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A Survey on Electronic Data Interchange

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***Abstract*— Electronic Data Interchange is the exchange of business documents between computers or systems. By moving from a paper-based exchange of business document to one that is electronic, businesses appreciate major benefits such as reduced cost, increased processing speed, reduced errors and improved relationships with business partners. The documents exchanged must adhere to certain standard called EDI standards, such as X12, EDIFACT etc. This paper explores several implementation techniques and frameworks that were built across globe in several organizations. The intent of this paper is to survey the techniques used in implementing electronic data integration in any domain – financial, supply chain, retail or automotive industry and in any size of industry – small scale or large scale. The common tools or platforms used for implementation and the common standards followed are discussed in brief.**

***Keywords*— EDI, Electronic Data Interchange, framework**

I. INTRODUCTION

Electronic Data Interchange is a concept of trade of business archives between computer systems. By moving from a paper-based trade of business record to an electronic one, organizations appreciate significant advantages, for example, diminished cost, expanded handling speed, lessened errors and enhanced associations with business accomplices. There are a few exchanges as for production network and undertaking asset making arrangements for which business archives must be sent, for example, orders, order change, shipment notification, invoice and so forth. The most widely recognized archives traded by means of EDI are buy requests or purchase orders, solicitations or invoices and advance shipment notifications takes note. However, there are many, numerous others, for example, bill of filling, customs records, inventory reports, shipping status archives, payment documents and installment reports. These archives must hold fast to certain standard called EDI measures, including X12, EDIFACT etc. EDI is one of the techniques for businesses to communicate electronically, certain information that was traditionally communicated on paper. The two classic examples of such information are purchase orders and invoices. Standards for EDI exist to facilitate parties transacting such instruments without having to make special arrangements. In 1996, the National Institute of Standards and Technology defined EDI as "the computer-to-computer interchange of strictly formatted messages that represent documents other than monetary instruments. EDI implies a sequence of messages between two parties, either of whom may serve as originator or recipient. The formatted data representing the documents may be transmitted from originator to recipient via telecommunications or physically transported on electronic storage media."[1].

Framework is an abstraction which provides the generic functionality for processing the EDI document for a transaction. The received document must be authenticated, validated and then processed to convert it into ERP system compatible format for storing. The framework for each transaction consists of a basic functionality to receive the document, check for the customer identification and call business rules to find the map for the customer, execute the map and generate the output file which is compatible with the ERP system configuration. The ERP system accepts only flat files for storage or further processing, hence all the documents must be converted to flat files with the specified schema before sending it. The maps are generalized for each version of the map and standard. Thus, custom mappings and outputs are done using user specific custom code.

EDI application framework enables timely response. This is because of the speed in which the trading partners receive and incorporate the information into their systems as a result greatly reducing cycle times. For this reason, EDI can be an important component of just-in-time production systems [2]. Businesses that apply EDI also profit from enhanced information accuracy because it reduces typographical errors. This is possible because, with EDI there is minimum human intervention in the information flow since it removes the need to re-feed documents on the end point. EDI application framework further maintains effectiveness while reducing lead time giving the company the capability to smooth out the highs and lows in the production cycle. EDI in companies also improves trading partner relationship. This is because EDI application framework allows access to point of sale data and demand visibility between trading partners ensuring accurate and efficient processes and the ability to lock the trading partners in, i.e. maintain permanent business from trading partner, through participation in an EDI network.

EDI also helps the environment as it eliminates the usage of paper and since the process is automated, consumption of less power and almost zero human intervention in the process.

II. THE DOMAIN

The domain of electronic data interchange is currently stable with lot of applications in various industries such as supply-chain, automotive industry, hi-tech industry, financial domain and retail industry. For each industry there are specific rules, standards and networks that are provisioned for in EDI.

The automotive industry has been using electronic data interchange for decades and will continue to do so in future as EDI provides a global standard and the onboarding of the new customer or supplier is very easy once the installation is done. The agreements are quick and easy to configure in the system and need to be done only once. The communication takes place over File Transfer Protocol (FTP) or Odette File

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Transfer Protocol (OFTP). There are several versions of these protocols that can be used according to the agreement, the geographical location of the company and the plant or the infrastructural aspects. The network used is generally Value-Added Network (VAN).

In the financial domain, the industries trade financial documents through EDI with clients, retail partners, banks, insurance providers, merchants, security providers and employer services etc. Finance is the core running juice of every industry and thus it makes the most critical application of electronic data interchange. The most common transaction carried out through EDI in the financial industry is the account payables and receivables. There is wide range of communication protocols that can be used for trading such as FTP, OFTP, AS2, MQ Series etc. The use of communication protocol is dependent on the type of documents traded, the partners that are communicating and the nature of communication.

The retail industry, high tech industry, supply chain industry etc. work in a similar way but may have different preference of the network or communication protocol used for transactions depending on the nature of transactions, trading partners or the infrastructural constraints.

III. HISTORY

Although the very first EDI standards were published in 1968 by Transportation and Data Coordinating Committee, the revolution and adoption of EDI in industries was far off. There were other papers published for usage of EDI in industry, but it caught on in 1990s. One of the early paper published on EDI was in 1990, by Ir. Coen in Netherlands. He described Electronic Data Interchange, its usefulness, standards, logistics and how it can be used by industries effectively to reduce cost and operate efficiently. He has identified the applications and concerns of implementing EDI by an organization with emphasis on the key benefits of implementation [1]. One of the referred paper or article in his paper is 'Strategic Issues of EDI Implementation' by Emmelhainz Margaret A. which finds and points out issues in the implementation whereas Ir.Coen has given methodology and means of implementation in his paper further [3].

North Western Journal of International Law and Business had published an article defining the International E-commerce in spring 1992. The author Jeffery Ritter has analyzed the business impact of the implementation and how e-commerce facilitates the business growth. The author has also written the law perspective of information exchange and carrying out international trade transaction. The full account of the transport process, networks, data authorities and participants are discussed. The law binding on internal trade is an important aspect and tallies a substantial amount in the finance of organization [4].

Norbert Reekers and Steve Smithson of London School of Economics and Political science described the theoretical perspective of integration of applications for an organization. The article explores the ways in which EDI is used to control the activities within and among organizations. A framework of implementation is described and its effectiveness in terms of structure and dependency of the organization on human intervention to carry out a task is compared. An example of a automotive manufacturer and a supplier is taken to better explain the concept in theory. Assumptions are noted down in the beginning and theories are put forth – transaction cost theory, resource dependence theory and network approach. Then a theoretical model of framework is prototyped, and the efficiency is discussed with various parameters [5]. Several other authors have published their findings in the same year about EDI implementation. One of the papers suggested the innovation characteristics and diffusion theory in EDI. Variables were identified, based on which the implementation and performance is measured for an organization model. The cost, compatibility and time elapsed are computed to find the performance and is compared to the traditional methods of paper-based exchange of documents [6]. A case study for implementation strategies was published by Richard Vlosky, Paul Smith and David Wilson which states the objectives and methodology of implementation. They identify the buyer and supplier motivations for adopting EDI and strategies and the managerial capabilities and strategies to adopt for communication and co-ordination [7].

A study done at Carnegie Mellon University defines the business value of electronic data integration in terms of IT for an organization and proposed a framework for assessing the business value of EDI. They identify the transaction sets and find the extent of EDI network. Then the control variables are identified based on the production and operation procedures which help mitigate the problems and shortcomings of paper-based trading [8]. Another article from the same journal describes the state of adoption of EDI in small scale industries and the impact it makes on the business and revenue of the industry. The authors have surveyed the small-scale industries and their conduct of business in several areas for all domains – retail, finance and supply chain and proposed a model for EDI adoption. The organizations are categorized into unprepared, coerced, ready, unmotivated, initiator and non-adopter and then the adoption is measured in parameters such as perceived benefits, organizational readiness, pressure and impact. It is pointed out in the paper that the small-scale organizations adopt EDI due to external pressure whether or not they are capable and bid their revenue on success of EDI implementation. This can be a liability and organizations strive to lead it away by promotional efforts and subsidies [9]. Eric Wang and Abraham Seidman discuss the implementation polies and competitive externalities of EDI implementation in their paper. EDI implementation would increase the buyer's profit only when the suppliers are supportive and adoptive of EDI, but the supplier's profits may decrease in proportion to the number of adopters. The trade-off plays a vital role in calculation of marginal profit for the overall transactions made between the buyers and suppliers and thus the competitive externalities are discovered, both positive and negative [10].

Towards the very end of 20th century, most of the large-scale organization have come forward to embrace EDI and small-scale industries are also trying to catch up to the trend. Therefore, security and trustworthy-ness of EDI is given more emphasis on. The security was mostly dependent on the underlying network and the communication protocols used for communication between entities and trust between the organizations would have to be developed with a long and friendly relation. Pauline R published her research about the security and trust in EDI with a case study of risks undertaken. The paper describes the security threats – internal and external, generic and specific to an organization. The risks include

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interconnection problems, delayed delivery or non-delivery, inaccurate transactions, legal liabilities, audit problems, alteration of files, unauthentic or unauthorized transaction, denial of service, third party software and lack of a formal agreement. The interconnection problems were mostly found in telecom organizations that adopted EDI, the non-delivery or delayed delivery problems were most common among automotive industries and the legal liabilities were found to be common in banks and financial firms. It is to be noted that the paper ranks each threat for each of industry domains from 1 to 10 with 1 being the most important threat to be mitigated [11].

The threats and risks in EDI are fairly mitigated and reduced with the advent of new technology and the advancement in networking domain. The protocols have been implemented that provide point-to-point communication facility between the trading partners with security such as digital signatures for authentication. The protocol is called Applicability Statement or AS in abbreviation and multiple versions of the protocol have been implemented and released for public usage. There are third party network providers such as VAN or Value-Added Network for the organizations that cannot afford to have the infrastructure for AS2. Although the price is a little expensive, many organizations opt for VAN as the network is reliable, secure and the organizations do not have to maintain the infrastructure.

In the early 2000s the research in EDI mainly focused on improving the standards to be more adaptive to the industries and provide various versions of message schemas for the standards. The papers published were focused on identifying the best practices, strategic approach and bringing about a process change. The research points out different perspectives such as impact on inter-organizational structures, business process re-engineering, the transactional cost and efficiency, technological approach and barriers etc. [12]. The authors have collected best practices followed across organizations and compared them in terms of each perspective and how the same perspective differently reflects the efficiency according to the domain and indicated that the implementation is heavily dependent on the contextual environment and the strategy of SOA should not be confined to technology transfer [12].

Oracle Corporation employee Christoph Bussler published a research as a part of their R&D of EDI suggesting how the EDI is being integrated, its semantics and the B2B standards. The author emphasizes that the B2B i.e. Business-to-Business protocol standards decouples the messages from the back-end systems and hence the messages – syntax and semantics are independent of the underlying architecture of the system and also the underlying infrastructure of network. The messages sent or received over any EDI network are governed by the EDI standards version of the document agreed upon before the implementation. The paper describes various semantics for the messages such as business context or the vocabulary, constants, data types, intent, binding, definition and sequence [13]. Several other papers published discuss the various ways to implement semantic and syntax for the messages.

Also, there is significant research on the tools to be used for implementation. The most popular platform chosen in Microsoft BizTalk. There is research on how BizTalk can be used to implement the business policies required for the successful trading, how BizTalk enables e-commerce framework development, how to implement business contracts using BizTalk [14]. The surveys have chalked up each feature of a hypothetical framework built for EDI – security, service discovery, protocol, repository, message format, scalability and ontology against various tools available for implementation – BizTalk, eCo, OBI etc. The architecture of each is compared and several conclusions are drawn from it suggesting the best tool and framework standard to be used in the organization. The suppliers to buyer implementation is done using another standard called RosettaNet standard which has its own feature list and transactions to be implemented [15].

In the period of rapid application development and affluence of internet, XML or extensible markup language was popularized. The National Chiao-Tung University in Taiwan developed an Extensible Markup Language(XML) framework for electronic document delivery that offers a innovative electronic document delivery system and also locates publishers who can provide the copyrighted material in an electronic format via the OPAC. XML has rich structures that make it useful for larger projects as it can be altered, manipulated, processed, split, and reconstructed far more easily than preceding formats [16].

With automation, many businesses today are using EDI with little or no security built in the system. Furthermore, it is assumed that once EDI is set up it will take care of itself [17]. For most technologies, including EDI, many of the benefits from the technology that accrue to an adopting firm come about through changes made to assimilate the technology into the organization. Some describe how ITs act as change agents, leading companies to alter business processes to ``routinize" the technology into the operations of the organization. With EDI, an adopting organization might assimilate the technology by making changes at one or more levels. Organizations can opt to make strategic level process changes in addition to the operation level process changes given by EDI [18].

Narayan, Marucheck and Handfield have stated that despite a significant amount of literature available, the research leads to unconvincing and contradictory results and they have attempted to clarify the results in their paper. They have analyzed a theoretical framework for EDI adoption and conceptualized a model to determine the impacts of EDI with expected and actual results. They have listed each paper of their literature review with the feature they want to compare and depicted the results of their conceptual framework with significant and insignificant features. Variables considered for evaluation are industry and competitor influence, technical capability, organization size, data accuracy, speed of communication, environmental uncertainty etc. in their research methodology for each of which a sample is tested and weighed against the hypothesis. They conclude that they have identified the gap in research to promote better understanding of the technology [19].

Two other authors from University Tunn Hussein Onn Malaysia have recorded their findings about adoption of EDI by Nigerian Small and Medium Enterprises. The study was conducted for 306 small and medium sized enterprises and the empirical data was analyzed for finding the suitability of EDI adoption. The idea of implementing EDI was pitched to the owners and their responses were recorded for readiness and compatibility [20]. Another study was conducted in University of Malaysia about adoption of EDI. The authors examine the determinants of EDI adoption using a research model that is

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developed based on factors that influence adoption of EDI. They provide a theoretical as well as practical perspective of implementing EDI by analyzing the characteristics and plotting the logistic regression model [21].

Another research based on implementing EDI with Value-Added Network (VAN) was published. It studies the VAN based theoretical framework and compares the impact of cryptographic application models in B2B. They have given an account of cyber attacks that target B2B transactions and compare business models from Cisco and Dell with security issues and threats. They have proposed an enhanced model for security with data security for which they have evaluated using key performance indicators [22].

IV. CONCLUSION

The main aim of this paper is to give a brief account of how EDI has evolved over the years in terms of technical article published in various journals and how the industries have embraced the technology. The EDI standards have provided a boundless way of communicating and trading between the organization paving way for the globalization that we see today. This electronic and secure way of communication has led many large-scale industries of any domain to grow exponentially as the it has reduced the cost of communication and increased the efficiency and speed. The paper has summarized the history of EDI through the articles by several authors published over the years and gives a glimpse of the current trends in the domain. The intent of this paper is to throw light on the technology that has existed since several decades but being embraced by the industry only couple decades ago.

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