The Danish EDI Bandwagon Gaining Momentum

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Abstract
This paper explores the diffusion of Electronic Data Interchange in Denmark. EDI forms a complex and interorganizational innovation and therefore a multitheoretical framework is suggested to study its diffusion. The framework takes into account institutional, industry specific and organizational factors and thus extends the analysis beyond organizational borders. The framework delivers an account of EDI diffusion in Denmark based on field study data. The field study covers three industries in Denmark; the finance, the retail and the transportation sector. The study clarifies how organizational, industry and environmental factors simultaneous are brought to bear to understand the diffusion process. The content analysis distinguishes six diffusion patterns and associated mechanisms that mold diffusion patterns in three diffusion arenas: local dyadic relationships, industry networks, and national initiatives. The analysis demonstrates that EDI diffusion is a complex interplay of organizational, industry and institutional factors. On the theory plane the study calls for the need to orchestrate multitheoretical approaches to study the diffusion of complex, and networked technologies.

1. Introduction

At the tip of continental Europe lays the monarchy Denmark. The population of Denmark is c.a. 5.1 millions and it covers an area of 43,069 sq. km. Denmark has traditionally been an agricultural country. However after 1945 it greatly expanded its industrial base. The main commodities raised are livestock, root crops, and cereals. The leading manufactures include food products, chemicals, machinery, metals, and electrical and electronic equipment. Fishing, shipping, and tourism is also important. Denmark is a longtime member of NATO (North Atlantic Treaty Organization, 1949) and EU (European Union, 1972). The Danish economy is quite liberal and foreign trade is common.

Denmark has an excellent underlying infrastructure with an extensive transportation network (land, water, and sea ways) and it has a sophisticated telecommunication system (4.4 million telephones in use).

In 1992 the Danish Article Numbering Association had 180 subscribers to the EANCOM subset of the international UN/EDIFACT standard. That was 19% of all users worldwide [14]. In 1993 there were 270 subscribers. A 1996 study shows those 51% of all Danish companies are using some kind of electronic exchange with other businesses, and 31% are using Electronic Data Interchange [18]. These figures suggest that EDI is well established in Denmark, but the motivations and dependency paths through, which companies have adopted EDI are not well understood.

This paper therefore seeks an answer the question: What are typical EDI diffusion patterns in Denmark, and how do these patterns mix together and depend on organizational, industry and environmental factors? These are examined in the context of Denmark because it offers a good opportunity to learn about how complex technologies diffuse in a relatively open environment, which at the same time has a proficient underlying economic and technological infrastructure. To understand the dynamics of EDI diffusion, it is necessary to consider several adoption patterns that operate beyond and beneath institutional initiatives, i.e. by probing individual organizational cases in specific industries. It is expected that such analysis will dissect interactions between multiple factors that are likely to affect the diffusion of EDI.

The organization of this paper is as follows. First, a characterization and a discussion of EDI from a diffusion of innovation viewpoint. Second, an introduction to a number of diffusion theories and a justification of the need to adopt a multitheoretical approach to study EDI.
diffusion. Section 4 describes a field study and its research design. Section 5 presents and analyzes six patterns of EDI diffusion based on the field study. Section 6 discusses the distinguished patterns and some conclusions are made.

2. Definition and traits of EDI

The definition of EDI is as follows: EDI technologies support standardized interorganizational communication between independent computerized systems and convey know how of integrating existing organizational information systems and organizational practices with computerized interorganizational communication [11].

EDI technologies are critical in implementing interorganizational IS that enable customer-supplier relationships and they also occur as a consequence of such relationships along Porters value system [33]. Some key features of EDI are: (a) the use of electronic transmission medium; (b) the use of structured, formatted messages based upon agreed standards; (c) relatively fast delivery from sender to receiver; and (d) direct processing by the receiving organization’s application software, generally resulting in a response to the sending organization [40]. Among the claimed virtues of this technology are: a rapid and less error prone request/answer ratio, a quick and accurate placement and cancellation of orders, automation of repetitive administrative processes, and optimization of inventory levels.

EDI is here perceived as one step in the evolution of information technology (IT) applications within the organizational domain. It has the following distinctive traits [10, 11]:

1) It is interorganizational in nature.
2) It links organizations by electronic means. Thus the organizations boundary is depleted and the organization’s interior is to a certain degree exposed to trade partners.
3) It relies on a developed and reliable telecommunications infrastructure.
4) It forms a complex, innovative and abstract innovation that requires high skills and know how to implement and operate.
5) Standards are instrumental in its successful adoption and developing any EDI system must recognize them. Therefore EDI creates and depends on a high degree of mutual interdependence between participating organizations, and necessitates some institutional involvement and regulation.
6) Network externalities are important in making decisions to adopt EDI because to deploy it efficiently requires a considerable critical mass [32].
7) EDI implementations are in most cases based on third party operated VANs. This is often the only economically feasible solution, because creating and maintaining direct links to all partners forms a very expensive one-to-many relationship. At the same time third party service providers complicate the provision of EDI services.

EDI is currently raising considerable interest, because it will not only assist organizations in doing business, but will also change the way organizations do business, i.e., to regard it as a substantial process innovation that reduces uncertainties in the supply-chain. Direct benefits of EDI include better efficiency of internal operations, better responsiveness to customers, better trading relationships and increased competitive capability. Many argue that indirect benefits are more substantial and involve profound changes in supply chain structures and relationships, which is often denoted as “business network redesign” [36]. In addition, usage of EDI can bring several intangible benefits such as demonstrations of competency, increases in organizational reliability, improved accountability, or better monitoring of the environment [19]. No wonder, that many observe EDI adoption to be necessary to sustain the competitive capability of nations, regions and industries [20, 21, 15, 37].

From a diffusion point of view EDI has several prominent features, which typically characterize transfer of complex networked technologies. First, points (1), (3), (4) and (7) imply that its adoption can create complex path dependencies with earlier innovation decisions. Second, points (1) and (6) suggest that the decision to invest in EDI is not solely dependent on singular adopters but on “herd” effects of creating sufficiently large scale simultaneous adoption decisions. In other words the diffusion arena for EDI involves several organizations or industries. Third, points (1), (5) and (7) underscores that the success of EDI adoption does not depend on singular adopters’ goals and desires, but as well on the effectiveness of broader institutional and regulatory regimes in creating a favorable momentum for diffusion. This may vary at different stages but it is critical in the discovery and institutionalization phases. Finally, points (2) and (4) imply that due to its originality there is high knowledge and learning barriers for its diffusion [1]. Difficulties in understanding what EDI is and can do create an additional hurdle for adoption. Because of these features several theoretical accounts to characterize EDI diffusion is needed. Focusing just on the individual adopter behavior like in some diffusion accounts following Rogers’ analysis [34] or more recent diffusion models (e.g., the Bass model) [27] will miss points (1) and (6). Likewise a sole institutional analysis would lead to underestimate the point (4). Therefore this study needs an array of diffusion accounts. Next, a discussion of these.
3. A framework for the analysis of diffusion

This section integrates investigations of diffusion to simultaneously cover organizational, industry and institutional factors to identify alternative patterns which EDI diffusion might follow. Parallel work by the author also report this theoretical work, where the framework is applied to examine diffusion patterns in Hong Kong [10] and in Finland [11]; respectively.

3.1. Theoretical perspectives on diffusion

Each perspective focuses on specific traits of the diffusion process and clarifies distinct mechanisms that can affect its proceeding. Thereby they bring specific factors in the diffusion domain into the foreground. In the case of EDI, the following prominent traits need to be addressed while selecting the perspectives: interorganizational nature, network externalities, dependency on infrastructure, standards and complex nature. To achieve this one must distinguish between micro, meso and macro perspectives, which bring different elements and actors into the foreground. The three perspectives complement each other by suggesting explanations, which are not available from other perspectives.

3.1. Micro perspective

The Micro perspective focuses on characteristics of individuals or organizational units that already use or might adopt EDI. Specific features that are crucial in this perspective are: complex nature of the technology, its abstract content, and its capability to exhibit a large number of path dependencies. The perspective relies on concepts from economics and innovation theory [34, 31] and helps understand diffusion patterns among similar organizations and populations, i.e., within a narrow diffusion scope. It prominently carves out factors that will affect individual EDI adoption decisions. However it largely fails to account for diffusion factors that prevail for longer periods of time and in broader scopes, i.e., it cannot account for differences in diffusion patterns due to variances in environmental and institutional factors.

The studies informed by this perspective focus on the rate of the innovation diffusion (and differences in such rates), and how differences in communication and learning related factors influence adoption decisions [34]. In particular, such studies emphasize intra-organizational characteristics such as user-awareness, or the type of user that might hinder or further adoption [28, 29, 17, 16]. Other typical factors considered are: characteristics of the innovation, type of innovation decision, communication channels, and nature of the social system [34, 38]. Usually, according to such models, organizations go through successive stages of diffusion finally reaching some equilibrium state. Further products or process innovations repetitively disturb this equilibrium, which may lead to successive similar diffusion curves. The S-shaped form of the curve is often used to divide the diffusion curve into distinct and recognizable stages [28, 29, 17]. EDI diffusion analysis using such models would thus focus on specific features of EDI technology such as its triability, communicability and originality [3, 38]; and the structure of the social system in communicating such features.

3.2. Meso perspective

The Meso perspective focuses, using strategy analysis and power dependency analysis, on networks of interacting agents, which shape the trajectory of innovation diffusion [33, 25, 39, 12]. This perspective is necessary to cater for the interorganizational nature of EDI, its dependency on infrastructure, and on third party operators. The perspective is valuable in understanding how extra-organizational power dependencies shape and are being shaped by the diffusion process. Hence accounts of diffusion in this perspective are wider in scope as they lead to appreciate the impact of long term industry specific factors. Despite this broader perspective it fails to account for changes in regulatory regimes (such as standard setting) which embed the adopters.

Accounts of EDI diffusion in this perspective narrate stories about interactions between adopting organizations and external institutions, their mutual technology dependencies and power relationships. Transaction specific investments (such as proprietary EDI standards), information asymmetries, loss of resource control, or buying power [25, 12] may create such relationships. Each agent is regarded to actively seek to achieve some selfish ends by influencing the other agents and thereby the diffusion process [39, 1]. Examples of agents considered powerful are: supply-chain intermediaries, trade and industry associations, multinational corporations and telecommunication service providers.

3.3. Macro perspective

The Macro perspective establishes boundaries for the diffusion process by recognizing regulatory regimes as focal points that constrain or enable the diffusion process. The dependency of EDI on advanced infrastructures, standards and its abstract and innovative nature legitimates the need for the macro perspective.

The regimes create a space of necessary standards, value orientations and policies that are favorable or constraining for the diffusion process (such as incentives,
3.3. An integrated framework

Combining the perspectives leads to a framework to organize the analysis of EDI diffusion into a set of interrelated issues that affect diffusion. Accordingly it helps organize data about each diffusion process and to carry out a disciplined investigation into possible causes that may hinder or speed up the examined diffusion process.

The framework investigates all EDI diffusion processes: as an uptake of technology standards and policies in some regulatory regime, as a competitive move in some industry, and as an adoption decision in some user organization. These are all a set of interdependent phenomena. All of them constitute a specific viewpoint into a diffusion arena.

This mode of analysis suggests a systematic, yet flexible and rich approach to make sense of a complex diffusion process that extends beyond behaviors of individual adopters and issues of communication design.

4. Field study

The goal of the field study was to evaluate the applicability of the framework, and to distinguish a number of distinct diffusion patterns for further elaboration. In addition the goal was to deliver a systematic and detailed account of the possible reasons for the success or failure of EDI diffusion in Denmark. It is the third part of an international comparative field study covering Hong Kong (longitudinal) [10], Finland [11] and Denmark (this paper).

4.1 Research design and method

The framework, and associated sets of issues guided the formulation of the field study. It consisted of multiple case studies [42] which aimed at delineating typical patterns in the diffusion, and to distill theoretical constructs that explain the evolution of these patterns. The studies focused on diffusion (or non-adoption) patterns in three industries in Denmark.

The study used a rich and flexible data gathering strategy, which sought to find a representative and unbiased set of data. To achieve this the case studies dealt with different industries, and different organizations (if possible) in the diffusion process. In gathering data key informants were approached at all layers that had a stake in the EDI diffusion in the identified industry. Accordingly, the set of informants used in the study covered: government agencies, semi public organizations, trade associations and individual user organizations. Each interviewee was asked to state their opinion on issues affecting EDI diffusion.

4.2 Research process

The overall study sample includes 13 interviewees from three industries: transportation, retail, and banking. These three industries were chosen because of their importance for Denmark’s economy and their generally advanced use of IT technologies. It was also well known that in all these industries some organizations were using EDI. This study included representatives from the Customs and Taxation Department, the Ministry of Research and IT, and the national association of EDI users, an association of banks, an EDI consultant company, a VAN, the Board of Finance, and the Danish article numbering association. A number of individual adopters were interviewed as well, there were representatives from: a bank, the national rail cargo company, a department store and a retailer. The data gathering lasted 2 months (January - February 1995).

The information sought was mostly unstructured and non-quantitative. Therefore the primary data collection method followed was semi structured interviews. Each interview was scheduled to last approximately two hours to allow a thorough examination. The interviews were carried out using a set of open questions that were organized into a questionnaire. Moreover, the questionnaires addressed normal background information about the size and type of business and about the affiliation and education of the interviewee. A questionnaire developed for a European field study of EDI diffusion was used as a model to organize some questions to allow for comparison [23, 24]. The questionnaire was also previously applied in similar field studies [10, 11]. The interviews were tape recorded and transcribed. Written documents were collected from all the participating organizations, and additional notes were taken during the course of the interview. This included information leaflets, annual reports and other printed material. The interviews were conducted in Danish and transcribed in Danish. Quotations used here have been translated by the author.

All transcriptions and notes along with available printed material were subsequently analyzed for each data point (organization) and a case story was written for each interview. The case descriptions were shared with the
interviewees to check for possible errors and omissions and to evaluate the validity of the interpretation of their “story”. All the errors and omissions were corrected and some stories were modified to reflect the true opinions and perceptions of the interviewees.

The resulting case stories and their description of diffusion behavior were classified into a number of themes using the study framework such as diffusion barriers in different cases, observed value of the technology, and possible benefits for the interviewee’s organization. These themes were summarized into a number of typical diffusion patterns on the basis of industry and the similarity of diffusion behavior using the method of content analysis [30]. This ranged from bilateral interventions into building industry wide networks, from differences in the power dependencies among the parties to differences in the distribution of benefits. A number of sorts and investigations of the data set resulted in six patterns. The next section discusses each pattern in terms of the success of the diffusion process and how it took shape over time.

5. A spectrum of EDI diffusion in Denmark

Six patterns were condensed in terms of varying scope and how the stakeholders perceived three themes that were found important in explaining the patterns. These are impediments to diffusion; the competitive value of EDI technologies; and finally benefits realized using EDI. The patterns are presented using the scope of the diffusion arena as an ordering mechanism. First the local and narrowly defined diffusion arena, where most of the diffusion barriers relate to the organizational level or industry level, to reach the broadest diffusion arena defined by national EDI initiatives. Three streams classify these arenas: local dyadic relationships, industry networks, and nation wide initiatives. The three streams also organize the cases in terms of the complexity of the factors and issues that have to be taken into analysis when seeking to understand the success or failure of the adoption process.

5.1. First stream: Local Diffusion Patterns

This section analyzes a local EDI adoption process that seeks to achieve relatively narrow integration effects (both horizontally and vertically). The hubs described in this first stream all probed for an arrangement that Yates and Benjamin [41] call “virtual vertical integration”.

Pattern One: Retail: Streamlining the order circle

This case involves several dyadic relationships between a number of suppliers (spokes) and a large (hub) customer. The customer is a dominant wholesale company within the Danish retail sector. The wholesale company moves towards an increasingly complex use of IT and especially of EDI. The wholesale company has around 1.200 outlets and a revenue of 32 billion DKK (1993).

The wholesale company has received electronic invoices since 1973. These implementations were mainly made with big suppliers and based on proprietary standards. In 1987 the wholesale company participated in a pilot project undertaken by the Danish article numbering association. The outcome of the project was that EDI was a promising tool for the future, but the UN/EDIFACT subset designed for retail was not ready at that time, therefore the wholesale company decided to wait for its release.

The subset (EANCOM²) was released in November 1990. At that time the wholesale company contacted 1.200 of their suppliers to probe them for their EDI plans for the future. Potential EDI partners were recognized as suppliers not already exchanging information on diskettes or magnetic tape and representing an engagement above 3 million DKK and a weekly average of at least 25 order lines. By the end of 1993 120 suppliers used EDI for invoicing and by medio 1995 the number was 200.

The Danish retail sector is highly competitive and small cost variations highly influence the market. The wholesale company’s main benefit of implementing EDI is a reduction in operation costs. This has been transformed into a strategic benefit as it allows the wholesale company to perform more efficient. Orders are delivered two days faster than before and most invoices are received and processed without manual intervention. In the long term perspective the wholesale company hopes to apply EDI to more business functions. This includes linking EDI to a sales forecasting system and POS (Point Of Sale) data, i.e., a move from the implementation phase to the institutionalized phase.

The highest benefit of introducing EDI has so far been a substantial reduction of human resources allocated to match invoices with orders and goods received. According to the wholesale company the savings are around half a person pr. big supplier.

The value of EDI has mainly been limited to reducing operating costs, but the image of the wholesale company has also been improved because of EDI. The suppliers now perceive the wholesale company as a modern and advanced user of complex IT.

The main barrier for further EDI diffusion within the retail sector was identified by the wholesale company to be small suppliers’ lack of knowledge and skills to implement and operate EDI systems. In the wholesale company’s experience do medium sized suppliers move the fastest in

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2 EANCOM is an implementation guideline of the UN/EDIFACT standard. The EANCOM subset provides a definition and explanations allowing trading partners to exchange commercial documents. In EANCOM messages, each product is identified by a unique standard EAN number (bar-code) and each party is identified by a unique EAN location code [13].
implementing EDI. In general, adopting spoke companies can be divided into three groups according to size. The first group consists of medium sized enterprises with relatively poor and unsophisticated in-house systems. These medium sized companies usually buy off-the-shelf EDI compilers and hire outside consultants to customize the software package. Medium sized enterprises also exhibit a relatively fast decision turn-over and they are in a bad bargaining position for postponing or omitting EDI.

Large engross companies follows the medium sized suppliers. There are several reasons for this. One reason is that the big companies are in a better bargaining position due to their size and they can therefore successfully postpone implementing EDI. Another reason is that the big companies have sophisticated in-house systems that do not easily interface with EDI. Another delaying factor is that the big companies usually build bigger and more sophisticated EDI systems, so when they decide to switch to EDI, they do it effectively, but it takes a long time to implement. Large companies usually undertake the implementation themselves and do not buy software and expertise, but need time to grow this expertise in-house.

The third and last group are the small sized companies. They are typically not connected yet, but the wholesale company believes they will, when standards get more mature and EDI converters become easier to install and customize. This scenario is quite common in all three sectors examined in Denmark.

**Pattern Two: Retail: Waiting for suppliers to mature**

This pattern deals with a large Danish department store. The department store has circa 2,000 suppliers primarily in southeast Asia, Denmark and eastern Europe. In 1993 the turnover was 2,820 million DKK. The department store has a sophisticated in-house system and it is already connected to a number of suppliers from the grocery sector. These arrangements function to the satisfaction of the department store. Therefore the following will concentrate on the department store’s relationship with suppliers from the garment industry.

Sale of garments is one of the main sources of income to the department store, but the communication with garment suppliers is unsatisfactory. The main hurdle is to get reliable data from suppliers and to reduce the long order circle. The EDI manager explained about the situation for garments:

*One thing which is no secret is that in 80% of the cases we do not receive what we ordered. These are not all mistakes, but also that the product is out of stock. Furthermore in 60% of the cases we do not know when to expect delivery. We usually know within a four week period, but if it is today or in three weeks we do not know.*

This means that sometimes a lot of trucks are queuing to deliver goods...

The department store seeks to lure suppliers into doing EDI by offering POS data. However most garment suppliers do not realize what to do with POS data.

The EDI manager explained about the long term strategy for the department store:

*What we are aiming at in the long perspective is to have the goods that are in demand. This is not just achieved by EDI, but through a combination of EDI, EAN numbers, and scanning of bar-codes. It is primarily the information level and reaction time that need to be improved. Today if something sells very much or very little, we react too slow.*

The main barrier for furthering EDI is to get the basic clear. The department store therefore concentrates on explaining suppliers about the benefits of assigning EAN numbers to their products. Even the Danish garment producers are just beginning to realize this.

The main value of EDI relates to improving internal operations resulting in cost reductions. The department store also believes that EDI is a competitive necessity.

The accrued benefits steam from reduced document handling and improved business relationships with EDI partners. The level of information is also improved significantly with EDI partners.

**Pattern Three: Banking: EDI makes the difference**

One of the largest Danish banks is differentiating itself from its competitors through aggressive use of IT. The bank has 12,158 employees (1994) and a profit before taxes of 349 million DKK (first six months of 1994).

The bank has recently engaged itself in the exchange of electronic business to bank transactions. The have done so to expand their banking services and to position itself at the core of the customers' business circle. One of the interviewees explained:

*What EDI is all about is to get information to cycle in closed circuits, instead of having information come out on paper every once in a while.*

The bank does not believe that EDI is a sustainable differentiation factor. The bank is therefore seeking to shake off competitors by a continuous stream of IT service innovations that will keep them ahead. This is especially true for EDI since it actually reduces switching costs for customers. The needed knowledge to innovate and implement these new systems have to be developed and kept in-house. Therefore the bank is slowly pulling out from the jointly owned computer service center. The center was set up a number of Danish banks to provide Denmark with an extensive electronic infrastructure for the finance sector (see pattern five).

The bank is a service organization and it is therefore naturally in a weak bargaining position. The bank therefore...
welcomes the UN/EDIFACT standard. The use of a recognized international standard is an advantage since the bank is in a better bargaining position when large customers suggest the use of proprietary standards.

The value of EDI to the bank is substantial cost reductions, and it differentiates the bank from their closest competitors. One of the interviewees explained: 

**EDI is a product which our customers demand. EDI is a sales factor for selling bank services, since EDI reduces costs not only for the bank, but also for our customers. Some large Danish companies demand EDI both from their business partners and their bank.**

The main benefits of EDI are, that it reduces human resources and it reduces document handling. At the same time has EDI also opened a new business alley for complex and more advanced bank services.

The bank believes that the largest barrier for further EDI diffusion is small and medium sized companies lack of knowledge and skills to implement and integrate EDI to their core business processes. Another impediment is the price of acquiring the technology.

**5.2. Second Stream: Industry Networks**

This section analyzes industry specific EDI diffusion processes. The processes all seek to reconfigure and transform a larger portion of the value adding network.

The pattern denoted as concessioned industry networks deals with public or semi-public companies attempt to improve their corporate image and respond to external pressure to reduce operating costs from the Danish Government. Another goal is to achieve long term operational advantage by transforming and changing operations in the value system. The two concessioned companies are the national rail cargo company and the Customs and Taxation department.

In the finance sector initiatives to change the current consensus usage of IT to a more competitive mode is identified.

In the retail sector diverse historic background and unwillingness among the two dominant hubs segment and impede EDI diffusion significantly.

**Pattern Four: Retail: A segmented solution**

The grocery sector in Denmark is highly centralized. The two dominant hubs (wholesale companies) have very different background and history. One of them grew out of the cooperative movement, which swiped through Denmark in the late 1800’s. The other one is relatively young and represents strong capital interests.

EDI-like systems started in the mid 70’s with the exchange of magnetic tapes. The tapes were formatted in proprietary standards. The benefits of introducing a larger variety of messages were recognized in the grocery sector in the late 80’s with the introduction of the UN/EDIFACT standard, and the efforts made by the article numbering association to promote the assignment of bar-codes to products and location numbers to outlets. The speed of adaptation has been relatively fast after the question of bar-codes and subsets was settled.

The two wholesale companies have not taken a joint approach to implement EDI in common, on the contrary they have taken a strategic approach to EDI and introduced it as a competitive tool. The consequence is that they have issued different implementation guidelines for the EANCOM messages, which in reality means that common suppliers need two protocols for formatting messages. Moreover there is no consensus among the hubs as to when to implement new versions of EANCOM. One of them has postponed the switch to a new version two years. This fact also induces further confusion over EDI standards in the retail sector.

The largest impediment for further EDI adoption and more sophisticated use in the retail sector is the two hubs' inability or unwillingness to approach EDI in common.

The business value of introducing EDI in the retail sector has increased the hubs’ power over its suppliers. This is underscored by the large capital investments made by the suppliers in implementing and operating at least two systems for EDI communication with the two hubs.

The benefits relate to reduced document handling that implies that the efficiency gains have been mostly internal to the adopting organizations. However improved business relationships among EDI partners are also mentioned.

**Pattern Five: Finance: Defending the Infrastructure**

The Danish finance sector is highly sophisticated in terms of its application of IT. It has in the past taken a common approach in building up at common nation-wide electronic infrastructure. The basic idea was to develop a technical infrastructure which is open and joint. This open infrastructure in reality increased the competition in other areas since the banks had very little possibility for keeping customers based on technical reasons. The banks invested in developing a common computer service center. This center has been responsible for developing and maintaining a nationwide network for creditcard/cashcard/interbank clearance.

Two events is currently putting a halt to this policy. The first one is a centralization of the finance sector in Denmark that is undergoing a large number of fusions. The largest Danish bank is seeking to differentiate itself through offering sophisticated business IT services. This can only be achieved with the basic infrastructure in place and by developing the IT services in-house. The banks
want to get back into the customers core business processes.

The second reason is the establishment of the European Union’s Open Market which allows open competition across borders among the 15 member states. The Danish banks that have invested heavily in building up an infrastructure are seeking ways to put up barriers for foreign banks to establish themselves in Denmark. One way, to keep foreign banks out, is to hinder that they get access to the lucrative financial infrastructure. However the European Commission demands that foreign banks, wishing to establish themselves in Denmark, get access to the same infrastructure that is common to Danish banks.

The response from the Danish banks is to minimize and lower the sophistication of the operations of the computer service center, which makes the infrastructure less attractive. Another response is to set up bilateral agreements for more advanced IT services, because bilateral arrangements cannot be demanded open to others by the European Commission.

The barriers to further EDI diffusion is the lack of a common approach to EDI in the finance sector. A common coordination among the hubs as in the past would speed up the diffusion significantly. The finance sector will therefore most likely experience increased competition and preying on customers, which will not further EDI diffusion. However the basic infrastructure is in place and this is definitely an EDI enabler.

The business value of EDI is connected to general cost reductions for the banks and those customers who are able to implement an EDI system. One of the interviewees explained: That banks give a gentle push by encouraging the right behavior through the use of fees.

The benefits are common to both customers and banks. It seems limited to reductions of human resources allocated to routine administrative work. This indicates that the application of EDI is not well connected to internal business processes. The finance sector’s use of EDI must therefore be characterized as being in the implementation phase.

**Pattern Six: Concessioned Companies showing the way**

This pattern evolved in relatively large diffusion arenas. Two cases support this pattern. This exhibits that the pattern is quite well established in Denmark. The pattern evolves around large government or semi-government owned enterprises. Common for the companies are that they are privileged in a way which limit or remove competition from their functional areas. Another representative trait is the desire to improve the image of the company as a modern and advanced user of IT. Exemplary is also that they have been first movers and have started EDI off in their functional areas. A similar diffusion pattern is also recognized in the transportation industry in Finland [11].

**CASE A: Rail Transportation: Putting the locomotive on the right track**

The cargo handling part of the Danish state owned railways handles all transportation of goods on rails in Denmark. It started doing EDI in 1991 and it is exchanging EDIFACT messages with 10 partners. The messages account for 20-25% of the total transportation volume [2]. In 1995 the number had risen to 75 partners and this represented 30-35% of the total volume.

In 1990 a new cargo handling system was implemented. At that time a few visionary people suggested that the new system incorporated EDIFACT. The structure of the new system was consequently built around the EDIFACT standard. This way the EDI was added to new system for a very limited cost. EDI was still in the discovery phase within the transportation sector, so the cargo handling company gained an immediate competitive advantage. The IT manager explained: that many transport-buyers switched transporter because they foresaw they wanted to do EDI in the future. The IT manager explained:

*In the period of implementation we held some meetings with some very big potential customers. We did get some of these customers because they wanted to do EDI. Some of these are still not connected...*

The main barrier is the low percentage of transport companies that are currently doing EDI, but special low cost PC solutions were developed for small and medium sized enterprises. This way knowledge barriers are somewhat circumvented.

The value of the technology is mainly a competitive advantage. Furthermore has the fast and committed move into EDI also improves the image of the state owned cargo company.

The benefits of EDI are reductions in document handling and human resources dedicated to red tape, and improved business relationships. The IT manager explained:

*We communicate more. We are practically tied to each other. This is true on many levels, both on the management level and user level.*

**CASE B: Customs and Tax: Declaring EDI a success for import/export**

The Danish Customs and Tax department started offering EDI in 1987 based on its own proprietary standard. Today 70% of all imports are declared electronically and more than 200 companies are connected to the system. The 70%
has been stable for the last 3 years. The interviewee explained that the 80-20 rule applies here. He does not believe the percentage will raise more than a few points in the future.

The Customs and Tax department introduced EDI part of their service concept, which is to be technological ahead of the companies they service. As a consequence the relations with the trading community improved. In addition has the image of Customs and Tax department as a slow and dull government department shifted towards an image of a modern and progressive service organization.

One of the main problems for the department is that it from the beginning allowed multiple standards, and multiple entries to the system. The interviewee explained that now it would be impossible for the department to reduce the number of entries and endorse only one standard. It would be against the department's service concept. The interviewee strongly recommended that everyone, if possible, should avoid multiple standards and entries.

The main value has been a cost reduction. The Customs and Tax department has no immediate competitors, but, as the interviewee indicated, the customs and tax department may very well have competitors in the future. Therefore it should be prepared to face competition.

The principal benefits are reductions of human resources dedicated to trivial paper work. The surplus is reallocated in the department for a more smooth and effective taxation of the companies. Another benefit is the ability to offer a better service to the companies.

One of the barriers to further EDI diffusion is the instability of standards. New versions are issued and new implementation guidelines are published at too high a rate. The interviewee explained that it is his impression that the companies will stick to their own proprietary standards, if the rate is not slowed significantly.

5.3. Third Stream: Nationwide initiatives: EDI the Danish Way

Denmark is a developed country. It has a high level of supporting infrastructure, a well-educated workforce, a sophisticated industry and an advanced telecommunication infrastructure. This and the creation of trust in EDI through the UN/EDIFACT standards has set off EDI diffusion in Denmark.

The Danish Government has limited its direct intervention to a minimum. Instead it concentrates on building up the basic infrastructure, liberalizing telecommunication services, and make sure that the legislation is not in the way for electronic exchange of business data. Besides this, the Danish Government has set up a new ministry for IT and research that has put focus on IT and the national information infrastructure. In addition the Danish Government exerts considerable pressure on public or semi-public organizations to reduce operating costs. These organizations looks for ways to reduce operating costs. One common way is to investment in new technology; for example IT (see also pattern six).

The Danish Health sector is adopting EDI as well. It is intended to be the primary tool in the communication between hospitals, private clinics, pharmacies and laboratories. This reduces operating costs in the health care sector and make it more efficient. As a side-effect EDI will probably spread to neighboring sectors.

The European Commission’s TEDIS programme allocated in 1993 resources to set up a Danish coordination body for EDI initiatives. The consul is responsible for gathering, disseminating and coordinating information about EDI initiatives. The counsel has been successful in attracting the primary EDI promoters. The immediate success of this new institution made it clear to the Danish Government that such a initiative was in need, and the counsel now receives part of its funding from the Government.

6. Discussion and conclusions

This study has dissected six different patterns of EDI diffusion simultaneously unfolding in Denmark. None of these patterns are uniquely new as all of them have been in one form or another discussed in the literature. A great deal of the factors that affect the success of each of these diffusion patterns is known. What is unique in this analysis, is to show how these patterns are interwoven and take place simultaneously within a specific socio-economic unit like Denmark. Moreover, none of the diffusion processes can be understood without the interference of the other processes. The diffusion patterns criss-cross one another and may change over time from one pattern to another. This could happen through changes in the service scope, underlying technology, or the institutional arrangement.

The analysis suggests that a more complete understanding of EDI diffusion rates and patterns requires both breadth and depth in the analysis. This is true not only at the organizational level, or within the industry sector or using institutionally based analysis. Instead all of them are needed simultaneously in the study of EDI diffusion. Accordingly a focus on a complex mixture of different elements located at different levels of the analysis is necessary.

In the past many of the initiatives have been launched within local arenas in industry segments and most of these have been implemented with considerable success. Like in Bouchard’s study [3] it was observed that the main reason for adopting EDI in dyadic cases has been the “herd” effect and not the direct benefits or other intangibles accrued through EDI use. The key question in singular adoptions
was: whether important business partners are using EDI or whether these partners “encourage” its use.

At the level of industry networks the logic of adoption decisions was more complicated. Organizations did not decide only on adopting the EDI service, they were also opting for a specific strategic choice and seeking for a business opportunity through a business alliance. In the case of the finance sector external events (the establishment of the Open Market) and the business strategy of one of the biggest players were the most important explanatory factor. In other industries, concessioned companies have taken the lead and implemented EDI for the common benefit for the whole sector and improve their image as advanced and modern companies.

At the level of national initiatives the Danish Government has limited its role to provide an advanced supporting infrastructure and some funding for the association of EDI users. Instead public organizations have launched initiatives to provide Denmark with a comprehensive public EDI infrastructure. The fact that the Danish Government has not directly been a major facilitator does not seem to have impeded the diffusion of EDI in Denmark at all.

In synthesis the major parameters to explain EDI diffusion in Denmark are neither technological, nor economic. They cover a mixture of institutional, socio-economic and cultural factors including: 1) Many Danish companies has adopted EDI after the EDIFACT standard was issued. In this sense the Danish companies have started relatively late compared to some countries, like Finland [11], but they have reacted fast. 2) The Danish Government has been streamlining its state owned monopolies, which has encouraged them to look for technological improvements in their operations. This happened at the same time the UN/EDIFACT standard was issued. Two state owned monopolies consequently adopted EDI early and they are taking a lead in using and promoting EDI in their respective functional areas. 3) The image improving feature of EDI seems to be an important factor when deciding to adopt. 4) The role of the UN/EDIFACT standard is imperative. It provides a trust in EDI and it is some guarantee that the investment will not be obsolete in a short while. However the standard’s size and continuous modifications seem to impede the diffusion somewhat. This inhibits the implementation of standard software packages, which is perceived by many to be one of the only ways in which SMEs can adopt this complex and abstract technology.

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References


