

CHALLENGES FOR ELECTRONIC DATA INTERCHANGE IN THE DIGITAL AGE

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Abstract: Electronic Data Interchange (EDI) became popular to facilitate international business transactions in the 1990s, but, even today, it can be seen that its use is not introduced everywhere. This article reviews some statements on the adoption of EDI in companies and integration into other IT systems. Furthermore, it looks at situations in specific countries. Statements are made how to integrate Electronic Data Interchange in cloud-based systems.

Key words: Electronic Data Interchange, International Business, Inter-organisational Information Systems.

1. INTRODUCTION

Good supply chain management leads to a smooth flow of goods without move interruptions. Can it be imagined that, not so long ago, goods sometimes arrived at a destination and could not move forward to their final customer because the accompanying documents did not arrive yet? Such delays due to delays in document processing has been present in international business mainly due to the use of different languages on the documents, different currencies, different document formats, etc. Instead of exchanging paper documents (like purchase orders, invoices, etc.), an electronic exchange of messages between agreed trading partners could solve this problem. Out of this idea, Electronic Data Interchange (EDI) has been born, as well as the standardisation and simplifications of trade procedures and documents [1]. An operational definition for EDI might be “the process of computer to computer, business to business data transfer of repetitive business processes involving direct routing of information from one computer to another without human interference, according to predefined information formats and rules” [2]. EDI belongs to a class of information systems, which are called ‘interorganisational information systems’ (IOS), i.e., automated information systems shared by two or

more companies. EDI allows electronic communication of business information with trading partners across a company's borders. It permits organizations to generate electronic purchase orders, invoices, bills of lading and a variety of other documents and sends them instantly to trading partners anywhere in the world, taking into consideration data security and network reliability.

Starting in 1960, the Economic Commission for Europe of the United Nations (the UN/ECE Working Party 4) spent much effort on designing and harmonising standards for uniform trade documents. During a long period of time, three standards were developed towards electronic messaging: (1) the UN Layout Key which is a standard paper form for trade documents (later accepted as the ISO standard 3535; (2) the ECE/UNCTAD Trade Data Elements Directory (TDED) which assigns fixed positions for data on a standard form including a standardised vocabulary; and (3) the ECE/UNCTAD Trade Data Interchange Directory (TDID) containing a terminology, syntax rules and standards for the exchange of messages composed by these rules [3].

In the third step, a move was made towards messaging in an electronic way. The first important step towards electronic messaging has been realised through the development of the Trade Data Interchange Directory (TDID). The TDID contains a terminology, syntax rules and standards for the exchange of messages composed according to the rules. This electronic message traffic later received the name: Electronic Data Interchange. Since 1985 both the UN/ECE's working party (from the European side) and JEDI (from the US side) worked towards a common standard to be called EDIFACT (EDI Standard for Administration, Commerce and Trade). The EDIFACT syntax has been accepted by the ISO in 1987 and published under the norm ISO 9735. In 1988 the UN agreed to maintain the standards. The use of EDI, however, became popular and widespread in the early 1990s.

The remaining part of the article is as follows. Section 2 discusses the benefits of EDI. Especially it looks at how perceived benefits in companies may differ from the promoted benefits. It also looks at how EDI is adopted or not in several industrial and which factors induced the motivation to adopt or not. Section 3 studies how EDI is adopted and implemented in several countries, including some third world countries. In some of the cases, advice is formulated to augment the introduction of EDI in those countries. Section 4 looks at how EDI can evolve from on-premises implementations to inclusion in cloud-based systems.

2. BENEFITS AND MOTIVATION TO ADOPTION

In [1], the benefits of EDI are spelled out based on a document by the European Commission and are further specified, but also disadvantages are reported. The benefits include: (1) single input of data; (2) better service to the client; (3) better inventory control; and (4) faster cycle sales/invoice/payment. However, also problems are mentioned like (1) EDI messages remain in a mailbox until someone

picks them up, maybe leading to a loss of time; (2) the unavoidable use of paper, due to legal reasons, can be a source of inefficiency; (3) a cost-benefit justification because the benefits are hardly measurable; and (4) internal control, which means that not everyone in the company is authorised to view and approve the electronic transactions.

[4, 5] proposed an implementation process, giving details and comments on each of the implementation steps. Furthermore, attention is paid to a cost-benefit analysis for and EDI implementation. The applications of EDI in the international business are numerous. Specially, the applications in important ports need to be mentioned as many players are involved. The exchange of information is as important to freight movement towards or in a port as the movement of the cargo itself or the equipment that is moving it. The more seamless the information flow is, the quicker cargo can get from its origin to its destination. Electronic Data Interchange (EDI) communications facilitate the smooth handling of cargo from mode to mode, as well as automating billing, data entry, tracking functions, and other information exchanges such as cargo manifests, vessel arrival times, inbound movements, and status notifications [6].

Studies, however, do not always come to the same conclusions regarding benefits. For instance, whether EDI leads to less (or perhaps more) inventory in a supply chain from inbound through to finished goods, is studied by [7]. The argument for 'less inventory' is most probably the increased accuracy in demand forecasting. But also, an argument for 'more inventory' can be advanced. As the customers have access to availability of a product, an out-of-stock situation at a supplier becomes immediately transparent, so, an order with a supplier with an existing stock of finished goods might be preferred, which may encourage suppliers to hold larger inventories than without EDI. As could be expected, their study shows that the relation between the use of EDI and the inventory level in the company is weak, unless other controlling factors are considered: (1) when demand is stable, inventory increases when EDI increases; when demand has greater uncertainty, the electronic connection or not does not have an influence; (2) larger companies have the power to offset the cost of sales due to stock-outs, while smaller ones do not; and (3) the relation is stronger if the type of production is of the routine type; those companies produce according to forecasts and are considered about product availability, while customized or small production postpones mostly production until orders are received.

EDI adoption is the process during which a firm becomes capable of transacting via EDI, usually through a front-end, PC-based EDI server. [8] mention some conflicting studies' results. For instance, the impact of supplier coercion on EDI adoption has been heavily studied. Some studies find that pressure from a customer is a significant driver influencing the supplier's adoption decision, but other studies do not. In assessing the barriers to EDI adoption, some studies find that the size of

the initial investment is a significant barrier to EDI adoption, while others find no statistically significant relationship. Studies report conflicting benefits that firms have realized from the use of EDI. A study finds that EDI integration leads to reduction in the overall error rates in document transaction, while another one does not find any support for reduced errors.

While the benefits mentioned by the European Commission focused on operational aspects, also further reaching benefits have been investigated. [9] has found, through empirical research, that a higher level of EDI systems uses leads to a higher level of process improvement initiatives, and also to a higher level of customer focus. EDI systems enable sales and marketing people to handle customer orders, billing, and invoicing much more easily and allows them to respond to customer requests efficiently.

Businesses have realised that customers and suppliers should develop close relationships to work in coordination. Adoption of an EDI system between the trading partners is one way through which suppliers and buyers establish such long-term relationships for sharing their coordinated efforts. When companies start working in close co-ordination through EDI systems, they also begin to change their internal processes to take the maximum advantage of EDI systems in data accuracy, timeliness of data, and document handling. EDI systems can result in building long-term relationships with a few suppliers, accounting for substantial cuts in clerical overhead in managing fewer relationships.

Interesting is the investigation whether in situations of volatile demand that hampers the production process, the use of EDI can contribute to a reduction of the bullwhip effect in supply chains. [10] states that the root of the bullwhip effect can be described as “a lack of inter-company communications combined with large time-lags between receipt and transmittal of information”. As the use of EDI drastically reduces information delays, it should substantially reduce the bullwhip effect. This should also involve a reduction in related costs for the chain as a whole and for the individual partners. To be effective in reducing the bullwhip effect, EDI must be installed throughout the complete supply chain. Using simulators, [11] demonstrated that the use of EDI facilitates the management of the chain and reduces the costs involved, but it does not completely eliminate the bullwhip effect. There is still a difference in variability of the number of orders placed for each successive pair of stages in the chain when using EDI, even though the variability has been somewhat reduced.

[12] study the determinants of EDI adoption and integration by U.S. automobile suppliers, with a focus on buyer-supplier relationships. “Buyer-push” was the most frequent reason regarding EDI adoption, confirming that EDI adoption in the automobile supply chain is governed by a buyer-supplier power relationship. The factor ‘frequency of transactions’ was found to be statistically significant in the process of EDI adoption with automobile suppliers. It represents a low-risk

partnership—i.e., a supplier is likely to adopt EDI because it perceives lower risk when having frequent transactions with an EDI promoter. Before the start of the 21st century, [13] noticed that small businesses in the automotive industry are lacking EDI awareness, confounding standards, too high costs, low transaction volume, technical complexity and data security concerns, and therefore, the adoption was rather low.

There is a difference between EDI adoption and EDI integration. Integration can be looked at from both an internal and external point of view. Internal integration refers to the variety of applications interconnected through EDI such as order entry, invoicing, billing and payment transfer. A measure of internal integration is the degree that an EDI transaction is integrated with the internal business systems of the firm, eliminating the need for manual processing and data entry redundancy. External integration, in turn, refers to the number of trading partners such as suppliers, customers, and government agencies, and can be measured by identifying the extent that EDI is used to communicate with trading partners—customers, suppliers and banks.

EDI integration can be used as a measure of EDI success. [14] claim that EDI integration is necessary to seamlessly transfer information across organizational functions and to gain “economies of scale” and become cost effective. Technical capability of a supplier may bias EDI adoption and integration decisions. For example, a supplier with higher technical capability may adopt and/or integrate EDI much earlier than those without.

[15] investigated the key obstacles to widespread use of EDI in small manufacturing companies in the US. It came out that the main obstacle was the ‘lack of integration with internal/external computer systems’ in order to achieve benefits, more specifically: reduced administrative/transaction costs; improved information accuracy; and enhanced competitiveness. Also ‘lack of managerial leadership/organizational readiness’ has been found significant as obstacle. The companies, which adopted EDI, provided sufficient training to their managers, developed an organisational culture and procedures, and maintained appropriate audit trails and system stability. Finally, a third obstacle is related to security and legal concerns. Companies that found this a lesser issue, achieved a higher level of EDI success. Therefore, smaller firms need to take precautionary measures against potential security and legal problems.

Early this century, it was predicted that the Internet would completely replace EDI soon as an inter-organizational system (IOS), by pointing out the rapidly growing Internet users and the unique capabilities of the Internet for conducting business-to-business transactions. However, others believed that EDI would continue to be used as an important communication medium by many business organizations for years to come because of the following major reasons. Many large companies have invested large amounts of money on EDI systems and have achieved

strategic benefits from this technology. At that time, the Internet was still viewed by many top managers as a vulnerable and insecure vehicle for electronic commerce. Finally, the EDI-capable firms could use recently developed software that integrates the Internet into existing EDI systems and benefit from the speed and flexibility of the Internet without losing their EDI investment [15].

A review on EDI for the manufacturing industry has appeared in [16]. Recently, as the availability of the Internet has become more and more ubiquitous, much effort has been made in each sector of industries and in each corporate group to introduce Web-assisted EDI systems. As "cloud computing" stands for the use of IT resources over the Internet, which are billed on demand, also EDI is a candidate for this kind of services. More on this topic is discussed in section 4 [17].

3. ELECTRONIC DATA INTERCHANGE IN VARIOUS COUNTRIES

In 2007, [18] conducted a study on the adoption of EDI in Small and Medium-sized Enterprises (SMEs) in *Brunei*. Three factors were found significant in the adoption of EDI: management support, government support, and perceived benefits. The plausible reason for the relevant importance of the variable 'perceived benefits' in SMEs is due to the better management structure and policies. The management of these SMEs considered the perceived benefits as an important prerequisite to decide on technology adoption. These SMEs were rapidly adopting EDI if they were provided with benefits that could be accomplished through EDI.

[19] look at the determining factors of EDI implementation in *Korea*. Decentralization, formalization, EDI standards, technical compatibility, technical support by EDI vendors, education and training, user involvement, top management support and control procedures partly affect EDI implementation. Organizational size, management risk position, control procedures, information intensity and competition in industry do not affect EDI implementation. The companies which heavily use EDI systems have the following characteristics: (1) the organizational structure is decentralized; (2) EDI standards are compatible with those of trading partners; (3) EDI systems have greater compatibility with previously adopted systems; (4) the technical support from EDI vendors is strong; (5) education and training on EDI is provided consistently; (6) there exists strong trading partners' participation during EDI implementation. The companies with the integrated EDI systems with their application systems have the following characteristics: (1) the formalization of the organization is high; (2) EDI systems have high compatibility with existing systems; (3) EDI user involvement is high; (4) Participation from trading partners is high during EDI implementation processes.

[20] state that SMEs in *Nigeria* have been slow in adopting EDI, due to a perceived high cost of implementation, a lack of willing trading partners and a lack of awareness of EDI benefits. The authors found that the slow adoption of EDI among Nigerian SMEs is due to the perceived excessive cost of implementation and

the lack of supply chain partners' awareness of the EDI benefits. They formulate recommendations to the Nigerian government to increase the use of EDI. Firstly, SMEs with a strong support and commitment to EDI from the SMEs management are more likely to adopt EDI at a faster rate. The non-commitment of management of SMEs should be overcome through education. The management of all SMEs should be motivated towards personal learning. Secondly, SMEs that have the required IT and business skill competence have a better chance at adopting EDI. SMEs should encourage training of staff to meet current trends in technology required knowledge, such that the needed IT skills could be improved. Thirdly, SMEs that have sound IT technologies in place, are in a better position to adopt EDI. Therefore, there is a need for Nigerian SMEs to follow the current technological trends.

While not performing a large study in *Turkey*, [21] reflect on their findings in the automotive industry. After successful EDI implementation in the sector, the companies listed the benefits as follows: cost savings, time savings, increased efficiency, better communication, less errors and delays. The main important issues for SMEs include: develop the suitable organizational environment for managing the EDI systems; choose the right EDI solution to meet the needs of the organization and related partners and obtain the support and commitment of top management, as implementation can be a long process. For companies that are beginners in EDI, do not want to invest on EDI, but with EDI a priority requirement for their customers, a first suggestion by the authors can be the use WebEDI. The promise of WebEDI is low cost and small effort integration of even smallest partners of a value chain, basically if they have a modem. But it is important to note that most WebEDI approaches are mostly no more than an HTML-front-end to a shopping system. A user manually enters data into a form using a web browser as communication interface, which can be hardly called EDI.

The major motivation behind EDI implementation in companies in *Malaysia* is due to an imposition by large trading partners or by government enforcement. Therefore, the implementation does not go further than a single, or a few transactions, and not a full integration of EDI in other applications. Resistance to a full implementation is due to pessimistic beliefs in the efficiency and effectiveness of EDI. There appears to be interest in EDI but little commitment and less urgency. In addition, lack of financial and technical resources, as well as lack of top management support, have become significant barriers for a successful EDI implementation and integration [22]. With a better understanding of the factors that affect EDI adoption in Malaysia, companies, industry associations and the government which seek to increase EDI usage among companies, can address the adoption issue better. [23] found costs, size, external pressure and interorganizational trust to be significant adoption factors. Top management of the EDI initiator should take an active role if they want their suppliers to be EDI-enabled, for example by

applying coercive measures, even by threatening to cut business ties to suppliers who do not comply. The study found that these coercive measures are very effective to EDI adoption. Knowledge of the significant EDI facilitators and inhibitors and the EDI adopter characteristics are also advantageous to the vendor. If benefits are not a significant factor, the vendor should emphasize less on benefits. If, in turn, costs are a significant factor, the vendor should try to change the customer's preconception that costs are high, by offering a low-cost solution. The authors' advice is that the Malaysian government should consider giving more tax incentives to encourage businesses, especially the SMEs, to adopt EDI, because costs are a significant barrier to adoption.

Compared with developed countries, the development of EDI in *China* has been relatively slow [24]. In recent years, EDI technology is used successfully in a few areas such as foreign trade or at the customs, but other areas are still in a trying stage. The workforce to work on developing EDI standards in China is very scarce and the standards are very slow to launch, causing delay in EDI implementations. Most of the enterprises lack basic knowledge and sufficient awareness of the emerging technology and do not realize that EDI is a basic tool for enterprises to participate in international trade in the future. As measures to accelerate the development of EDI, the authors propose to formulate unified domestic standards, to develop security laws and regulations by an effective integration of existing laws with specific laws and regulations of logistics, trade and shipping,

[25] investigates the adoption of EDI in the *Czech Republic*. It is found that 70% of the interrogated businesses never heard of EDI and only 2% are using it, using email as the prevailing method of communication between, business partners. Even though the enterprise information system often supports EDI, this option is not exploited due to the company's ignorance. In this context, it is interesting to look at a question in a survey of Czech companies by [26], on the consideration of substituting EDI. Many respondents do not know about their future use of EDI but, if they substitute, they will choose to manually check on a website platform or via email.

Despite the capability of the electronic means to reduce expensive and inefficient paper-based processes, many SMEs in *Saudi Arabia* hesitate to adopt information technology, maybe because the greater part of the SMEs is family-owned. Due to the importance that is attached to EDI and the contribution of SMEs, [27] find it vital to investigate the key factors that could determine the intention of SMEs in Saudi Arabia to adopt EDI. There is evidence that perceived technology benefits, organisational readiness, government support and trading partners' pressures are all important factors that can affect the intention of SMEs to adopt EDI. Most of the SMEs in Saudi Arabia depend on the government to successfully adopt and sustain EDI technology. In addition, pressure from trading partners also appears to be another factor that may influence the SME's intention to adopt EDI. Smaller

or less influential SMEs may feel forced to upgrade their technology adoption to be on the same level as their more powerful trading partners, for keeping a continuous business relationship. The government's policy of supporting such training programmes will certainly facilitate the upgrading and the maintaining of a high-quality human resource pool for the EDI implementation.

4. ELECTRONIC DATA INTERCHANGE IN THE CLOUD

EDI via Value Added Networks (VAN) is a cloud-hosted solution that deploys private networks provided by VAN providers to connect trading partners. The VAN provider manages the network and provides organisations with 'mailboxes' where one can send and receive EDI documents. Companies need to analyse the added value of cloud computing versus the acquisition and operation of an on-premises EDI software implementation. Since most cloud offerings do not incur any significant initial investment costs, a general superiority of cloud use over in-house EDI in terms of profitability is likely [17].

There are three main groups of main cloud technologies that a user can get: software as a service (hereinafter SaaS), platform as a service (hereinafter PaaS) and infrastructure as a service (hereinafter IaaS). Currently, SaaS is considered to be the most widely demanded type of cloud technologies, among others, also in the field of education [28]. Web EDI or EDI via a VAN work like a SaaS tool in so much as it delivers, as a service, over the internet.

5. FINAL NOTE

EDI remains a technology which is widely used and forms the basis for many interorganizational information systems. The emergence of internet-based communications has positively affected EDI use, but, more importantly, it also may give a signal to better inform managers on the benefits of EDI use. While EDI technology has been available for a very long period of time and many organizations have aggressively pursued it, many others have been slow and cautious in its adoption [27]. The benefits of EDI are based on logical and rhetorical arguments, but the evidence has been many times anecdotal. Empirical evidence has been simply slow in coming. In logistics and manufacturing, EDI is recognized as an essential part of information technology.

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