Lessons in Electronic Commerce

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The case of Electronic Transportation Markets^{*}

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Abstract

Over the past 20 years a variety of electronic markets have been set-up to improve the allocation of capacities in road transportation. Although existing inefficiencies and cost pressures provide a strong rationale for electronic market solutions, most attempts have failed so far. Based on an overview of the so-called electronic transportation exchanges we will analyze the factors that were involved in the repeated failures. By using a multi-layer framework which integrates established research approaches for interorganizational systems (IOS) we argue that the failures provide valuable insights for the configuration of electronic commerce (EC) systems in general and in particular for the transportation exchanges that are currently emerging on the Internet.

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Introduction

In view of the Internet-frenzy of the 1990s the awareness and usage of electronic commerce (EC) in a business-to-business setting, formerly often referred to as interorganizational systems (IOS), has spread tremendously. This area generates the majority of electronic revenues and is attributed the highest expectations for growth (e.g. Tedeschi, 1999). However, not only will relationships among businesses spread significantly, but since information technology is believed to reduce transaction costs they will also use more market coordination in the future (e.g. Wigand, 1997). Thus, electronic markets which are known in several industries since the 1960s (e.g. the famous computer reservation systems) and which are currently flourishing on the World-Wide Web (e.g. Hof et al., 1998) will be an important element for relationships among companies. At the same time increased market coordination also changes the requirements for logistic services which have to offer integrated solutions from warehousing and delivery to payment at competitive rates and high quality. As Jones (1998) describes, information is key to these services and applying EC systems within the sector becomes a strategic necessity. Relevant applications are chain monitoring (e.g. Internet tracking&tracing systems) and electronic markets for trading (standardized) capacities and shipments. Since electronic markets are at the heart of tomorrow's logistic services their availability determines the feasibility of these services.

Indeed, the application of EC already has a long tradition in the logistics sector (e.g. Stenger, 1986) but despite their pioneering role many systems have fallen short of the

expectations or have even failed. At the same time, it is almost paradoxical that the very applications which suffer from profound diffusion problems often are nevertheless crucial for an industry's (future) competitiveness. One such example are the electronic transportation exchanges (ETX) which aim at improving the allocation of cargo space in the road transport sector. In the following we will analyze the nature and the intricacies of these systems and try to answer the questions why - despite a convincing rationale - these systems have not yet succeeded. These cases are particularly interesting because they highlight some lessons which also have to be taken into account when building EC applications in general.

Studies on Success and Failure of Interorganizational Systems (IOS)

In the first step we will review the existing research on success factors for business-to-business EC systems or IOS, respectively. As described in section 2.1 relevant approaches have focussed on different aspects of interorganizational relations and have not developed a holistic perspective of these relationships. To a large extent these impact analyses have concentrated on the formulation of success factors that have been derived from studying successful systems. Failures which also are abundant in EC have rarely been research objects although "from a rational point of view, failures should be publicized even more than successes" (Makridakis, 1991, 6). Section 2.2 gives an overview on lessons provided in previous failure research.

Different Research Perspectives on Success Factors

The impact of information technology (IT) on economic activity is a topic of broad interest. Many research approaches have developed in the last decades which emphasized different success factors. One of the first to address the profound changes that IT has on industry structure and a company's competitiveness were Porter & Millar (1985). They scrutinized how

IT transforms the informational component of a product, but they gave no precise indications on the factors that would lead to successful implementations. In the quest for success factors, Copeland & McKenney (1988) have identified economies of scale, congruence between task and technology as well as importance of intelligent persistence as general strategic success factors. McKenney's (1995) long-term study of successful IS found that a good working relationship and coordination between CEO, CIO and the IS project team to be a major success factor. Venkatraman & Short (1992) who have studied Baxter Healthcare's IOS summarize three findings of previous studies as key factors: the strong product pull through the electronic order entry system, high switching costs for hospital customers and high barriers to entry for competitors. The authors emphasize the dynamic character of these factors and described how Baxter's strategies changed over time from a single- to a multi vendor platform and towards a value-added partnership with hospitals. In seven case studies Iacovou et al. (1995) have identified organizational readiness, external pressures to adopt and perceived benefits as key adoption determinants and proposed recommendations for successful EDI (Electronic Data Interchange) partner expansion plans, such as promotional efforts, financial and technical assistance and coercive tactics. Comparable factors are reported by Premkumar & Ramamurthy (1995) who distinguished between interorganizational (competitive pressure and exercised power) and organizational variables (internal need and top management support) for IOS adoption. Webster (1995) has found that despite a strong rhetoric for the collaborative nature and advantages of IOS, coercive relations between sponsors and adopters of EDI systems dominate and thus limit the potential advantages of the participants.

Besides this large number of research on competitive impact and industry structure two other aspects have evolved (Table 1). On the one hand technological and process issues posit that

business processes have to be streamlined and that inter- and intraorganizational EC systems have to be closely integrated for achieving maximum benefits. On the other hand many of the later studies go beyond the industry analysis level of the earlier contributions and draw upon the theory of critical mass and networks. Finally, some authors suggest combinations of several perspectives. For example, the analysis of Mitev (1998) who has scrutinized the implementation and adaptation of the CRS Sabre by the French Railways, comprehends industry structure, economic, political and cultural factors. Although others (e.g. Eistert, 1996) propose multi-disciplinary approaches to the study of adoption as well, a systematic framework that encompasses industry and network levels is still missing.

Insert Table 1 about here

Study of Failures in Electronic Commerce

Another neglected area is the study of implementation pitfalls and failure of broad acceptance in the marketplace. Various examples indicate that the lack of acceptance and diffusion is more common than communicated by participants who typically are not inclined to publish information in this regard. There is a common thread of failures from the MIS systems of the 70s, the CIM systems of the 80s and the EDI systems of the early 90s, which has however only been gradually acknowledged. *Failure* in this perspective does not refer to explicit technical or organizational failures. The former denote dysfunctional systems or computer crashes (e.g. Wise & Debons, 1987) and the latter organizations which face bankruptcy etc. (Makridakis, 1991). In the context of EC failure refers to the stated expectations regarding diffusion, which is particularly critical for systems with positive network externalities (Katz & Shapiro, 1985) such

as IOS. For example, Sokol (1995, xi) notes concerning the diffusion of EDI: „...*While many companies have begun to use EDI and many more have since joined the ranks, EDI is not taking the world by storm. Even in those companies that are doing EDI [...] it is rarely the primary mode of doing business.*“ Part of the failure of EDI can be attributed to a negative cost / benefit ratio for the foreseeable future, which diminishes the diffusion among those players, such as SME, who cannot invest into new systems hoping that they will get a return in a distant future.

A literature review yielded only a few studies on implementation failures of IOS: In her work on bugs and features Markus (1984) describes the resistance effect, a phenomenon where systems are used in different ways from what was intended by the system designers. In her explanation she mainly builds on the lack of understanding the interaction between organizational and technological variables. Christiaanse et al. (1996) have analyzed the failure of cargo-community systems in the air cargo community and conclude that institutional factors have not been taken into account. Tschanz & Klein (1997) have identified obstacles to the diffusion of EDI in the tourism industry. Strategies for persuading non-adopters, especially SMEs have been described by Iacovou et al. (1995). In summary, inverted success factor research has proved as a valuable tool in complementing and verifying lessons proposed in success stories. We also face the lack of an overall framework for analyzing IOS here.

The Case: Electronic Transportation Exchanges

In our case study of electronic markets in road transportation we intend to provide further insight in success factors for IOS by scrutinizing implementation pitfalls and failures and suggest a framework that distinguishes various levels of IOS analysis and design. First, section 3.1 illustrates why electronic markets are especially beneficial in road transportation. Section 3.2

describes the functionality of the so-called electronic transportation exchanges and section 3.3 how this class of EC systems has developed in Europe.

Rationale of Electronic Transportation Exchanges

Transportation is one of the core components for logistics concepts. In contrast to transportation, logistics has a broader scope as it focuses on all physical activities, e.g. also on warehousing and transshipment, as well as on the information flows and the need to manage entire (transportation) systems. As Jones (1998, 228) states “logistics is the key to the virtual organization” and requires profound competencies concerning the physical and the informational activities. The latter include establishing transparency on movements along the entire logistics chain (‘in-transit visibility’), the ability to quickly (re-)schedule movements and to seamlessly exchange documents and information with other participants involved. The lack of information on available capacities, road conditions and the like are important causes for today’s inefficiencies in the transportation of physical goods. Well known symptoms are unnecessary and costly inventories at the interfaces (such as forwarders, ports), insufficient reliability, and the growing congestion of the road infrastructure. In Europe, the estimated costs related to these problems amount to 15 % of the total transportation costs or \$300 billion annually (CEC, 1992) and all forecasts predict a growing transportation volume for the forthcoming years. Since the majority of this additional transportation volume will concern road transportation inefficiencies will become an even more alarming issue. At the same time the physical capacities are only partly used. In Europe, only half of the capacities in road transportation are used or, in other words, half of the trucks in Europe are driving empty. For example, the truck capacities in Germany are only used to 56% with the ratio being a mere 41% for corporate fleets (Büllingen, 1994). Reducing these inefficiencies is important because they add to the costs of a primary

product. Despite current logistic strategies emphasizing the need for reliability, full service and the like (e.g. efficient consumer response, ECR), cost still acts as the prime decision variable for shippers.

In principle, there are three approaches to solve this problem (Baum et al., 1994). The first, the reduction of transportation volume, limits an economy's performance as well as its future growth and poses no viable option. Expanding a country's transportation infrastructure has become a complex political issue especially in Europe and is in many cases associated with high risks of resistance from powerful interest groups. Therefore, the intensified usage of today's road capacities, which are in fact only partly exploited, remains the only promising alternative (cf. OECD, 1996).

Insert Figure 1 about here

There is a significant gap between the existing inefficiencies in road transportation and the cost pressure of shippers. The reasons for this sub-optimal allocation of resources are mainly attributed to an information deficit, i.e. providing information on who has and who carries cargo would increase the efficiency of road transport. In the early 70s various research projects have been launched in Europe to initiate an IT solution to this problem. The emerging electronic transportation exchanges (ETX) made information available to both shippers and forwarders and aimed at removing the existing information asymmetries in the market. The ETXs were the first electronic markets in logistics and had a convincing rationale which was based on three factors:

- The increased performance of telematic services, namely the emergence of Videotex systems during the late 70s, enabled the instant and ubiquitous availability of information.

- The growing salience of information for efficiency improvements in transportation.

Traditionally, increasing the performance of the transportation system was equivalent with advances in the area of the physical infrastructure (e.g. double-stacked railroad cars, containerization) and information management was only regarded as an auxiliary factor. Due to the changing profile of logistic services and the apparent needs for planning and control we expect the design of the information flows to dominate the design of the physical flow. King (1995) referred to this development as 'Great Reversal'.

- The homogeneous nature of road cargo transportation. Although the goods being transferred are highly heterogeneous themselves, the transportation industry has made significant achievements in reducing this complexity by means of standardized containers, classes for dangerous goods, and the like. Therefore, in many cases only a limited amount of information is required for the specification of transports.

Due to these advantages, the concept of the transportation exchange has not only spread in road transportation but in other areas of logistics as well. Examples are exchanges for container space in seaports such as Hamburg, Germany, or for air cargo space in airports such as Amsterdam, The Netherlands (Christiaanse et al., 1996). Since the experiences of these systems are comparable with those made in the area of road cargo we believe that the following analysis is valid for them as well.

Functionality of ETX or 'Why Transportation Exchanges are no Exchanges'

The exchanges in the financial sector are often considered to be markets that come close to the ideal market described in neoclassical market theory. Computerization is spreading in this area and well known examples for electronic exchanges come from the future and the option markets.¹ In general, electronic exchanges have two major characteristics:

- Electronic exchanges are EC systems that support entire market transactions which consist of information, trading and settlement processes (cf. Schmid, 1993; Schmid & Lindemann, 1998). Traders screen and compare positions in the order book which contains open bids and offers in the market (information phase). In the trading phase a match is incurred depending on various tie break rules (e.g. price-time priority) and accounts are cleared afterwards in the settlement phase.

Insert Figure 2 about here

- Electronic exchanges use market principles for the coordination of supply and demand side. These are competition among multiple autonomous actors and the use of prices as the basis for allocation (cf. Eatwell & Milgate, 1994).

The ETX-concept differs considerably in both dimensions. Traditionally, road transport services are being sold by means of specialized newspaper magazines and personal contacts on the phone. Trading activities are almost exclusively done in personal contacts between forwarders and carriers and settlement is highly paper-intensive (e.g. waybills, declarations). ETXs primarily target the information phase and provide centralized online-blackboards. Supply (cargo) and demand (freight) can be submitted and displayed to all participants which are mainly forwarders and carriers but no shippers. The databases usually contain information on the transportation company's identity (e.g. address, main area of business and years in business) and a specification of the cargo or the cargo space such as dimensions, destination, or time. Information on conditions or price is not included. In case a participant is interested in a

displayed item, the ETX's mission is fulfilled. As in the non-electronic scenario the agent calls his counterpart by phone and negotiates on the terms of the deal.

Compared to the financial exchanges, trading and settlement occur outside of the system and electronic coordination is limited to the information dissemination among multiple actors. For ETX we have to relax the definition somewhat in order to include the current implementations.

Evolution of ETXs: Myths and Realities

The idea for ETXs dates back to the 1970s when the German institution SVG initiated a database for freight capacities that could be accessed by participants through contacting an operator by phone. Table 2 shows that numerous other systems were developed in various European countries after the introduction of Videotex in the early eighties (e.g. Minitel in France). A second push came with the Internet. While many existing ETX providers switched over time to the new IT infrastructure, new Web-based ETXs were initiated by startups primarily in the US (see table 3 below). Besides the systems which are interorganizational in nature, the ETX-concept was also used in the intraorganizational setting. Large forwarders such as Switzerland's Danzas or Germany's Schenker aimed at increasing the allocation efficiency, i.e. the payload factor, of their trucks. A system which supports the consolidation of cargo within big shippers is offered by the Bertelsmann subsidiary Media Log (Bentrup, 1994).

Insert Table 2 about here

One of the myths that has been driving the repeated initiation of ETX within inter- and intraorganizational settings are their benefits and rationales which have been shown in various

forecasts and field tests. In the case of AMÖ, an ETX for moving companies, simulations undertaken in 1981 produced an increase in the payload factor from 37,1% to 73,2%. The simulations not only underlined the economic but also the ecological rationale of the ETX: instead of 188 only 93 moving-vans would have been necessary for the same transport volume (Büllingen, 1994). In the INTAKT research project, trials were undertaken with four German forwarders in 1989 which led to a productivity increase² from 37% to 55%. Furthermore, qualitative advantages such as improved disposition results and a reduction of manual interventions were reported in these field experiments. In sum, the ETX's strong rationale and their expected benefits kept driving the repeated initiation of these systems in various countries. Due to the win-win situation for all participants a quick diffusion of the systems was widely expected in the road transport industry.

A rapid diffusion of ETXs, however, has not occurred and almost all systems have faced severe problems in the marketplace. From our interviews we identified five areas of failure which are summarized in Table 3. Especially in the internal setting (e.g. within large road carriers) ETX were often conceived, but did not receive a 'go' decision due to lacking funding or sponsors. In some cases prototypes were built which have not been rolled out. Since these cases are difficult to document we concentrate on ETX which have already been rolled out to a group of participants. As Table 2 shows, many systems discontinued operation after a short to medium-range period. It was not that the predicted and simulated economic and ecological benefits were not confirmed by users of the systems, but rather that the systems were unable to sufficiently attract active users. Today, six of the traditional ETX are still alive with four of these six ETX having been in the market for almost ten years.³ COMIS and Teleroute are referred to as relatively successful although they acquired only a very small segment of the road transport

market and their development did not live up to the expectations. It is this lack of adoption which is at the heart of failures at the development stages three to five. The responsible factors which have been reported in the interviews are included in Table 3. However, further clarification of these rather general factors is needed to fully understand the failure of ETX.

Insert Table 3 about here

Analysis of the Failure of European ETXs

In order to identify and explain reasons behind the failure of ETXs a qualitative research methodology was used based on a complex, multi-layer framework (Håkansson, 1982).⁴ Our analysis is twofold. The first step concerns the review of relevant literature on ETXs. This includes the documentation on concepts and trials namely for those ETXs which were nationally funded research initiatives as well as analyses on the impact of ETXs.⁵ In the second place, semi-structured interviews were conducted with two ETX providers (Switzerland and Germany) and two major Swiss freight forwarding companies in 1996 and early 1997. These interviews were backed up in nine interviews with individuals from the logistics industry.

Insert Figure 3 about here

For the discussion we have adapted the interaction framework (left side in Figure 3) that covers and integrates the three perspectives we identified in section two (Table 1). It consists of the four elements (1) interaction process, (2) interaction atmosphere which denotes the relationship between two actors, (3) parties involved in the interaction and (4) environment in

which the interaction takes place. The interaction framework is particularly suitable to EC due to its explicit focus on the interaction or transaction process, respectively. It provides multiple factors relating to this process and has also been applied to multiple actors in business networks (Håkansson & Snehota, 1995). However, the interaction approach originates from the marketing area and has not been designed for the analysis of EC systems in the first place. Therefore, modifications will be undertaken which lead to the formulation of three perspectives which are embedded in a network setting.⁶ As shown on the right side in Figure 3 these perspectives are:

- A *technological perspective* focusing on the technological platform of the IOS, e.g. the protocols being used, the architecture of the IOS and qualitative aspects of the infrastructure such as speed, cost or accessibility.
- A *process perspective* that concentrates on the coordination and business processes which are realized 'upon' the technological infrastructure. Relevant aspects are what kind of transaction phases (Figure 2) are electronically supported and to what degree electronic support is achieved across all phases.
- An *actor perspective* is used to understand the impact of IT on industry structures. It highlights the competitive, organizational and political aspects of the relationships between individual and organizational actors within the transportation industry.
- A *network perspective* which takes into account that ETXs draw upon the participation of multiple actors. As soon as multiple actors interact, additional effects result that cannot be explained on the more dyadic actor-to-actor relationship level. Networks have a characteristic of their own, namely the self-reinforcing effects of externalities and critical mass (e.g. Economides, 1996), and are important aspects in explaining the diffusion and adoption of EC systems.

The Technological Perspective

State-of-the-art technology - with varying levels of sophistication - was used to build the ETXs. The first ETX dates back over 20 years. Cost for hardware and software was high in these days and performance was low. Although both factors were considered responsible for the failure of the SVG-system, they only provide a partial explanation since they cannot comprehend the organizational and political reservations which were reported (Eckstein, 1985). A comparable situation can be observed for the Videotex-based systems which spread in the mid-80s. Videotex promised to be an infrastructure which was available on a broad scope and required only limited investment in technological equipment on behalf of the forwarders. Keeping infrastructural investments low was an important factor in an industry dominated by small and medium enterprises and a low diffusion of technological equipment and knowledge. The Videotex-based systems provide an ambivalent picture in that on the one hand many of them failed and on the other hand some survived. From a technological viewpoint three explaining factors can be found:

- The *diffusion of the technological infrastructure* proved to be a success factor for Teleroute which was initiated in France. Minitel, the French Videotex System, is widely used in the business community and an estimated 95% of all transportation companies were already connected to Minitel. In most other European countries, Videotex systems struggled with diffusion problems themselves.

- The *diffusion of the technological equipment* which was necessary to access the ETX.

Although Videotex already reduced the necessary technological investments, the coordination and information benefits were not sufficient to justify these investments. Again, Teleroute benefited from Minitel, because terminals were distributed to many potential participants already.

- The *proprietary nature of the technology* was a problem since the participants could not use the technological investments for other business applications, e.g. EDI or payment services as well. With the Minitel and to a certain extent with the German Btx system as well, a variety of other established services could be accessed as well.

The Process Perspective

With their functionality the ETXs are partial market mechanisms which aim at increasing allocation efficiencies in the road cargo market through improving market transparency.

However, the central criterion for market mechanisms, liquidity, has not been achieved. The ETX's main problem was on the supply side, since sufficient cargo was not available. In case cargo was submitted, it often was only cargo which could not be sold through the traditional channels. Hence the exchanges included cargo not only in a low volume but also cargo which was unattractive for most users. In our studies we identified three factors that were relevant for this lack of liquidity:

- *Incentives for repeated transactions.* Opacity of the market is apparently only of limited concern for the transportation agents. They usually have a sound overview of their market and problems are only perceived when transportation is sought in foreign markets or unfamiliar market segments. It is in this niches that Teleroute is fairly successful. If agents used an ETX they strived for bilateral contacts in follow-up transactions. This 'marriage' or matching effect led to bypassing the ETX and was experienced in the INTAKT trials:⁷ During a three month period the number of entered payload dropped from 17,2 in the first month to 16,1 in the second month to 11,8 in the third month (Eckstein et al., 1990).
- *Support of transaction process.* A partial explanation of the bypassing effect is the lack of benefits the ETXs offered for transactions where transparency was not perceived as problem.

This mainly refers to electronic support in the trading and settlement phase. ETX were isolated systems which did not support entire transaction processes. They implied a change of the medium of communication (from computer-based to phone-based) and were not integrated into forwarders or carriers internal systems (e.g. for disposition, equipment management).

Organizational benefits were very limited because transaction costs were seldom significantly lower than in entirely phone-base transaction.

- *Industry characteristics.* Cost and quality are the main criteria for purchasing transportation services. With a growing specialization in terms of transported goods and risks incurred, e.g. fraudulent declaration of hazardous shipments, electronic descriptions of shipments might not be sufficient and further information is necessary before a shipment can be contracted.⁸ Consequently, the markets on ETXs have become segmented, the overall liquidity is limited and the incentives to participate in the ETXs are diminishing. Incentives increase with the availability of agreed-upon quality levels and the possibility to follow-up a carrier's performance, e.g. by linking the ETX to tracking and tracing systems.⁹

The Actor Perspective

Looking at the relationships between the various players in the contested road transport market, we find a limited amount of horizontal cooperation and trust among the competitors. The players show a preference to deal with each other at arm's length and compete for bilateral relationships with the shippers. This makes sense since logistics companies are squeezed between the interests of their customers, i.e. the shippers and consignees. They have considerable potential for economies of scale and for gaining a professional profile by consolidating deliveries etc. as well as for adapting to the customer's administrative requirements. Forwarders and carriers are therefore trying to build stable relationships with their customers. More anonymous

transactions on ETXs are counterproductive to strategies that aim at improving and deepening customer relations and at maintaining control over these relationships. Outsourcing of logistics services, e.g. warehousing and distribution, recently has become quite popular and logistics companies are trying to increase forward and backward integration with their customers and thus evade cutthroat price competition (cf. Clemons & Reddi, 1994).

As quality requirements for logistics services are increasing (accurate timing, treatment of the shipment etc.), shippers are less inclined to hand their shipments to unknown forwarders or carriers and face numerous risks from delays to the loss of entire shipments. Bakos & Brynjolfsson (1993) have shown that when quality is a concern, it can be optimal to reduce the number of suppliers. In our analysis we found three factors that supported the inhibiting attitude of logistic companies towards ETXs:

- The *personal contacts* were not supported by the ETXs. Personal experiences and credible recommendations reassure agents that certain quality standards are met (e.g. reliability, damage in transit, financial difficulties). ETXs lacked an institution which was able to not only define quality standards, but also to control and to sanction players which did not meet these standards.
- As intermediaries, forwarders feared *changes in information asymmetries*. Bakos (1997) has explained how market coordination leads to more transparent markets and decreases the profit margins of intermediaries. Thus, these players are interested in maintaining the current asymmetric distribution of information and suspect that ETXs might put carriers in direct contact with shippers (disintermediation) or that customers/shippers might be lost to competitors. In comparison to passenger transport or the financial sector, the transportation industry faces relatively little external regulation.

- ETXs were faced with a *highly integrated demand and supply side*. In Europe forwarders, especially large forwarding companies, often also act as carriers which explains why neither of both parties really promoted ETXs. In addition to the fragmented nature of the market, no key players existed that were in the position to force other players in using the systems.

The Network Perspective

Based on the effects on process and actor level, especially big companies hesitated to use the ETX and there was not sufficient support from logistics associations. Without their support and their potential volume of transactions, many of the mentioned projects never gained critical mass. On the contrary, negative externalities were experienced due to a lack of liquidity. Although the ETXs had quite a number of participants, transaction volume was low because the users had low expectations that attractive cargo would be available and therefore refrained even from accessing the ETX. With the exception of COMIS and Teleroute none of the ETX gained sufficient mass to offset positive externalities. These examples show that ETXs are subject to dual externalities:

- *Infrastructure-specific externalities*. Teleroute was launched in France where the national Videotex infrastructure has reached a critical mass of users. This favored the diffusion of the ETX because potential ETX-users had the technical equipment already in place and were used to electronic transactions.
- *ETX-specific externalities*. Both COMIS and Teleroute were able to take advantage of institutional regulations. In COMIS all payload surpassing 75 km had to be submitted into the system. In the French market where Teleroute was launched, 40% of all cargo had to be publicly advertised.

Perspectives for Internet-based Exchanges

A strong economic rationale and profound changes in the cost/performance ratio of IT has led to the emergence of numerous new ETX. However, the question remains, about the differences to the traditional ETX and whether past lessons have been learned.

Although technology has not been identified as a major inhibitor for the success of ETXs, the emergence of the Internet as a global communication infrastructure is likely to affect the rationale and configuration of ETXs. Table 4 lists recent ETXs based on the (World Wide) Web, which have been initiated mostly by new players in this field. These systems are still very young and empirical evidence about the diffusion is hardly available. However, in some interviews with freight forwarders skepticism was reported concerning the immediate acceptance of these systems in the business community. Today's Web-based ETXs more or less reflect the same configuration as the traditional ETX and the potentials of the Web are only partly exploited. We are using our framework to show the extend to which the Web can make a difference and what might be success factors for Web-based ETXs.

Insert Table 4 about here

The Technological Perspective

The diffusion of the Web is affecting the economic rationale and the positioning of ETXs because all three factors identified in section 4.1 are influenced. The Web is the fastest growing Internet service¹⁰ and well established in the business community. Generally, client-server technology with Web browsers as standardized intelligent clients provides an environment to develop versatile and flexible inter-organizational applications (Kalakota & Whinston, 1996).

Compared to the Videotex systems that have mainly been used for ETXs, the Web has specific structural properties:

- *Global scope.* The Web transcends the national perspective and is global in nature which is especially important because logistic chains are increasingly international and ETX proved valuable in discovering foreign markets.
- *Low cost.* The equipment needed for Web access (PC, Browser etc.) is a commodity and widely available. Since even small transportation companies are using PC-based systems already, entry barriers have been lowered significantly while functionality (e.g. speed, graphical interfaces) has been extended.
- *Standardized platform.* Furthermore, these investments are not specific to the ETX application and the Web represents an open technological platform for the support of other business processes as well (e.g. EDI, payment services).

Transportation companies can start with their most central applications and then gradually, as they become more experienced, extend the scope of their Web activities.

Cybermediaries, which offer to host their clients' Web-sites, function as outsourcers and enable small and medium enterprises to build a Web presence even before the technical know how has been built internally. The foreseeable competition will yield a broad stream of high-quality products at reasonable prices

The Process Perspective

As standardized, open and platform-independent infrastructure with an attractive cost structure the Web represents a highly appropriate infrastructure for ETXs. From a process perspective several characteristics create positive effects on ETX participation and liquidity:

- *Increasing the value added.* The evolution of Web technology from static HTML pages to interactive applications with links to internal databases has opened up the scope of applications towards more comprehensive support of transactions. Since the Web does not determine the structure of the application it is a well-suited integration platform for bundling (traditional) information processes with (new) value adding trading and especially settlement processes. This leads to reduced transaction costs compared to phone-based transactions, takes advantage of integration effects and increases the incentives for participants.
- *Providing a mix of coordination mechanisms.* ETXs have to cope with the need for flexible, multilateral and integrated, bilateral relationships at the same time. Web applications can be set-up and focused on specific market segments more easily. We therefore expect that the Web will enable mixed-mode configurations (Holland & Lockett, 1994) where logistics companies will use different coordination mechanisms concurrently (from hierarchy to market) according to their dynamically changing requirements. Technologically advanced and highly successful Web-applications in the parcel segment (e.g. <http://www.fedex.com>) are setting the level of expectations for other market segments as well.
- *Active process coordination.* Compared to the Web traditional ETX were rather passive in the sense that users had to access the systems to see whether suitable postings were available. On the Web agent-systems which constantly gain in sophistication are spreading and information will be 'webcasted' to the users whenever postings match a certain profile. These individual transportation agents might also monitor multiple ETX as well as carrier's tracking and tracing sites once the cargo is shipped.

The Actor Perspective

As our analysis of the actor level in section 4.3 showed, there has been considerable resistance on this level and we have indicated that traditional ETX changed the way business has been done in the industry without providing adequate instruments which could compensate for the increased anonymity. The intelligent and tailored use of Web-resources could foster an adequate environment for ETX-usage on the Web.

In the first place we see a structural *isomorphism between the transportation industry and the Web*. The Web mirrors the structure of logistics and vice versa. Both are highly decentralized and distributed in nature and players are rather heterogeneous. It is important to realize that attempts to centralize road cargo are doomed to fail because a dominating actor does not exist and cooperation between transportation companies is still at arm's length. Information sharing is a highly political issue and we expect structures to emerge which limit the risks of unauthorized access to data and unknown business partners. We see the application of ETXs within Intranets and Extranets (cooperation with major trading partners) and within virtual communities on the Internet.

Communities reduce anonymity in transaction and represent platforms for the definition, control and sanctioning of community-wide standards (e.g. quality levels). The Web has lowered the threshold for cooperation and has become a community builder. It enables cooperation strategies which are of increasing relevance in road transport and allows the coexistence of cooperation and competition. The combination of a fluid and dynamic medium which encourages trials and low initial investments and low asset specificity helps to overcome prior obstacles to develop an ETX.

Research shows that electronic commerce has a profound impact on the role of *intermediaries*. While on the one side disintermediation and bypassing is occurring, Sarkar et al. (1995) explain the substantial need for Web-specific intermediaries, so called cybermediaries, on the other side. Cybermediaries act e.g. as trusted third parties, information brokers or platform providers in order to reduce the complexity and opaqueness of the Web. Thus the Web enables disintermediation in some cases while new business opportunities emerge for intermediaries. We see two trends, which occur concurrently: As it becomes easier and cheaper to set-up an ETX on the Web, more focused and specialized ETXs organized within communities are likely to emerge. On the other hand, more open and less specialized exchanges will be organized by players who have sufficient clout in the market.

In a recent case study of Global Logistics System Asia, which has been initiated by four airlines, Damsgaard (1998) has pointed out that the system has been fairly successful because it has been carefully designed to meet the needs of the envisioned participants (airlines, forwarders, and air cargo terminals) and to preserve the sensitive balance of power and responsibilities among them.

The Network Perspective

To a great extent the network level reflects the mentioned success factors on various levels. Low costs, open technical systems, high value added and low transaction costs together with a limited amount of uncertainty concerning disintermediation, security and quality will generate positive expectations and spur the diffusion of ETX. The advantage of the Web is the critical mass of participants and the technical scalability with limited initial investments. Since critical mass has already been reached, ETXs can benefit from positive network externalities on the infrastructural level. Even competing ETXs might yield more users as long as they are built

on the same infrastructure and protocols. Low transaction fees reduce the incentives for bypassing and hence the risks of losing business as a result of bypassing. However, the integration of ETXs into the internal operations requires more specific technical solutions.

Conclusions

ETXs have been falling short on both ends of the continuum between markets and hierarchies: Neither did they support entire market transactions and thus generate specialized market segments nor were they used to improve the process integration among logistics companies and their customers. Despite an apparently convincing macro-economic rationale (more efficient use of the congested transport infrastructure) and successful examples of electronic markets in related transport segments, namely the CRS, ETXs did not succeed because of the underlying structures of the services, the relationships between the business partners and structural features of the industry. Our framework emphasized that there is no single factor that is responsible for the lacking diffusion but a set of various highly interrelated factors. Understanding industry characteristics are key to EC systems since they are network goods which require the participation of autonomous actors. The following table summarizes design recommendations for successful ETXs which mirror industry specific requirements.

Insert Table 5 about here

Using an information infrastructure which mirrors the structure of the industry helps in establishing successful EC systems. While the Internet does not by itself lead to improved liquidity and incentives for ETX users, it is, however, profoundly changing the economics of

ETXs as the communication infrastructure and client software (browsers) are almost pervasive and for free. As a result, ETX are sustainable with lower transaction fees and a lower transaction volume and therefore can be targeted for specific market segments. In addition the Web will be used more extensively for network like governance structures (closer coupling, higher level of integration etc.) among logistics companies and their customers.

Therefore, lessons from traditional ETX encompass multiple factors. First, technological investments should be kept at a minimum regarding cost and asset specificity and offer maximal openness in order to include heterogeneous participants. Second, the systems have to provide benefits in the transaction process, thus increasing the operational incentives for participation. Third, actors who possess volume are critical for liquidity and should be included in early development stages already. There is clearly an opportunity to overcome some of the obstacles ETX have faced so far and to align the economic rationale of ETXs and their strategic positioning through a careful configuration of technical, procedural, institutional and network dimensions.

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Footnotes

* An earlier version of this paper has been presented and included in the Proceedings of the 31st Annual Hawaii International Conference on System Sciences. Los Alamitos, CA.: IEEE, 1998, Vol. IV, 102-111.

¹ For an overview and a comparison of various electronic exchanges cf. Domowitz (1993).

² The productivity is calculated (payload shipped × hours of usage) / (vehicle payload × maximum hours of usage).

³ We term them *traditional* because the following analysis does not include the status of the Internet-based ETXs where experiences are still lacking (see section 5).

⁴ A similarly complex approach has also proven to be suitable in failure analyses by other authors (e.g. Mitev, 1998).

⁵ This mainly refers to reports in newspapers and periodicals and the studies undertaken by Büllingen (1994) and Baum et al. (1995).

⁶ Using different layers for designing IS has already proved useful in other approaches, namely the business engineering model from Österle (1995) which distinguishes strategy, process and IS/IT layers.

⁷ The *marriage effect* is closely related to the fundamental transformation known in transaction cost economics (Williamson, 1985).

⁸ For the role of product descriptions in the development of electronic markets cf. Malone et al. (1987).

⁹ *Tracking* enables to identify the whereabouts of a shipment while in transit and *tracing* to determine ex-post the itinerary of a shipment together with the critical events that occurred.

¹⁰ In January 1993 the number of Internet hosts was 1.313.000. In January 1999 approx. 43.230.000 Internet hosts were counted (Network Wizards, 1999).

Figure 1. Factors leading to the Great Reversal

Figure 2. The transaction process

Figure 3. The Interaction Framework

Table 1

Research perspectives on IOS

Focus	Research perspectives
<i>Technology and process issues</i>	Research on EDI and CIM: (re)design of business processes, e.g. organizational integration of EDI (e.g. Wagenaar & Heijden, 1994)
<i>Competitive impact and industry structure</i>	Research on changing industry structures (e.g. Porter & Millar, 1985)
<i>Network analysis</i>	Structure of networks (e.g. Economides, 1996), quality of the relationships among the players

Table 2

Evolution of ETX in Europe

System	Regional scope	Operation	Provider	Communication
SVG-Datafracht	Germany	1973 – 1974	Association of German road hauliers (SVG)	Phone
LOG	Germany	1980 – 1986	Project funded by German Ministry for Research & Technology	Datex-P (X.25)
Telefracht	Germany	1982 – 1985	Log-Sped (Group of road transport carriers)	Videotex (Btx)
Tradicom	Netherlands	1982 -	NOB-Wegtransport (Group of road transport carriers)	Videotex (Viditel)
AMÖ-removal exchange	Germany	1985 – 1990	Association of German furniture removal companies	Btx
Intakt	Germany	1985 – 1989	Project funded by German Ministry for Research & Technology	Datex-P, Btx
Transpotel	Europe	1984 – 1995	German road transport publishing company	GEIS, Btx
Teleroute	Europe	1986 -	Wolters-Kluwer Publisher	Videotex/ Datex-J
COMIS	Germany	1987 -	Confem-furniture removal company	Btx, SNA, ISDN
BWV	Germany	1990 -	Federal association for corporate transport and shippers (BWV)	GEIS Mark III, Videotex
Transponet / TIR-Online	Europe	1985 -	Elsevier (Dutch publishing company)	X.25, Videotex
EFIS	Europe	1994 – 1995	Mercury, DVK, Hanro, Infocheck, Shohet and Cie.	Phone, Fax, Modem
Telefracht	Switzerland	1995 -	Telefracht (Information service provider)	Phone, Fax, Modem

Table 3

Taxonomy of development stages and degrees of IOS failure

Development stage	Outcome	Failure factor
1. Conceptual stage of solution	No funding, no sponsors for a 'go' decision	Funding Lack of sponsors
2. Prototype realized	No roll-out	Business model not convincing, requisite support could not be solicited
3. Roll-out accomplished	Quiet termination after brief operation	Lack of acceptance by critical players in the application domain
4. Roll-out, initial acceptance of a small group of players, later diminishing rate of acceptance	Application not sustainable, initial subsidies and probably external project funding spent, no further funding could be solicited	Lack of critical mass Lack of viable business model
5. Living application, however too small to flourish too big to die	Scaled down application, viable for the time being for political reasons (sunk investments too high for immediate shut down)	Lack of critical mass of users Political, technical and / or financial obstacles to broader acceptance

Table 4

Web-based ETXs

Initiator	Example of Web-based ETX
<i>Established player</i>	<p>Teleroute (http://www.teleroute.com)</p> <p>BWV-Cargonet / TIR-Online (http://www.tir-online.com)</p> <p>Transport Exchange (http://www.transportexchange.com)</p>
<i>New player</i>	<p>Eurotrans (http://www.eurotrans.com)</p> <p>Internet Trucking Info (http://www.internet-trucking.com)</p> <p>Internet Truckstop (http://www.truckstop.com)</p> <p>Loglink (http://www.loglink.net)</p> <p>Massmotion (http://www.massmotion.com)</p> <p>National Transportation Exchange (http://www.nte.net)</p> <p>The Cargo Exchange (http://www.cargox.com)</p> <p>Trucknet (http://www.truck.net)</p>

Table 5

Lessons for the configuration of ETXs

Industry characteristics	Configuration of the ETX
<i>Distributed operations and network externalities</i>	<ul style="list-style-type: none"> • Exploit advantages of distributed low-cost communication infrastructure, e.g. for internal purposes, closed user groups, and open communication • Include key partners in ETX design stages
<i>Segmented market with intense price competition and antagonistic relationships among the players</i>	<ul style="list-style-type: none"> • Design adaptable ETX with variable focus on market segments and variable degrees of transparency, varying coordination mechanisms (mixed-mode) • Use low-cost infrastructure with low asset specificity
<i>Lack of coercion and dominant players</i>	<ul style="list-style-type: none"> • Offer benefits in transaction process, especially integration along the transaction phases (from information to settlement) • Define intermediation roles, i.e. check who plays cybermediary role and who is disintermediated
<i>Focus on relation building, quality and trust</i>	<ul style="list-style-type: none"> • Integrate ETX seamless in traditional operations • Provide support for personal contacts (communities, trust services etc.)