is related to small/ medium ones. It is of importance to mention that the categorisation of companies in relation to their size is based on several factors such as the sales volume, number of personnel, and etc.

We decided to narrow our research down to this category, as the EDI application prevails in large companies. One of our main reasons underlying the delimitation of study is due to limited time and resources.

Thereafter, by contacting the switchboard of the companies, and asking them to put us through to the IT or purchasing/ selling units, we attempted to contact the right persons responsible for EDI. These contact persons might have positions as EDI user in the business side or as IT responsible for implementation of EDI.

Instead of contacting all 600 EDI responsible persons, which is a very time-consuming job, we thought that it was best to focus on a small proportion of this number. In our case, we needed a sample of at least 50 companies in order to run our analysis, and get a fairly precise result. Selection of companies has been done randomly, attempting to include firms from different Swedish industries.

2.2.3. Our questionnaire technique

The questionnaire includes the items which are planned to determine the criticality of each success factor. A 7-point Likert scale (1= not critical at all; 7= very critical) will be applied to the questionnaire in order to measure the criticality of each factor.

Finally, the questionnaire has been emailed to 72 companies from Sweden. A cover letter explaining the objectives of our study along with a short explanation of the main questions from the questionnaire accompanied the letter. Fifty-one questionnaires have been returned. Consequently, the response rate to our inquiry was approximately 71%. However, two responses were missing some data, and have therefore not been used in analysis. Thus, our study is focused on the remaining 49 returned questionnaires.

Disadvantages of questionnaire. The probable downside of using e-mail can be a long processing time that is made up of several steps (1) making questionnaire; (2) sending out them to relevant people; (3) filling in the questionnaire by respondents; (4) sending back the complete questionnaire. Furthermore, there are difficulties in following up the answers with further questions, due to not having face-to-face communication. On the other hand, sending questionnaire backwards and forwards between people is very time-consuming.

2.3. Validity and Reliability

Before sending out the questionnaire to the relevant persons, we decided to make an interview with Lars Jonsson as Business System Manager in Astra Tech AB, and Mats Larsson as EDI Group Chief in Göteborg Hamn AB, in order to make sure that the structure of the questionnaire was crystal clear. Another factor that enhanced the validity of our research was that we managed

to have telephone conversions with all responsible persons for EDI in 72 medium/ big Swedish companies, and get them to understand the purpose of our thesis. During the conversation, we tried to describe our questionnaire in order to avoid any misunderstanding later on. Therefore, we can claim that the questionnaires have been filled in by experienced and skilful persons in the EDI area.

The last phase of our thesis was dealing with analysing the responded questionnaires from the Swedish companies. In order to perform data analysis, we have applied statistical formula and econometrics models into our data sample. Since applying any inappropriate econometric models could have resulted in misinterpretation or errors in our study result, we realised that it would be worthwhile to get comments of Professor Lennart Flood who has been teaching and researching in econometrics area for many years.

III. THEORETICAL FRAMEWORK

3.1. Review of previous studies

Since a huge investment is involved in the adoption, implementation and maintenance of the EDI system, we conclude that companies are very interested in putting into practice a successful EDI project. Consequently, if companies concerned are to benefit in full from the potential of EDI, a considerable amount of attention has to be paid by them to the implementation of this technology (Angeles et al, 2001). A proper implementation of EDI may eliminate or at least minimise its disadvantages and improve the effectiveness of EDI system by increasing its value (Bidgoli, 1999). These arguments determined our interest in investigating the importance of different factors that will lead to the successful implementation of EDI across the different sectors of Swedish industries.

There are several case studies devoted to analysing specific factors of EDI implementation in organisations. The review of some of these studies follows below.

The main objective of the study done by Angeles et al (1998) was to examine if the levels of EDI success measures and importance of EDI implementation factors correlate or vary in a positive direction along with the level of EDI implementation. Data from 128 firms (or 64 dyads of customer-supplier relationship) have been collected for this study. The results of this study relate that the EDI level significantly predicts overall success of the EDI system as perceived by customers and does not predict overall success as perceived by suppliers. Also, in the case of this study, it has been found that the EDI level of implementation predicts the criticality of 4 out of 13 EDI implementation

factors. They are the following: conduction of the pilot project, use of cross-functional EDI teams, security and auditing control and training in EDI of the end-user. It has been concluded by the authors of this study that the results of this study suggest the need to accomplish further investigations in the area, and to determine other factors that may affect the relationship between the level of EDI implementation and system success.

In the study done by Angeles et al (2001), the factors that are critical for American companies in successful EDI implementation in the US, and internationally, have been investigated. Data collected from 56 firms has been analysed here. EDI implementation factors relating to the domestic level (US) are compared with those appropriate for international EDI. Moreover, the relative importance of each implementation factor with regard to EDI success at the domestic and international level has been reported. The following key factors related to successful implementation of EDI within the US has been identified: the selection of EDI standards, relationships with trading partners, support and commitment of top management, the availability of value-added networks (VANs), and security and audit controls. For the success of EDI at the international level, availability of mature communication infrastructure, accessibility to international VANs, adequate security measures for international data transmission and "friendliness" of laws governing international trade, has been found to be critical.

The study done by Heck and Ribbers (1999) have analysed the factors responsible for the adoption/implementation of EDI system and its impact on small businesses in Netherlands. This study has been supported by 137 small firms, which included 83 non-EDI-adopter and 54 EDI-adopter companies. The results of this study showed that the dominant factor that explains the adoption of EDI by small businesses is 'external pressure'. The underlying reason is that small businesses are forced to do this by their dominant

suppliers or customers. An additional result of this study shows that for the EDI-adopters from the investigated group, there was no significant relationship between the level of EDI integration and the actual benefits adopters received from utilising EDI.

Iskandar et al (2001) have examined in their study the process of adoption and integration of EDI by US automobile industry suppliers. Their study has been based on data from 103 responding companies, where 81 firms had already introduced EDI and 22 companies had not. Their study shows that the factors affecting EDI adoption are different from those affecting EDI integration and success. According to their findings, it seems that managerial proactiveness is the most significant factor for EDI integration and success. In order to implement EDI successfully in the supply chain, it is necessary for EDI promoters to stimulate the managerial proactiveness of low bargaining power suppliers by cooperatively helping them in the process of learning how to identify and explore EDI benefits.

In the absence of similar researches in Sweden, we will try to identify and examine the research factors associated with successful implementation of EDI in Swedish companies.

3.2. Definition of 'level of EDI implementation'

Different EDI-related literature articulates a positive relationship between the level of EDI implementation and the ability to achieve significant benefits from its implementation, for all participating firms in the network. The identification of the levels of EDI implementation is significant due to the relationship between progress in the implementation of EDI system and the benefits obtained by organisations (Lummus, 1995). Therefore, the major objectives of this study are to observe the correlation between the level of EDI implementation in relation to the perceived overall success of EDI network,

and the degree of criticality of different EDI implementation factors that will lead to the successful implementation of the EDI system in companies that operate in Sweden. In order to identify various stages of EDI system implementation for the companies from our research-sample, the classification criteria developed by Emmelhainz (1993) has been used in the questionnaire. According to Emmelhainz' classification system, three levels of EDI implementation have been developed. They are as follows:

Level 1. simple transaction of information without integration in the internal processes;

Level 2. exchange of data between the applications of two firms;

Level 3. EDI has changed the way of doing business through business process reengineering

Level 1: The company is using EDI with a few trading partners for a limited number of transactions. Thus, only some business documents are handled electronically, while all others are completed manually. Since the transaction information is not integrated into the internal process of the organisation, the electronic documents are manually entered into the materials requirements planning system.

Firms that implement EDI at the Level 1 can expect to receive minimal benefits from the installation. At this level of implementation, companies can expect only those benefits which result from improvements in the transaction process. These benefits can be the following: reductions in paperwork, reductions in time spent sorting and filing mailed documents, reductions in input errors, improved pay cycle, faster response time, standardised information.

Level 2: An organisation uses EDI to exchange transactions with its suppliers and customers. EDI technology is integrated into the manufacturing planning

system (MPS) of the organisation, so that it is possible to update transaction driven information without additional data entry. Data from customers is integrated into the planning system with minimal human intervention to eliminate duplicate transactions.

At this level, companies can expect improvements in lead time, reductions in inventory, improved customer relations and other benefits from open sharing of information with its customers and suppliers.

Level 3: An organisation has integrated EDI system on its entire business process, by linking all the functions in the organisation. Firms that reach the Level 3 of implementation are openly sharing information between their customers and suppliers. This sharing requires a level of trust between most trading partners.

At the Level 3, companies can expect cost benefits due to reductions in personnel and efficient business operations, and strategic time-based competitive advantage as EDI links all functions in the firm.

3.3. Description of success factors of EDI implementation

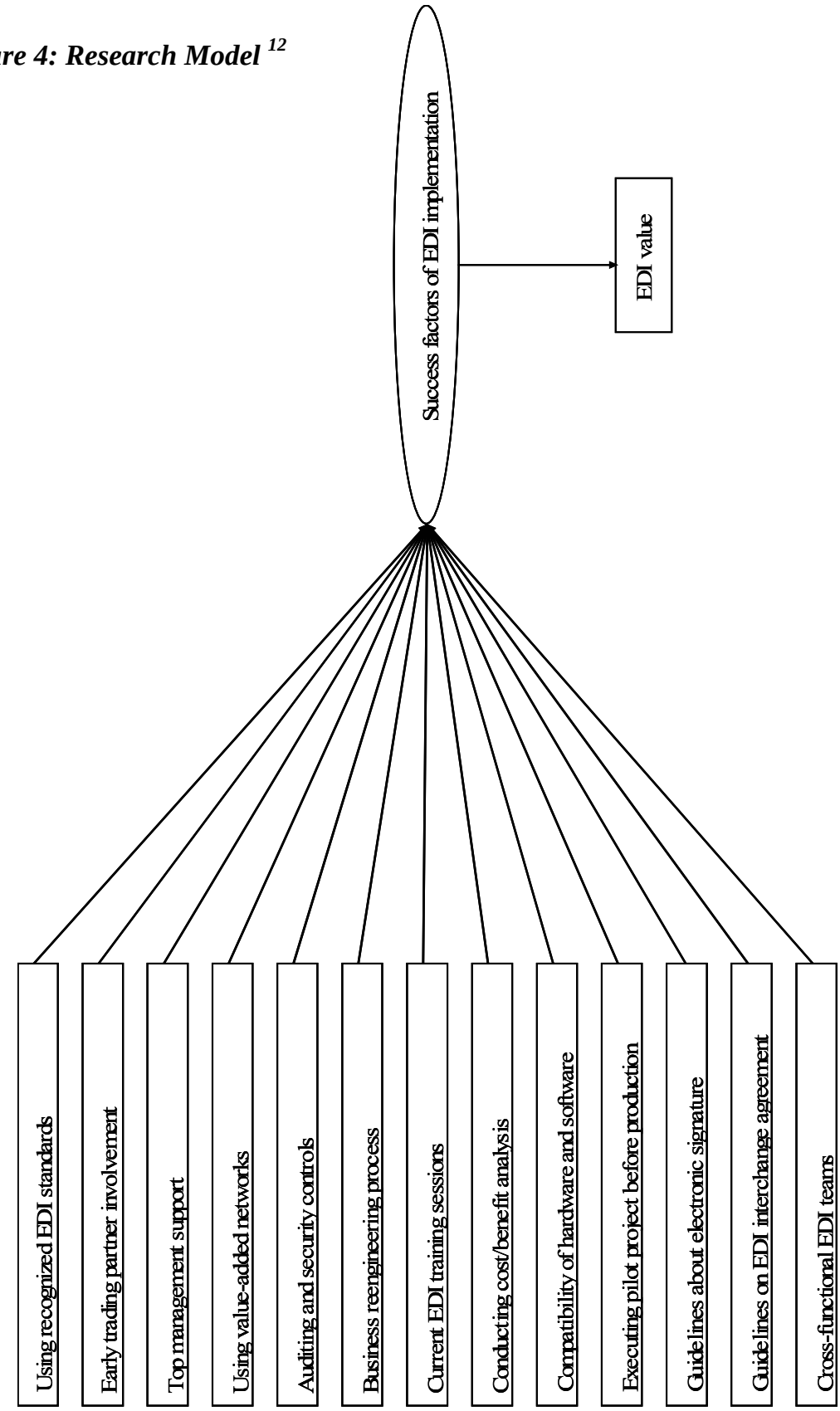
There are a lot of findings in academic literature and practical work emphasising that adoption of EDI result in both positive and negative effects over companies. Different EDI-related studies highlight diverse problems and barriers that are related to its adoption and implementation. Thus, it is possible to find a lot of factors hindering the process of EDI implementation over its potential users. As times goes by, new factors are revealed to be critical for the successful implementation of the EDI system. Therefore, the major purpose of our study was to emphasise the potential factors that might influence the successful implementation of EDI in different sectors within Swedish industry.

Given the limited time, resources and difficulties in accessing required data, we have narrowed down the scope of our investigation by selection of potential factors that might influence the successful implementation of EDI from reviews of EDI-related literature and not from companies' interview as it was believed at the beginning of our survey.

In the study by Angeles et al (2001), the importance of different factors perceived as key elements to facilitate successful EDI implementation has been investigated. On the basis of these investigations, the most important factors for successful implementation of EDI have been selected by the researchers. These findings have been supported by other researches which emphasised similar factors that lead to successful implementation of EDI: for instance Rahman & Raisinghani (2000) and Angeles et al (1998). In accordance with these findings, the same EDI implementation factors have been selected in our research. In the model presented in Figure 4, the relationships between selected factors, successful EDI implementation and the value gained from EDI have been sketched out.

The detailed description of the selected factors is presented in the following subchapters.

Figure 4: Research Model [12]



[12] Angeles et al (1998); Heck and Ribbers (1999); Rahman and Raisinghani (2000); Angeles et al (2001)

3.3.1. Selection of EDI standards

There is no basic requirement for trading partners to have the same document processing system when transferring information electronically, such as EDI. Since any one of the trading partners have their own format of document processing system, there should be some common standard available among trading partners for transferring documents which is understandable for all the parties. Therefore, EDI translation software performs a crucial task when converting the special document format of the sender trading partner into an agreed upon standard. On the other hand, when the information of the sender partner is received by the other partner in the standard format, the EDI translation software is then required again to turn the standard format into the special format of the receiver's own document processing software. (Davis and O'Sullivan, 1998)

UN/EDIFACT and ANSI X.12 are two prevailing international EDI standards, which have been developed and supported as technical problem solutions in inter-organisational communication by two dominant international institutions; namely the United Nations Centre for the Facilitation of Procedures and Practices for Administration, Commerce and Transport (UN/CEFACT) and the American National Standards Institute (ANSI). (Damsgaard and Truex, 2000)

According to Williams and Magee (1998) industry standards define the grade of homogeneity of electronically transferring information and product identification scheme, as well as the degree of proprietary formats versus industry-wide EDI standards formats. One of the obstacles faced by different companies for EDI adoption is the lack of information consistency among trading partners.

One of the critical factors in the successful adoption of EDI is the availability of EDI standards. By using commercially accessible standards and common message format, the development cost and the risk related to the new EDI application will be reduced. These advantages make potential trading partners want to adopt EDI. (Williams and Magee, 1998)

According to Leyland (1993), there are three situations which will determine the choice of standards:

1. A situation in which EDI has not yet been adopted as a means of electronic interface among trading partners, and that a new trading group is being formed and developed. In the beginning, it is very likely that the group will choose EDIFACT. From the political perspective it is important to do this, since there are no industry-specific standards anyway. Other organisations will be persuaded to trade electronically, also using EDIFACT.

2. A situation in which your company is rather a large one and a part of a widespread established EDI community which has an experience and history of using EDI earlier. In this case, the choice of your company in choosing EDI standards will be dependent on the business requirement. One of the underlying indicators that helps your company to choose the most applicable and useful EDI standard is to identify the biggest potential trading partners who has the largest trading volumes. Thereafter, you will choose the EDI standards that those trading partners use.

3. A situation in which your company is a small/medium one and your company would be dominated by a big potential and powerful trading partner such as supplier or customer. In this case, your company, in order to be able to maintain and survive in this trading chain, should adopt its transaction processing system with those dominant ones. The EDI standard will be dictated to you. But do remember that, if you should find yourself in this

situation, most firms will be faced with multiple standards usage anyway. The action of a dominant supplier or buyer in dictating initial standards usage should not deter you from carrying out an analysis of trading partners, so that you can determine how you best want to use EDI.

Technical compatibility problems are such concerns that delay prevalent external distribution of EDI. None of the trading partners such as suppliers, manufacturers, wholesalers, retailers and customers are willing to use multiple data formats when transferring documents with one another. EDI exposure will be largely prevented, unless dominant international standards such as UN/EDIFACT and ANSI X.12 are put into operation dynamically. This is especially correct in international business where the potential for EDI use is very large, but the technical compatibility problems are also equally discouraging. (Premkumar et al, 1994)

3.3.2. Trading Partner Relationship [13]

Trading Partner Trust in B2B E-Commerce – Since the use of business-to-business (B2B) e-commerce and other form of electronic markets is being greatly expanded, the significance of trading partner trust for developing and maintaining mutual business relationship is coming to light. One of the underlying characteristics which has to be taken into account by trading partners is trust. Trust can definitely perform a crucial role among the trading partners who are willing to develop the interdependencies and relationships in order to accomplish an intended target and realise the most benefit out of the trade.

Since the early days of trade history, trust has been a key factor for successful long term trading partner relationships. Trust can contribute to increasing in

[13] Ratnasingam and Phan, 2003

the cooperation and communication openness and information sharing. The B2B inter-organisational trust can be argued from three angles:

1. *The organisational and economic perspective*: in managing inter-organisational relationships, organisations attempt to minimise uncertainties related to dependence for resources and bring their trust under control through laws and social sanctions.

- *Deterrence-based trust*: in order to get trading parties to perform their transactions via EDI in correspondence with trading contract and to avoid any fraud in trading, deterrence-based trust can be viewed as a significant motivator for doing so. In this case, trading parties relying on the threat of punishment by social institutions to conduct exchanges.
- *Knowledge-based trust:* this kind of trust is completely relying on the knowledge of trading parties on each other, so that any of them can forecast other trading partners' behaviour and performance. By means of this, they can dampen the severity of uncertainties occurring in the different trading parties' performance in the future.
- *Identification-based trust:* refers to empathy and common values among trading partners which get them to understand that success of one party will lead to all participating trading parties' winning. Therefore, this kind of trust would drive them to act as an agent for the other.

2. *The technological perspective*: trust in technology can be reached by technical protection, protective measures, and control mechanism that aim to provide consistent and trustworthy transactions with timely, accurate, and complete data transaction. Nowadays, such issues can be addressed by available E-commerce security technologies that include digital signature, encryption mechanism (public key infrastructure), authorisation mechanism (user IDs and passwords), and best business practices that enforce regular

audit, top management commitment, standards, professional codes of conduct, and contingency procedures.

3. *The behavioural perspective*:

- *Competence trust:* is completely relying on the financial and technical strength of the trading partners. Technical strength can be interpreted as technical knowledge, ability to operate B2B E-commerce applications correctly. On the other hand, financial strength can be viewed as the ability of trading partner to pay for goods and services, and the ability to stand behind the quality of products and services long after delivery.
- *Predictability trust:* refers to the consistency in the trading partners' behaviour and performance, so that it provides sufficient knowledge for other trading partners to make decisions and forecasting based on prior experiences.
- *Goodwill trust:* refers to reliance on trading partners' helpfulness, care, concern and honesty that allows trading partners to expand their relationship. This kind of trust leads to further investment and holding long run relationship.

3.3.3. Compatibility of hardware and software among trading partners

There are some obstacles to the adoption and diffusion of the EDI system which should be taken into account in advance. Technological incompatibility is one those issues which should be addressed by IT experts. Technical issues cover the compatibility of hardware/software and data format between the participating trading partners processing systems in order to have a clear transfer of information between one another. Technical incompatibility can have a negatively impact on the adoption of EDI. There are huge external pressures such as competitive pressure and imposition by trading partners on the small firms; therefore they are more willing to adopt EDI in order to survive in this competition. On the other hand, these small firms are very

unlikely to be successful to diffuse it far more, due to incompatibility difficulties with the internal information system application. Problems may occur in expanding EDI externally among the trading partners due to their multiple hardware platforms and using different protocols. These kinds of technical problems will be expanding enormously when many trading partners with a variety of data formats and hardware/software standards try to communicate with one another. (Premkumar et al, 1994)

3.3.4. Availability of Value Added Networks

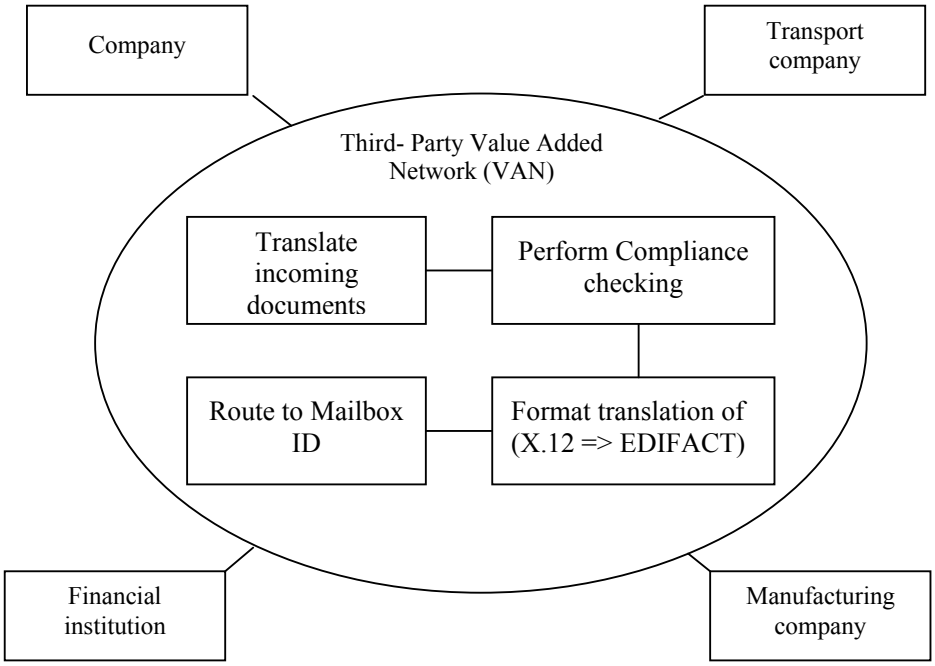
Value-added networks (VANs) have been applied traditionally as a facilitator which provides for networking connectivity among EDI trading partners. With the arrival of Internet-based EDI, the significant degree of using EDI will be weakened, especially when encryption software gains in sophistication, effectiveness, and wide usage by firms. (Angeles et al, 1998)

A VAN functions as a telephone switching station which transfers a huge amount of information among trading partners. VAN has been known as dedicated, private or third-party proprietary communications companies that provide for multi-protocol connectivity. Electronic mailboxes and various translation tools can be mentioned as other services provided by VAN. Translation tools can be used to transform a trading partner's application-specific format into a standard format or vice versa. By doing so, the trading partners with different internal applications protocols can communicate with one another without any difficulties. (Threlkel and Kavan, 1999)

As an advantage of using EDI, the ability to secure the transaction can be pointed out. Due to using measures such as firewalls, encryption programs and digital signature, VAN can make sure a secure connection that guarantees delivering of information from point A to B in time, and without any corruption and missing data. Since running EDI has high implementation and

maintenance cost, it has been assumed to be a good solution just for big companies, their customers and suppliers. (Threlkel and Kavan, 1999)

Figure 5: Functions of a third-party VAN (by Kalakota and Whinston, 1996, p.388)



Companies can perform businesses with each other either by connecting directly to the relevant companies or by connecting to VAN. VAN acts as middleman among trading partners who allow them to place purchase orders, invoices and remit payment automatically and securely. As illustrated in Figure 5, when company A sends an EDI transaction to manufacturing company B, first it arrives at the message storehouse on the VAN. Thereafter, VAN picks up the message from its storehouse and delivers it to trading partner B's mailbox. The message will remain there until manufacturing company B logs on and pick it up. Trading partner B will interact with trading partner A in the same way. The cycle repeats itself among the trading partners on a weekly, daily, or perhaps even hourly basis as needed. This service is generally known as mail-enabled EDI. (Kalakota and Whinston, 1996)

The weakness of EDI-enabling VANs is that the companies face an enormous amount of expenses related to the connect time and mailbox charges. On the other hand, the speed of data transmission in VAN is very slow. (Kalakota and Whinston, 1996)

3.3.5. Business Process Reengineering (BPR)

Business process reengineering in an organisation brings reoptimisation of organisational processes and structures, which often follows the launching of new information technologies. There are several indications which imply that even small changes, in the use of information technology, might require big restructuring changes in the organisation matrix in order to gain in full utilisation of new technology. (Orman, 1998)

Without doing major changes in the structure of organisation, the sufficient payback will not be gained in order to cover the high implementation and maintenance cost of IT technology. There are two kinds of changes in the organisational restructuring, so called micro-and macro-level changes. At the macro-level, the most significant subjects concentrate on the changes in the degree of centralisation of decision making, with related questions about the depth and shape of organisational hierarchies. On the other hand, at the micro-level, the most significant subjects are dealing with the job definition and content, with related questions about communication patterns, employees' job satisfaction, and skill requirements. While there is considerable evidence and agreements on the close relationship between organisational restructuring and technological changes, there are much fewer agreements on what kind of organisational changes should be made in order to gain in the full advantage of the technology utilisation. (Orman, 1998)

Business process reengineering is a tricky concept to implement since organisations face up to lot of challenges and barriers which might hold back

the diffusion of this concept. Therefore, a good understanding of these challenges for achieving implementation of this concept throughout the organisations is necessitated. In the study done by Marshall (1995), the following challenges have been emphasised:

- *Resistance:* there are many people in the organisation who are willing to stick to the traditional way of doing things. They oppose any adoption and alterations that occur due to new ideas and technologies. All of these resistance are because of they are afraid of losing their job and not being able to adopt themselves to new technologies.

- *Cost:* the first step for implementing BPR in an organisation is making a complete survey of the way business is carried out currently. Thereafter, the survey is followed by bringing up a clean sheet of paper and rethinking the company's business processes. The performance of these steps is very expensive.

- *Job Losses:* as business process reengineering is aiming for taking most advantage of using advanced technology such as IT, it will definitely lead to employee layoffs. Before reengineering runs its course, as many as 25 million jobs may be lost to BPR.

- *Trading and Culture*: the business processes that are inefficient and decades old are often complying with corporate culture of the organisation. To be able to reengineer the inefficient business processes, the corporate culture will have to change, which is not an easy task. Corporate culture comprises the traditional behaviour and performance of employees.

- *Lack of Management Support:* many top managers are not completely aware of benefits gained from BPR. As there is a huge investment involved in the implementation and maintenance of BPR, they are afraid of undertaking this concept in organisation. Therefore, without having top management support, reengineering has little chance of succeeding.

- *Risk of Managers:* performing BPR in organisation is a risky task for top managers to take on. It is very likely that top managers will lose his position in case BPR does not succeed. On the other hand, if BPR is a success they will be awarded and promoted. Thus, there are often uncertainties for top managers to take on this risky task.

- *Retraining:* due to radical changes made by many reengineering projects, the up-to-date education and training courses will have to be hold for employees in order to get them familiar with the new way of doing things. These training courses are very time-consuming and expensive processes.

- *Scepticism:* some people are suspicious about the successfulness of BPR and they doubt BPR can make business processes more efficiently. Others look on BPR as the same old traditional systems development with a fancy new name and a more attractive wrapper. In order to get BPR implemented in the organisation, such scepticism must be prevented either by making sceptics aware of benefits of BPR or keeping them away from negatively influencing others.

3.3.6. Dependable Security and Audit

Although implementation of EDI has a significant impact on the business processes such as cost savings and reducing lead-time, there are also some weaknesses relating to EDI such as security risk issues. Thus, EDI presents some additional security considerations such as timeliness of delivery, error detection, impact of system failures, and transaction auditing in order to cope with such security risks. It can be concluded that the merits of implementing EDI in the organisation can be put at risk by not taking account of security controls. According to Waksmunski (1996), the challenges created by the application of EDI include the following:

- *Lack of paper documentation.* In traditional business processes which are not equipped by an electronic data transferring application, paper documents play a crucial role. Paper documents contains legalisation features such as approval signatures, processing time and date stamps and other type of information which can be used to validate the content of transactions. By using paper documentation, trading partners can ensure that no corruption or missing data will occur during transmission. By introduction of the EDI application into business process, all of these paper documentation will be eliminated which can be viewed as a downside of EDI.

- *High speed processing.* By running EDI, all transactions among trading partners are processed very rapidly, compared to the traditional systems. Due to high speed processing in the EDI-based transaction, there is little time left for error detection. Thus, doing transactions through EDI is not completely precise. On the other hand, paper-based transactions are more precise than EDI due to human intervention which provides the necessary error detection to assure the correctness of transactions. There is no guarantee in using EDI application unless the software programs used comprise the controls and checks to authenticate information, detect errors, and activate automated exception processes to trigger human intervention.

- *Access control/Confidentiality.* Another important issue that should be taken into account when using EDI is confidentiality. It implies that users, who are not given permission to perform EDI transaction, should be limited from having access to EDI application due to security and secrecy issues. For instance, National Defence is one of those practical examples where confidentiality of information are of importance, as disclosure of secret information leads to political and financial instability.

- *Message sender authentication.* It is of great importance to make sure of the authentication of the message sender who places orders via EDI, especially

when it concerns large volume of purchasing. If such a security measure is not taken into consideration, many unauthorised orders will be processed by manufacturing trading partner without having any real demand. Thus, it leads to huge losses for the manufacturing trading partner and shakiness of relationships between the trading partners. From another point of view, message sender authentication is very important to ensure that the sender of message can not deny originating a message. Thus, it can be concluded that message source authenticity protects both the sender and receiver of EDI.

- *Data integrity.* This concept implies that information sent by one trading partner via EDI should be completely the same as information received by another one. By implementing data integrity, the trading partners are not afraid of data corruption or missing data any more. This leads to a close relationship and trust among trading partners.

- *Timeliness.* Implies that business transactions should be carried out in time. Facing any delay in delivering business transactions results in lost opportunities and financial impacts for trading partners. Therefore, it is of importance for trading partner to stick to a specific time frame in order for getting the business transactions done before deadlines.

- *Record sequence integrity.* EDI-based business transaction and computer processes might be dependent on the sequence in which EDI transactions are sent and/or received. Thus, it is of high importance to take into consideration that the order of receiving transactions should be in accordance with the order of their sending and no transactions should be repeated.

- *Auditing.* In order to keep track of all EDI transactions activities, an audit trail is necessary to ensure that related activities are recorded as trustworthy accounting of events. Audit trails also provide a record of all EDI transactions, including authorisations, dates, times, and any approved changes.

- *Legal issues.* Implies that each of the trading partners should be completely aware of what responsibilities and liabilities they are going to undertake. The conditions and terms that exist on physical business documents should be discussed and agreed upon by all of trading partners. Any contractual arrangements should be placed in writing.

From 1998 Info World's survey made up of 31 IT decision makers' responses, it has been revealed that the security was the top prerequisite for successful implementation of EDI comparing to the cost and management issues. According to Angeles et al, (1998) the three main prerequisites for EDI to succeed through the auditing test are as follows:

1. EDI systems should include built-in controls in order to ensure that transactions are checked and also guarantee the accuracy, completeness, security, auditability, timeliness, and recoverability of transactions;

2. The EDI system should provide for compliance reporting in order to ensure that verification standards and agreed-upon procedures among trading partners are achieved; and

3. The EDI system should not allow unauthorised users to have access to business processes to do any changes in terms of modification of the data and disclosure of information.

By blooming Internet technology and its widespread application into EDI transmission, a renewed interest in security and auditing controls is coming into light. Convergence of electronic commerce technologies is one of the significant consequences of Internet-based EDI. One of the security measures which has been taken into account in I-EDI is developing of new software and technologies to encrypt data and/or files and protect them against unauthorised access. (Angeles et al, 1998)

The Internet Engineering Task Force (IETF) is an institute which is dealing with developing standards and recommending one security method to be used by all I-EDI participants. It has been emphasised by Angeles et al (1998, p.788) that IETF faced four major tasks:

1. "select a general encryption method among Secure Multipurpose Internet Mail Extensions (S/MIMI), Pretty Good Privacy/MIME (PGP/MIMI), and Multipart Object Security Standard (MOSS);
2. institute non-repudiation or receipt of origin;
3. consider message duplication and sequencing issues;
4. determining the best method for managing public keys"

3.3.7. Top Management Support

"The role of top management support in the success of a MIS (Management Information System) project is not only intuitive but also axiomatic. The same is true for EDI project implementation, where the implementation efforts must be protected by top echelon mandate and nurturing. A common complaint in many firms' EDI department is the lack of top management support for EDI programs." (Angeles et al, 2001, p.340)

According to Angeles and Nath (2001), top management support can play a crucial role in the following area:

- Persuading and supporting business process reengineering ;
- Commitment to the goals of EDI network; and
- Adopting innovative technologies

3.3.8. The commitment and sense of ownership of a cross-functional EDI implementation team

In many ways, non-technical issues of an EDI initiative – such as organisational issues – can be more daunting and expensive than the technical issues of EDI implementation. The "human" costs associated with education, training, and implementation management constitute a significant part of EDI implementation costs. Consequently, in order to successfully implement EDI system, it is necessary to develop a strategy that will manage the non-technical, organisational issues involved in the process. (McLure and Moynihan, 1995)

Involvement of the staff to form a cross-functional EDI team is an important step in both planning and implementation of EDI system projects. The organisation requires cross-functional team for the successful implementation and successive support of the EDI system. The mission of the EDI team is to establish specific EDI policies and procedures to meet the business challenges of the organisation. Sequentially, the EDI team has to develop and implement an EDI working plan that will include a detailed description of all the compulsory activities for the implementation and after that for maintaining of the EDI system. Furthermore, the EDI team has to provide expert resources that can help users and information system staff plan, implement and support EDI system.

The importance of cross-functional team to both plan and implement EDI system projects has been analysed to a great extend in the specialised literature. As it was emphasised by Angeles et al (1998) previous researches revealed the following empirically supported success factors for cross-functional team use in a sourcing environment:

- availability of organisational resources, specifically, time to pursue team assignments, support services, and financial backing;

- participation and involvement of suppliers in the team;
- higher levels of internal and external decision-making authority;
- effective team leadership;
- higher levels of effort from team members.

3.3.9. Provision of clear guidelines about the rules governing EDI interchanges agreements

In the past, most on-line or electronic contracts were conducted in the context of EDI. The EDI system is imposed on continuing relationships and thus pre-agreed 'interchange agreements' or 'trading partner agreements' could be made. These agreements are overriding contracts that specify everything pertaining to the future relationship: on-line contract information; attribution of risk; operation procedures; security; even technical aspects such as the standard format of the data fields.(Chissick and Kelman, 2000) Consenting partners are free to choose their own procedures and requirements for electronic contracts, agreements, and records (DeMaio, 2001).

Since interchange agreements were extremely detailed and explicit, very little litigation occurred in the area, making the structure they imposed a legal success. Thus, EDI interchange agreements have the luxury of having a pre-agreed umbrella agreement that settles disputes. (Chissick and Kelman, 2000)

3.3.10. Execution of the pilot project before fully committing to the operational implementation of EDI

Implementation of EDI requires significant investment in infrastructure. Therefore, a good way to start this is to undertake a small EDI pilot project.

There is a growing trend between organisations to run small, pilot projects with their IT services suppliers before committing to a long-term outsourcing contract. Companies are taking a tactful approach to their outsourcing

strategies, which are driven by uncertain economic conditions and concerns over success rates on outsourcing contracts. (Computer Weekly, 8/19/2003)

A pilot project will help a company to decide whether, and how, to proceed with the proper version. Furthermore, the pilot project will provide information about how to proceed with a full version. It is vital that the project has a clear critical success factor and key performance indicators so that it is possible to measure and learn from success, or failure. Adopting a focused and well-targeted pilot project will increase the chances of a successful implementation on a larger scale later in the day. This will give a quicker return on investment than might be achieved after a rapid, perhaps ineffective, implementation that does not involve a pilot project. (Computer Weekly; 4/15/2003)

Finally, the biggest benefit of the pilot project is in reducing risks arising from large-scale failures that have been poorly evaluated.

Since pilot projects help to discover problems early, modifications in the project after the pilot is completed are likely (Turban et al 2000).

3.3.11. Provision of clear legal guidelines for such issues as the legality of electronically transmitted documents and contracts, the acceptability of electronic signatures and authorisations, etc.

As information and telecommunication technologies are making advanced, electronic forms are beginning to predominate in newly created documents over the traditional form. Documents made out in the traditional paper form can be signed in one's own hand. Subsequently it can be determined, either according to a specimen signature, or on the basis of a graphologist's evidence, whether it is the signature of the particular person. However, these methods cannot be applied in the digital world. (Bosakova, 2003)

Like a written signature, the purpose of a digital signature is to guarantee that the individual sending the message really is who he or she claims to be. Digital signatures are especially important for electronic commerce, and are a key component of most authentication schemes. To be effective, digital signatures must be un-forgeable. There are a number of different encryption techniques to guarantee this level of security. (DeMaio, 2001)

On January 19, 2000 the Electronic Signatures Directive (1999/93/EC)[14] was published in the Official Journal of the European Communities. "The purpose of this Directive is to facilitate the use of electronic signatures and to contribute to their legal recognition. It establishes a legal framework for electronic signatures and certain certification-services in order to ensure the proper functioning of the internal market."[15] The Electronic Signatures Act came into effect in October 2000. The EU member states are obliged to implement the Electronic Signatures Directive in their national legislation (Bosakova, 2003).

According to the Directive 1999/93/EC, 'electronic signature' is defined as "data in electronic form which are attached to or logically associated with other electronic data and which serve as a method of authentication". The validity of an electronic signature or contract may be challenged on the same legal grounds as a traditional written Signature or contract. Accordingly, electronic signatures are subject to the challenges based on authenticity (is the signature message a forgery or otherwise unauthorised?) and integrity (was the message received in the same form as it was sent?). (Hurewitz and Nadon, 2002)

An email message, or even a mere mouse click, may constitute an electronic signature. However, it is not possible to trust to this kind of signature very

[14] See: http://europa.eu.int/ISPO/ecommerce/legal/digital.html
[15] Directive 1999/93/EC of the European Parliament and of the Council of 13 December 1999 on a Community Framework for Electronic Signatures

much. Thus it is essential to define what sort of electronic signature can be considered authentic enough that it can be used to sign legal transactions.(Bosakova, 2003) For such a signature the Electronic Signatures Directive (1999/93/EC) introduces the notion of an 'advanced electronic signature' that has to meet the following requirements:

1. to be uniquely linked to the signatory;
2. to be capable of identifying the signatory;
3. to be created using means that the signatory can maintain under his sole control;
4. to be linked to the data to which it relates in such a manner that any subsequent change of the data is detectable.

Other digital signatures guidelines and standards have been developed by, for example, by Federal National Institute of Standards and Technology (USA), the American Bar Association, The United Nations Commission on International Trade Law (UNCITRAL). Model Law on Electronic Signatures does not mandate a particular implementation of digital signatures but establishes "criteria of technical reliability" under which electronic signatures shall be treated as equivalent to hand-written signatures. (Hurewitz and Nadon, 2002)

Companies are free to choose their own procedures and requirements for electronic contracts, agreements, and records. Consenting partners can decide for themselves how to implement electronic signatures and how to verify the authenticity and integrity of an electronic signature. To protect against fraud and coercion in electronic contracting, the E-SIGN law requires businesses to obtain informed consent from consumers in order to conduct electronically any transactions that a law requires to be in writing. (Hurewitz and Nadon, 2002)

3.3.12. Providing educational training sessions for all EDI participants (managers, coordinators, users, technicians, etc.)

The following human resource educational problems that may challenge an EDI project's ability to be successful have been introduced in the study by Grover et al (1995):

- Inadequate training for personnel affected by the business process reengineering project;
- Lack of time for developing new skills required by new systems;
- Lack of the appropriate incentive, training and cultural change programs required by the business process reengineering.

Any individual entering or processing data should have the appropriate "education, training and experience" or a combination thereof, to perform this task. Training sessions should be provided not only for specific operations, but also on a continuing basis, as needed, for familiarity with any changes in operation. (Keatley, 1999)

Staff education is especially necessary to create significant change within an organisation. Education creates an understanding of the scheduled change and its process, and justifies the need for a new course of action. People affected by change need to know the nature of the change, how it will occur, its impact, and their role in the process of change. Their participation, acceptance, and active assistance are the desired ends of an EDI-educational program. (McLure and Moynihan, 1995)

An organisation's employees must understand EDI's purpose, its benefits, how it works, and the positive effect EDI will have on an organisation's business (McLure and Moynihan, 1995).

Developing an EDI education agenda should be part of an EDI Director's job description. Thus, EDI directors should chair the EDI Steering Committee and

work with representatives from multiple departments that will be affected by EDI and appropriate outside resources to guide the educational process. Training requirements and completion are to be documented. (McLure and Moynihan, 1995)

3.3.13. Justification of the EDI system using a thorough cost-benefit analysis

Quantitative justification of IT investment has always been a good idea. However, the typical methods of making these cost-benefit analyses are imperfect (Clermont, 2002).

The analysis of EDI investment is more difficult than many other investment decisions, because the costs and benefits of this investment are hard to identify and quantify, and the intangible factors are likely to be significant. Consequently, companies do not know whether and to what extent they should invest in EDI and they are unable to measure the return on this investment.(Hoogeweegen et al, 1998) These un-quantifiable costs and benefits of EDI investment require integration of different other factors in the traditional investment analysis.

Thus, the major difference of an EDI investment from a traditional IT investment is that EDI should be multi-organisational with the following characteristics, which are a part of feasibility analysis:

- "EDI is a technology infrastructure that spans multiple independent organisations. As such, EDI investment is meaningful only when trading partners are willing to participate in it.
- The costs and benefits involved in the EDI investment are seldom equally distributed over the participating organisation.

- EDI assumes a minimal level of IT maturity among the partners and requires a rather formal way of conducting business.
- In many countries, EDI messages have not yet received the same legal status as their paper counterparts." (Rahman and Raisinghani, 2000)

However, any new system must be evaluated before management decides to accept it for implementation. Since the cost-benefit analysis is recognised by many researchers as a strong factor for EDI investment analysis, a few models for cost-benefit analysis are briefly introduced below. Thus, the techniques used to evaluate certain investments can be based on:

1. "**Deterministic models** provide a set of formulas that produce certain outcomes based on business context-dependent parameters. The same set of parameter values will always produce the same outcome.

2. **Stochastic models**, on the other hand, incorporate probability as a moderator between the context parameters and the final outcome.

3. **Multiple-criteria analysis models** calculate outcomes based on a set of weighted scores. These weighted scores are assigned by the decision-makers to a checklist of variables, such as 'contribution to strategy', 'expected payoff', and the like. There are certain multiple criteria methods which incorporate qualitative factors along with quantitative parameters to produce the outcome.

4. **Simulation models** reflect a system's current way of working and would allow the EDI decision-maker to change certain parameters to measure their effect on the system's performance." (Rahman and Raisinghani, 2000)

Table 1 presents several methods available in the literature, used for general information systems investment analysis.

Table 1: Overview of Available Assessment Methods (by Rahman and Raisinghani, 2000, p.156)

Methodology	Name of Method
Deterministic	Cost-Benefit Analysis
	Financial Analysis
	Value Analysis
Stochastic	Decision Analysis
	Option Valuation Model
Multiple-criteria	Multiple Criteria Analysis
	Information Economics
Simulation	Simulation Modelling
	Multiple Criteria Analysis

In practice, many organisations combine different methods by varying them to suit the specific situation. The most frequently used methods by companies might be described as ad hoc methods. (Rahman and Raisinghani, 2000)

In accordance with our study limits, the above mentioned 'cost-benefit' methods are not described in this paper.

IV. ANALYSIS

4.1. Sample profile

Our empirical research is based on the questionnaire-survey of 49 Swedish companies that was conducted in the autumn of 2003. According to the survey results, the majority of companies from the analysed sample are from manufacturing sector (60%). The rest of our sample is divided between service and finance sectors with 34% and 6% respectively. A more detailed description of our sample across major industries is summarised in Table 2. Some of the inquired companies are doing business in more than one field of industry. Therefore, the total number of companies that have been counted in different industries is higher than forty-nine. The largest amount of companies from the sample are related to the 'computers and communications' field (12%), which is followed closely by the 'construction', 'transportation' and 'wholesale' fields (10% each).

Table 2: Industry Profile of Companies from our Sample

Industries	Number of companies	% of sample
Mining	1	2 %
Construction	5	10 %
Automobile	3	6 %
Metals	3	6 %
Rubber and plastics products	1	2 %
Computers and communications	6	12 %
Paper and paper products	1	2 %
Chemical products	1	2 %
Publishing and printing	1	2 %
Furniture manufacturing	3	6 %
Food and beverages	3	6 %
Machinery and equipment	4	8 %
Transportation	5	10 %
Wholesale	5	10 %

Retail	2	4 %
Banking	3	6 %
Other sectors not mentioned above	5	10 %

In order to determine the magnitude of surveyed companies, questions related to the amount of firm's 'Net Assets' and 'Net Sales' have been included in the basic questionnaire. In view of the fact that a lot of companies refused, from different reasons, to disclose any information related to their 'Net Assets', this question has been removed from our survey. In fact, companies have been more willing to disclose information concerning their annual turnover. According to the survey results, 37% of companies reported an annual turnover between 1 billion SEK and 5 billion SEK; 29% of companies have the sales volume less than 1 billion SEK; 18% range from 5 billion SEK to 30 billion SEK and the 'Net Sales' of 8% of inquired firms is over 30 billion SEK (see Table 3). The remaining 8% of inquired firms didn't disclose any information regarding their sales volume. Also, this information has not been available on the companies Web-page.

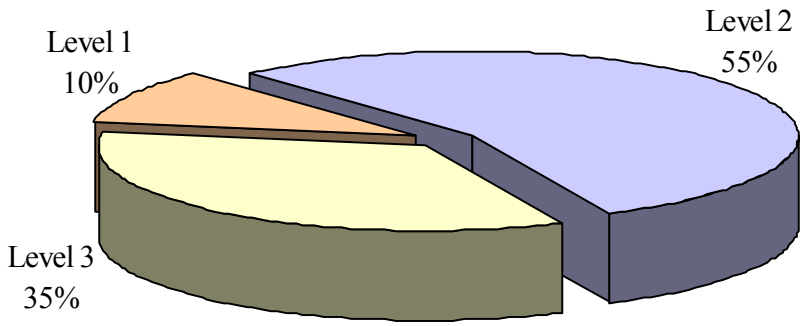
Table 3: Sale profile of the companies from the sample

Sales	Number of companies	% of sample
Less than 1 billion SEK	14	29 %
1 billion SEK – 5 billion SEK	18	37 %
5 billion SEK – 30 billion SEK	9	18 %
over 30 billion SEK	4	8 %
Information not available	4	8 %

Since all the inquired companies use EDI, a question that will find out the level of EDI implementation, according to the predetermined criteria, has been included in the questionnaire. The stages of EDI implementation have been defined based on the criteria developed by Emmelhainz (1993). The identification of the levels of EDI implementation is significant due to the

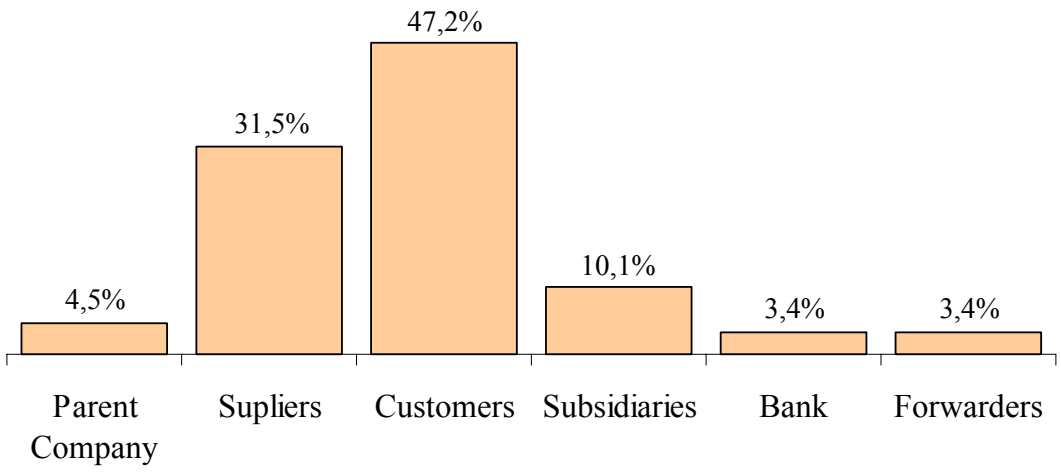
relationship between progress in the implementation of the EDI system, and the benefits obtained by organisations (Lummus, 1995). According to the survey results, most of companies from our sample (about 55%) reported level 2 of implementation of EDI technology (exchange of data between the applications of two firms). Thirty-five percent of questioned companies stated a progress in implementation of EDI up to level 3 (EDI has changed the way of doing business through business process reengineering). And only 10% of firms from the sample mentioned level 1 of EDI implementation (simple transaction of information without integration in the internal processes). Figure 6 depict the levels of EDI implementation for questioned companies.

Figure 6: Level of EDI implementation in the analysed sample



Furthermore, questioned firms has been asked to identify the nature of the trading partner with whom they exchange information through EDI system. Our detailed investigation shows that 47,2% of companies from the sample use EDI in the exchange of data with their customers, 31,5% mentioned that they exchange the information with their suppliers and 10,1% with subsidiaries (see Figure 7).

Figure 7: Nature of trading partners with whom the exchange of data through EDI is performed.



4.2. Analysis and results

In order to identify which factors are perceived to be important for the success of the EDI system, the mean score and standard deviation of each factor for 49 questioned firms have been calculated. These calculations are based on companies' estimation of the criticality of each success item. The value of each success factor is based on a seven–point Likert scale which means that attributed values range from 1 (not critical at all) to 7 (very critical). Table 4 shows the rank of theses success factors in which the highest rank has been attributed to 'dependable security and auditing control for transmitted data' with mean 5,43 and σ=1,19 that is closely followed by 'relationships with valuable trading partners' with mean 5,35 and σ=1,16. The lowest rank has been attributed to the factor – 'compatibility of hardware and software among potential trading partners' that has the mean of 3,84 and σ=1,89. Consequently, our findings strengthen the results of Info World's survey (1998), which revealed that the security is the top prerequisite for successful implementation of EDI system. Thus, it seems that security considerations like timeliness of

delivery, error detection, impact of system failures, and transaction auditing are still very important for successful implementation of EDI.

One important point which has to be taken into consideration is that if the mean of two success factors are the same, the distinction and ranking of these two will be based on their standard derivation. As seen in Table 4 the difference between the mean and standard deviations of these success factors are not that big, which implies that all these factors might be important for successful implementation of EDI.

Table 4: Success factors for EDI implementation[16]

Success factors	Rank	Mean	SD
Dependable security and auditing controls for transmitted data	1	5,43	1,19
Relationships with valuable trading partners	2	5,35	1,16
Selection of widely accepted EDI standards	3	5,18	1,68
Commitment and ownership of a cross-functional EDI team	4	5,16	1,33
Executing a pilot project before fully committing to the implementation of EDI	5	4,92	1,51
Provision of clear guidelines for EDI interchange agreements	6	4,65	1,47
Provision of clear guidelines for electronic signatures and authorisations	7	4,53	1,67
Redesign of existing business processes	8	4,51	1,50
Top management support	9	4,39	1,60
Conducting a cost-benefit analysis	10	4,35	1,45
Availability of network services from value-added networks	11	4,22	1,64
Provision of current training sessions for all EDI participants	12	4,06	1,42
Compatibility of hardware and software among potential trading partners	13	3,84	1,89

[16] A seven-point Likert scale was used with 1='not critical at all' and 7='very critical'

Another factor of our high interest was the level of EDI implementation which has been answered by companies from our research sample. The discrete value attributed to this item ranges from 1 to 3. In order to find out whether the level of EDI implementation predicts the criticality degree of success factors or not, a regression analysis between each success factor and its level of EDI implementation has been performed. In other words, using this statistical model we would like to test if changes in the Level of EDI implementation have any effect (either positive or negative) on the criticality of the EDI success factors. Thus, it will be determined if there is a "statistically significant" relationship between 'EDI Success Factor' and 'Level of EDI implementation'.

In our analysis, the regression equation is equivalent to $Y = \beta_1 + \beta_2 X$. The definition of the variables is as follows:

- Y – EDI Success Factor (ESF)
- X – Level of EDI implementation

The major reason for performing the regression analysis is to examine how the value of the dependent variable (Y) changes as the independent variable (X) changes. Thus, the magnitude of β_2 measures the amount of change in the criticality degree of the success factor for a given change in EDI Level. If $\beta_2>0$ then X has a positive effect on Y which mean that the increase in implementation of the EDI level leads to an increase in the significance of EDI success factor. Conversely, if $\beta_2<0$ then X has a negative effect on Y, and the increase in the level of EDI implementation leads to the decrease in significance of the EDI success factor. The results of the regression analyse for our research sample are presented in Table 5. It is necessary to mention here that the least square estimators (β_1, β_2) are random variables. In other words, they take on different values in different samples and their values are unknown until the sample is collected and their values computed. Thus the calculated

values of the least square estimators are true only for our research sample. (Hill et al, 2001)

As a consequence of our regression analysis, the value of coefficient of determination (R^2) has been included in the third column of Table 5. According to Hill et al (2001), R^2 is a descriptive measure of the regression model that measures the proportion of variation in Y (EDI Success Factor) explained by X (Level of EDI implementation). The closer R^2 is to 1, the greater is the predictive ability of the regression model over the sample observations. In accordance with the obtained results, the EDI success factors with highest value of explanatory measure are 'business process reengineering', 'top management support' and 'organisation of educational training sessions' with 0,11329; 0,10896 and 0,08461 respectively. Nevertheless R^2 does not measure the quality of the regression model. Therefore, other measures in the analysis of the quality of the regression model are required.

According to Hill et al (2001) one major method for making statistical inferences from data is Hypothesis Testing. Each hypothesis test contains 4 components which is (1) a null hypothesis (H_0); (2) an alternative hypothesis (H_1); (3) a test statistic; and (4) a rejection region.

In our statistical analysis, the definition of null hypothesis (H_0) and alternative analysis (H_1) are as follows:

- H_0: $\beta=0$ implies that the level of EDI implementation does not predict the EDI success factor
- H_1: $\beta\neq 0$ implies that the level of EDI implementation does predict the EDI success factor

Rejection rule for a hypothesis test implies that "when the *p*-value of a hypothesis test is smaller than the chosen value of α, then the rest procedure

leads to rejection of null hypothesis"(Hill et al, 2001). In addition, *p*-value shows the probability that null hypothesis can be true.

By looking deeply into the gained results of relevant regression analysis presented in the first column of Table 5, it will be realised that *p*-value related to "top management support", "business process reengineering" and "training" is less than the significance level of 5 percent. This results in the rejection of the null hypothesis (H_0: $\beta=0$) and acceptance of alternative hypothesis (H_1: $\beta\neq 0$) just for the three above-mentioned success factors.

Another way of performing hypothesis testing is to calculate the *t*-statistic value and compare it to the *t*-critical value. Rejection rule for a two tailed test implies that "if the value of test statistic falls in the rejection region, either tail of the *t*-distribution, then we reject the null hypothesis and accept the alternative" (Hill et al, 2001).

The critical value t_c can be found in the statistical table (Right-tail Critical Values for the *t*-distribution) which in our case is t_c= 2,009 considering the degree of freedom DF=47 and significance level α= 0,05. By looking at *t*-value column of Table 5, it will be realised that just those three above-mentioned success factors have a test statistic larger than t_c= 2,009 which results in the rejection of the null hypothesis (H_0: $\beta=0$) and acceptance of alternative hypothesis (H_1: $\beta\neq 0$).

Table 5: Simple regression between level of EDI implementation and success implementation factors [17]

Regression equation	t-value (significance)	R^2	Results
ESF1= 4,4399+0,396825X_t EDI Level (*p*-value=0,15021)	1,46269	0,04354	EDI level does not predict ESF1 (trading partner relations)
ESF2= 5,8095-0,16667X_t EDI Level (*p*-value=0,55799)	-0,59004	0,00735	EDI level does not predict ESF2 (security and auditing controls)
ESF3= 2,4104+0,865079X_t EDI Level (*p*-value=0,02054)	2,39731	0,10896	EDI level predicts ESF3 (top management support)

[17] the level of significance α= 0.05

Regression equation	t-value (significance)	R^2	Results
ESF4= 3,9297+0,539683X_t EDI Level (*p*-value=0,08473)	1,76106	0,06190	EDI level does not predict ESF4 (cross functional EDI teams)
ESF5= 3,6054+0,690476X_t EDI Level (*p*-value=0,08092)	1,78375	0,06340	EDI level does not predict ESF5 (widely used EDI standards)
ESF6= 2,6236+0,825397X_t EDI Level (*p*-value=0,01804)	2,45049	0,11329	EDI level predicts ESF6 (business process reengineering)
ESF7= 4,4354-0,261905X_t EDI Level (*p*-value=0,56122)	-0,58519	0,00723	EDI level does not predict ESF7 (IT compatibility)
ESF8= 3,1859+0,507936X_t EDI Level (*p*-value=0,13920)	1,50427	0,04593	EDI level does not predict ESF8 (cost-benefit analysis)
ESF9= 2,5918+0,714286X_t EDI Level (*p*-value=0,06334)	1,90174	0,07145	EDI level does not predict ESF9 (value-added network services)
ESF10=4,7732+0,063492X_t EDI Level (*p*-value=0,86074)	0,17640	0,00066	EDI level does not predict ESF10 (pilot project)
ESF11=2,5193+0,674603X_t EDI Level (*p*-value=0,04259)	2,08428	0,08461	EDI level predicts ESF11 (training)
ESF12=5,4739-0,412698X_t EDI Level (*p*-value=0,29990)	-1,04822	0,02284	EDI level does not predict ESF12 (guidelines for electronic signature)
ESF13=4,5442+0,047619X_t EDI Level (*p*-value=0,89206)	0,13643	0,00040	EDI level does not predict ESF13 (guidelines for EDI interchange agreements)

The correlation between the level of EDI implementation and EDI implementation success factors have been calculated and presented in Table 6. These values have been obtained through Pearson correlation analysis tool available in SPSS. The correlation formula is as follows:

$$\rho_{X,Y} = \frac{COV(X,Y)}{\sigma_X \cdot \sigma_Y}$$

where

$$COV(X,Y) = \frac{1}{n}\sum(Xi - \mu_x)(Y_i - \mu_y)$$

$$\sigma_X^2 = \frac{1}{n}\sum(X_i - \mu_x)^2$$

$$\sigma_Y^2 = \frac{1}{n}\sum(Y_i - \mu_y)^2$$

As seen in Table 6, there is high correlation between the level of EDI implementation and "business process reengineering", "top management support" and "training" that are 0,337; 0,330 and 0,291 respectively. The *p*-values calculated by applying Pearson correlation are equal to the one

computed by the regression analysis. The obtained results can be interpreted as confirmation to the result obtained from the above regression analysis and hypothesis testing. These high values imply the direct and close relationship between the trend of changes in EDI level and implementation success factors. Thus, in order to gain sufficient payback that will cover the high implementation and maintenance cost of EDI technology, a high attention should be paid to the three above-mentioned critical implementation factors. In addition, it makes them understand that expensive investments in the reorganisation of the business process have to find the support of companies' top-management. Moreover, these changes in the organisation matrix have to be followed by "most up-to-date" educational training sessions for all EDI participants.

The obtained results imply that changes in the Level of EDI implementation have an extremely low effects on factors like 'execution of the pilot project' (ρ=0,026; *p*-value=0,861) and 'clear guidelines for EDI interchange agreements' (ρ=0,02; *p*-value=0,892). These results imply a conclusion that the Level of EDI implementation has no any effect on the importance of these factors. Hence, the criticality of these factors does not vary with the changes in the level of EDI implementation.

The obtained results are in close agreement with our literature findings presented in Theoretical Framework. Thus, since the EDI system is imposed on continuing relationship between trading partners, pre-agreed covenants are made all the time. In these covenants, trading partners specify their own procedures and requirements for electronic contracts, agreements, and records pertaining to their future relationship.

In addition, implementation of EDI requires significant investment in infrastructure. Therefore, a good way to perform changes is to undertake a small EDI pilot project.

Table 6: Correlation between EDI level and EDI implementation success factors

EDI implementation success factors	Correlation with level of EDI implementation	*P*-value[18]
ESF1 (Winning and maintaining solid relationships with valuable trading partners)	0,209	0,150
ESF2 (Designing appropriate and dependable security and auditing controls for transmitted data)	-0,086	0,558
ESF3 (The support of a top management in implementation of EDI)	0,330	0,021
ESF4 (Ownership of a cross-functional EDI implementation team)	0,249	0,085
ESF5 (The selection of widely accepted EDI standards)	0,252	0,081
ESF6 (Redesign of existing business processes and applications)	0,337	0,018
ESF7 (Compatibility of hardware and software among potential trading partners)	-0,085	0,561
ESF8 (Justification of the EDI system using a thorough cost-benefit analysis)	0,214	0,139
ESF9 (The availability of network services from value-added networks)	0,267	0,063
ESF10 (Executing a pilot project before fully committing to the operational implementation of EDI)	0,026	0,861
ESF11 (Providing "most up-to-date" educational training sessions for all EDI participants)	0,291	0,043
ESF12 (Provision of clear legal guidelines for electronic signatures and authorisations, etc.)	-0,151	0,300
ESF13 (Provision of clear guidelines for EDI interchange agreements)	0,020	0,892

Perceived overall success of the EDI network is another item of the questionnaire which has been answered by 49 Swedish companies. The discrete value attributed to this item ranges from 1 to 7. In order to check whether there is any close relationship between the level of EDI implementation and perceived overall success of EDI network, another regression analysis and hypothesis testing has been performed. The same procedure for hypothesis testing has been applied here as previous part. As shown in Table 7, the *t* statistic value is 2,63874 which is larger than the critical value t_c= 2,009. This result is in the rejection of null hypothesis and acceptance of alternative

[18] the level of significance α= 0.05

hypothesis which implies that EDI level significantly predicts perceived overall success of EDI network.

Table 7: Simple regression between level of EDI implementation and EDI system success measures [19]

Regression equation	T-Value (significance)	R^2	Results
Success = 3,4762 + 0,666667 EDI Level (*p*-value=0,0113)	2,63874	0,129032	EDI level significantly predicts perceived overall success of EDI network.

By using the Pearson correlation analysis tool available in SPSS, the correlation value between the level of EDI implementation and perceived overall success of EDI network have been computed and presented in Table 8. The high correlation value implies that there is close and direct relationship between the explainable and dependable variables. Therefore, this high correlation value can be interpreted as confirmation to the result obtained from the above regression analysis and hypothesis testing.

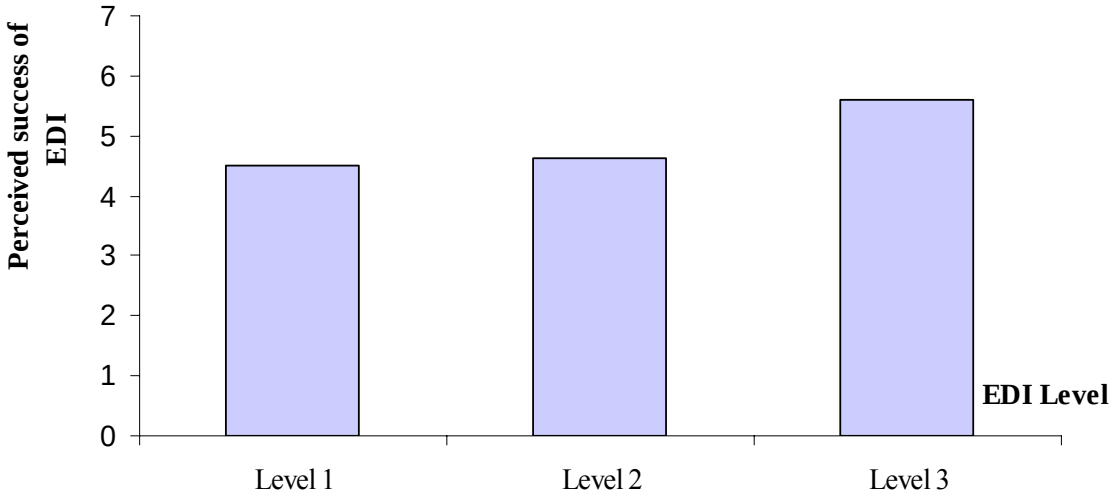
Table 8: Correlation between EDI level of implementation and EDI success measure

EDI success measure	Correlation with EDI level of implementation	*P*-value
Overall success of EDI system	0,359	0,011

In Figure 8, the relationship between EDI level and perceived success of the EDI has been graphically demonstrated. The average value of perceived EDI success for each category of EDI implementation level has been calculated and figured on two – dimensional diagram. As shown in Figure 8, the higher the level of EDI implementation, the greater the EDI success will be obtained in system.

[19] the level of significance $\alpha = 0,05$

Figure 8: Relationship between the level of EDI implementation and perceived success of EDI system



4.3. Analysis of different industry sectors

In order to expand our research of the EDI implementation success factors the analysis related to different industrial sectors has been performed. Our research sample includes companies from manufacturing (60%), service (34%) and financial (6%) sectors.

Since our research sample includes only three companies from the financial sector, we did not analyse this sector because such a small samples size is not statistically significant and is not able to provide valuable results.

Manufacturing sector review. Table 9 summarise the statistical results of the EDI implementation success factors for the companies from the manufacturing industry. In accordance with the mean score presented in the second column of Table 9 the following success factors have been perceived to be important for the companies from the industrial sectors: 'selection of widely accepted EDI standards' (mean=5,25; σ=1,41), 'relationship with trading partners' (mean=5,22; σ=1,04) and 'security and auditing controls for transmitted data' (mean=5,13; σ=1,16). The low correlation value of these three factors with the

level of EDI implementation implies their constant importance for the companies with different implementation level of EDI system. The positive Pearson correlation has found that only 'commitment of cross-functional EDI team' and 'redesign of existing business processes' are successfully predicted by the level of EDI implementation and has been found to be significant at 0,421 and 0,448 respectively (level of significance α=0,05).

Table 9: Success factors for EDI implementation for companies from manufacturing sector

Success factors	Mean	SD	Correlation with EDI Level	*P*-value
Security and auditing controls for transmitted data	5,13	1,16	-0,126	0,492
Relationships with valuable trading partners	5,22	1,04	0,133	0,467
Selection of widely accepted EDI standards	5,25	1,41	0,124	0,5
Commitment and ownership of a cross-functional EDI team	5,09	1,23	0,421	0,016
Executing a pilot project before the implementation of EDI	4,88	1,41	-0,103	0,573
Provision of clear guidelines for EDI interchange agreements	4,47	1,32	0,061	0,741
Provision of clear guidelines for electronic signatures and authorisations	4,13	1,54	-0,132	0,47
Redesign of existing business processes	4,72	1,35	0,448	0,01
Top management support	4,41	1,43	0,249	0,169
Conducting a cost-benefit analysis	4,28	1,37	0,111	0,544
Availability of network services from value-added networks	4,63	1,50	0,175	0,338
Provision of current training sessions for all EDI participants	4,03	1,28	0,301	0,094
Compatibility of hardware and software among potential trading partners	3,72	1,87	-0,144	0,431

By looking deeply into the gained results of relevant regression analysis presented in the first column of Table 10, it will be attested that *p*-value related to 'commitment and ownership of a cross-functional EDI team' and 'business

process reengineering' is less than the significance level of 5 percent. These outputs justify the correlation between the criticality degree of the two above-mentioned EDI implementation factors, and the level of EDI implementation within companies that operate in manufacturing industry in Sweden. These results in the rejection of the null hypothesis (H_0: $\beta=0$) and acceptance of alternative hypothesis (H_1: $\beta \neq 0$).

Table 10: Simple regression between level of EDI implementation and success implementation factors for companies from manufacturing industry [20]

Regression equation	t-value (significance)	R^2	Results
ESF1= 4,625+0,25X_t EDI Level (*p*-value=0,46739)	0,73609	0,01774	EDI level does not predict ESF1 (trading partner relations)
ESF2= 5,75-0,26316X_t EDI Level (*p*-value=0,4923)	-0,69516	0,01585	EDI level does not predict ESF2 (security and auditing controls)
ESF3= 2,875+0,64474X_t EDI Level (*p*-value=0,16945)	1,40788	0,06198	EDI level does not predicts ESF3 (top management support)
ESF4= 2,875+0,93421X_t EDI Level (*p*-value=0,01634)	2,54417	0,17747	EDI level predict ESF4 (cross functional EDI teams)
ESF5= 4,5+0,31579X_t EDI Level (*p*-value=0,50029)	0,68229	0,01528	EDI level does not predict ESF5 (widely used EDI standards)
ESF6= 2,125+1,09211X_t EDI Level (*p*-value=0,01014)	2,7442	0,20065	EDI level predicts ESF6 (business process reengineering)
ESF7= 4,875-0,48684X_t EDI Level (*p*-value=0,43145)	-0,79747	0,02076	EDI level does not predict ESF7 (IT compatibility)
ESF8= 3,625+0,27632X_t EDI Level (*p*-value=0,54393)	0,61387	0,01241	EDI level does not predict ESF8 (cost-benefit analysis)
ESF9= 3,5+0,47368X_t EDI Level (*p*-value=0,33771)	0,97428	0,03067	EDI level does not predict ESF9 (value-added network services)
ESF10=5,5-0,26316X_t EDI Level (*p*-value=0,57322)	-0,56956	0,0107	EDI level does not predict ESF10 (pilot project)
ESF11=2,375+0,69737X_t EDI Level (*p*-value=0,09404)	1,72928	0,09065	EDI level does not predicts ESF11 (training)
ESF12=5-0,36842X_t EDI Level (*p*-value=0,46989)	-0,73193	0,01754	EDI level does not predict ESF12 (guidelines for electronic signature)
ESF13=4,125+0,14474X_t EDI Level (*p*-value=0,74129)	0,33322	0,00369	EDI level does not predict ESF13 (guidelines for EDI interchange agreements)

Service sector review. The summary of the statistical results for the companies from the service sector are presented in Table 11. The success factors with the

highest rank of the mean score that are perceived to be critical in EDI success are as follows: 'security and auditing controls for transmitted data' (mean=5,79; σ=1,05); 'relationships with trading partners' (mean=5,64; σ=1,28); 'commitment of cross-functional EDI team' (mean=5,29; σ=1,64); 'execution of the pilot project' (mean=5,21; σ=1,37).

The positive Pearson correlation between the EDI success factors and Level of EDI implementation are found to be significant for 'relationships with valuable trading partners' at 0,62 (significance level α=0,05). These findings imply that the criticality of the above mentioned factors increase by improving the level of EDI implementation in companies from the Swedish service sector.

The results from calculation of Pearson correlation imply the conclusion that factors like 'security and auditing controls for transmitted data' (ρ=0,000; *p*-value=1; mean=5,79) and 'commitment of cross-functional EDI team' (ρ=0,000; *p*-value=1; mean=5,29) have tremendous importance for the companies that activate in service sector at all three levels of EDI implementation. In other words, these two factors are very critical for all the companies from the service sector and at all levels of EDI implementation.

Table 11: Success factors for EDI implementation for companies from service sector

Success factors	Mean	SD	Correlation with EDI Level	*P*-value
Security and auditing controls for transmitted data	5,79	1,05	0,000	1
Relationships with valuable trading partners	5,64	1,28	0,620	0,018
Selection of widely accepted EDI standards	4,71	2,20	0,309	0,282
Commitment and ownership of a cross-functional EDI team	5,29	1,64	0,000	1
Executing a pilot project before the implementation of EDI	5,21	1,37	0,331	0,248
Provision of clear guidelines for EDI interchange agreements	4,71	1,73	-0,131	0,655

[20] the level of significance α= 0.05

Success factors	Mean	SD	Correlation with EDI Level	*P*-value
Provision of clear guidelines for electronic signatures and authorisations	5,07	1,77	-0,191	0,512
Redesign of existing business processes	4,07	1,44	0,157	0,591
Top management support	4,64	1,55	0,512	0,062
Conducting a cost-benefit analysis	4,14	1,56	0,362	0,203
Availability of network services from value-added networks	3,36	1,82	0,248	0,392
Provision of current training sessions for all EDI participants	4,36	1,01	0,449	0,107
Compatibility of hardware and software among potential trading partners	3,79	2,04	-0,111	0,706

By looking deeply into the gained results of relevant regression analysis presented in the first column of Table 12, it will be attested that *p*-value related to 'trading partner relationships' is less than the significance level of 5 percent. Another way of performing hypothesis testing is to look at the *t*-statistic value (presented in the third column of Table 12) and compare it to the *t*-critical value. The critical value in this case is t_c= 2,131 (DF=15, α= 0,05). According to the rejection rule for the two tailed test only the value of the 'trading partner relations' falls in the rejection region. In this way, the values of the *t*-statistic generate the same conclusion, which results in the rejection of the null hypothesis (H_0: β=0) and acceptance of alternative hypothesis (H_1: β≠ 0) for this EDI implementation success factor. In other words, there is a relationship between the criticality degree of the 'trading partner relationships' factor and the level of EDI implementation within Swedish service industry.

Table 12: Simple regression between level of EDI implementation and success implementation factors for companies from service industry [21]

Regression equation	t-value (significance)	R^2	Results
ESF1= 3,31+1,17X_t EDI Level (*p*-value=0,01791)	2,74061	0,38496	EDI level does predict ESF1 (trading partner relations)

[21] the level of significance α= 0.05

Regression equation	t-value (significance)	R^2	Results
ESF2= 5,786+0X_t EDI Level (*p*-value=1)	0	0	EDI level does not predict ESF2 (security and auditing controls)
ESF3= 2,309+1,667X_t EDI Level (*p*-value=0,06155)	2,06205	0,26163	EDI level does not predicts ESF3 (top management support)
ESF4= 5,286+0X_t EDI Level (*p*-value=1)	0	0	EDI level does not predict ESF4 (cross functional EDI teams)
ESF5= 2,714+X_t EDI Level (*p*-value=0,28246)	1,12531	0,09545	EDI level does not predict ESF5 (widely used EDI standards)
ESF6= 3,405+0,33X_t EDI Level (*p*-value=0,59113)	0,55193	0,02476	EDI level does not predicts ESF6 (business process reengineering)
ESF7= 4,452-0,333X_t EDI Level (*p*-value=0,70625)	-0,38601	0,01226	EDI level does not predict ESF7 (IT compatibility)
ESF8= 2,4762+0,8333X_t EDI Level (*p*-value=0,20279)	1,34723	0,13138	EDI level does not predict ESF8 (cost-benefit analysis)
ESF9= 2,0238+0,6667X_t EDI Level (*p*-value=0,3918)	0,8884	0,0617	EDI level does not predict ESF9 (value-added network services)
ESF10=3,881+0,6667X_t EDI Level (*p*-value=0,24787)	1,21462	0,1095	EDI level does not predict ESF10 (pilot project)
ESF11=3,024+0,6667X_t EDI Level (*p*-value=0,1071)	1,7418	0,20180	EDI level does not predicts ESF11 (training)
ESF12=6,07-0,5X_t EDI Level (*p*-value=0,51206)	-0,67567	0,03665	EDI level does not predict ESF12 (guidelines for electronic signature)
ESF13=5,38095-0,333X_t EDI Level (*p*-value=0,65535)	-0,457686	0,0172	EDI level does not predict ESF13 (guidelines for EDI interchange agreements)

The gained results of the regression analysis presented in Table 12 also imply the conclusion that there is a lack of any relationship between 'security and auditing controls' factor (β_2=0, *t*-statistic = 0, R^2 = 0, *p*-value =1), 'commitment of cross-functional EDI team' factor (β_2=0, *t*-statistic = 0, R^2 = 0, *p*-value =1) and the implementation level of EDI. These results bring us about the great importance of these two factors for the companies from service sector with different EDI levels.

CONCLUSION

The more far-sighted EDI users believe that the higher level of EDI implementation will lead to the greater benefits gained from EDI application (Swatman and Swatman, 1992). As pointed out in different EDI-related literature, the major benefit of using EDI is not in the replacement of manual data handling (such as telephone, fax, paper-based communication) with electronic data exchange, but in redesigning and improvement of the entire business process of the organisation in relation to its trading partners. Thus, EDI has to be considered as a powerful tool that offers to organisations a new way of doing business (Ferguson et al, 1990).

By driving towards a highly integrated execution of EDI in the logistics field and supply chain management, it is very crucial to clarify the underlying implementation success factors. At the same time, much attention should be paid to the application of these factors before being committed to the full version of EDI.

Selection of companies for our research sample has been done randomly, attempting to include firms from different Swedish industries. Thus, 49 companies have been included in our sample. This size of the research sample has been recognised as statistically significant to provide significant results.

Looking through different EDI-related literature, it has been identified that there are 13 factors that contribute to a great success in implementation of EDI system. It is very unlikely that the EDI system succeeds in making significant benefits without taking account of these critical factors. Not considering these critical factors during EDI implementation, the management will be facing difficulties in making enough profits in order to cover the huge expenses such as implementation and maintenance cost. In order to identify the importance of

the selected factors, the mean score and standard deviation of each factor for 49 questioned firms have been calculated. The highest rank has been attributed to ‘security and auditing control for transmitted data’ and ‘relationships with valuable trading partners’.

The next stage of our analysis deals with measuring the correlation between the criticality degrees of 13 success factors and changes in the level of EDI implementation. Having completed our analysis, we have resulted in that only 3 out of 13 success factors are sensitive to the trend of changes in EDI level. These three success factors given their rank are as follows: (1) redesign of business processes; (2) top management support in implementation of EDI system; (3) provision of “most up-to-date” training sessions for all EDI participants. Furthermore, the obtained results imply that the improvement in the EDI level has extremely low effects on the criticality of factors like ‘execution of the pilot project’ and ‘clear guidelines for EDI interchange agreements’. Thus, the criticality of these two factors does not vary with the changes in the level of EDI implementation.

An additional result from our research was that level of EDI implementation significantly predicts perceived overall success of EDI network for the companies from our sample.

By expanding our research, an analysis of the criticality of the EDI implementation success factors for the companies from manufacturing and service sector has been provided. These analyses have resulted in partially different outcomes. These discrepancies have been caused by changes in our new research samples as the result of rearrangement of companies in two different samples according to their industry profile.

As a final point of our study, we would like to mention that the findings from this paperwork can act as a signal to the companies’ management in order to

make them aware of how to invest their scarce resources wisely. The outcome of this survey will contribute to the knowledge of EDI coordinator and electronic commerce managers involved in EDI enabled logistical system. In addition, it makes them understand that investing more resources for developing the EDI level, will not automatically brings the organisations to success. Hence, greater attention should be paid to the above-mentioned success implementation factors and their correlation with EDI Level for achieving the overall success of the EDI system.

It is necessary to point out that in our increasingly integrated world the international relationships between the companies are becoming extremely important. Therefore, the development of electronic data interchanges at the international level become more significant. Unfortunately, because of the limited time, resources and difficulties in accessing required data, there was not possible for us to investigate the effects of successful implementation of EDI at the international level.

However, we think that the results of this study should be of value for practitioners as well as for academics. For practitioners these results can be used as a guideline in reaping the benefits of EDI technology. For academics it provides a starting point for further research in this area, and especially to successful EDI implementation at the international level.

ABBREVIATIONS

ANSI	– American National Standards Institute
BPR	– Business Process Reengineering
B2B	– Business to Business
EC	– Electronic Commerce
EDI	– Electronic Data Interchange
EDIFACT	– Electronic Data Interchange for Administration Commerce and Transport
ESF	– EDI Success Factor
IETF	– Internet Engineering Task Force
IT	– Information Technology
JIT	– Just in Time System
MIS	– Management Information System
MOSS	– Multipart Object Security Standard
MPS	– Manufacturing Planning System
PGP/MIMI	– Pretty Good Privacy/ Multipurpose Internet Mail Extensions
S/MIMI	– Secure Multipurpose Internet Mail Extensions
UN/EDIFACT	– United Nations/ Electronic Data Interchange for Administration Commerce and Transport
UNCITRAL	– United Nations Commission on International Trade Law
VAN	– Value Added Networks

BIBLIOGRAPHY

Books:

1. Chester, Michael; Kaura, Rukesh; Linton, Peter (2003). "Electronic Business and Commerce"; Springer-Verlag London Limited
2. Chissick, Michael; Kelman, Alistair (2000). "Electronic Commerce: law and practice"; Sweet and Maxwell, London
3. Chissick, Michael; Kelman, Alistair (2002). "Electronic Commerce: law and practice"; Sweet and Maxwell, London
4. Dahmström, K. (1995). "Från Datasamling till Rapport"; Sweden; Studentlitteratur
5. DeMaio, Harry B. (2001). "B2B and Beyond: New Business Models Built On Trust"; John Wiley and Sons
6. Emmelhainz, M.A. (1993). "EDI: A Total Management Guide"; Van Nostrand Reinhold, New York
7. Hill, Cartel; Griffiths, William; Judge, George (2001). "Undergraduate Econometrics"; John Wiley & Sons, Inc. USA
8. Kalakota, Ravi; Whinston, Andrew B. (1996). "Frontiers of Electronic Commerce"; Addison-Wesley Publishing Company, Inc.
9. King, David; Lee, Jae; Warkentin, Merrill; Chung, Michael H. (2002). "Electronic Commerce 2002: a managerial perspective"; Pearson Education, Inc.
10. Leyland, Valerie A. (1993). "Electronic Data Interchange: A management view"; Prentice Hall International (UK) Ltd
11. Merriam, S. B. (1998) "Fallstudien som Forskningsmetod"; Sweden; Studentlitteratur
12. Neef, Dale (2001). "E-procurement: From Strategy to Implementation"; Financial Times Prentice Hall
13. Rahman, Syed Mahbubur; Raisinghani, Mahesh S. (2000). "Electronic Commerce: Oportunity and Challenges"; Idea Group Publishing
14. Tayur, Sridhar; Ganeshan, Ram; Magazine, Michael (1999). "Quantitative Models for Supply Chain Management"; Boston, Mass., Kluwer Academic
15. Turban, Efraim; Lee, Jae; King, David; Chung, Michael H. (2000). "Electronic Commerce: a managerial perspective"; Prentice Hall International
16. Wiederheim, P.; Eriksson, T. (1991). "Att Utreda, Forska och Rapportera"; Sweden; Liber Hermods

Articles:

1. Angeles, Rebecca; Corritore, Cynthia L.; Basu, Suvojit Choton; Nath, Ravinder (2001). "Success factors for domestic and international electronic data interchange

implementation for US firms" International Journal of Information Management; Vol. 21, p. 329-347

2. Angeles, Rebecca; Nath, Ravinder; Hendon, Donald W. (1998). "An empirical investigation of the level of electronic data interchange (EDI) implementation and its ability to predict EDI system success measures and EDI implementation factors"; International Journal of Physical Distribution and Logistics Management; Vol. 28, No. 9/10, p. 773-793
3. Angeles, Rebecca; Nath, Ravinder (2000). "An empirical study of EDI trading partner selection criteria in customer-supplier relationships"; Information and Management; Vol. 37, p. 241-255
4. Angeles, Rebecca; Nath, Ravinder (2001). "Partner congruence in electronic data interchange (EDI)-enabled relationships"; Journal of Business Logistics; Vol. 22 Issues 2, p. 109-128
5. Bidgoli, Hossein (1999). "An integrated model for the introduction of electronic data interchange (EDI) into your organisation"; Management Information Systems, California State University; p. 1-5
6. Bosakova, Dagmar (2003). "Development of Electronic Signatures"; Czech Business and Trade; Issue 7/8, p. 14–17
7. Chen, Jui-Chih; Williams, Bernard C. (1998). "The impact of Electronic Data Interchange (EDI) on SMEs: summary of eight British case studies"; Journal of Small Business Management; Vol. 36 Issue 4, p. 68-73
8. Clermont, Paul (2002). "Cost-Benefit Analysis: It's Back in Fashion, Now Let's Make It Work"; Information Strategy: The Executive's Journal; Vol. 18 Issue 2, p. 6-12
9. Computer Weekly (10/31/2002). "EDI kit lets small firms get in to corporate supply chains"; p. 36
10. Computer Weekly (4/15/2003). "Strategy clinic getting the most out of pilot projects"; p.30
11. Computer Weekly (8/19/2003). "Taking Outsourcers for a Test Drive"; p. 8
12. Dahmström, K. (1995). Från Datasamling till Rapport, Sweden: Studentlitteratur
13. Damsgaard J.; Truex D. (2000). "Binary trading relations and the limits of EDI standards: the Procrustean bed of standards"; European Journal of Information Systems; Vol. 9 Issue 3, p. 173-188
14. Davis, Mark; O'sullivan, David (1998). "Communications technologies for the extended enterprise"; Production Planning and Control; Vol. 9, No. 8, p. 742-753
15. DIRECTIVE 1999/93/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 December 1999 on a Community framework for electronic signatures; Official Journal of the European Communities; 19 Jan 2000; L 13/14
16. Ferguson, Darnel M.; Hill, Ned C.; Hansen, James V. (1990). "Electronic Data Interchange: Foundations and Survey Evidence on Current Use"; Journal of Information Systems; Vol. 4 Issue 2, p.81-92
17. Grover, V.; Jeong, S. R.; Kettinger, W.J.; Teng, J. T. C. (1995). "The implementation of business process reengineering"; Journal of Management Information Systems; Vol. 12 Issue 1, p. 109-144

18. Heck, Eric van; Ribbers, Pieter M. (1999). "The adoption and impact of EDI in Dutch SME's"; Proceedings of the 32nd Hawaii International Conference on System Sciences

19. Hill, Craig A.; Scudder, Gary D. (2002). "The use of electronic data interchange for supply chain coordination in the food industry"; Journal of Operations Management; Vol. 20 Issue 4, p. 375-387

20. Hoogeweegen, Martijn R.; Streng Robert J.; Wagenaar, Rene W. (1998). "A comprehensive approach to assess the value of EDI"; Information and Management; Vol. 34 Issue 3, p. 117-127

21. Hurewitz, Barry J.; Nadon, Bipassa (2002). "Electronic Signature Standards Create Contracting Options"; Journal on Internet Law; p. 20–21

22. Johansson, Anna (2002). "Index för Elektroniska Affärer", Andra halvåret, Svenskt Näringsliv, Confederation of Swedish Enterprise.

23. Keatley, Kendy L. (1999). "A review of US EPA and FDA requirements for electronic records, electronic signatures, and electronic submissions"; Quality Assurance; Vol. 7, p.77–89

24. Laage-Hellman, Jens; Gadde, Lars-Erik (1996). "Information technology and the efficiency of materials supply. The implementation of EDI in the Swedish construction industry"; European Journal of Purchasing and Supply Management; Vol. 2 Issue 4, p. 221-228

25. Lummus, Rhonda R.; Duclos, Leslie K. (1995). "Implementation of EDI systems: a case study of benefits for a small manufacturing company"; Journal of Systems Management; Vol. 46 Issue 5, p. 42-48

26. Mackay, David; Rosier, Malcolm (1996). "Measuring organisational benefits of EDI diffusion - A case of the Australian automotive industry" International Journal of Physical Distribution and Logistics Management; Vol. 26 Issue 10, p. 60-78

27. Marshall, Romney (1995). "Business process reengineering"; Internal Auditor; Vol. 52 Issue 3, p. 24-30

28. McLure, Marcia L.; Moynihan, James J. (1995). "Organising for EDI"; Healthcare Financial Management; Vol. 49 Issue 1, p. 90–94

29. Mukhopadhyay, Tridas; Kekre, Sunder (2002). "Strategic and operational benefits of Electronic integration in B2B procurement processes" Management Science; Vol.48 Issue 10, p.1301-1313

30. Nakayama, Makoto (2003). "An assessment of EDI use and other channel communications on trading behaviour and trading partner knowledge"; Information and Management; Vol. 40 Issue 6, p. 563-580

31. Orman, Levent V. (1998). "A model management approach to business process reengineering"; Journal of Management Information System; Vol. 15 Issue 1, p. 187-212

32. Premkumar G.; Ramamurthy K.; Nilakanta, Sree (1994). "Implementation of Electronic Data Interchange: An innovation diffusion perspective"; Journal of Management Information Systems; Vol. 11 Issue 2, p. 157-187

33. Ratnasingam, Pauline; Phan, Dien D. (2003). "Trading partner trust in B2B E-commerce: a case study"; Information Systems Management; Vol. 20 Issue 3, p. 39–51

34. Swatman, P.M.C.; Swatman, P.A. (1992). "EDI system integration: a definition and literature survey"; Information Society; Vol 8 Issue 3, p. 169-205

35. Threlkel, Mireille S.; Kavan, C. Bruce (1999). ”From traditional EDI to Internet –based EDI: managerial considerations”; Journal of Information Technology; Vol. 14 Issue 4, p. 347-361

36. Waksmunski, Dennis (1996). “Electronic data interchange security and information assurance”, Government Information Technology Issues

37. Williams, Lisa R. (1994). “Understanding distribution channels: an interorganisational study of EDI adoption”; Journal of Business Logistics; Vol. 15 Issue 2, p. 173-204

38. Williams, Lisa R.; Magee, George D.; Suzuki, Yoshinori (1998). “A multidimensional view of EDI: testing the value of EDI participation to firms”; Journal of Business Logistics; Vol. 19 Issue 2, p. 73-87

Web Pages:

1. DIRECTIVE 1999/93/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 December 1999 on a Community framework for electronic signatures; Official Journal of the European Communities; 19. 1. 2000; L 13/14 (see: http://europa.eu.int/ISPO/ecommerce/legal/digital.html)

2. United Nations Directories for Electronic Data Interchange for Administration, Commerce and Transport (UN/EDIFACT); ISO 9735:1993 standard; Definition of EDI (see: http://www.unece.org/trade/untdid/welcome.htm)

ATTACHMENTS

Attachment 1: Research Questionnaire (based on Angeles et al, 1998 and Angeles et al, 2001)

ATTENTION:

1) **Please colour the right answers in red! (For example: □ Customers)**
2) **Please after filling in the questionnaire below, save it as a new file and send it back to us as an attachment**
3) **In case you find some of the questions unclear, you can turn to the description file attached to this questionnaire.**

Part I

1. With whom does your company exchange data through the EDI system?
   □ Parent □ Customers
   □ Suppliers □ Subsidiary
   □ Other (please specify) _____

2. Which is the level of EDI implementation in your company?
   □ Level 1 – simple data exchange without integration into any of the firm's internal processes;
   □ Level 2 – data being exchanged between applications of the two firms; and
   □ Level 3 – business process reengineering is performed to allow EDI to change the way the firm performs its activities.

Part II

Please colour (in red) the number that most closely indicates how critical an item is in ensuring the successful implementation of an EDI project. The criticality of each success item is measured according to the 7-point Likert scale (1=not critical at all; 7=very critical).

1. The support of a top management in implementation of EDI

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

2. The commitment and sense of ownership of a cross-functional EDI implementation team

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

3. “Winning” and maintaining solid relationships with valuable trading partners

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

4. The selection of widely accepted EDI standards (such as ANSI X12 or EDIFACT)

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

5. Redesign of existing business processes and applications

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

6. Compatibility of hardware and software among potential trading partners, especially for direct EDI connections

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

7. Justification of the EDI system using a thorough cost-benefit analysis

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

8. The availability of network services from value-added networks

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

9. Executing a pilot project before fully committing to the operational implementation of EDI

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

10. Designing appropriate and dependable security and auditing controls for transmitted data

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

11. Providing “most up-to-date” educational training sessions for all EDI participants (managers, coordinators, users, technicians, etc.)

1	2	3	4	5	6	7
NOT CRITICAL AT ALL						VERY CRITICAL

12. Provision of clear legal guidelines for such issues as the legality of electronically transmitted documents and contracts, the acceptability of ‘‘electronic’’ signatures and authorisations, etc.

1 2 3 4 5 6 7
NOT CRITICAL AT ALL VERY CRITICAL

13. Provision of clear guidelines about the rules governing EDI interchange agreements

1 2 3 4 5 6 7
NOT CRITICAL AT ALL VERY CRITICAL

Part III

1. Please provide the following demographic information about your firm:

Net Assets: _____

Net Sales: _____

2. Title of person in charge of the EDI system: _____

3. Type of firm: □ Manufacturing □ Service □ Financial

4. Type of industry sector:

□ Mining
□ Construction
□ Automobile
□ Metals
□ Computers/ communication
□ Other manufacturing: _____
□ Transportation
□ Wholesale
□ Retail
□ Other sectors not mentioned above: _____

Final question: How would you rate your success in organising and managing your particular EDI system?

1 2 3 4 5 6 7
COMPLETE FAILURE EXTREMELY SUCCESSFUL

Attachment 2:The List of Questioned Companies.

AB Sandvik Coromant

AB Sandvik Tamrock Tools

ABB Automation Techn Products

ABB Group Services Center AB

ABB Power Technology Products

Akzo Nobel Industrial Coatings

Apoteket AB

Arla Foods

Astra Tech AB

Autoliv Electronics AB

Bong Ljungdahl Sverige AB

Cederroth International AB

Cerealia Unibake AB

Elektroskandia

Elfa Sweden AB

Fondförsökring AB SEB Trygg L

FöreningsSparbanken AB

Fortum Service AB

Fujitsulnvia AB

Göteborg Hamn AB

Halens AB

Hillerstrops Trä AB

HL Display Sundsvall AB

Holmgrens Bil AB

ITT Flygt AB

Kalmar Industries AB

Kinnarps AB

Mälarenergi AB

Nexans IKO Sweden AB

Papyrus Sverige AB

Pharmacia AB

Philips AB

Proffice Sverige AB

Saba Trading

Samhall AB

Sapa Heat Transfer AB

SAS Airlines Sweden AB

SAS Cargo Sweden AB

SKF Sverige AB

Solar AB

Stora Enso Fors AB

Strålfors Svenska AB

Swedish Meats

Thule Sweden AB

TNT Sverige AB

Trygg Hansa Försäkrings AB

Viking Line Skandinavien AB

Wasabröd AB

Wmdata Utilities AB