

26 INTERNATIONAL TRADE AT THE SPEED OF LIGHT: BUILDING AN ELECTRONIC TRADING INFRASTRUCTURE IN DENMARK, FINLAND, AND HONG KONG

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Abstract

In this paper, we analyze the creation of electronic trading infrastructures using Electronic Data Interchange (EDI) standards and associated technologies. We compare the evolution of such infrastructures in Denmark, Finland, and Hong Kong. We analyze attempts to build trading infrastructures in these three countries by examining eight initiatives. We probe how these initiatives support the building efforts by locating the eight initiatives into a two dimensional framework, which distinguishes between the strategic intent of the initiative and the type of initiator. In each case, we examine the dynamics of each initiative and its success. Our analysis shows that the building of trading infrastructures can take place through multiple paths—in this study called patterns—and it can be “pulled” or “pushed” by multiple forces. As a result, we can draw conclusions about how each pattern can help in building the infrastructure. The analysis demonstrates that the trading infrastructure in Hong Kong

has largely emerged through grassroots “bricolage.” In Finland and Denmark, in contrast, public institutions or state owned monopolies have played a critical role in building the infrastructure. On a theory plane, our study calls for the need to expand the scope of analysis beyond individual adopting organizations when analyzing electronic trading infrastructures. We also need to probe industries and public institutions when studying electronic infrastructure development.

Keywords: International trading, electronic infrastructure, electronic data interchange, EDI, diffusion, institutional theory, Hong Kong, Denmark, Finland, case study, field study.

Introduction

This paper investigates the emergence of communities of electronic trading. These communities—normally called hubs—consist of trading and transportation organizations and government bodies that jointly carry out logistic and trade related functions. The hubs normally include a multimodal transportation system consisting of a port, an airport, and other transportation systems (roads and railroads), which together with financial and other services (banks, insurance, freight forwarders, etc.) provide necessary services to conduct international trade, i.e., global economic activity (Wrigley, Wagenaar, and Clarke 1994). Organizationally they are arranged as a set of interdependent trading organizations¹ that are linked to higher level “operators” like customs, health authorities, insurance companies, etc.

Efficient and reliable logistic and information services offered within the hub are becoming of key importance in the global race between the hubs. In general, the challenge facing the trade and transportation community is to optimize and streamline international trading procedures. This has implicated higher levels of computerization, which has had a pervasive impact on the trading structures and processes. While a majority of the in-house operations have been computerized, the transportation and trade sector is now reaching beyond existing boundaries to look for further improvements. A next obvious step is to interchange documents via electronic links. This step has been accompanied with initiatives to radically reengineer the trade and transportation processes involving transport sellers, cargo terminals, truck companies, trade departments, Customs authorities and other related public agencies. Consequently hubs are fast changing from being transportation points that provide logistic goods handling-facilities into radically “reengineered” information service based environments. The core of such services is provided by advanced information infrastructures that electronically link different trading partners in the hub and between hubs. All this necessitates vast investments in electronic trading infrastructures, which enable efficient, reliable, and fast

¹Additionally, many organizations (including shipping companies, air carriers, freight forwarders) participating in a hub may operate within several hubs around the globe.

trading activities. In consequence, such infrastructures have become critical in the building of electronic trading communities and they have important characteristics such as longevity, ubiquitous nature, criticality, and mutual dependency on the communities (Leigh-Star and Ruhleder 1996).

Electronic data interchange (EDI) has been envisioned by many to be a critical element in the construction of electronic trading and electronic commerce infrastructures (see, for example, <http://www.iitf.nist.gov/elecomm/ecom.htm>). EDI helps integrate electronically trading partners by establishing necessary standards and services (addressing, routing, etc.) for the automatic exchange of trading documents. The puzzling question in the uptake of EDI is: who should establish and maintain such a set of standards and services—private or public sector organizations? Some argue that a tightly regulated top down approach is the right way to establish such an infrastructure. Singapore is a good example of how this strategy can be followed. Singapore has tightly regulated its telecommunication services and successfully implemented EDI-based trading infrastructures of which TradeNet is the most well known (King and Konsynski 1990b, 1990c; Neo, Khoo, and Ang 1994; Neo, King, and Applegate 1993). A good example of the opposite approach—that of leaving the initiative with private sector organizations—is Hong Kong, where the business community has been the primary initiator in attempts to establish trading infrastructures of which Tradelink is the most prominent (King and Konsynski 1990a; Surmon and Huff 1995). Tradelink came into existence in 1988 and, after a decade of chronic attempts the late Crown Colony is still struggling to establish its EDI-based trading system (Kimberley 1994; King and Konsynski 1990a; Surmon and Huff 1995). Some argue that the reason for this is that, in an unregulated environment like Hong Kong, the adoption of networked technologies is likely to be dismal.

Yet, this conclusion can be too hasty. Most studies on the construction of trading infrastructures have focused on large government initiatives. Our conjecture is that by extending the analysis into specific industry segments and private grassroots implementations we may reveal a more diversified picture of the evolution of electronic trading infrastructures. This also suggests that the building of infrastructures can happen through several alternative paths—in this study called patterns—and that it can be “pulled” or “pushed” by a diverse set of forces (Damsgaard, Rogaczewski, and Lyytinen 1994). Moreover, the tight control and the top down approach is but one set of measures to foster the creation of an electronic infrastructure.

In this paper, we examine the building of electronic trading infrastructures in Hong Kong, Finland, and Denmark in the banking and cargo industries. We are interested in Hong Kong because it offers a unique laboratory to learn about how networked technologies are taken into account in an environment that is largely unregulated, has a good underlying telecommunication infrastructure, and follows the ethos of the “marvel of the markets.” Finland and Denmark are included in this study because not much is known about trade related efforts in these two countries, which have open economies largely dependent on the efficiency of their international trade. Both of them enjoy excellent telecommunication infrastructures.

The paper is organized as follows. First, we discuss how and why EDI forms a critical element in the electronic trading infrastructures. We then develop a research framework and describe our field study and its research design. The four section analyzes eight initiatives to build trading infrastructures in Hong, Finland, and Denmark; respectively. The evolution of electronic trading infrastructures in the three countries based on our analysis is then evaluated. Finally, we synthesize our results in several critical observations about the construction of electronic trading infrastructures.

Definition and Traits of EDI

At present, EDI is regarded by many to be the key element in the creation of national trading and electronic commerce infrastructures. Key features of EDI are (a) the use of an electronic transmission medium; (b) the use of structured, formatted messages that represent trading documents which are based upon agreed standards; (c) a fast delivery of electronic trade documents from sender to receiver using shared telecommunication services; and (d) an immediate and automatic processing of the documents by the receiving organization's application software, generally resulting in an automatic response to the sending organization (O'Callaghan and Turner 1995; Wrigley, Wagenaar and Clarke 1994). EDI is thus perceived to be one step in the evolution of interorganizational systems (Iacovou 1995; Saxena and Wagenaar 1995) with the following distinctive traits:

1. EDI is interorganizational and networked in that its use is not controlled by any centralized authority, although some parts of the required infrastructure can be controlled by a central authority (e.g., Customs or other authorities). Business to business related interchange, however, is still left under the control of trading partners.
2. EDI links organizations through electronic means so that the organizational "boundary" is lowered (Ciborra 1995) and its interior is exposed to business partners (Webster 1995).
3. EDI forms a complex and abstract innovation in that it requires considerable technical and business skills and know-how to implement and operate (Webster 1995). It also exhibits path dependencies in that adopting organizations must link their internal information systems to EDI service to reap its full benefits. Thus adopting organizations must be relatively mature in their in-house application of IT (Nygaard-Andersen and Bjørn-Andersen 1994).
4. EDI relies on a mature telecommunication infrastructure (Kimberley 1994). Therefore EDI implementations are most often built using third party operated VANs.² The necessity of the third party, however, complicates the provision of EDI services (Ciborra 1995).

²This is often the only economically feasible solution because creating and maintaining direct links to all partners form a very expensive one-to-many relationship (O'Callaghan and Turner 1995). Recently Internet-based EDI solutions have become common, either through intranet or extranet solutions.

5. Standards³ form a crucial component in the EDI adoption (Swatman, Swatman, and Fowler 1991). Thereby EDI creates a high degree of organizational interdependence between organizations (Hørlück 1994), and necessitates some degree of institutional regulation and intervention (Swatman and Clarke 1990).
6. In EDI adoptions, positive network externalities are large. Therefore, EDI implementations require a large user population to be efficiently deployed (O'Callaghan and Eistert 1995; Pfeiffer 1992).

This characterization departs radically from some “EDI or DIE” models of EDI implementation in which an individual powerful actor used EDI to exercise unilateral control over other subcontracting firms (Nygaard-Andersen and Bjørn-Andersen 1994; Webster 1995). Our focus on the critical role of EDI, as an *enabling process technology* with large network externalities, dependency on agreed standards, and on a complex lattice of service providers, requires a deeper appreciation of how governments, industry sectors, and individual organizations should work together to establish a common electronic infrastructure (Damsgaard and Lyytinen 1996a).

Research Approach to Electronic Trading Infrastructures

Research Goals and Model

Because little is known about how electronic trading infrastructures emerge, we conducted a comparative field study to learn how EDI-based infrastructure initiatives had succeeded or failed in Hong Kong, Finland, and Denmark. We wanted to examine what types of initiatives had been launched and by whom. In addition, we wanted to probe how local contingencies, history, and cultural traditions had affected the deployment of various measures to design and implement the trading infrastructures. The goals of the field study were

1. to investigate different types of initiatives to establish an information infrastructure for international trade;
2. to identify what types of companies had initiated these efforts, and with what purpose;
3. to learn how successful these initiatives had been;

³Since the United Nations in the mid-1980s announced its commitment to EDI, vast resources have been poured into developing standards for commercial and administrative electronic information exchange. Currently there are two separate alternatives for EDI standards: ANSI X.12 for the North American continent and the United Nation's supported EDIFACT standard (EDI For Administration, Commerce, and Transport) for the rest of the world. In addition, a myriad of local implementation guidelines (and subsets) of these standards exists. This reflects the dilemma of defining the standards broadly enough to accommodate a large variety of business needs, while at the same time trying to keep the standards simple and useful (Hørlück 1994). To further complicate the matter, new versions of standards are issued at a fast pace. It is clear that the confusion over standards and their interpretations will continue to play a vital role in the future, and it poses a significant barrier to the application of EDI.

Table 1. Overview of the Study Framework

	Private	Public
Strategic	Initiatives launched primarily by private companies for strategic reasons I	Initiatives launched primarily by public companies for strategic reasons II
Operational	III Initiatives launched primarily by private companies for operational reasons	IV Initiatives launched primarily by public companies for operational reasons

4. to examine to what extent and how the initiatives were shaped by the local context, history, and business traditions; and finally,
5. to identify barriers that block the further development of the infrastructure.

In examining the construction of the infrastructure, we assume that two aspects in the initiative have a decisive role. The first deals with the initial *intent* or *purpose* of the effort. The initial goal of the initiative can be either to change the strategic positioning of the trading partners, the trading hub, or the industry segment. In such a situation, we call the initiative *strategic*. If this is not the case, we call the initiative *operational*. The other dimension deals with the institutional control or mode of the intervention. The initiative can be based on public or legislative initiative by public (or semipublic) authorities, in which case we call the initiative a *public* one. If this is not the case, we call the initiative *private*. The resulting organizing framework for the study of different infrastructure construction initiatives is depicted in Table 1. Here each entry captures a specific set of actors (and their modalities) and the overall aim of promoting an electronic infrastructure.

Our aim is to identify within each quadrant a set of initiatives, which can be located in each country, and then to examine which types of initiatives have been typical in each country, and thereafter to identify for each initiative its diffusion pattern. By a diffusion pattern we mean the evolution of the whole institutional environment and trading technologies that constitute the infrastructure for electronic trading. The pattern includes also identification of factors that can impact or change the “push” or “pull” of the trading technologies. For each quadrant, we shall ask what are typical diffusion patterns of EDI in each quadrant and country, and how were these patterns influenced and shaped by technological, organizational, industry, and environmental factors? Moreover, what has been the success rate of various diffusion patterns in institutionalizing the EDI service?

Table 2. Study Data Collection Sites in Hong Kong, Denmark, and Finland

	Hong Kong	Denmark	Finland
Government	<ul style="list-style-type: none"> • Trade Department • Trade and Industry Branch • HK Productivity Council • Census and Statistics Department • Customs and Excise Department 	<ul style="list-style-type: none"> • Customs and Taxation Department • Ministry of Research and IT 	<ul style="list-style-type: none"> • Customs Department
Associations	<ul style="list-style-type: none"> • Tradelink • Association of freight forwarders 	<ul style="list-style-type: none"> • Danish national association of EDI users 	<ul style="list-style-type: none"> • Finnish national association of EDI users
Network operators	<ul style="list-style-type: none"> • Network operator • Five EDI service providers 	<ul style="list-style-type: none"> • Network operator • Consultant company 	<ul style="list-style-type: none"> • Two EDI service suppliers
User organizations	<ul style="list-style-type: none"> • Two shipping lines • Two terminal operators • Air cargo terminal • Airline • Two freight forwarders 	<ul style="list-style-type: none"> • The Danish national rail cargo company 	<ul style="list-style-type: none"> • The Finnish national rail cargo company

Research Method and Data Collection

We chose to study emerging EDI-based trading infrastructures in Denmark, Hong Kong, and Finland (Damsgaard 1996, 1997; Damsgaard and Lyytinen 1996b, 1997). These countries formed a “convenience sample” in the sense that in each case EDI is widely utilized in the trade and transportation sector. Overall the research methodology followed an explorative multi-site case study approach (Yin 1989). In our data gathering strategy, we sought to find a representative and unbiased set of data from several sources. Therefore, we approached key informants that had a stake in the EDI diffusion and interviewed them.

The study covered interviews in all three trade and transportation sectors. For a summary, see Table 2. The data was gathered between March 1994 and July 1995 in four tempi (two data collections in Hong Kong).

The information we sought during interviews was unstructured and qualitative.⁴ Each interview took at least two hours, which allowed a thorough examination of the

⁴The interviews were carried out using a set of open questions that were organized into a questionnaire. The questionnaire, in addition to normal background information about the size and type of business and about the affiliation of the interviewee, asked each interviewee’s view of the diffusion history and his/her opinion on issues that affected EDI implementation. The interview format is available on request from the authors (or see Damsgaard 1996).

diffusion history and factors that shaped it. All interviews were tape recorded and notes were taken during the interview.⁵ Other written documents were collected from all of the participating organizations including information leaflets, annual reports, and material on the implemented EDI systems. Based on the archival data and interview data, we could narrate rich process descriptions of the EDI use in each site.

The narratives of EDI evolution were subsequently analyzed for content to discover local causalities between observed events (Patton 1990; Yin 1989). By doing so, we could classify each initiative into one quadrant of our framework, analyze its diffusion pattern, and subsequently examine its scope success. Altogether we identified eight attempts to build EDI infrastructure through several sorts and investigations of the data set. These will be presented next.

Electronic Trading in Hong Kong, Finland, and Denmark

In the following, we analyze the identified initiatives. For each country, we discuss the initiatives within that country and place them in the study framework (Table 1). The eight initiatives are numbered in sequence. Table 3 provides an overview of the eight initiatives identified and how they were organized into our study framework. Each entry in the table exhibits a path to establish electronic infrastructure for international trade and transportation.

Table 3. Overview of the Initiatives Launched in Hong Kong, Denmark, and Finland

	Private	Public
Strategic	2. HK Sea Cargo 3. HK Air Cargo	7. Danish Rail 4. Finnish Rail
	I	II
Operational	III	IV
	1. HK Tradelink	5. Finnish Customs 8. Danish Customs 6. Finnish Ports

⁵All tape recordings were transcribed and a case story was compiled for each interview. The case descriptions were shared with the interviewees to check for possible errors and omissions and to evaluate the validity of our interpretation in their "story." All errors and omissions were corrected and some stories were modified to reflect the true opinions and perceptions of the interviewees.

Initiatives in Hong Kong

Initiative One: HK Tradelink

Tradelink was set up in 1988 by 11 leading Hong Kong businesses to get government support for an initiative to build an EDI-based system for custom clearance and port services. It was the second attempt⁶ to provide Hong Kong with an electronic infrastructure (see also Damsgaard and Lyytinen 1997; King and Konsynski 1990a; Surmon and Huff 1995). In 1990, Tradelink persuaded the Hong Kong government to participate in and sponsor part of the so called SPEDI project (Shared Project for EDI). The aim of SPEDI was to analyze all alternatives and options in respect to a community-wide EDI infrastructure in Hong Kong. The principal recommendations of SPEDI were: the need for a community-wide electronic infrastructure and also the need for a *community coordinating company* (i.e., Tradelink). The shareholders should be a mix of Government departments and private sector organizations to ensure commitment and agreement among all stakeholders. The need for fast action was emphasized and the establishment of a community-wide network was identified as a “soft” infrastructure comparable to transportation and communication. Ironically, Tradelink and the Hong Kong government thereafter negotiated two years on the form and contents of a community wide EDI network. The Hong Kong government finally gave in and commissioned a seven years franchise to Tradelink, and bought a 48% stake in Tradelink.⁷

The initiative was initially launched by private companies that saw beyond their individual needs and decided to create a common electronic platform. At the same time, the Hong Kong government was reluctant to get involved and never shared Tradelink’s vision of the need to establish an electronic infrastructure for the principal trade and transportation hub in Southeast Asia.

Initiative Two: HK Sea Cargo

During 1995, a new private EDI network emerged when several large private companies in the trade and transportation industry, partly in response to Tradelink’s inability to launch a satisfactory service, established a new EDI service provider. The aim of the network was to interconnect the leading 5% of the companies within the transportation chain. The strategic goal was to start with parties that had complementary interests within trading and transportation, but which together covered the whole value system. The initiative was strategic and it was launched by opportunistic private companies that

⁶The first attempt to build a community-wide EDI network in Hong Kong was launched in 1984 by the Hong Kong Trade Facilitation Council. The Council proposed a project called HOTLINE (**H**ong Kong **T**rade **L**ocal and **I**nternational **N**etwork). It failed due to lack of support from the Hong Kong Government and leading businesses.

⁷For a general description of the Hong Kong government’s IT policies, see Greenfield and Lee (1992).

sought to fill the gap, which the failed Tradelink had left. The network planned also to open itself to technology “bench-sitters” to attract a critical mass of users. These new players were only “users” and they were not invited to become owners. Such a network—if established—would have no competitors in Hong Kong. Due to the size of the initiating companies, it was expected to create a sufficient critical mass for the successful diffusion. It was also expected to become the largest and the predominant information service network in the sea cargo industry.

Immediately after the public announcement of the network, several other players in the transportation sector decided to get involved in the network. Many of them indicated that this decision was motivated by the fear of losing business opportunities and of being left out in the technology race (Perez and Soete 1988).

Initiative Three: HK Air Cargo

A largely similar pattern was identified in Hong Kong’s air cargo industry. Here four competing airlines formed, in 1991, an international network to coordinate transactions between freight forwarders, air cargo terminals, and airlines. The founders together represented 40% to 50% of the air cargo volume worldwide and about 80% in Hong Kong. They sought to persuade all other airlines to use the same network and thereby to form one single worldwide network for air cargo. The other carriers saw the initiative, however, as a strategic maneuver to hijack the market. They feared that the four airlines would dominate the cargo market through the network. Therefore a lot of defensive actions were launched and competing airlines set up similar systems (see Christiaanse and Huigen 1995; Christiaanse et al. 1995). However, in Hong Kong the move was successful and the network became dominant. The result is that 94% of the air cargo volume handled through Hong Kong is coordinated through the network.

Here again a few players (but this time competitors) decided to build a common electronic infrastructure to optimize the air cargo business processes. It formed a strategic move and the launching companies were able to become owners of a lucrative infrastructure (comparable to owning a monopoly once the network has become predominant). Others were invited to use the network but again not to become owners.

Electronic Infrastructure Development in Hong Kong

Several reasons blocked these three initiatives from converging into a fully interlinked electronic trading hub. One of them is the structure of the business, as a large portion of companies in the transportation sector are small companies in Hong Kong. Another impediment is that the Hong Kong government does not want to release its decision power to process trade declarations, export licenses, or certificates of origin to any other organization including Tradelink. Instead these documents still have to be forwarded to several government departments for “checking and validating,” which is not likely to reduce the handling times and complicates the implementation of the infrastructure. Compare this with Singapore, where TradeNet provides this service fast and automatically by using sampling and focused examination in finding mistakes, errors, and violations (Neo, King, and Applegate 1993). The lack of an early and strong commit-

ment from government forms the third reason for the slow progress in building the electronic infrastructure to the extent that some regarded Tradelink to be a significant barrier:⁸

Hong Kong is getting there too late. Most countries in Asia now have their own EDI program. I have never heard Tradelink describe any incentives as to why someone should do EDI, they always focus on the technology. The whole business community is waiting for Tradelink to happen. The companies we have been in contact with in the import and export industry tell us that they are not going to do anything until Tradelink is up and running.

Overall there is too much uncertainty and speculation of services so that organizations are not able to rely on them in planning for their future strategies. Yet, the recent attitude change in the government has restored some faith in community-wide EDI.

The government's positive noninterventionism policy is what in most cases has made Hong Kong so successful in many areas. Businesses have been able to work without having to worry about what the government is going to dump on its back next. So government and government servants have gotten used to the idea of not getting in the way of business and not doing anything to help. But what is gradually coming about is government's recognition that an EDI community-wide system is as much an infrastructure as the road system. That recognition has been slow to come, but it is there now. EDI still takes much more effort, but the government is now paying attention to the electronic infrastructure.

Initiatives in Finland

Finland is a highly developed industrial country with an advanced transportation and telecommunications infrastructure, a well-educated workforce, and a sophisticated industrial base. The Finnish experience in relation to EDI has been to follow grassroots initiatives (Damsgaard and Lyytinen 1996b). There are several reasons for this. One of them is the tight social networks that exist between industry and government organizations. This has helped mobilize necessary resources and create bias in the diffusion of EDI. This is amplified by Finland's consensus oriented culture,⁹ which has also been followed in most EDI implementations. This has to a large extent been created by the harsh history of the Finnish nation—especially during the Winter War in World War II. Most Finns share the feeling that they only can survive by being united.

⁸Now Tradelink is operational and it has already attracted 10,000 traders. See URL: <http://www.tradelink.com.hk/>

⁹For example, Finland is the only country in Europe where the conservatives, the communists, and the greens can sit in the same cabinet as they do now; it is called the "rainbow" cabinet (the name comes from the political colors of all parties involved in the cabinet).

Initiative Four: The Finnish Railway

The cargo division of the Finnish state-owned railways handles all transportation on rails in Finland. It started doing EDI in 1991 and by 1994 it was exchanging EDI messages with 10 partners. The messages accounted for 20% to 25% of the total transportation volume. The reasons to launch the EDI system were clarified as follow:

It is obvious that we have a competitive advantage by using EDI. It is also obvious that it is harder for our customers to switch to another transportation company because they do EDI with us. This is also because we are the most advanced in EDI within the Finnish transportation sector. Nevertheless the best value, to us, is undoubtedly the cost reduction.

A public owned company launched this initiative. Nevertheless the primary reason for the start up of the service has been to cut costs and thereby to gain a strategic advantage. It did not emanate from a direct desire to provide a common electronic infrastructure for the Finnish trade and transportation industry, but nevertheless it forms an important component in future efforts to do so.

Initiative Five: The Finnish Custom

Customs in Finland has been using IT systems for many years. One of the goals of introducing the EDI system for custom clearance was to promote the use of EDI in Finnish companies involved in international trade. By the end of 1991, Finnish Customs therefore introduced its EDI system. The system allows traders to declare imported goods. By 1995, over 50% of import declarations were received in electronic form. The EDI project has improved Customs' relations with the trading community and the image of Customs as a slow, dull, and insufficient government department has shifted toward an image of a modern and progressive organization. For Customs, the benefits of EDI have been a reduction of document handling and better service to its customers. The point of departure for this initiative is Finnish Customs' desire to provide a better service through a common electronic infrastructure for customs clearance. Later on this service can form one component in the emerging information infrastructure for international trade.

Initiative Six: The Finnish Ports

The Finnish ports are owned mainly by municipalities. Because of increasing demands for efficiency and better service by major Finnish exporters such as the paper and pulp industry and the metal industry (Finland's ratio of export in its GNP is the highest in the world) and the increased competition over the lucrative Russian trade within the Baltic, the Finnish ports have launched a similar initiative. The new PortNet serves mainly as a system that carries out administrative functions related to port activities. Its basic idea is that shipping agents can give a pre-arrival notice while the vessels are on sea with an estimate of the arrival of a ship. The system will then generate the necessary information to the appropriate authorities that will prepare the needed documents for clearing. Closer

to arrival, the shipping agent can send another EDI message with more detailed information of the ship and what services are required for the ship and whether it needs a pilot. The Finnish Customs system connects to the service and it receives information about the cargo for control and statistics. For small shipping agencies, a cheap PC-based solution has been developed. What is unusual for the system is that it is a national system that covers all major ports in Finland. (Finland has a coastal line of over 1,500 kilometers plus some inland ports in the lakes. Overall there are about 10 hubs.) The system is mainly intended to serve the operational needs of port authorities and to speed up the document handling activities in the ports. The government, the ports, and the shipping agents developed it as a joint effort because all of them could benefit from its service. For example, the shipping agencies can obtain better and faster proactive service from the ports and Customs gets its information automatically. Although the main intent of the system was initially operational in nature, it can form later on a strategic core of the whole trading infrastructure.

Electronic Infrastructure Development in Finland

Although Finland has no master plan for developing its national EDI-based trading infrastructure, all of the initiatives that have been launched within various industry segments of the trade industry share complementary features and they serve well the long term goal of a joint trading infrastructure. All major parts of the trading infrastructure—customs, transportation systems, and hub structures—have evolved to the level where their synergistic impacts may start to become visible.¹⁰ Notable with all three initiatives is that they have evolved around large government or semi-government owned enterprises. Common to these companies is that they are privileged in that there are governmental regulations that remove competition from their functional areas. Another representative trait in the initiatives is their desire to improve their image as a modern user of IT. Also exemplary is that they have been first movers and have started EDI early in their functional areas. Although the building of the Finnish trading infrastructure is not finished, there is a vision and a will to implement that in the next four to five years following the grassroots strategy that has functioned well in the past. One of the interviewees clarified the matter:

EDI is a competitive necessity, when taking into account Finland's geographical situation. When we are importing goods or exporting goods our major trading partners are located in central Europe. So it is a competitive necessity to Finland to have our foreign trade practices and procedures as smooth and effective as possible.

¹⁰Finland also has very advanced electronic banking and insurance infrastructures and air cargo systems which can be relatively easily integrated with the emerging trading infrastructure. All these systems have been developed, however, with private initiatives.

Initiatives in Denmark

Like Finland, Denmark is a highly developed country with a good supporting infrastructure, a well-educated workforce, and a sophisticated industry. This and the creation of trust in EDI through the UN/EDIFACT standards has set off EDI diffusion in Denmark. In building the electronic trading infrastructure, the Danish government has concentrated on providing a better telecommunication infrastructure by liberalizing it and making sure that Danish legislation is not in the way for electronic exchange of business data. In addition, the Danish government exerts considerable pressure on public or semi-public organizations to reduce their operating costs. These organizations must look for ways to reduce operating costs. One common way is to invest in new technologies, for example IT. In addition, the Danish government has set up a new ministry for IT and research that focuses on the national information infrastructure. The Ministry has recently issued a national EDI plan (Ministry of Research and Information Technology 1996¹¹). In 1993, the European Commission's TEDIS program (EDI awareness and promotion campaign) allocated resources to set up a Danish coordination body for EDI initiatives. This council is responsible for gathering, disseminating, and coordinating information about EDI initiatives. The council has been successful in attracting the primary Danish EDI users and promoters.

Initiative Seven: The Danish Railway

The Danish government has put severe pressures on its subsidiaries to become more efficient and show a profit. One response from the subsidiaries has been to invest in new technologies—for example EDI. Partly in response to this pressure, the cargo handling part of the Danish state-owned railways developed an EDI system in 1990. The company is a semi-public company and it handles all transportation on rails in Denmark. When a new cargo handling system was to be built by the railways, some visionary people suggested that it should incorporate EDI services. The new system was consequently built around the UN/EDIFACT standard. The system was launched in 1991 and it originally exchanged messages with 10 partners. These accounted for 20% to 25% of the total transportation volume (see also Bjørn-Andersen and Nygaard-Andersen 1995). In 1995, the number had risen to 75 partners and this represented 30% to 35% of the total volume.

The rail cargo company has been able to attract more customers due to EDI capabilities, and some companies switched to it to learn about EDI before they ventured into large scale EDI systems with their suppliers or customers. In this way the original strategic intent was also gained.

¹¹See also URL: <http://www.fsk.dk:80/fsk/publ/index-uk.html>

Initiative Eight: The Danish Customs

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. This figure of 70% has been stable for the last three years. The percentage is not expected to raise more than a few points in the future (it has more or less reached the point of saturation). The Customs and Tax department introduced EDI as 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, the image of Customs and Tax as a slow and dull government department has shifted toward an image of a modern and progressive service organization. One of the main problems for the department is that, from the beginning, it 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 the nightmare of allowing multiple standards and entries. Otherwise this initiative is very similar to the Finnish initiative in Customs.

Electronic Infrastructure Development in Denmark

In Denmark, two initiatives that form one component in the trading infrastructure have been launched. These are the customs clearance and rail-based cargo systems. Both initiatives have evolved around large government or semi-government owned enterprises. As with the Finnish initiatives, what is common is that the companies are privileged in a way that limits or removes competition.

Discussion

In analyzing the eight initiatives, one notable difference is that all identified Finnish and Danish initiatives were launched by public or semi-public companies, whereas in Hong Kong all initiatives were launched within the private sphere. This could be a general observation of a difference between Scandinavia and Asia. However in Singapore, in some other countries in Asia, and also in Australia, the public sector has been the key player (Damsgaard and Lyytinen 1996a; Kimberley 1994; Swatman, Swatman, and Fowler 1991). A more likely answer is therefore that the type of involvement is rooted in traditions and in the type of economy and also in the interpretation of the nature of the EDI trading infrastructure. Governments in open market economies usually leave the initiative with private sector organizations if it is regarded as business as usual, while in more regulated economies the public sector plays a much larger role in sustaining and fostering innovative activities—especially when they are seen as infrastructure development (Boyer 1988; Dosi et al. 1988; Freeman 1988; Porter 1990; Unger 1988). Nevertheless as electronic infrastructures become increasingly important in the future—and obtain the status of true “infrastructures”—governments will play a more visible role while private businesses will have to decide their level of involvement in using such an infrastructure and their role in providing associated services.

Based on our analysis, we will condense our conclusions into four quadrants and thereafter discuss what can be learned from the respective patterns in the diffusion of the EDI-based infrastructure.

Strategic and Private Initiatives

Entry I is comprised by patterns which we call *strategic alliance through virtual integration*. There are two initiatives that conform to this pattern (2 and 3). In sea cargo, the companies were opting for a strategic position by interlinking companies with complementary interests in the value chain (i.e., horizontal integration). In the air cargo industry, four airlines (competitors) worked together to establish a network for more efficient transportation procedures (i.e., vertical integration). In both cases, the aim was to attract a critical mass of users and thereby to become the owner of the infrastructure (this is in fact similar to initiatives in the flight reservation systems [McKenny 1995]), which leaves the remaining industry players to pay the costs of a monopoly situation (Katz and Shapiro 1994; Oliva 1994).

Strategic and Public Initiatives

Entry II covers two initiatives (4 and 7) that established a pattern which we call *strategic positioning for the future*. Common to both initiatives is that they were launched by semi-public companies that are independent profit-centers or expected to be so in the future. In this sense, the initiative is a strategic maneuver to reduce costs and improve the company's image as a progressive IT user. Also exemplary is that these companies have been first movers.

Operational and Private Initiatives

In entry III, we find the Tradelink initiative. This pattern we call *collaborate action to create a new reign*. Initiatives in this entry seek essentially to find a strategic positioning of a higher order, because it does not accrue direct benefit to the individual firm but rather benefits the community in which the firm operates. This pattern materializes when there is no central authority to coordinate infrastructural activities, or when existing institutions are unwilling or unable to undertake such a responsibility (Boch 1987; Damsgaard and Lyytinen 1998; Sako 1996). This pattern also finds support elsewhere for example in the Finnish retail sector and banking sector, where a group of companies jointly created an institution to coordinate common EDI activities (see Damsgaard and Lyytinen 1998).

Operational and Public Initiatives

Entry IV is populated by government initiatives that aim solely to provide a better service to the trading community. We name this pattern *servicing the community*. These

public companies are often key players in the provision of an electronic infrastructure, since they possess the exclusive right to perform certain operations such as export and import licenses. In this sense, they are necessary players and no efficient electronic infrastructure for international trade and industry can be built without the participation of these authorities.

Lessons Learned

Patterns in entry I capture unregulated and purely market driven approaches to establish electronic infrastructure. This is likely to happen if the initiative is left solely to opportunistic parties to pursue, or if no institution is capable or willing to undertake the challenge. The dangers of following this alley are the cost of creating a *de facto* monopoly. Often it results in having two (or more) competing, incompatible infrastructures though this situation is not economically beneficial (Katz and Shapiro 1994; Oliva 1994). It may also result in a poor quality of infrastructure and low level services due to the low number of users and small network externalities. On the positive side, this pattern usually develops fast and its implementation is efficient. Furthermore it is customer driven so the infrastructure is designed to meet customers' needs rather than some grand national plan.

The pattern in entry II is that concessioned companies operate a monopoly, but still are subjected to quasi market structures. Such companies usually have the privilege to cross subsidy activities in one area with revenue generated in another (more mature or profitable) area. For example, telephone companies can often cross subsidize local infrastructure with revenues made from long distance calls or from business customers. On the positive side, concessioned companies can afford to undertake long term development projects (e.g., postal services, telecommunications, telegraph network, railways, and bridges) without having to show an immediate return of investment for each separate activity. In addition, because of their monopoly situation, they usually attract a critical mass of users and thus can create high network externalities. Furthermore, when the monopoly sets a standard, all must follow suit. This helps avoid the locking effect of earlier adoption decisions. On the negative side concessioned companies may decide to push a technology too early or against well-established or well-functioning practices. There is also the danger of too heavy cross subsidy that may slow technology use and adoption down.

Patterns in entry III are promoted by a number of companies working together to promote or facilitate what they perceive to be a common good (here the electronic infrastructure). The aim could be to prompt government or institutional action as the original Tradelink initiative clearly demonstrates. Or it might be to create a new trade and industry association to promote and coordinate technology adoption process (Benson 1975; Boch 1987; Damsgaard and Lyytinen 1998; Lundvall 1988; Sako 1996). It is probably the most difficult and uncertain path of the four alternatives, since the companies are venturing into a "no man's land" of no institutional support while at the same time trying to work together (suppliers, buyers, and competitors alike). On the positive side, there is usually a "real" need for action to get the business community to react and invest resources. In fact, most trade and industry associations have come into existence in this manner (Boch 1987). On the negative side, there is the danger that the

coalition fails due to discrepancies of interests or failure to reach common ground, or that they stand in the way of other initiatives.

The pattern for entry IV provides the story of a traditional public service provider. In this context, public authorities decide to promote some technology that offers services to the wider population (Damsgaard and Lyytinen 1996a; King et al. 1994). On the positive side, this is one of the foremost reasons for governments to exist: by providing a legal infrastructure, a financial system, an educational systems, or a transportation infrastructure. Why not also provide an electronic infrastructure? Whether an electronic trading infrastructure is indeed a basic societal infrastructure that must be provided to all and should enjoy characteristics of equal access, mutual consistency, etc., must be decided by individual governments. This will clearly depend on their traditions, local contingencies, and past experiences. On the negative side, as in pattern II, government may push too early, or against existing practices. Finally, there is also the danger of governments enforcing national adoptions of specific technologies or standards just for the sake of national coherence which will later on be passed by international services and practices (cf. French Minitel, Cats-Baril and Jelassi 1994).

Conclusions

Electronic data interchange forms one of the key components in establishing electronic trading infrastructures. This is recognized now by many and it has prompted action from a number of players both in the public and private sectors. Our study identified eight initiatives to launch parts of such an infrastructure. These were categorized in our study into four typical patterns. Each pattern lays down a context and a likely trajectory to establish an electronic trading infrastructure with different benefits and risks. Thus there are both pros and cons connected to each of the patterns. Moreover, these patterns are not exclusive and can be followed simultaneously in different parts of the trading community and business chain.

It is worth noticing that many private companies form active players both on the local scale and on the broader scale simultaneously. This reflects the companies' dilemma of on the one hand competing for the same limited resources and on the other hand working together to build up a common electronic infrastructure (Boch 1987; Damsgaard and Lyytinen 1998).

Despite the grim experience associated with the community-wide EDI service, Hong Kong has made steady progress with the adoption of EDI technologies. This has taken place mostly at the grassroots level, or through a strategic positioning of some key industry segments. In fact, some interviewees argued that the general level of EDI use in Hong Kong had surpassed that of Singapore, where EDI use has mostly been concentrated on government related interactions (and not on advancing business-to-business related infrastructures).

In Finland and Denmark, the pictures are surprisingly similar. In both nations public companies have been the main actors in providing for a common electronic infrastructure.

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