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Jouni Kauremaa

STUDIES ON THE UTILIZATION OF ELECTRONIC TRADING SYSTEMS IN SUPPLY CHAIN MANAGEMENT

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Abstract

Innovations in information technology, Internet-technology in particular, have provided a significant new potential to exchange data beyond organizational boundaries and reduce the costs of interorganizational supply chain management. Furthermore, modern e-business standards, such as the RosettaNet, have been proposed as key enablers of efficient and flexible operational linkages between trading partners in the supply chain. This dissertation investigates three overall research questions: (1) how do companies utilize electronic trading systems in supply chain management; (2) what kinds of benefits do electronic trading systems provide in supply chain management; and (3) what is the role of newer e-business standards in supply chain management. The dissertation is a compilation of four individual studies reported as four peer-reviewed publications.

Firstly, on RQ1 the dissertation finds that (1) electronic trading system utilization realizes on two levels: relationship mode (unilateral or bilateral) and technical design (function, architecture, automation, and communication standards and networks) and that (2) effective utilization of electronic trading systems is characterized by differentiation over transaction instances (partner and task combinations). Secondly, on RQ2 the dissertation finds that (1) cooperative, operational, and commercial supply chain integration are distinct results of electronic trading system utilization in supply chain management and that (2) unilateral adjustments supplement benefit generation from electronic trading system utilization. Finally, on RQ3 the dissertation finds that (1) the RosettaNet e-business standard does not fully compensate for the weaknesses of older EDI-based e-business standards and that (2) dyad-level application of e-business standards calls for dyadic adjustments amongst the trading partners. The dissertation contributes to understanding on how to effectively utilize contemporary electronic trading systems in supply chain management.

Keywords Electronic trading systems, interorganizational information systems, supply chain management, supply chain integration, EDI, RosettaNet.

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Tiivistelmä
Innovaatiot tietoteknologioissa erityisesti Internet-teknologioiden osalta ovat tarjonneet merkittäviä uusia mahdollisuuksia vaihtaa tietoja yli organisaatiorajojen ja vähentää organisaatioiden välisen toimitusketjun hallinnan kustannuksia. Lisäksi nykyaikaisia elektronisen liiketoiminnan standardeja on ehdotettu tärkeiksi mahdollistajiksi tehokkaiden ja joustavien yritysten välisten yhteyksien luomisessa. Tämä väitöskirja tutkii kolmea yleistä tutkimuskysymystä: (1) miten yritykset hyödyntävät sähköisiä kaupankäyntijärjestelmiä toimitusketjun hallinnassa; (2) mitä hyötyjä sähköiset kaupankäyntijärjestelmät tuovat toimitusketjun hallintaan; ja (3) mikä on uudempien sähköisen liiketoiminnan standardien rooli toimitusketjun hallinnassa. Väitöskirja on kooste neljästä tutkimuksesta, jotka on raportoitu neljänä erillisjulkaisuna.

Väitöskirjan ensimmäisen tutkimuskysymyksen osalta havaitaan että (1) sähköisten kaupankäyntijärjestelmien hyödyntäminen realisoituu kahdella tasolla: yhteistyösuhteen luonne (unilateraalinen tai bilateraalinen) ja järjestelmien tekninen rakenne (toimintatarkoitus, arkkitehtuuri, automaatio ja viestintästandardit ja –verkot) ja että (2) sähköisten kaupankäyntijärjestelmien vaikuttavalle hyödyntämiselle on luonteenomaista erilaistaminen transaktioinstassi–kohtaisesti. Toisen tutkimuskysymyksen osalta havaitaan että (1) yhteistyö-pohjainen, operaativinen ja kaupallinen toimitusketjun integraatio ovat eriluonteisia mahdollisia tulemia sähköisten kaupankäyntijärjestelmien hyödyntämisestä toimitusketjun hallinnassa ja että (2) yksipuoliset mukautukset täydentävät sähköisistä kaupankäyntijärjestelmistä saatavia hyötyjä. Kolmannen tutkimuskysymyksen osalta havaitaan että (1) RosettaNet–pohjaiset sähköisen liiketoiminnan standardit eivät korvaa täysin vanhempien EDI-järjestelmien puutteita ja että (2) sähköisen liiketoiminnan standardien soveltaminen vaatii kahdenvälisiä mukautuksia kauppakumppaneiden välillä. Väitöskirjan tulokset lisäävät ymmärrystä kysymykseen miten hyödyntää sähköisiä kaupankäyntijärjestelmiä toimitusketjun hallinnassa.

Asiasanat Electronic trading systems, interorganizational information systems, supply chain management, supply chain integration, EDI, RosettaNet.

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Otaniemi, May 4, 2010

Jouni Kauremaa

I looked ahead to see how far I had to go. The glance gave me one of my last images of Richard Parker, for at that precise moment he jumped over me. I saw his body, so immeasurably vital, stretched in the air above me, a fleeting, furred rainbow. He landed in the water, his back legs splayed, his tail high, and from there, in a few hops, he reached the beach --- He ran a hundred yards or so along the shore before turning in --- At the edge of the jungle, he stopped. I was certain he would turn my way. He would look at me. He would flatten his ears. He would growl. In some such way, he would conclude our relationship. He did nothing of the sort. He only looked fixedly into the jungle. Then Richard Parker, companion of my torment, awful, fierce thing that kept me alive, moved forward and disappeared forever from my life.

(From Yann Martel's Life of Pi*)*

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PAPER II

Kauremaa J., Småros, J., Holmström J., 2009. Patterns of Vendor-Managed Inventory: Findings from a Multiple-Case Study. *International Journal of Operations and Production Management*, 29 (11): 1109-1139.

PAPER III

Kauremaa J., Kärkkäinen, M., Ala-Risku, T., 2009. Customer Initiated Interorganizational Information Systems: The Operational Impacts and Obstacles for Small and Medium Sized Suppliers. *International Journal of Production Economics*, 119 (2): 228-239.

PAPER IV

Kauremaa J., Nurmilaakso, JM., Tanskanen, K., Forthcoming. E-business Enabled Operational Linkages: The Role of RosettaNet in Integrating the Telecommunications Supply Chain. Accepted for publication in the *International Journal of Production Economics*.

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KEY TERMS

Term	Definition
Backend information system	Internal information systems of an organization which either send or receive information via an electronic trading system.
Bilateral relationship mode of electronic trading system utilization	Electronic trading systems deployed from perspective of dyad-level joint goals and respective mutual benefits.
E-business standard	A class of non-proprietary communication standards designed to support the integration of interorganizational business processes via system-to-system integration.
Electronic data interchange (EDI) (in general)	Interorganizational exchange of business documentation in structured, machine-processable form (Emmelhainz 1990, p. 4).
Electronic data interchange (EDI) (standard)	Specific e-business standards: EDIFACT (EDI for Administration, Commerce and Transportation) and ANSI (American National Standards Institute) X12 and their subsets EDIFICE (EDI Forum for Companies with Interests in Computing and Electronics) and EIDX (Electronics Industry Data Exchange) for the electronics industry.
Electronic trading systems (e-trading systems)	The means related to the digital transfer of data between two separate organizations.
Interorganizational information systems (IOISs)	Information systems linking separate organizations (Barret and Konsynski 1982, Cash and Konsynski 1985, Johnston and Vitale 1988, Bakos 1991b). Synonym in this work to electronic trading systems.
Relationship mode issues of electronic trading system utilization.	Selection between the unilateral and bilateral modes of interorganizational electronic exchange of an electronic trading system.
RosettaNet (organization)	The organization that develops the RosettaNet standard.
RosettaNet (standard)	An open business process standard, encompassing data dictionaries, implementation framework, and XML-based business message schemas and process specifications (RosettaNet 2008).
Supply chain	An identifiable system of material and information flows involving a set of organizations engaged in the process of delivering a good or service to a party ultimately in need of it.

Term	Definition
Supply chain integration	The process and the state of cooperative, operational, and commercial unification of autonomous businesses along a supply chain in order to increase revenues, decrease costs, and improve asset utilization.
Supply chain management (SCM)	Supplying of products to meet demand in a complex and uncertain world from the point of view of the entire supply chain (Kopczak and Johnson 2003, p. 28).
System-to-human integration	Semi-automated data exchange. Data from the internal information system of one transacting party is delivered or received in an electronic format to the other transacting party, who processes this data manually.
System-to-system integration	Fully automated data exchange. Data is exchanged between the internal information systems of the transacting parties without human intervention.
Technical design issues of electronic trading system utilization	Selection of function, architecture, automation, and communication standards and networks of an electronic trading system.
Transaction instance	The unique occurrence of a recurring task taking place at in the interorganizational context between a given buyer and a given supplier.
Unilateral relationship mode of electronic trading system utilization	Electronic trading systems deployed from a single party perspective and aimed for individual benefits.
Vendor-managed inventory (VMI)	The transfer of decision rights and responsibilities related to replenishment from buyer to supplier.

PART I:
SUMMARY

”The proper uses of the Internet have become a key source of productivity and competitiveness for all kinds of businesses.” (Castells 2001, p. 64)

1 INTRODUCTION

1.1 Background

Oliver Williamson has proposed that in organizing interorganizational transactions firms should either resort to markets or internalize a given transaction. The selection of each governance form should be based on considerations on the transaction specific attributes: asset specificity and environmental and behavioral uncertainty (Williamson 1985, 1994). Assuming the inclination of human agents to profit at the expense of others, both the higher perceived uncertainty of future events and the specificity of assets to a given transaction should raise the attractiveness to organize under a single authority. Conversely, firms would rather favor markets over hierarchies in other kinds of instances.

However, in practice, firms increasingly operate between these two idealizations, under hybrid forms of governance. Williamson (1985), although focused on the two ends of the continuum, also recognized the central role of the hybrid forms by noting that “transactions in the middle range are much more common” (p. 83) and “[while] the tails of the distribution are thick … greater attention to transactions in the middle range will help to illuminate an understanding of complex economic organization” (p. 84). Today, the reason for the relevance of hybrid governance forms stems from two ongoing and intertwined trends: specialization of the business function and developments in electronic communication technologies. The first of these undercurrents implies the ever increasing outsourcing of non-core business operations (Prahalad and Hamel 1990) and reliance on multi-company supply chains (Kemppainen and Vepsäläinen 2003). Thus, supply chain management has emerged both as a notable profession and academic discourse (Fisher 1997, Mentzer, DeWitt, Keebler, et al. 2001, Kopczak and Johnson 2003, Halldorsson et al. 2007).

The second trend implies significantly increased possibilities to enhance the effectiveness and efficiency of supply chain management. To exchange data in electronic format beyond organizational boundaries organizations need electronic trading systems. These systems comprise the means to digitally transmit data between two separate organizations. Intermediately, organizations want to improve the efficiency and effectiveness of supply chain management processes (Bowersox et al. 1999) and ultimately, to reach competitive advantage

through increased sales, reduced costs, and improved asset utilization (Christopher 2005). The key mechanism is the reduction of coordination costs (Malone et al. 1987, Bakos 1991b, Clemons and Row 1992, Clemons et al. 1993, Malone and Crowston 1994). Broadly, these costs arise from the need to manage dependencies between separate activities (Malone and Crowston 1994). Innovations in information technology (IT), Internet-technology in particular, have provided a significant new potential to exchange data beyond organizational boundaries and thus reduce the costs of interorganizational supply chain management (Gunasekaran and Ngai 2004). Furthermore, management information system scholars have been promoting modern e-business standards as key enablers of efficient and flexible operational linkages between trading partners in the supply chain (Gosain et al. 2003, 2004, Bala and Venkatesh 2007, Malhotra et al. 2007, Chong and Ooi 2008). Others have suggested that newer e-business standards, such as the RosettaNet, would overcome the challenges of older EDI standards (Reimers 2001, Goldfarb and Prescod 2004). Yet, the question of effective utilization of electronic trading systems in supply chain management is far from settled (Boone and Ganeshan 2007).

1.2 Objective and research questions

The objective of this dissertation is to improve understanding on how to effectively utilize contemporary electronic trading systems in supply chain management. From a macro-economic perspective, the use of e-trading systems has become business as usual. The US Census Bureau predicted in 2007 that the total value of business-to-business electronic trading within the US economy would reach $5.8 trillion by 2010, up from $3.6 trillion (30 % of GDP[1]) in 2007 (Laudon and Traver 2008, p. 754). Yet, academic literature points to challenges in realizing the potential. Bagchi and Skjoett-Larsen (2002) observe from a study of five cases underinvestments in electronic trading systems. Similar conclusions are reached by a later European level survey with 149 respondents representing various manufacturing industries (Bagchi and Skjoett-Larsen 2005). More recently, Angeles and Nath (2007) conclude from a survey of 182 purchasing experts that lack of system integration and standardization issues provide a notable category of obstacles in integrating interorganizational procurement processes. Fawcett et al. (2008) report from a survey of 588 managers inadequate information systems as the top perceived barrier to effective supply chain management. Confusion is added by success stories of electronic trading systems

[1] 2005 figures (Economist 2008)

utilization by Internet-era icons such as Cisco, Dell, and Intel (Bunnell 2000, Magretta 1998, Christopher 2005, pp. 19-28, Cartwright et al. 2005).

Motivated by the preceding, this dissertation investigates the following three research questions:

> ***RQ (1)****: How do companies utilize electronic trading systems in supply chain management?*
>
> ***RQ (2)****: What kinds of benefits do electronic trading systems provide in supply chain management?*
>
> ***RQ (3)****: What is the role of newer e-business standards in supply chain management?*

Answers to these descriptive questions are aimed to better understand how to utilize electronic trading systems for effective and efficient supply chain management. Such normative implication calls for better understanding the ways companies use modern e-trading systems, the kinds of benefits these systems provide, and the role of newer e-business standards in using these systems.

1.3 Outline

This dissertation comprises four individual studies from four different empirical supply chain management contexts. These studies are reported as four peer-reviewed publications as follows.

In the context of Finnish manufacturing and trade industries, Paper I "Benefits of IT in Supply Chain Management: An Explorative Study of Progressive Companies", reports the findings of an exploratory case study of the state-of-practice in e-trading systems utilization in 2003 among Finnish manufacturing and trade companies. Paper I studies three specific research questions: (1) what are the benefits e-trading systems for supply chain management, (2) how are e-trading systems utilized in the supply chain context, and (3) whether there is a trend in the use of e-trading systems for supply chain management.

In the context of buyer-supplier replenishment systems, Paper II, "Patterns of Vendor-Managed Inventory: Findings from a Multiple-Case Study", reports findings from a multiple-case study on the vendor-managed inventory (VMI) model, an example of an innovative supply chain management practice, coupling interorganizational business process

development and digital data exchange (Clark and Stoddard 1996, Holmström 1998). Paper II studies two specific research questions: (1) what kinds of benefits are realized from a VMI program (operational, i.e. efficiency related, versus commercial, i.e. sales related) and (2) how the benefits are shared at the dyad level (suppliers versus buyers). As a result, three empirically grounded patterns of VMI utilization are identified. In addition, five contextual inhibitors of VMI impacts are proposed.

In the context of supplier-facing transaction systems, Paper III, "Customer Initiated Interorganizational Information Systems: The Operational Impacts and Obstacles for Small and Medium Sized Suppliers", reports the findings of a case study on the use and benefits of an e-trading system offered by a consumer durables retailing company to its suppliers, all small and medium sized enterprises (SMEs). Paper III studies in particular how system-to-human and system-to-system integration compare as means for supply chain integration from the perspective of non-initiating SME suppliers. The results are summarized as two key findings.

Finally, in the context of customer-facing transaction systems, Paper IV, "E-business Enabled Operational Linkages: The Role of RosettaNet in Integrating the Telecommunications Supply Chain", evaluates the effectiveness of the RosettaNet in integrating the telecommunications supply chain. The in-depth case study analyzes the efforts of a globally operating manufacturer of infrastructural equipment for mobile telecommunications networks to create system-to-system integration supported business processes towards its customers, telecommunications operators. Paper IV studies the role of the RosettaNet standard in supply chain integration in the context of telecommunications equipment supply from both the supplier's and the buyer's perspectives. As a result, the paper develops two propositions for further research on RosettaNet-based e-trading systems.

The remaining structure of the summary of this dissertation summary is as follows. Chapter 2 reviews prior literature on hybrid forms of governance (Section 2.1), supply chain management and integration (Section 2.2), and electronic trading systems (Section 2.3) to explicate a gap in prior literature (Section 2.4). Chapter 3 exhibits research methods and data. Chapter 4 reviews the four disclosed publications. Chapter 5 interprets the empirical results as overall findings against the three overall research questions. Discussion of the contribution, limitations, and implied further research follow in Chapter 6.

2 LITERATURE REVIEW

Next, prior literature to this dissertation is reviewed. The chapter starts with a review of the high-level theory bearing relevance on this study, the transaction cost economics (TCE) framework. For this work, the most important implication of TCE is the concept of hybrid forms of transaction governance. These two topics are addressed in Section 2.1. Sections 2.2 and 2.3 review literature on the two specific research discourses this work builds on. The topic of Section 2.2 is supply chain management (SCM) and supply chain integration, the key goal of SCM. The topic of Section 2.3 is electronic trading systems – key concepts and their brief near history, data exchange standards, and prior conceptualizations of their utilization. The chapter ends in Section 2.4 with the identification of a gap in prior literature this dissertation contributes to.

2.1 Hybrid forms of transaction governance

The notion of hybrid forms of transaction governance originates from the *transaction cost economics (TCE)* framework (Rindfleisch and Heide 1997, Carter and Hodgson 2006). In general, TCE as developed by Williamson (1985, 1991, 1994), can be placed within the discourse on the theory of the firm, dealing with the fundamental questions of why do firms exist and what determines their scale and scope. In this respect, Coase (1937) asked in his article “The Nature of the Firm”, why do firms exist altogether and all economic activity conducted through market transactions and price based coordination. Coase’s answer was that firms exist because there are costs using the price mechanism, i.e. *transaction costs*, such as discovering relevant prices, negotiating and concluding a contract, and, in the longer term, specifying *ex ante* all *ex post* contingencies.

Williamsonian TCE takes its base from Coase’s work. The TCE framework suggests that companies should economize on transaction costs given differences in the attributes of the transactions (Williamson 1991, p. 79). The TCE perspective posits organizations determine relevant transactions (which occur whenever “a good or service is transferred across a technologically separable interface” [Williamson 1985, p. 1]); next, determine the attributes of these transactions; further, determine their economic implications; and finally, design and deploy governance structures and safeguards to match transaction attributes in order to economize on transaction costs. TCE is based on two key behavioral assumptions of individual agents operating within organizations: bounded rationality (human behavior being

"intendedly rational, but only boundedly so" [Simon (1945) 2000], p. 88, original emphasis) and opportunism ("self interest seeking with guile" [Williamson 1985, p. 30]). These behavioral assumptions give three relevant implications: all complex contracts are unavoidably incomplete, contract as a promise is fraught with troubles, and there is an added value in economizing on bounded rationality and safeguarding against opportunism (Williamson 1991, p. 79).

Noting this, TCE posits that transactions – the basic unit of TCE analysis – have four elementary attributes: (1) frequency, (2) behavioral uncertainty (i.e. risk of opportunism), (3) environmental uncertainty, and (4) asset specificity (assets that "cannot be redeployed without sacrifice of productive value if contracts should be interrupted or prematurely terminated" [Williamson 1985, p. 54]) (Williamson 1985, 1991). Given a basic level of frequency of transactions and environmental uncertainty, both opportunism and asset specificity drive transaction costs, necessitating – by farsighted, yet boundedly rational agents – the *ex ante* design and implementation of safeguards of varying calibers (Williamson 1994). In particular, asset specificity is the nexus concept of the TCE framework, or as Williamson puts it, "the big locomotive to which transaction cost economics owes much of its predictive content" (1985, p. 56). It activates the basic mechanism within TCE, making things difficult, insecure, and expectedly costly by accentuating the potential forthcoming hazards by raising the risk of *de facto* loss of balance sheet item value through unexpected events and eventual opportunism of the contracting parties.

To organize a transaction, Williamson (1985, 1994) suggests two main forms:

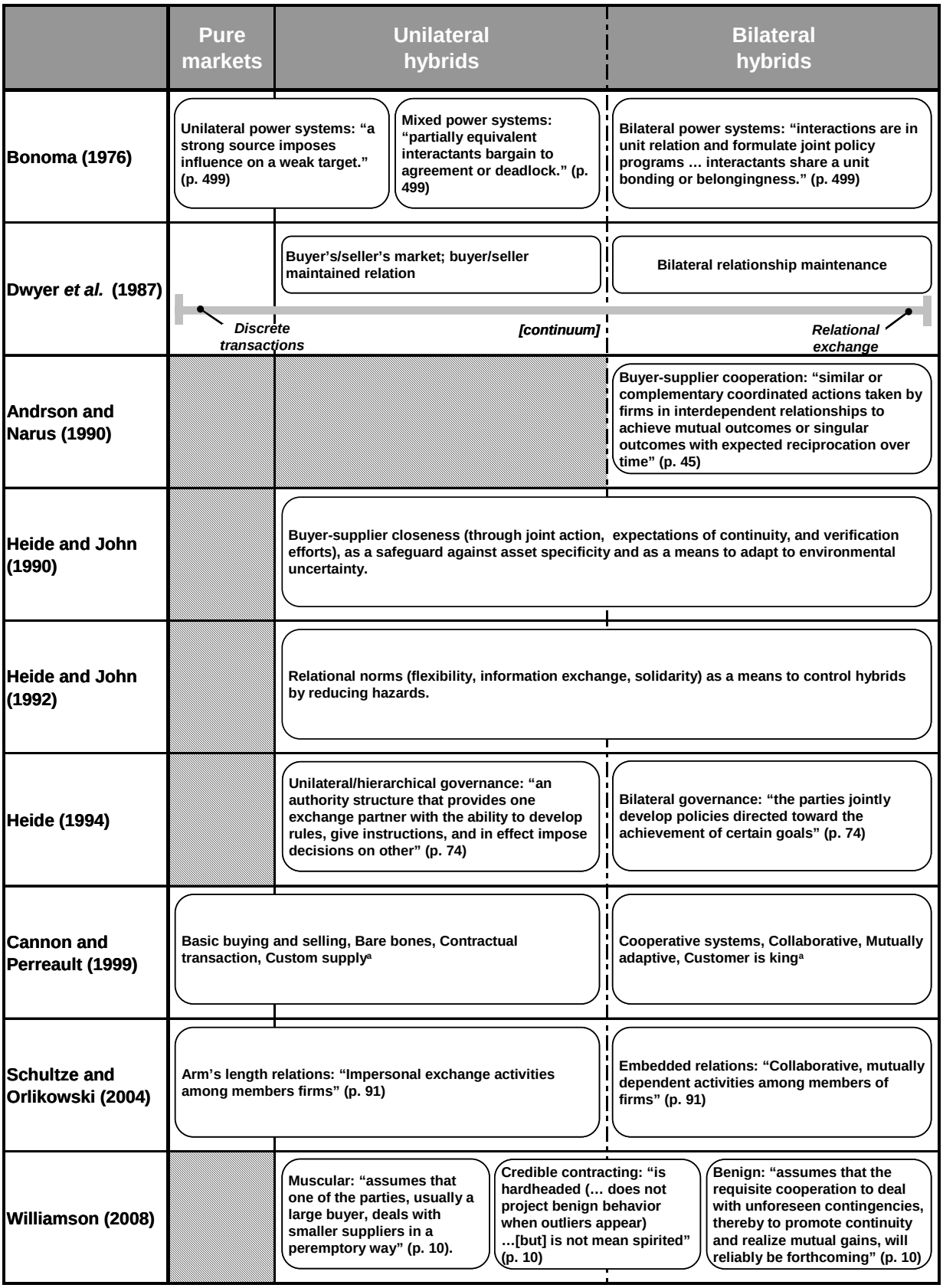
(1) Markets, where interorganizational governance is made purely via price (elaborated by the neoclassical economics perspective according to Hayek [1945]); and
(2) Hierarchy, where transactions are internalized within a single organization (elaborated by the internal organization perspective according to Barnard [1938]).

The governance forms are essentially the overall structures within which organizations design safeguards against *ex post* hazards. To Williamson (1991, p. 83) the hierarchy acts as the last resort when expected transaction costs are too high to bear under other governance forms.

Between markets and hierarchies exists an eclectic mass of hybrid governance forms, such as long term contracts, joint ventures, and franchising, blending the features of both markets and hierarchies (Williamson 1991). But instead of depicting these hybrids as a mass, it is possible

to demarcate between two basic kinds of hybrids in terms of the nature of buyer-supplier relationship incorporated. In particular, prior literature suggests a division into the *unilateral* and *bilateral forms* of hybrid governance (Heide 1994, Rindfleisch and Heide–1997). Unilateral hybrid governance mechanisms "provide a way to safeguard specific assets by solidifying *ex ante* agreements with an exchange partner", whereas bilateral mechanisms "provide a firm with a way to safeguard its specific assets by developing closer ties with its exchange partners" (Rindfleisch and Heide 1997, p. 44).

More generally, the conceptualizations by various authors appearing in various streams in literature lend support for this dual interpretation of hybrids (Figure 1). These two basic modes differ in particular in ways the relationship is established and maintained (Heide 1994, p. 75). The question is about whether the supplier and the buyer of a given transaction act separately with their own, potentially diverging goals, or whether the supplier and the buyer act together by forming and striving towards a common goal. The parties of a bilateral hybrid "behave as there were some [mutually relevant] third party to their interaction" (Bonoma 1976, p. 507). Furthermore, within unilateral hybrids there are two parties for whom the benefits and costs of the transaction to the other party are less relevant; with bilateral forms the more relevant entity is the dyad, where mutual benefit is the norm, and to secure it, necessary reciprocal adjustments are made. And while unilateral hybrids are characterized with subtle or outright blatant behavior to secure the fulfillment of own agenda, the bilateral hybrids are characterized with taking as a starting point an open discussion about what the agenda is in the first place and then pursuing it cooperatively.



a = Categorization of buyer-supplier relationships through six specific relationship connectors: information exchange, operational linkages, legal bonds, cooperative norms, adaptations by the supplier, adaptations buy the buyer.

NB: patterned cells indicate an out-of-scope area in terms of proposed conceptualizations

Figure 1: Kinds of hybrid governance forms: interpretation from prior literature

2.2 Supply chain management and integration

The concept of supply chain refers to a multi-echelon sequential system comprising autonomous organizations participating in an input-output transformation process around a good or a service, including both material and information flows, eventually leading to the delivery of an end-product or service to the end-user (Stevens 1989, Chopra and Meindl 2001, Simchi-Levi et al. 2003). In particular, as reflected in the classic Beer Game (Sterman 1989), a supply chain is commonly perceived to comprise a multi-tier structure of manufacturers, delivery channel members – such as wholesalers and distributors – and finally at the furthest end, retailers with the end-customer contact. Some have provided further elaborations on the linear conceptualization of supply chains. Thus the concept of supply network has been proposed (e.g. Choi et al. 2001, Kemppainen and Vepsäläinen 2003). In this work the concept of supply chain refers to an identifiable system of material and information flows involving a set of organizations engaged in the process of delivering a good to a party ultimately in need of it.

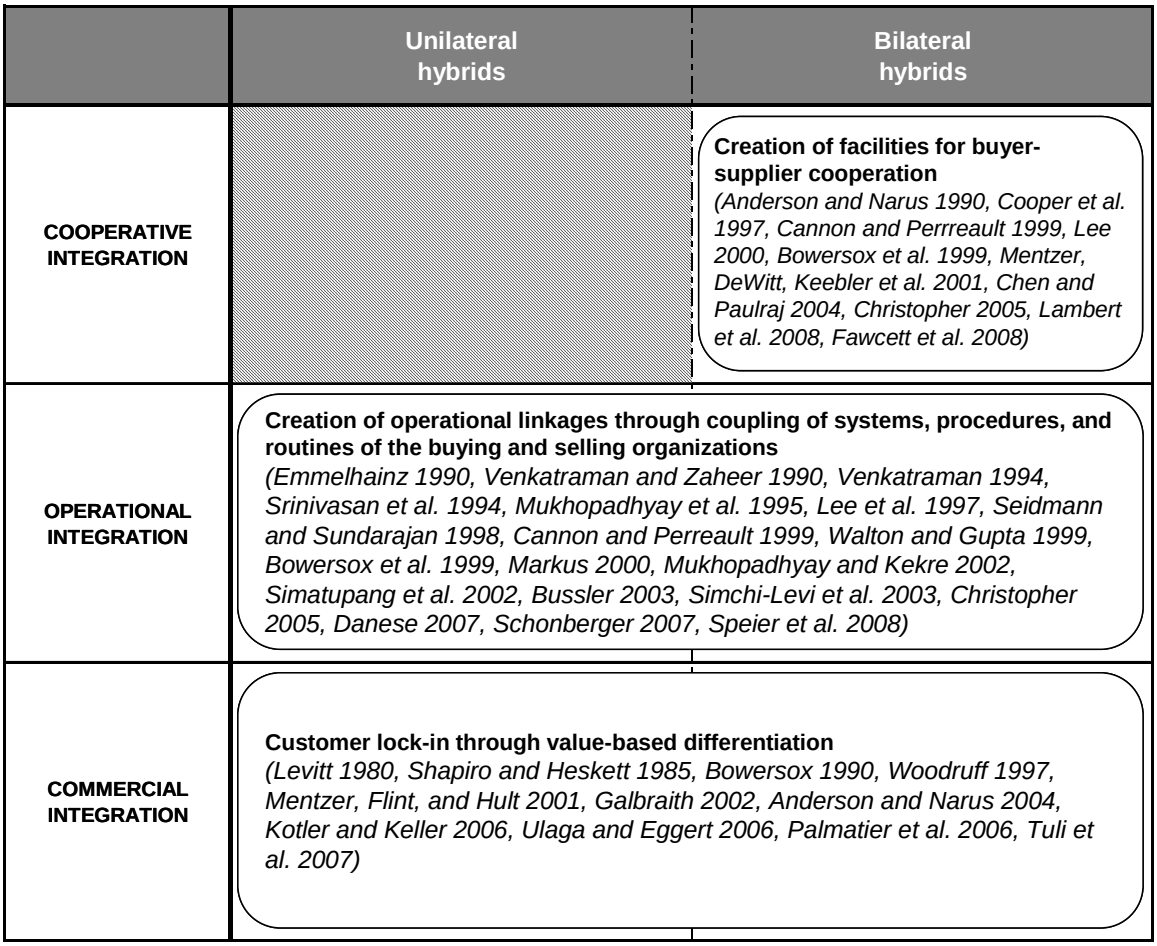
Supply chain management (SCM) refers to supplying of products to meet demand in a complex and uncertain world from the point of view of the entire supply chain (Kopczak and Johnson 2003, p. 28). The ultimate goal is to improve efficiency and deliver value to customers (Bowersox 1990, Heikkilä 2002, Kopczak and Johnson 2003). Renowned definitions of SCM (Mentzer, DeWitt, Keebler, et al. 2001, CSCMP 2009) highlight the notions of tight, cooperative relationships with flawless day-to-day execution within the key members of the supply chain and a customer focused, value offering approach towards the end-customer. The SCM approach, thus, as typically depicted, lays considerable weight, besides perceiving the organization of material and information flows from an integrated supply chain perspective (Stevens 1989) and coordination of day-to-day activities (Thomas and Griffin 1996), on the cooperative nature of the relations between the supply chain members (Cooper et al. 1997, Mentzer, DeWitt, Keebler, et al. 2001, Simatupang and Sridharan 2002, Heikkilä 2002, Chen and Paulraj 2004, Min et al. 2005, Halldorsson et al. 2007). A further aspect commonly stressed is the ultimate objective of SCM efforts: to deliver superior value to the end-customer (Bowersox 1990, Mentzer, Flint, and Hult 2001). In particular, the view on deep cooperative buyer-supplier relationships characterizes literature on SCM.

Supply chain integration is commonly regarded in SCM literature as the key goal of SCM (Frankel et al. 2008). In an early and widely referenced work, Stevens (1989) equated supply chain integration with the management of material flows from strategic, tactical, and operational perspectives. Since then a range of conceptualizations (e.g. Lee 2000, Bask and Juga 2001, Lee and Whang 2001) and empirical operationalizations (e.g. Frohlich and Westbrook 2001, Vickery et al. 2003, Chen and Paulraj 2004, Rai et al. 2006) have appeared in literature. However, researchers have given the concept various diverging interpretations (Fabbe-Costes and Jahre 2007, van der Vaart and van Donk 2008).

Supply chain integration is defined here as the process and the state of cooperative, operational, and commercial unification of autonomous organizations along a supply chain in order to increase revenues, decrease costs, and improve asset utilization. From the *cooperative integration* perspective the intention is to create facilities for interorganizational cooperation (Smith et al. 1995, Cooper et al. 1997, Lee 2000, Mentzer, DeWitt, Keebler, et al. 2001, Chen and Paulraj 2004, Christopher 2005, Lambert et al. 2008, Fawcett et al. 2008), in order to nurture buyer-supplier relationships and improve decision-making within the supply chain. From the operational integration perspective the intention is to unify separate businesses by coupling interorganizational business processes related to material and information flows (Venkatraman and Zaheer 1990, Srinivasan et al. 1994, Lee et al. 1997, Walton and Gupta 1999). Finally, from the commercial integration perspective the intention is to lock-in customers with value-offerings, a view prominently held by marketing scholars (Levitt 1980, Woodruff 1997, Anderson and Narus 2004, Kotler and Keller 2006) and also inherent in the SCM perspective (Shapiro and Heskett 1985, Bowersox 1990, Mentzer, DeWitt, Keebler et al. 2001). Ultimately, all these three forms of supply chain integration embrace a shared set of goals: to reach for increased sales, reduced costs, and minimized asset commitment (Lambert and Pohlen 2001, Collin 2003, Christopher 2005) – the commercial integration viewpoint, though, remaining distinctly focused on the nurture of revenues.

These three kinds of supply chain integration can be perceived through the lens of unilateral and bilateral hybrids (Figure 2). A cooperatively integrated buyer-supplier dyad corresponds to a bilateral hybrid as developed above (Section 2.1.). Cooperative supply chain integration aims to “achieve mutual outcomes or singular outcomes with expected reciprocation over time” (Anderson and Narus 1990, p. 45) essentially, while pursuing joint ends in the context of inter-enterprise supply chain operations. Operational integration is characterized by the

creation of operational linkages, or the coupling of systems, procedures, and routines of the buying and selling organizations (Cannon and Perreault 1999, p. 442). Pursuit of efficiency



NB: the patterned cell indicates an out-of-scope area in terms of proposed conceptualizations

Figure 2: Kinds of supply chain integration interpreted as unilateral and bilateral hybrids

appears relevant for both unilateral and bilateral hybrids. Examples of prior conceptualizations of operational integration include sharing of relevant information between supply chain members (Lee et al. 1997, Seidmann and Sundarajan 1998, Speier et al. 2008), the creation of tighter linkages between different computer-based information systems and databases (Markus 2000), electronic data interchange (Emmelhainz 1990, Venkatraman 1994, Walton and Gupta 1999), interorganizational information systems (Venkatraman and Zaheer 1990), system-to-system exchange of messages between separate information systems (Mukhopadhyay and Kekre 2002, Bussler 2003), just-in-time systems (Srinivasan et al. 1994, Mukhopadhyay et al. 1995, Schonberger 2007), vendor-managed inventory models (Waller et al. 1999, Simchi-Levi et al. 2003), collaborative planning forecasting and replenishment systems (Bowersox et al. 1999, Danese 2007), and the generic synchronization of buyer-supplier operational processes

(Bowersox et al. 1999, Simatupang et al. 2002). Broadly, operational integration is in its extreme form intended to mould a particular buyer-supplier transaction into a single operation; in reality shades do exist as operational integration could be seen to entail as little as the systematic exchange of order messages digitally between a given buyer and supplier. Heavy forms of operational integration can be seen to relate to buyer-supplier dyads bound together by tight interdependence and investments in transaction specific assets with little or no use as such in other instances (Thompson [1967] 2003, Zaheer and Venkatraman 1994, Bensaou and Venkatraman 1995, Dyer 1996) – with operational linkages as one class of specific assets themselves (Hart and Estrin 1991, Holland and Lockett 1997, Christiaanse et al. 2004).

Finally, commercial supply chain integration employs the lens of customer lock-in through attractive value-offerings. This perspective, too, is relevant for both kinds of hybrids, although more conspicuous in the unilateral mode, operating from a more traditional buyer-supplier setup with diverging goals. Marketing scholars in particular have stressed the notion of value-based differentiation in buyer-supplier interactions (Levitt 1980, Woodruff 1997, Anderson and Narus 2004, Kotler and Keller 2006). Value is defined as "the perceived worth in monetary units of the set of economic, technical, service, and social benefits received by a customer in exchange for the price paid for a product offering, taking into consideration the available alternative suppliers' offerings and prices" (Anderson et al. 1993, p. 5). Ulaga and Eggert (2006, pp. 119-120) explicate the logic further: "differentiation in business relationships can be researched from a value-based perspective. To be effective, differentiation must contribute to customer value either by providing benefits to the customer or lowering a customer's costs." Thus, from the commercial integration perspective, in order to remain competitive, suppliers should deliver market offerings that either bring benefits or lower costs for their customers (Galbraith 2002, Ulaga and Eggert 2006), for example by means of services or systems that augment the core product (Levitt 1980, Anderson and Narus 2004, Tuli et al. 2007). Palmatier et al. (2006), following Berry (1995), use here the term structural relationship marketing programs, referring to "programs [that] increase productivity or efficiency (or both) for customers through investments that customers would probably not make themselves" (Palmatier et al. 2006, p. 477). Supply chain practices have been commonly presented as one particular value-based differentiation tool (Shapiro and Heskett 1985, Bowersox 1990, Mentzer, Flint, and Hult 2001, Fisher 1997). Usually associated with such value-based differentiation is the supplier's intent to become a preferred supplier (Galbraith 2002), and thus seeking closer relationships with the customer (Dwyer et al. 1987, Ulaga and

Eggert 2006). Thus, the basic interest in commercial integration is to secure the key resource base and justification for existence of any for-profit business operation: revenues.

2.3 Electronic trading systems

Electronic trading systems comprise the means to digitally transmit data between two separate organizations. As the management of material *and related information flows* is key in SCM (Mentzer, DeWitt, Keebler et al. 2001), electronic trading systems are an essential class of means to support and execute SCM (see e.g. Bowersox and Daugherty 1995, Holland 1995, Christiaanse and Kumar 2000, van Hoek 2001, Johnson and Whang 2002, Frohlich 2002, McLaren et al. 2002, 2004, Gunasekaran and Ngai 2004, Craighead et al. 2006, Johnston et al. 2007, Boone and Ganeshan 2007, and van Donk 2008). Essentially, electronic trading systems address two main features of an information transfer system: capacity (bits of data reliably transmitted over a given time period) and response time (period of time after which the channel is available for further data transmissions) (Bakos 1991b, p. 34). Improvements in both of these issues are possible when traditional telecommunications technology – telegraph, telex, telefax, telephone – are replaced with the electronic exchange of messages either directly or indirectly between the information systems of the transacting organizations (Bakos 1991b). More broadly, electronic trading systems have important impacts on *coordination costs* – the various costs of the process of managing dependencies among activities (Malone and Crowston 1994). In the supply chain context these coordination costs arise from the management of interdependent interorganizational information and material flow processes. Malone and Crowston propose impacts of information technology on coordination costs in three orders of magnitude: in the first order, the simple substitution of human coordination with IT-based coordination; in the second, the increase in the total amount of coordination; in the third, a shift towards the use of more coordination-intensive structures (pp. 102-103). This last impact implies that coordination structures that were previously too expensive will become more feasible and desirable (p. 103). An example of such a structure is the virtual ecosystem Cisco has built around its supply-side transactions. Heavily outsourced manufacturing operations are executed by a set of suppliers who can continuously see the status of downstream demand as Cisco sees it and provide effective and efficient responses (Kuppens 2006).

Next, literature on e-trading systems is reviewed. Section 2.3.1 reviews key concepts and a brief near history of e-trading systems. Section 2.3.2 discusses standards of interorganizational

data exchange. Section 2.3.3. reviews prior conceptualizations on e-trading systems utilization.

2.3.1 Electronic trading systems – key concepts and a brief near history

In the turn of the millennium *e-business* – "the use of the Internet or any digitally enabled inter- or intra-organizational information technology to accomplish business processes" (Boone and Ganeshan 2007, p. 1195) – emerged as a new business management paradigm with the promises of revenue growth and improved customer service coupled with productivity and process efficiency enhancements, among a long list of related benefits (Cohan 2000, Hartman et al. 2000, Kalakota and Robinson 2001, Bauer et al. 2001). Admittedly, something truly new was involved in this significant turn, the diffusion of the multi-purpose Internet along with related technologies, offering high-powered capabilities for lean interorganizational information exchange and thus infrastructural information support to business process coupling. But related themes and concepts go further back than the commercial conception of the Internet in the mid 1990s. The idea of using information systems for interorganizational business management was advocated already in the 1960s. Bowersox (1969, p. 72) proposed "heavy reliance" on computers and high-speed data transmission for the coordination of multinational physical distribution systems. Kaufman (1966, p. 141, original emphasis) suggested that "even though internal systems may still be far from totally integrated, perceptive management needs to begin to consider the new possibilities for coordinating data processing *outside* its own organization limits."

More importantly, studies on *interorganizational information systems*, defined as information systems linking different organizations (Barret and Konsynski 1982, Cash and Konsynski 1985, Johnston and Vitale 1988, Bakos 1991b), have appeared within academic literature since the 1980s. Interorganizational information systems (abbreviated commonly as IOISs or IOSs) is the classic term management information systems scholars in particular use or have used for electronic trading systems as is understood in this dissertation. Here the term electronic trading system is used instead to emphasize the role of these systems as transmission media.

The single most studied class of electronic trading systems within management information systems discourse is arguably *electronic data interchange* (EDI), broadly the "interorganizational exchange of business documentation in structured, machine-processable form (Emmelhainz 1990, p. 4), commonly referring specifically to the application of EDI

communication standards such as the EDIFACT and the ANSI X.12. Research on electronic trading systems evolved within this discourse from more conceptual works in the 1980s to theory-based empirical studies in the 1990s and subsequently in the 2000s (for literature reviews see Kauffman and Walden 2001, Chatterjee and Ravichandran 2004b, and Elgarah et al. 2005). A landmark study was Malone et al.'s (1987) conceptual examination of electronic markets and hierarchies, and the famous proposition that the use of information technology for interorganizational processes decreases coordination costs through lowering the costs of communication (the electronic communication effect), enabling more efficient matching of demand of supply at the market place (the electronic brokerage effect), and supporting process integration between two organizations (the electronic integration effect). The 1990s saw the growth of both empirically and theoretically motivated studies on the topic (notable works inclue Venkatraman and Zaheer 1990, Gurbaxani and Whang 1991, Bakos 1991a,b, Clemons et al. 1993, Riggins and Mukhopadhyay 1994, Mukhopadhyay et al. 1995, Iacovou et al. 1995, Bensaou and Venkatraman 1995, Kumar and van Dissel 1996, Holland and Lockett 1997, Choudhury 1997, Hart and Saunders 1997) – a continued trend in the 2000s along the technological developments related to electronic trading systems (notable works include Chwelos et al. 2001, Iskandar et al. 2001, Mukhopadhyay and Kekre 2002, Barua et al. 2004, Subramani 2004, Kim and Umanath 2005, Saeed et al. 2005, Premkumar et al. 2005, Rai et al. 2006, Grover and Saeed 2007).

2.3.2 Standards of interorganizational data exchange

A fundamental feature in e-trading systems is the level of automation incorporated. In *system-to-human integration*, data exchange is semi-automated: data from the internal information system of one transacting party are delivered in an electronic format to the other transacting party, who further processes these data manually. A current prominent example is the web-portal. A database access is granted for a trading partner through a web-portal, to allow the trading partner to view (e.g. product data), create (e.g. an order), amend (e.g. to confirm an order), or query (e.g. order delivery status data). These portals are accessed by humans, implying a manual phase left in the data exchange process. This semi-automatic transacting can also happen without a web-portal. In fact, many early implementations of EDI (see below) were this kind of "teletype" (Mukhopadhyay and Kekre 2002) or "door-to-door" (Emmelhainz 1990) systems, where despite the electronic link data ware re-keyed into systems (Benjamin et al. 1990). In *system-to-system integration*, data exchange between the internal information systems of the transacting organizations is fully automated: no human intervention is needed.

This can be seen as the most efficient way to manage interorganizational data exchange, in terms of manual work content in the data exchange processes. In order to exchange data directly between two separate information systems communication standards are essential as backend information systems and enterprises are “fundamentally … heterogeneous, autonomous, and distributed” (Bussler 2003, p. 4).

Standards, however, can range in their focal level from company-specific proprietary agreements to industry-specific and global *de facto* standards (Verman 1973). *E-business standards* are a particular class of communication standards aiming for a broader appeal of the latter kind. Following Bussler (2003) and Boh et al. (2007), e-business standards are understood here as the class of non-proprietary communication standards specifically designed to support the integration of interorganizational business processes via system-to-system integration. Elsewhere terms to designate these standards include B2B frameworks (Shim et al. 2000), B2B interaction standards (Medhajed et al. 2003), B2Bi protocols (Bussler 2003), and e-business frameworks (Nurmilaakso and Kotinurmi 2004, Nurmilaakso 2008). In general, e-business standards come under various forms. Goldfarb and Prescod (2004) provide one conceptualization (Figure 3). Essentially, Goldfarb and Prescod present the development from what they call “ancient times” (around 1960s/1980s) into current day as an evolution from separate external (traditional EDI) and internal (middleware) approaches into an integrated whole – “eBusiness Integration (eBI)”, as the authors call it – where the decisions on internal information system integration (enterprise application integration [EAI] [Erasala et al. 2003] or application-to-application integration [A2Ai] [Bussler 2003]) are inextricably bound together with integration between information systems of separate organizations (or business-to-business integration [B2Bi] [Bussler 2003]). Whether or not Goldfarb and Prescod’s description of full-blown eBI is more a future vision rather than current practice among industrial corporations, EAI and B2Bi still constitute two distinct notions.

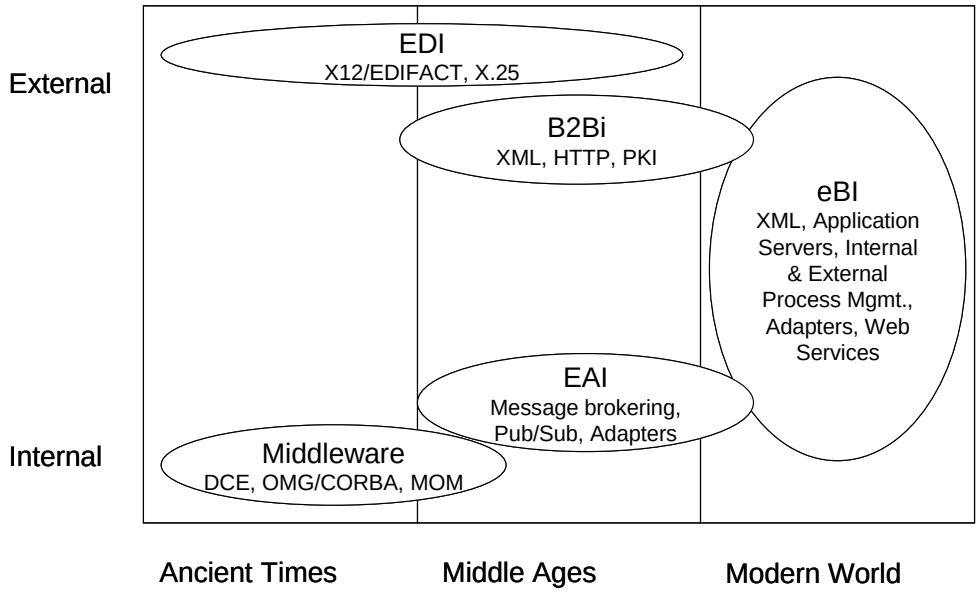


Figure 3: Information system integration: evolution of terminology (Goldfarb and Prescod 2004, p. 253)

The classic example of e-business standard is traditional EDI (Emmelhainz 1990, Damsgaard and Truex 2000). The most widely known and used traditional EDI-standards are the ANSI X.12 (mainly in the US) and the EDIFACT (developed by UN, intended as a global standard) (Nurmilaakso 2008). EDI-standards date back to 1970s and beyond; in the mid-1980 EDI use began to expand significantly (Emmelhainz 1990, p. 23), following the introduction of the first versions of ANSI X.12 in 1981 (Emmelhainz 1990) and the EDIFACT starting from 1985 (Goldfarb and Prescod 2004, p. 231).

Traditional EDI is a message-based communication standard meaning that it is built around the standardization of a given message. EDI standards can be seen as broad libraries of overall templates for various kinds of messages. For example, to exchange purchase orders, the EDIFACT standard includes the ORDERS –message while the ANSI X.12 has the X12.1 transaction set 850 for the same purpose (Emmelhainz 1990, Nurmilaakso 2008). Moreover, at the dawn of EDI-standards, communication networks were distinctively proprietary, giving rise to third party integration service providers – value-added networks or VANs (Emmelhainz 1990) – making a business in selling data transmission, conversion, and related services. Notably also, the EDI-message format was designed as concise as possible, making it harder for laymen to infer the contents of a given message. Thus traditional EDI has been criticized for being optimized for compressed messages, for requiring a dedicated EDI server, for the need to use third party VANs, for the EDI message format taking months to master, and for requiring costly program development (Goldfarb and Prescod 2004, p. 230). These reasons for

their part influenced that traditional EDI became used first and foremost by larger organizations with sufficient resources and high enough transaction volumes to justify the investments (Goldfarb and Prescod 2004).

Recently, it has been suggested that newer e-business standards would overcome the challenges of traditional EDI (Reimers 2001, Gosain et al. 2003, 2004, Goldfarb and Prescod 2004, Bala and Venkatesh 2007, Malhotra et al. 2007, Chong and Ooi 2008). In particular, by adding to the syntactic (common language) and semantic (meaning) level of EDI standards, the pragmatic level (intention of messaging) (Kubicek 1992, Bussler 2003) newer e-business standards have been claimed to help create more flexible and economical interorganizational system-to-system integrations (Reimers 2001, Johnston et al. 2007). Typically these newer e-business standards utilize the powers of the *Extensible Markup Language (XML)*, dating back to 1996 (W3C 2009). XML defines besides the data, through the so called tags, meta-data, i.e. data on data (Goldfarb and Prescod 2004, p. xl). However, XML as such defines only the data format and notably not how to exchange XML-based data between the information systems of separate organizations (Linthicum 2001, p. 270, Bussler 2003, p. 67). This remains the domain of e-business standards.

RosettaNet is a relatively widely diffused example of a newer XML-based e-business standard (Linthicum 2001, Bussler 2003). It is an exemplary comprehensive new e-business standard, in the sense that it defines not only the message content, but also other interoperability issues relevant in interorganizational system-to-system integration, such as messaging sequence and security issues (Bussler 2003). RosettaNet is not the only contemporary e-business standard around (Nelson et al. 2005, Chituc et al. 2008), but it has gained significant footing within the semiconductor and electronic components manufacturing industries (Damodaran 2004, Rosettanet 2004, Cartwright et al. 2005, Löwer 2006, Boh et al. 2007, Chituc et al. 2008). However, the field of empirical research on the actual utilization of RosettaNet is underdeveloped. Lu et al. (2006) report critical success factors from an implementation of an operational linkage between Cisco and Xiao Tong in China in purchase order processes. Gosain et al. (2003, 2004) have argued, based on empirical data from RosettaNet-based integrations, that contemporary e-business standards, such as the RosettaNet, offer a way of creating flexible integrations between trading partners. Malhotra et al. (2007) and Bala and Venkatesh (2007), both use RosettaNet as a particular example of a contemporary e-business standard, overcoming problems related to the older EDI standards. Malhotra et al. (2007) find

that such standards can be leveraged to build adaptive supply chain partnerships. Bala and Venkatesh (2007), on the other hand, study the factors explaining the adoption of such standards. Chong and Ooi (2008) study empirically the adoption factors of RosettaNet standards within the Malaysian electronics industry and find partner's power, trust, and product characteristics having an influence on adoption. Notably, all of these prior works draw data from the semiconductor and electronic components manufacturing industries, the breeding grounds of RosettaNet. As such, the role that the RosettaNet standard plays in dyad-level beneficial system-to-system integration beyond these contexts remains unclear. Further, independent of work on RosettaNet is needed to probe the value of more recent e-business standards over EDI standards (Reimers 2001).

2.3.3 Conceptualizations of electronic trading systems use

Barret and Konsynski (1982) provide one of the first systematic conceptualizations of electronic trading systems use. They employ an inductive research stance by developing a general classification scheme for electronic trading systems using on-site and telephone interviews with companies involved in electronic trading systems efforts. The main outcome of the study is a classification scheme based on the level of participation to an electronic trading system. The higher the level, the higher are the participant responsibility, cost commitment, and complexity of the system. The suggested levels of participation are:

(1) Level 1: remote input/output node. The participants connect to the system for example through a terminal and the commitment to the system is low.

(2) Level 2: application processing node. At this level the participant develops and shares a single electronic trading system application, such as an inventory query or order processing system. The participant has responsibility only for the specific application.

(3) Level 3: multi-participant exchange node. The participant develops and shares a network of linking itself with any number of participants at lower levels. An example given is a manufacturer with dealers.

(4) Level 4: network control node. The participant develops and shares a network with diverse applications that may be used by many different types of lower level participants. An example of this could be an electronic trading system offered as a service to the users of the system. Barret and Konsynski give a credit clearing house as an example. The credit clearing house offers the system of credit check including the point-of-sale terminals for other companies to use.

(5) Level 5: integrating network node. At this highest level, the electronic trading system is a data communication and processing utility which integrates in a real time fashion any number of participants at lower levels.

Although this elaborate framework must be seen in its context – the study was conducted several decades ago after which significant development on this field has occurred – there are surprisingly valid ideas. For example, the level 1 could be seen today as a web-portal used by the non-system initiator. The key insight in the model is that the user participation varies. The party that has the main interest, for example an OEM viewing its supply network, puts effort in the system, is at a "higher level" and tries to entice its suppliers as lower level participants. Barret and Konsynski also propose in their paper three main reasons for companies participating in electronic trading systems: (1) cost reductions, (2) productivity improvements, and (3) supporting product/market strategy. They submit that cost reductions are the paramount reasons for using an electronic trading system.

The works of Malone et al. (1987), Benjamin et al. (1990), and Choudhury (1997) collectively elaborate the overall structural aspects of electronic trading system use. Malone et al. suggest two basic e-trading system architectures: electronic markets and electronic hierarchies. Electronic market is typified by an interaction among a range of organizations, whereas electronic hierarchies are based on deeper interorganizational coupling of processes within a more limited set of organizations. For Malone et al. electronic hierarchy does not necessarily mean hierarchy by ownership, as in TCE, but can also be an interorganizational construct, a virtual hierarchy. Benjamin et al. build on Malone et al. and conceptualize electronic trading system use as a two-by-two matrix. They argue that besides looking into the application of electronic trading systems as electronic markets and electronic hierarchies, it is important to note what is done with the system. The second dimension of the framework thus asks whether the system is about transaction processing ("routine transaction processing … such as order entry or invoicing", p. 31), or task support ("non-routine task support for managerial, analytic, and design functions, that contribute to decision making", p. 31). Basing on a field study of three focal companies and eight dyadic links Benjamin et al. find that two critical aspects of electronic trading system utilization are communication standards and the management of change in structure and work design. Finally, Choudhury refined the dichotomous classification of electronic markets and hierarchies by introducing the trichotomy of bilateral dyads (one-to-one systems), electronic monopoly (one-to-many systems), and electronic markets (many-to-many) as the basic e-trading system architectures. In particular, the elaboration of electronic hierarchy into focal company -specific systems towards a range of trading partners (e.g. a supplier-facing e-trading system) and dyad-specific point-to-point links makes an important contribution.

Johnston and Vitale (1988) propose that electronic trading systems are an important tool for creating competitive advantage. In the paper they categorize different kind of electronic trading systems. The electronic trading system categorization model is built around four questions: (1) why (the business purpose of the system), (2) who (participants in the system), (3) what (the functions performed with the system), and (4) how (the improvement focus: search-related costs, unique product features, switching costs, internal efficiency, and interorganizational efficiency [following a classification schema by Bakos and Treacy [1986]).

Massetti and Zmud (1996) offer a conceptualization of electronic trading systems utilization, drawing from an empirical study of four organizations. The main finding is a well-known framework describing four measurement aspects of electronic trading systems use: volume (volume of electronic messaging as a share of all messaging), diversity (extent to which different types of documents are exchanged via e-trading systems), breadth (extent to which e-trading systems exist with different trading partners) and depth (extent to which messaging is automated – ranging from “file-to-file” [electronic transfer, manual rekeying], “application-to-application” [fully automated data exchange], to “coupled work environments” [computer based applications access directly data maintained within each trading partner’s system]). The key insight by Massetti and Zmud is that the use of electronic trading systems is a multifaceted phenomenon. The relevant dimensions are not only what share of all documents is handled electronically, but also how many different partners there are, what is the variety of types of documents exchanged, and what is the level of automation of the exchange. Finally, an important point made by Massetti and Zmud is that greater electronic trading system depth is not always desirable – the key contingency factors are the frequency and value of transactions. When the frequency and value of transactions is high, a coupled work environment would be the best choice. When frequency is high, but value is low, the efficient but lower risk application-to-application EDI is best. Low frequency and value implies file-to-file system – the costs of integration override the value achievable. These elementary notions are important starting points when considering where system-integration should be done and not.

Kumar and van Dissel (1996) develop theoretically a classification scheme of different types of electronic trading systems building on the notion of organizational interdependency of Thompson ([1967] 2003). Three types of electronic trading systems are identified: pooled

information resource (corresponding to Thompson's pooled interdependency), value/supply-chain (sequential interdependency), and networked (reciprocal interdependency). While widely cited, the paper can be criticized for a relatively simplistic depiction of electronic trading systems. For example the value/supply chain -type is presented as a single broad category. In any case, Kumar and van Dissel make an important attempt to bridge classic organizational theory and electronic trading systems research.

Premkumar (2000) characterizes the key aspects of Internet-era electronic trading systems with the focus on SCM applications. The article makes an important and relatively rare attempt to merge two independently developed research streams of electronic trading systems and SCM. Premkumar starts by separating three sophistication levels of electronic trading systems:

(1) Communication: Firms substitute paper, fax, and phone communication with electronic media. Messages may or may not be integrated with internal information systems.
(2) Coordination: system-to-system integration of messages. Firms are engaged in active coordination in production planning, delivery schedule, and logistics.
(3) Cooperation: Two business partners share common goals and measure performance of their interorganizational activities with similar measures. The cooperation can span multiple functional areas.

This sequential model shows a deep intertwining of electronic trading system depth (Massetti and Zmud 1996) and interorganizational process integration. The higher are the needs for process integration, the more sophisticated the used system has to be. Premkumar notes also the close linkage of the propositions of transaction cost economics (see Section 2.1) and electronic trading systems. In particular, Premkumar proposes that electronic trading systems reduce transaction costs by reducing coordination costs (reducing the costs of exchanging and processing information) and reducing asset specificity when an electronic trading system is implemented by utilizing open standards. Premkumar also provides guidelines for electronic trading system utilization for SCM. The first issue is to assess the internal organization climate. If this is in good shape, the external organizational (interorganizational) climate should be evaluated next (would the implementation be satisfactory to all parties). Finally, the technical infrastructure should be planned. Here, Premkumar provides a detailed framework on four key decisions (see Figure 4). Premkumar's discussion summarizes well key decisions on technical aspects of electronic trading system utilization. Similar clarity and comprehensiveness is relatively rare. There is a need to not only select the main technology

(which communication standard) but also the depth of integration (client/server structure, integration only at external interfaces – such as a web-portal – or also at internal information systems, implying a true system-to-system exchange), type of the link (message versus interaction; query versus update; batch versus realtime), and the communication network (media) on which the messaging is executed). The drawback of Premkumar's model is lack of empirical validity – the paper is purely conceptual.

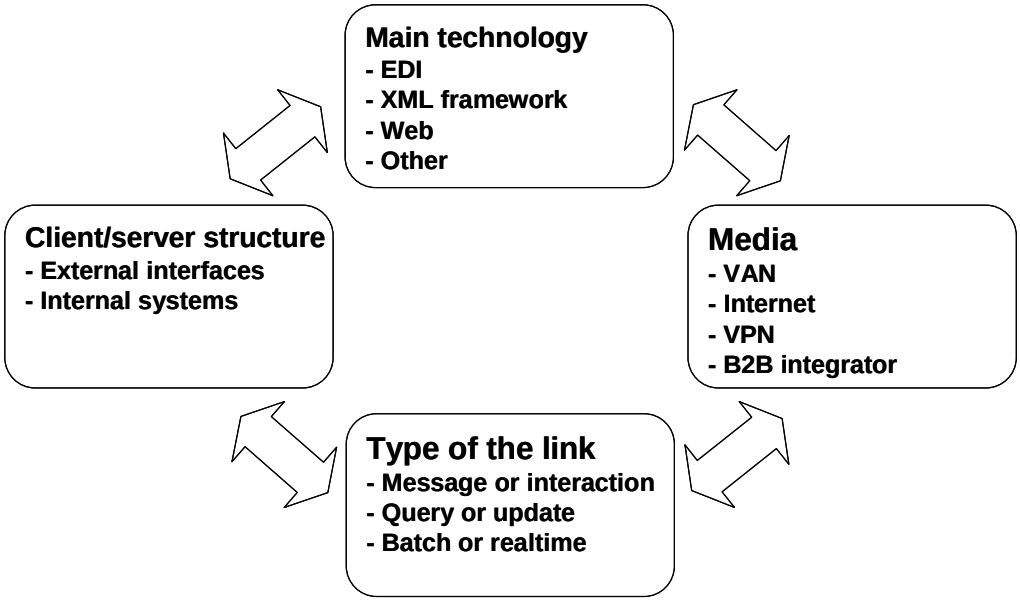


Figure 4: Framework on technical issues in electronic trading system design (summarized from Premkumar 2000)

Banerjee and Kumar (2002) propose, also in a conceptual work, a framework to support the selection of electronic trading systems infrastructure, given business goals and certain situational factors. In their model the business goal (e.g. reduction of inventories or improved customer service) drives the strategic choice of depth, breadth, and diversity (according to Massetti and Zmud 1996). These selections further drive two levels of electronic trading system decisions on the system infrastucture. At level 1, the choice is made between whether the system is internal or outsourced to a third party. At level 2 there are specific choices on communication standards and networks under each alternative at level 1. Finally, the authors suggest a set of situational factors influencing the choices on the two levels, including organizational readiness, interorganizational power and trust, competitive environment, technical performance factors, security requirements, and existing electronic trading system use.

Simchi-Levi et al. (2003), in a basic SCM textbook, is kindred to several of Premkumar's (2000) notions by describing four stages of electronic commerce in SCM: one-way communication with asynchronous communication and simple data look-up features, such as browsing web pages, database access where a trading partner types in or queries data from another party's database, data exchange where systems communicate automatically, and finally sharing processes where integration between trading partners extends beyond mere system integration towards business processes.

Finally, Chatterjee and Ravichandran (2004a) provide another recent conceptual synthesis of prior work on electronic trading system utilization. The authors suggest a relatively comprehensive four-dimensional structure of electronic trading systems summarizing much of the prior work. First is the control over the system in terms of financial and decision-making issues. The alternatives are a third party service provider maintained system, a single-party system (corresponding to Choudhury's [1997] bilateral links and electronic monopolies), or a multiple-party system (corresponding to an electronic market [Malone et al. 1987]). Here Chatterjee and Ravichandran complement prior works on electronic markets/hierarchies issues by proposing that the system in itself can be outsourced to a third, transaction-external, party. Second is the specificity of the technology used, ranging from open standards to dedicated proprietary solutions. Third is the level of integration with information systems, corresponding to messaging depth (Massetti and Zmud 1996). Fourth and finally is the relational support of the system ranging from arm's length relationship through selected relationships to exclusive partner relationships. This dimension corresponds to the division into unilateral and bilateral hybrid governance forms (as reviewed above in Section 2.1), added with the pure market-form transacting identified in the classic TCE framework (Williamson 1985). Chatterjee and Ravichandran further discuss in their paper two key determinants of the structure of electronic trading systems: characteristics of the exchanged products (product complexity, product consumption characteristics, and criticality of the product) and of the interorganizational relationship.

To sum up, prior works have suggested multiple dimensions of electronic trading system utilization. In particular Chatterjee and Ravichandran's (2004a) work is important in the sense that it summarizes much of prior literature notably by adding the characteristics of the interorganizational relationship as an explicit structural feature of electronic trading systems. However, Chatterjee and Ravichandran side-step two important features of electronic trading

systems utilization: communication standards and networks used (discussed by Premkumar 2000 and Banerjee and Kumar 2002) and function of the systems being either transaction execution or sharing of information for decision-making (discussed by Benjamin et al. 1990). Another recent synthesis by Banerjee and Kumar is stronger on the technical side but emphasizes less interorganizational relationship aspects of electronic trading system use. Finally, many of the reviewed conceptualizations above do not provide empirical evidence to support the proposed framework. Notably, this is the case with all of the four most recent works (Premkumar 2000, Banerjee and Kumar 2002, Simchi-Levi et al. 2003, Chatterjee and Ravichandran 2004a)

2.4 Research gap

Evaluation of prior academic literature on electronic trading systems points to three gaps. Firstly, there is a need to better understand the role of newer XML-based e-business standards in supply chain management and to probe the value of more recent e-business standards over EDI standards (Reimers 2001). Secondly, prior literature on electronic trading systems falls short on empirical studies on the conceptualization of the main construct itself. In particular, the body of research is incomplete in terms of comprehensive frameworks on how these systems are or should be used. Orlikowski and Iacono (2001) suggest that prior information systems research has commonly employed a simplistic view on the IT construct, i.e. treated it as a taken-for-granted omitted variable. Such a black box approach applies equally to e-trading systems research (Narayanan et al. 2009). In particular, Narayanan et al. report from an analysis of 103 empirical studies on electronic trading systems, published 1991-2005 in various mainstream journals that this research is highly fragmented with no overall theoretical perspective. Prior studies have accumulated notable volume of evidence on that e-trading utilization leads to benefits on multiple levels such as reduced inventory levels, improved customer service, quick response to market trends, improved communication with trading partners, reduced paperwork, increased productivity, or data accuracy (Narayanan et al.), but with notable inconsistencies (Ahmad and Schroeder 2001, Craighead et al. 2006, Narayanan et al. 2009). An important possible reason for these inconsistencies is a black-box approach in conceptualizing the intervention under study. Indeed, Narayanan et al. call for studies on the configurations of structure, process, and context of effective utilization of electronic trading systems. In another comprehensive literature review on electronic trading systems research Boone et al. (2007) find that prior literature has given less emphasis to what they call operational level decisions (decisions related to the impacts of specific technologies). These

decisions may according to Boone et al. often have more immediate impacts on the performance of an organization, than strategic and tactical decisions (p. 118). Finally, as reviewed, most recent conceptualizations of electronic trading systems omit either technical (Chatterjee and Ravichandran 2004a) or relationship aspects (Banerjee and Kumar 2002) of electronic trading system use. Even more importantly, these works only rarely incorporate explicitly the SCM perspective (exceptions include Premkumar 2000 and Simchi-Levi et al. 2003). Taken together, the gap of conceptualizing e-trading systems utilization needs to be addressed to understand better the effective deployment of e-trading systems in SCM.

Finally, mainstream research in electronic trading systems, especially beyond the 1990s, employs predominantly hypothetico-deductive theory-testing survey-based research designs (Elgarah et al. 2005, Boone et al. 2007). Elgarah et al. evaluate research on EDI published 1993-2002 in management information systems, logistics/transportation/marketing, production/operations management, and overall management journals, altogether 68 papers in 34 journals. They find that majority of these studies have focused on the outcomes, use and diffusion of EDI-based systems; in all reviewed studies, save for one, efficiency gains have been at least one of the study motives. In addition, they observe a shift over time from studying dyads into studying networks. Finally, and importantly, the majority of the studies are cross-sectional surveys. Boone et al. conduct a search within pre-specified target journals spanning major logistics/supply chain/operations management journals. After a pre-screen of 7,000 odd papers, 82 empirical studies are selected for a detailed review. As a result, Boone et al. find that almost two thirds of the reviewed studies are survey-method based. Further, majority of the research is theory testing and validating. To conclude, in the interest of methodological diversity there is a need to complement empirical research on electronic trading focused in the extant body of knowledge with theory-testing survey-based approaches. One notable alternative is the case study method (Eisenhardt 1989, Handfield and Melnyk 1998, Stuart et al. 2002).

3 METHODS AND DATA

Next, methods and data employed in this dissertation are exhibited. The chapter opens with a discussion on the choice of using the case study method (Section 3.1). Data collection and analysis within each of the four individual studies of this dissertation is the topic of Section 3.2. The chapter ends with an evaluation of validity and reliability of the empirical results of this dissertation against the common quality criteria of case study research (Section 3.3).

3.1 Selection of the case-study method

In an attempt to complement prior electronic trading systems research in terms of evidence-based conceptualizations of electronic trading systems use and research methods this dissertation employs the case study method. Firstly, the case study approach is especially strong when how or why questions are studied, when the investigator has little control over events, and when the focus is on contemporary events within some real-life context (Yin 1994, pp. 9, 13). As reviewed above, there is a need to clarify how in fact e-trading systems are used. Secondly, Handfield and Melnyk (1998) suggest that in-depth, focused, and multi-site case studies are strong in description (exploring territory), mapping (identification/description of key variables and drawing maps of the territory), and relationship building phases of a research program. This conclusion is echoed by Stuart et al. (2002). As reviewed in Chapter 2, prior literature is incomplete in terms of basic descriptions and mappings on key dimensions of how, for what benefits, and what is the role of newer e-business standards in SCM.

To contrast the case study method, survey research is especially strong in testing theoretical propositions (Handfield and Melnyk 1998). As noted above (Section 2.4), this has been a predominant method in mainstream e-trading systems research (Elgarah et al. 2005, Boone et al. 2007). For purposes of this work the case study method is a better choice. Both survey and scientifically realist case study method (Eisenhardt 1989, Yin 1994, Dubé and Paré 2003) maintain similar ontological and epistemological positions: that while observations are framework-dependent, there still exists an observer-independent reality from which accumulation of inter-subjectively valid knowledge is possible. A benefit – or side-product – of survey research is the quantification of constructs, their relationships and effect sizes. However, carefully analyzed qualitative data is a no less credible source of evidence (Eisenhardt 1989, Miles and Huberman 1994). There is a need to step back from the hypothetico-deductive theory-testing survey research design based research tradition in order

to evaluate with the benefit of rich in-depth case study data e-trading systems utilization in supply chain management.

Thus the four disclosed studies follow the case study method in different ways. In particular, the case study method is applied in three forms: exploration (following Yin 1994; Paper I), description (following Yin; Paper III), and proposition building (following Eisenhardt 1989 and Yin; Paper II and Paper IV). Although recognized as such a sound method for empirical operations and supply chain management research (Meredith 1998, Handfield and Melnyk 1998, Meredith and Samson 2002, Dubois and Araoujo 2007), the practice of the application of case method leaves room for improvement. In particular, Stuart et al. (2002) suggest problems in overall lack of rigor, especially in terms of vagueness in study goals, acknowledging prior research work, disclosing used study protocols, case selection criteria, data analysis process explicitness, and validation of findings. These pitfalls have been addressed in this dissertation by explicit about *ex ante* goals for each particular study and careful review of prior knowledge in the specific context of each study. Rigor has been further enhanced by attending to the evaluation criteria of study quality (internal, external, and construct validity as well as reliability, see Section 3.3) in general and using Yin's (1994) recommendations related to the use of case study protocol in particular. Further, the findings have been triangulated by collecting both qualitative and quantitative data from multiple sources (Stuart et al. 2002). Finally, transparency has been supported by disclosing analysis procedures on data, mainly of qualitative nature, as fully as possible, noting however the iterative and fuzzy aspects of the task (Eisenhardt 1989, Miles and Huberman 1994, Yin 1994).

3.2 Data collection and analysis

A detailed review of the specific methods and data used within this dissertation follows (for summary see Table 1).

Paper I. The study followed an exploratory multiple-case study approach, with a two-phase pre study leading to a collection of data from 18 cases of e-trading system utilization. Data for the study were collected in September-December 2003 in three phases. First, a pre-study with selected experts on e-business technologies was conducted. Second, a small-scale survey on 48 identified vanguard e-business users within Finnish manufacturing and trade was carried out to explore the state-of-practice. Third, data from 18 use-instances were collected and analyzed by within- and cross-case fashion. In particular, cross case analysis was used to

identify patterns of e-trading system use and benefits. The analysis was conducted in two dimensions, in terms of received benefits and the scope of e-trading system utilization (related to either processes within a focal company, processes within a buyer-supplier dyad, or processes on a broader supply network level).

Table 1: Summary of research methods and data

Paper/ study	Type of case study	Cases	Qualitative data	Quantitative data
Paper I	Exploratory multiple-case study	18 use instances of electronic trading systems	18 interviews with representatives from 18 companies (following 9 pre-study interviews with selected SCM/IT consultants)	Questionnaire responses from 48 Finnish manufacturing and trade companies
Paper II	Proposition building multiple-case study	5 dyads with a VMI-model in place	19 interviews with 14 informants representing 9 different organizations	Before/after data on VMI implementation impacts, where available
Paper III	Descriptive single-case study	Supplier-facing electronic trading system of CDRC	8 interviews with 8 CDRC informants; 5 interviews with 5 different of suppliers of CDRC	Questionnaire responses from 24 suppliers of CDRC; Several data from CDRC's internal information system (esp. relating to CDRC's purchases).
Paper IV	Proposition building single-case study with embedded units	6 customer-facing system-to-system integrations of MobInfra	51 interviews with 32 singular informants, representing three different organizations	Supplementary data from MobInfra (esp. overall number and type of integrations at MobInfra's customer interface) and from Alpha and Bravo (purchasing transaction volumes)

Paper II. The study followed a proposition building multiple-case study research design to enable the comparison of different VMI-implementations in multiple contexts. In a proposition building multiple-case study research design, the selection of cases is of fundamental importance (Dubois and Araujo 2007) and the selection should be guided by theoretical interests rather than statistical sampling logic (Eisenhardt 1989, Yin 1994). The unit of analysis in the study was a single implemented VMI arrangement that included the concerned supplier and buyer organizations (i.e. a dyad). The sampling logic was to cover

VMI implementations in different industry contexts. Altogether five dyads from various industrial contexts were studied. Qualitative and quantitative data were collected during February-May 2006. Qualitative data were collected through interviews with the persons most knowledgeable on the studied VMI model in each organization. Quantitative data was collected for the purpose of triangulating with interview findings. The data analysis followed an iterative process. In the first phase, within-case analyses were conducted and individual dyad-level reports prepared and checked by the informants in each dyad. In the second phase, a cross-case analysis was carried out in search of patterns with *a priori* constructs as well as constructs developed and refined during the analyses.

Paper III. The study followed a descriptive single-case study research design. The specific reason for selecting this design was to enable an in-depth evaluation of an instance of supplier-facing transaction system. The selection was also practical: there was access to CDRC, the focal company of the study, allowing a detailed examination of the effectiveness of both system-to-system and system-to-human kinds of e-trading system utilization. The case data were collected from three primary sources during May-November 2004: interviews with CDRC, interviews with CDRC's suppliers, and a questionnaire for CDRC's key suppliers. Data were analyzed on impacts and obstacles of CDRC's key suppliers in terms of CDRC's e-trading system.

Paper IV. The study followed a single case study approach with embedded units (Yin 1994). The overall studied case was the deployment of RosettaNet-based system-to-system integrations of MobInfra (a pseudonym), the focal company of the study; the embedded units were specific ongoing or complete customer-facing deployments of system-to-system integrations within specific business processes. Here, the case study method was selected in particular due to the need to understand in-depth the role and benefits of the RosettaNet e-business standard in integrating the supply chain with e-trading systems in the given context. Access to MobInfra provided the possibility to conduct the single-case study. Further, the embedded design with six individual integrations enabled effectively a cross-case analysis setup needed for a proposition building case study approach (Eisenhardt 1989). Data were collected in three phases spanning October 2006-June 2008, including pre-study interviews with MobInfra's representatives, a dyadic in-depth evaluation of the supply processes between MobInfra and two European telecommunications operators, Alpha and Bravo (pseudonyms), and a longitudinal analysis of an e-trading system implementation project between MobInfra

and Alpha in 2007-2008. The main data collection was supplemented through comparing MobInfra's system-to-system integrations with Alpha and Bravo to four other MobInfra's customer-facing system-to-system integrations (with telecommunications operators Charlie, Delta, Echo, and Fox [pseudonyms]). Data analyses were focused on MobInfra's perspective on the RosettaNet standard, on MobInfra's customers' perspectives on system-to-system integration towards MobInfra, in particular, using the RosettaNet standard, and on dyad-level perceived success of past and current system-to-system integrations between MobInfra and its customers.

3.3 Assessment of validity and reliability

Key criteria in evaluating the rigor of case study research are construct validity, internal validity, external validity, and reliability (Yin 1994). *Construct validity* establishes correct operational measures for the studied concepts (p. 33). It refers to the extent a given study investigates what it claims to and to the extent the employed research procedures lead to an accurate observation of reality (Gibbert et al. 2008, p. 1466). *Internal validity* establishes that a claimed causal relationship holds. This criterion is particularly relevant for explanatory case studies, i.e. case studies with an explicit interest to develop or test a causal relationship (Yin 1994, p. 33). *External validity* establishes the domain of generalization of the findings (p. 33). *Reliability* ensures that the procedures of the study can be repeated with the same results (p. 33). Of these criteria, construct and internal validity are of paramount importance since they are necessary conditions for external validity (Gibbert et al., p. 1468). Notably, based on a systematic review of published case studies in high profile organization theory journals, external validity concerns have been overemphasized in relation to both construct and internal validity issues (Gibbert et al.). Our approach to address Yin's criteria of case study quality within each study individually is summarized in Table 2. To complement this exhibit, following shortcomings are acknowledged.

Paper I. *Concerns on construct validity:* Since each company was interviewed only once, some important insights might not have been captured during the process. Second, the viewpoint of the study was on single companies rather than of dyads or supply networks. *Concerns on external validity:* Companies invited to the study were selected by expert assessment and is biased towards companies known for their advanced use of electronic trading systems and typically large R&D budgets.

Table 2: Assessment of validity and reliability

Test	Yin's tactic	Paper I	Paper II	Paper III	Paper IV
Construct validity	Use multiple sources of evidence	Multiple sources of evidence (two-phase pre-study); review of case write-ups by informants; review of tentative results by study steering group consisting of industry experts and senior research advisors; tentative results presented at a public Tekes seminar[a]	Multiple informants in each dyad; use of quantitative data where available; exhibiting audit trail from case data to the explicated framework and propositions; having informants review case study report drafts; presentation of tentative results at an Tekes-funded ELOCORE-project seminar to a practitioner audience[b]	Multiple sources of evidence; explicit grounding each key finding empirically from multiple data sources; presentation of preliminary results to key contact persons at CDRC and sending a summary of the preliminary results to the studied suppliers.	Multiple sources of evidence; exhibiting audit trail from case data to key concepts and propositions; providing MobInfra representatives, other informants opportunity to comment to intermediary results; presentation of the results to a meeting of a European professional association on e-business standards.
	Establish chain of evidence				
	Have key informants review draft case study report				
Internal validity	Do pattern-matching	N/A (exploratory case study without an interest to build explanations)	N/A (proposition building case study without an interest to build explanations)	N/A (descriptive case study without an interest to build explanations)).	N/A (proposition building case study without an interest to build explanations)
	Do explanation building				
	Do time-series analysis				
External validity	Use replication logic in multiple-case studies	Selection of 18 cases with different kinds of benefits, different kinds of e-trading systems employed, and different kinds of contexts of use.	Multiple-case design selecting cases from different operational contexts; supported further by coherent mapping of key findings with prior literature.	N/A (single case study)	Selection of Alpha and Bravo as same-sized customers (to MobInfra) operating in the same geographic region; selection of four additional system-to-system integration cases with the help of MobInfra representatives to illustrate different kinds of customer integrations.
Reliability	Use case study protocol	Yes	Yes	Yes	Yes
	Develop case study database	Yes	Yes	Yes	Yes

a = http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/ELO/fi/Omat_ELOnsivut/ELOn_vuosiseminaari_17032004.html

b = http://www.lrg.tkk.fi/elocore.html

Paper II. *Concerns on construct validity:* Low number of cases (being on the lower bounds of Eisenhardt's suggestion of 4-10 cases) may limit the accuracy of the description of VMI as three patterns of use. More variation in distinct modes could be possible to with more extensive multiple-case study setups. However, prior literature can be read to support the proposed categorization.

Paper III. *Concerns on construct validity:* The field note documents (records of the interviews made) were not checked by the informants. However, close cooperation with CDRC contacts throughout the study and the use of converging data from multiple sources supports the validity of conclusions. *Concerns on external validity:* Single-case study setup limits generalizing main findings to the context of supplier-facing transaction systems.

Paper IV. *Concerns on construct validity:* There was a limited access to empirical data, as data collection during the study proved challenging, especially gaining access to informants at the studied telecommunications operators. Due to this fact data on four of the six analyzed cases were collected solely from informants at MobInfra. These concerns were addressed by multi-informant data collection, collecting dyad-level data in instances where access was possible, and following longitudinally one implementation project. Furthermore, the selection of the unit of analysis can be questioned. The study of a set of companies, rather than a buyer-supplier dyad, might be a more pertinent unit of analysis (Damsgaard and Lyytinen 1998). One of the central ideas behind an e-business standard as the RosettaNet standard is the fluent integration among many companies, not just at a dyadic level. This concern has been addressed by aiming to understand more holistically MobInfra's customer-facing electronic integrations by covering six of the total thirteen customer-facing implementations active at the time of the study.

4 EMPIRICAL RESULTS

The empirical part of this dissertation consists of four original studies reported as four peer-reviewed publications. To better understand the utilization of electronic trading systems in SCM each study represents four different contexts: Paper I: progressive Finnish manufacturing and trade companies; Paper II: buyer-supplier replenishment systems; Paper III: supplier facing transaction systems; and Paper IV: customer-facing transaction systems. Next, these publications are reviewed in terms of their specific research questions and results.

4.1 Paper I: Exploration into the utilization of electronic trading systems

In the context of Finnish manufacturing and trade industries, Paper I reports the findings of an exploratory study of state-of-practice of e-trading system use, in 2003, among Finnish companies deemed progressive. The study is based on a commission by Tekes, the Finnish Funding Agency for Technology and Innovation, interested in academic evidence to base further funding decisions within the *E-business Logistics (ELO)* Research and Development program (running 2002-2005[2]). Against this background, a study with three specific research questions was carried out:

> ***RQ (1) Paper I**: What benefits electronic trading systems provide for supply chain management?*
>
> ***RQ (2) Paper I**: How companies use different types of electronic trading systems in their supply chain processes?*
>
> ***RQ (3) Paper I**: Is there a trend in the use of electronic trading systems for supply chain management?*

Based on the case analysis of 18 cases, Paper I presents five findings on the utilization of e-trading systems in the supply chain context. Firstly, it is proposed, a key operational impact of IT in SCM is the enhancement of customer service level; secondly, IT in SCM improves operational efficiency; thirdly, IT in SCM improves information quality; fourthly, IT in SCM enables agile supply chain operating models; and finally, the use of IT has to be coupled with

[2] http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/ELO/fi/etusivu.html

process re-design to receive supply chain –level competitiveness enhancing benefits[3]. The paper also observes that the studied companies had indeed evolved in their ways of utilizing e-trading systems in the supply chain context. In particular, Internet technology and third-party electronic integration services had provided these companies with increased possibilities to network with supply chain partners. However, in most studied cases the e-trading solutions were unilateral, as they had been developed typically from the focal company point of view. The case of Vaisala Instruments emerged as one exception, by showing intended impacts for a whole supply network, not just focal companies or single buyer-supplier dyads.

4.2 Paper II: Study on buyer-supplier replenishment systems

In the context of buyer-supplier replenishment systems, Paper II reports findings from a multiple-case study on the vendor-managed inventory (VMI) model. VMI is a commonly cited buyer-supplier replenishment system. VMI makes the supplier responsible for replenishment decisions on behalf of the buyer (Waller et al. 1999, Chopra and Meindl 2001, Simchi-Levi et al. 2003). Past research remains ambiguous on who benefits and how from such initiatives; in particular it appears hard for suppliers to benefit operationally (Clark and Stoddard 1996, Vergin and Barr 1999) or derive benefits from added visibility (Holweg et al. 2005). In addition, VMI has received only moderate attention in empirical research efforts, as the majority of work is conducted from the mathematical modeling/simulation perspectives. Against this background, an empirical case study with two specific research questions was carried out:

> ***RQ (1) Paper II****: What kinds of benefits are realized from VMI (operational, i.e. efficiency related, versus commercial, i.e. sales related)?*
>
> ***RQ (2) Paper II****: How the benefits are shared at the dyad level (suppliers versus buyers)?*

Based on an analysis of five buyer-supplier dyads using a VMI-model, the paper proposes three empirically grounded patterns of VMI utilization: basic, cooperative, and synchronized VMI. *Basic VMI* constitutes the use of the VMI model at the level of transferring

[3] Note that the original formulation in the paper reads “Use of IT has to be coupled with process redesign to receive strategic benefits”. However, the intention in Paper I in using the term “strategic” was to refer to benefits that realize at the supply chain level (not internal to some company, and not within specific dyads) and that provide competitiveness (see pp. 95-96 of Paper I).

replenishment responsibility, and the added information needed to fulfill that responsibility from buyer to supplier. *Cooperative VMI* is characterized by bilateral interests for improving the supply chain. Besides the basic effects on operational efficiency gains for buyers and on the buyer-supplier relationship through VMI, the cooperative implementation pattern was noted to incur certain unique effects: buyer-supplier goal alignment and joint action. In particular, the paper suggests that within cooperative VMI programs the implemented e-trading system can provide practical facilities to realize and nurture buyer-supplier cooperation. Finally, in *synchronized VMI*, an augment to either basic or cooperative pattern, the supplier complements the e-trading system by integrating downstream information directly or indirectly into its internal decision-making and striving for internal operational benefits with the benefit of improved decision-making. Synchronized VMI calls for an explicit intention by the supplier to make systematic use of VMI in its internal planning of operations.

Further, the paper recognizes five contextual inhibitors of VMI impacts: *ex ante* customized product offering as limiting the value of VMI as a customer lock-in tool; *ex ante* buyer purchasing proficiency as limiting the value of VMI as a customer lock-in tool and in reducing work at the buyer; supplier's large delivery package size as limiting the possibilities of reduced inventories at the buyer; small share of business as limiting supplier's possibilities to benefit from VMI internally; and supplier's long production cycle length as limiting supplier's possibilities to benefit from VMI internally.

4.3 Paper III: Study on a supplier-facing transaction system

In the context of supplier-facing transaction systems, Paper III reports the findings of a study on the use and benefits of an e-trading system offered by a consumer durables retailing company or CDRC (a pseudonym) to its suppliers. Specifically, CDRC managed at the time of the study a retail outlet chain consisting over 80 stores, located primarily in one North-European country. Previously vertically integrated, CDRC had outsourced virtually all of its manufacturing operations. Its supply base included at the time of the study around 400 suppliers. Approximately 30 of its key suppliers, small and medium sized manufacturing enterprises (SMEs), made up 80 % of CDRC's purchases.

The case company initiated in the late 1990s the development of an e-trading system towards its key suppliers. During 1996-1998 the system, essentially an electronic monopoly based on proprietary communication standards, was introduced as an extension to CDRC's internal information system. Suppliers could either use the system manually or integrate the data flow

to its internal system. A handful of the target suppliers started to transact electronically, remaining either system-to-human users (using CDRC's system manually from a dedicated terminal) or upgrading, at their own expense, the electronic link to a full system-to-system setup. In 2003, in order to increase the share of supply-side electronic transactions, a new development phase was initiated: a supplier web-portal was deployed. This system-to-human approach allowed a supplier only by using a standard desktop computer and an Internet browser, receive and confirm CDRC's orders, communicate with CDRC's retail outlets, send product availability data, and view inventory levels and sales figures of CDRC's retail outlets. Against this background, a study with the following research question was carried out:

> ***RQ Paper III****: How do system-to-human and system-to-system integration compare as means in supply chain integration from the perspective of non-initiating SME supplier?*

Based on the analysis of CDRC's supplier-facing transaction system, the paper presents two key findings on the utilization of a supplier-facing e-trading system from the perspective of non-initiating SME supplier:

(1) Interorganizational system-to-human integration can provide operational benefits for non-initiating SMEs, but not as much as system-to-system integration;

(2) System-to-system integration remains hard in the context of limited financial and other resources and backend information system capabilities.

The paper exhibits how the approach to provide both system-to-human and system-to-system communication alternatives has benefited operationally CDRC's suppliers. Yet, the level of automation was found out to make a great difference in terms of operational efficiency gains: the study found out that the evaluated system-to-system using suppliers reported on average one tenth of manual work content and perceiving higher benefits from their e-trading system investments towards CDRC than the studied system-to-human using suppliers. Further, the paper brings evidence that even if full system-to-system integration would be preferred at both ends of the dyad, capability to integrate operates as an effective obstacle; thus the intentions by CDRC's and its closest suppliers to increase the use of system-to-system integration proved to be a challenging task as system-to-system integration is costly and demands backend information system capability, issues particularly noteworthy in the context of SMEs.

4.4 Paper IV: Study on a customer-facing transaction system

Finally, in the context of customer-facing transaction systems, Paper IV evaluates the effectiveness of the RosettaNet standard in integrating the telecommunications supply chain. MobInfra, a globally operating telecommunications equipment supplier, joined the RosettaNet consortium, the body responsible for the development of the RosettaNet standard, in 2001 and implemented the first RosettaNet-based processes with its suppliers in the same year. RosettaNet was soon made a preferred way of interorganizational system-to-system integrations both towards suppliers and customers. As a result MobInfra was in 2003 one of the founding members of the RosettaNet Telecommunications council, along with several major OEMs and operators, in order to drive RosettaNet also towards its customers, telecommunications operators.

From an overall business perspective, MobInfra saw RosettaNet as a global standard compared to more regionally restricted variants of traditional EDI. In addition, RosettaNet was seen as a more open standard, enabling flexible integrations with many trading partners. Specifically, MobInfra's representatives remained confident that the key value of RosettaNet lies in its capability to support the automation of various kinds of business processes, that is, to extend system-to-system integrations to non-automated interorganizational processes. In short, perceived a MobInfra representative, RosettaNet is the *lingua franca* of e-business in a global operating environment calling for flexible and efficient integrations and disintegrations with various partners. By 2006, the total number of MobInfra's system-to-system integrated partners was several hundred, divided roughly equally between RosettaNet and EDI. At the same time, system-to-system integrations towards its customers were relatively scarce: only with 13 customers had MobInfra created system-to-system integrations, and among these not all were done with RosettaNet, but with older standards, several variants of traditional EDI. Against this background, a study with the following research question was carried out:

> ***RQ Paper IV**: What is the role of the RosettaNet standard in interorganizational system-to-system integration in the context of telecommunications equipment supply from both the supplier's and the buyer's perspectives?*

Based on the analysis of MobInfra's customer-facing electronic integrations, the paper presents two propositions on the role of the RosettaNet standard in operational level supply chain integration:

(1) The differential benefits of the RosettaNet standard are greater in business processes previously unexplored in the industrial context of the transacting parties.

(2) Standardization of trade item packages on the least complex level for both trading partners is a prerequisite for dyad-level economically beneficial RosettaNet-based integration in the context of multi-level trade item structures.

The paper argues based on accumulated evidence that newer e-business standards, such as the RosettaNet, would be valuable over traditional EDI-standards when the e-trading system integrations are *explorative* (March 1991), i.e. the integration is applied to interorganizational business processes with little or no prior implementations in the industrial context of the focal buyer-supplier relationships. In addition, the paper draws attention to an issue overlooked in prior research: the necessity, in order to reach economic benefits on the dyadic-level, to unambiguously define product item code data on the least complex level for the perspective of both trading partners. Such an approach simplifies the interorganizational data exchange and improves data quality to the extent that true benefits from automating the data flow are possible.

The paper also highlights two distinct modes in e-trading system utilization, termed adverse and cooperative. *Adverse* e-trading system integrations were signified with low extent of mutual process alignments and unilateral benefits while *cooperative* integrations with dyad-level mutual commitment and bilateral benefits and requisite mutual process development within the integration projects. In addition, cooperative integrations were associated with a true intention to enhance the related interorganizational business process, while adverse integrations embodied a unilateral pursuit of direct cost savings, e.g. through receiving invoices electronically.

5 OVERALL FINDINGS

Next, overall findings of this dissertation are summarized. The first paper of this dissertation, exploration into the practices of electronic trading system utilization within Finnish manufacturing and trade industries provided five tentative overall results on electronic trading system utilization in SCM: firstly, that a key operational impact is the enhancement of customer service level; secondly, that electronic operational efficiency is improved; thirdly, that information quality is improved; fourthly, that electronic trading systems enable agile supply chain operating models; and finally, that for supply chain –level benefits the use of electronic trading systems needs to be coupled with process re-design. The paper also observed a trend in increased possibilities through Internet-technologies and third-party electronic integration services. Next more specific answers are summarized on the three overall research questions of this dissertation from the empirical work reported in Paper II, Paper III, and Paper IV.

5.1 On the ways to utilize electronic trading systems

RQ1 of this dissertation reads: how do companies utilize electronic trading systems in supply chain management? On this question we find that electronic trading system utilization can be conceptualized as a two-level framework (Finding 1) and that effective electronic trading system utilization is characterized by partner-task transaction-instance -based differentiation (Finding 2).

Finding 1: Electronic trading system utilization realizes on two levels: relationship mode (unilateral or bilateral) and technical design (function, architecture, automation, and communication standards and networks).

We suggest based on our work a two-level conceptualization of electronic trading system utilization. On the level of the mode, the question is about the unilateral and the bilateral approaches: whether a system is deployed from a single party perspective and aimed for individual benefits or whether the buyer-supplier dyad in question pursues joint goals and respective mutual benefits. Secondly, on the more technical design level, important questions on electronic trading system utilization are of the function, architecture, automation, and communication standards and networks.

The finding is grounded both in prior literature (Figure 5) and our empirical work (Table 3). The role of the relationship mode is conspicuous in prior literature. Chatterjee and

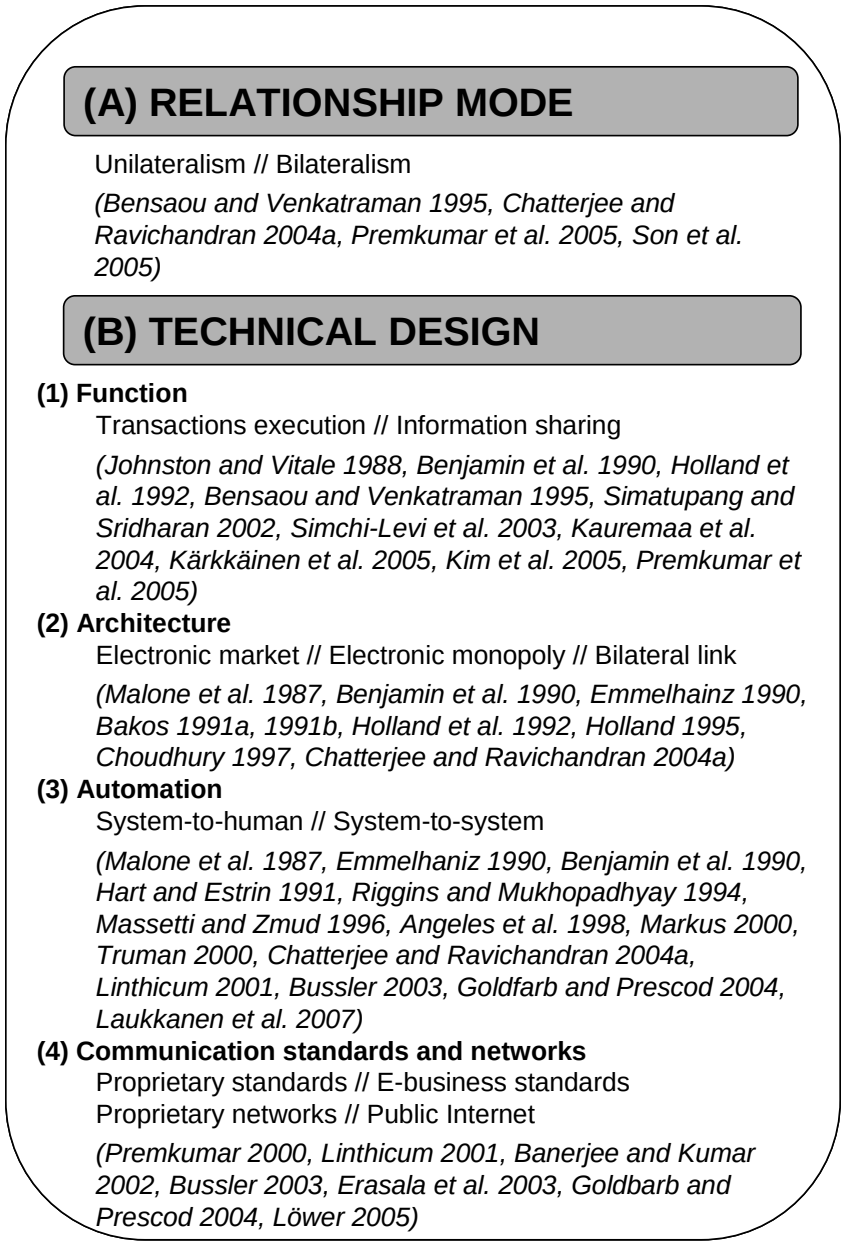


Figure 5: Two-level conceptualization of electronic trading systems utilization (a proposal based on synthesis of prior literature)

Ravichandran (2004a) have suggested that relational support is one key feature within e-trading system use; Son et al. (2005) that higher volume and diversified (by the function of the system) e-trading system use are related cooperative approaches; and Bensaou and Venkatraman 1995 and Premkumar et al. (2005) that distinct patterns of e-trading system use can be related to varying information processing needs. Notably, Premkumar et al. (2005), similarly as Bensaou and Venkatraman (1995), designate their patterns with to some extent unilateralism/bilateralism resonating titles: e-experimenters, e-cooperation, e-coordination, e-collaboration, minimalists, and traditionalist.

Table 3: Illustrated empirical results within the two-level conceptualization of electronic trading systems utilization

	Paper II	Paper III	Paper IV
Relationship mode			
Unilateralism	Basic VMI (Dyads 1, 2)	CDRC's approach to dictate its e-trading system use and to collect payments for its use from its suppliers; upgrade to system-to-system data exchange left to suppliers' own issue	Adverse electronic integrations
Bilateralism	Cooperative VMI (Dyads 3, 4, 5)	CDRC's future intentions to start helping its suppliers in their e-trading system utilization, e.g. by developing easier system-to-system integration tools for its suppliers	Cooperative electronic integrations
Technical design			
Function	Transaction execution of the VMI process. Information sharing on buyer's inventory levels	Transaction execution: order data to improve efficiency of basic trading routines Information sharing: exchange of product availability data to improve visibility of supply capabilities to end customers	Transaction execution: exchange of basic order-to-cash messages to either (1) to receive unilateral efficiency gains e.g. by having electronic invoices (adverse integrations) or (2) to improve the interorganizational business process (cooperative integrations)
Architecture	Bilateral links	Electronic monopoly	Bilateral links; however, in utilizing the RosettaNet standard for the integration, the inherent intention was to enable fluent many-to-many system-to-system integrations (resembling thus either a electronic monopoly or even a [private] electronic market open to multiple suppliers and operators with the benefit of the open RosettaNet standard.
Automation	System-to-human (Dyads 1 and 2); System-to-system (Dyads 3, 4, 5). Interpreted reason for this: mainly related transaction volume and backend system capability issues.	System-to-human and system-to-system alternatives within the same CDRC e-trading system; reason: to communicate electronically also with partners not able or willing to make specific investments to CDRC's e-trading system	System-to-system (with examples of non-desired system-to-human data exchange in failed system-to-system integrations)
Communication standards and networks	Standards: Proprietary (Dyads 1, 2, 5 [in inventory/production data exchange]); E-business standards: EDIFACT (Dyads 3, 4, 5 [in replenishment notification data exchange]) Networks: proprietary (Dyad 3, 4, 5[b]); Internet (Dyads 1, 2)	Standards: proprietary Networks: proprietary (older e-trading system); Internet (newer e-trading system)	Standards: e-business standards: traditional EDI in older integrations, RosettaNet in newer integrations; Reason for RosettaNet: to enable fluent integrations over a set of partners; Networks: proprietary (older traditional EDI-based integrations and 2007 MobInfra-Alpha RosettaNet-based integration); Internet (other RosettaNet-based integrations)

NB: Data is presented here partly also directly from the case study databases of the individual studies (for issues relevant to this analysis and not reported in the publications)

For the technical design level, the framework synthesizes common issues in recent conceptualizations of electronic trading systems (especially Premkumar 2000 and Banerjee and Kumar, see Section 2.3.3). Empirical results from this dissertation provide illustrations for the two-level conceptualization. On the relationship mode level the studies highlight the fundamental role of buyer-supplier relationship bearing relevance on electronic trading system utilization. This finding is most apparent in the results of Paper II. The paper finds that buyer-supplier VMI-replenishment systems can be conceptualized either basic or cooperative. Basic VMI denotes an electronic trading system use within more traditional – or unilateral – interests. Paper II observes how for the involved buyers the target of basic kind of VMI was the ease of supply and improved operational efficiency. The suppliers were in these instances chiefly concerned the preservation of their commercial position. In basic VMI, the electronic trading system thus acts for the supplier as a structural relationship-marketing program (Berry 1995, Palmatier et al. 2006, p. 477), i.e. a means for value-based differentiation (Levitt 1980, Shapiro and Heskett 1985, Woodruff 1997, Mentzer, DeWitt, Keebler, et al. 2001, Anderson and Narus 2004, Ulaga and Eggert 2006, Tuli et al. 2007). The buyer's objectives in basic VMI are satisfied to the extent that its purchasing operations are made easier, more efficient, and more effective: ordering work is eliminated, inventory levels are reduced, and material availability is improved. The supplier's target is met to the extent the VMI service is offered successfully. Within cooperative VMI, on the other hand, both buyer and supplier seek efficiency at the dyadic level. Besides the basic effects on operational efficiency gains for buyers and on the buyer-supplier relationship through VMI, the cooperative implementation pattern incorporates buyer-supplier goal alignment and joint action, as in an archetypical bilateral hybrid form of transaction governance (Heide 1994). The role of relationship mode is also perceptible in Paper III (approaches to dictate e-trading system use toward a set of suppliers on the one hand and the future intention to support suppliers in technical issues on the other) and in Paper IV (cooperative versus adverse electronic integrations).

On the technical design level, the empirical findings illustrate the conceptualization of important features of the utilization of e-trading systems through the four choices of function, architecture, automation, and communication networks and standards. The function of each system needs to be matched with the needs of relevant business processes: execution transactions of the VMI process in Paper II and of order-related messaging in Paper III and Paper IV; information sharing on buyer's inventory levels to support the VMI process or on supplier's inventory levels to inform the buyer on material availability within the supply chain

in Paper II. Architecturally, bilateral links (Paper II and Paper IV), and an electronic monopoly (a supply side transaction system in Paper III) were observed. In addition, the dyadic e-trading systems in Paper IV constituted essentially an attempt to establish a many-to-many private market-place, through the virtue of RosettaNet e-business standard potentially enabling the fluent (dis)integrations between various suppliers and buyers. Automation concerns were a further important consideration, relating specifically to the magnitude of direct efficiency benefits. These considerations were most present in Paper III where the focal buyer offered to its suppliers both the system-to-human and system-to-system alternatives, in an attempt to increase the share of its electronic supply-side transactions. In Paper IV the whole starting point was to build system-to-system links, with the idea that only direct data exchange beyond organizational boundaries brings true efficiency benefits. In Paper II the automation-level considerations were not that visible. In some studied dyads the VMI-based messaging had been fully automated, whereas in others not. But Paper II still exhibits incidentally that the higher the transaction volumes, the higher the need to build system-to-system link. Finally, communication standards and networks were a highlighted practical feature of e-trading systems in each of the papers, as summarized in Table 3. In particulaer, these were focal issues in Paper IV.

Finding 2: Effective utilization of electronic trading systems is characterized by differentiation over transaction instances (partner and task combinations).

Our study lends support to a conclusion that effective utilization of electronic trading systems is characterized by differentiation over transaction instances – partner and task combinations (Figure 6). Transaction instance is defined as the unique occurrence of a recurring task taking place in the interorganizational context between a given buyer and a given supplier. Following Lawrence and Lorsch (1967, p. 4), a task is further defined as the complete input-transformation-output process involving at least the production and distribution of some goods or services. Notwithstanding the special case of sole buyer-sole supplier process with a single task, transaction instances are many. Essentially, each transaction instance can be seen unique in terms of its particular context.

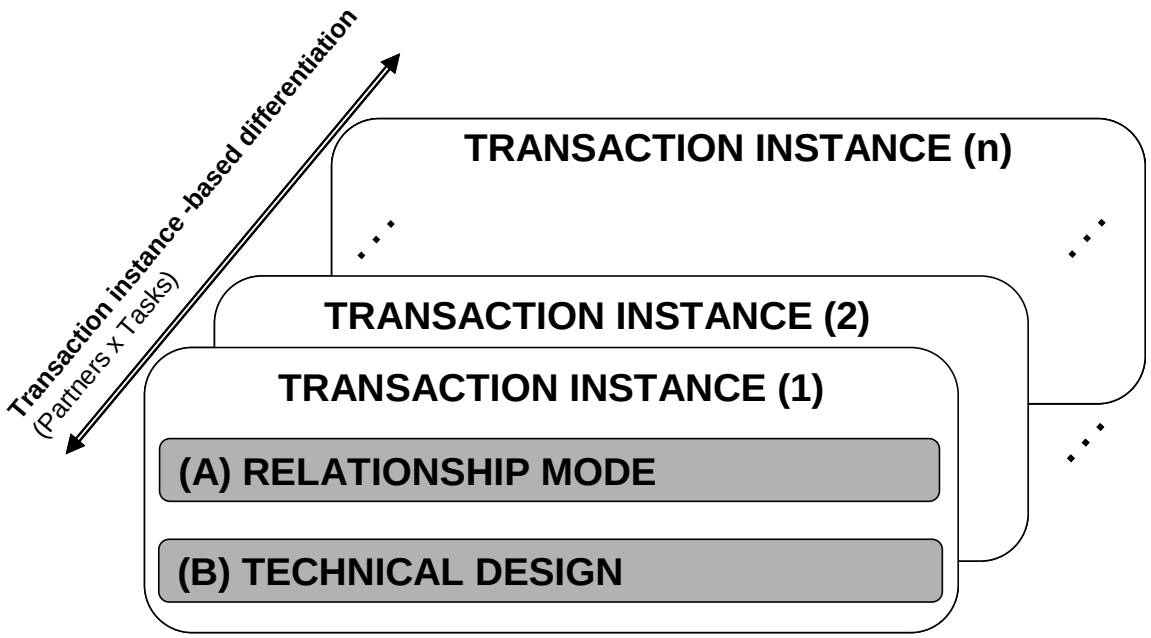


Figure 6: Transaction instance -based differentiation of electronic trading systems utilization

The finding has a basis both in prior literature and our empirical work. In prior literature, Holland and Lockett (1997) have elaborated the basic monolithic market-hierarchy dichotomy within TCE by proposing the concept of mixed mode network structures – combinations of market and hierarchy features – and matching empirically, through a case study of five transaction instances, specific kinds of mixed network structures with different kinds of e-trading system features. Johnston and Vitale's (1988) framework included as one of the key feature the "who" question, i.e. which partners (customers, dealers, suppliers, competitors) should be linked to the prospective e-trading system. Massetti and Zmud (1996) proposed in their typology, as reviewed in Section 2.3.3 above, diversity (extent to which different types of documents are exchanged via e-trading systems; for this work this issue relates fundamentally to different kinds of buyer-supplier tasks) and breadth (extent to e-trading systems exist with different trading partners) as intrinsic aspects of e-trading systems use. Within the SCM discourse, Lambert and Cooper (2000) have centrally conceptualized SCM as three key decisions – intrinsically, from this dissertation point of view, differentiating decisions: on who to integrate with, what processes to integrate with them and how deeply to integrate. A recent empirical evaluation suggests relatively few instances of differentiation as a state-of-practice. Kärkkäinen et al. (2007) found in a study of 16 large to very large Finnish industrial organizations from multiple industries that the focal organizations used up to around four separate e-trading systems in total (towards both suppliers and customers) with the key aspects

differing between the separate systems being their function (different kinds of transaction data versus different kinds of shared information) and their level of automation (system-to-human versus system-to-system communication). Furthermore, companies appear using e-trading systems prominently for transaction execution and less for information sharing purposes (Kauremaa et al. 2004).

The empirical results accumulated in this study complement these prior findings by pointing to the inherently instance-based nature of effective electronic trading systems utilization. Paper II reports how VMI systems were deployed under various ways, based on the nature of the transaction, ranging from implementations to receive operational benefits/offer service and maintaining a traditional buyer-supplier transaction to implementations to support buyer-supplier cooperation. Furthermore, Paper II identifies a list of contextual factors making it hard for suppliers to utilize VMI-enabled information internally and thus motivating the need to differentiate the ways VMI systems are used in terms of utilizing related visibility information internally. Paper III reports how in the context of supplier-facing transaction systems transaction-instance based differentiation enabled the extension partner base of the focal company.

Finally, Paper IV reports in the context of customer-facing transaction systems the challenges of a focal company trying to impose a single e-business standard towards all customers. As the needs and operational contexts of transacting parties differed, the focal company in question ran into challenges in trying to increase the volume, diversity (variety of processes), and breadth (variety of transaction partners) of system utilization in its customer end. One approach to solve the dilemma is reported in Paper IV. One of the customers of MobInfra, operator Alpha, had made a policy to use a third party integration service provider to connect with its suppliers. Alpha only delivers messages in the form that it prefers to its service provider; the suppliers get the messages in the form they then prefer; the conversion is done by the third party intermediary. The aim to use such third party was to make Alpha itself indifferent to these communication standard and network matters. However, such third party translation services cost, as do the traditional VAN services (Emmelhainz 1990). Furthermore, as observed in Paper IV, even this approach leaves the challenge of varying operational models and goals of transacting parties and the need for explicit choices within the two-level framework (Figure 5). To conclude, finding out similar-enough instances and separating them

by differentiated electronic trading system application from other instances appears, based on this study, a means to deploy electronic trading systems effectively.

5.2 On the benefits of electronic trading system utilization

RQ2 of this dissertation reads: what kinds of benefits do electronic trading systems provide in supply chain management? On this question we find that cooperative, operational, and commercial supply chain integration are distinct kinds of results of electronic trading system utilization in supply chain management (Finding 3) and that the use of unilateral adjustments supports generation of benefits from electronic trading system utilization, in particular under unilateral modes of electronic trading system utilization (Finding 4).

Finding 3: Cooperative, operational, and commercial supply chain integration are distinct results of electronic trading system utilization in supply chain management.

This dissertation provides evidence on the nature of supply chain integration realized through electronic trading system utilization. Above (Section 2.1), two kinds of hybrid governance modes for interorganizational transaction were reviewed: unilateralism with individual buyer and supplier ends and bilateralism incorporating joint buyer-supplier ends. Further, three distinct modes of supply chain integration were identified (Section 2.2): cooperative integration to create facilities for buyer-supplier cooperation, operational integration to create buyer-supplier operational linkages in terms of systems, procedures and routines, and commercial integration to lock-in customers through value-based differentiation (Section 2.2). Based on our study we find that all of these aspects of supply chain integration can be supported with e-trading systems but the nature of integration within a given use-instance varies.

The accumulated evidence on each reported study demonstrates how e-trading systems indeed provide various operational efficiency benefits stemming from improved operational supply chain integration ("Results" section of Paper I; Table 6 of Paper II; Table 2 and Figure 1 of Paper III and Case data display 2 and Section 4.2.2 of Paper IV). Yet the papers also collectively point out how cooperative supply integration through electronic trading system utilization is not always the case. In particular, Paper II suggests the decoupling of operational and cooperative level of supply chain integration. Thus this dissertation finds that supply chain management schemes can also be purely operational efficiency motivated without the intent of cooperative integration. Paper II proposes a conceptualization based on the locus of the integrative system in question. It links cooperative VMI schemes to situations where the

supplier and the buyer operate as an integrated dyad towards fulfilling the needs of commonly relevant third party, the buyer's customer and the basic VMI schemes to situations where no relevant external parties to the dyad exists. The intention and result in these instances was mainly that of commercial supply chain integration. We conjecture the same logic applying more generally to e-trading system utilization (Figure 7). Overall intentions to joint buyer-suppler supply chain management are best matched by utilizing an e-trading system from the

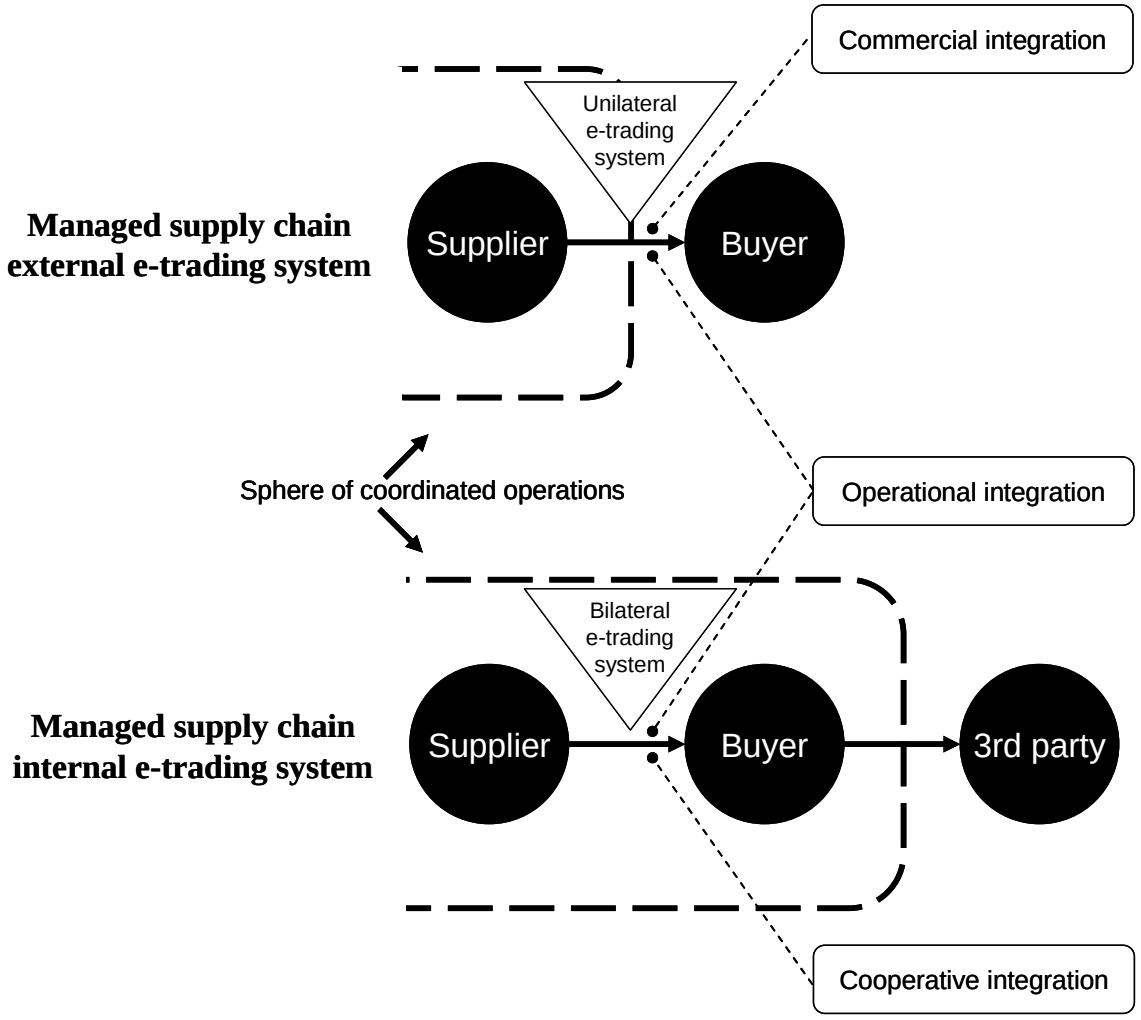


Figure 7: Electronic trading system utilization and distinct kinds of supply chain integration (developed from Paper II)

dyad-level perspective (the bilateral deployment mode); where commercial integration interests dominate, e-trading systems developed from the perspective of single trading parties best serve the purposes of the interorganizational exchange (the unilateral deployment mode). Bilateral e-trading systems calling for higher level dedicated investments are then placed within converging buyer-supplier goals under relatively tightly interdependent transaction instances. Such investments would be unnecessarily risky in less interdependent transaction instances where unilateral interest and diverging buyer-supplier goals prevail.

Finding 4: Unilateral adjustments supplement benefit generation from electronic trading system utilization.

Further, this dissertation finds that the accumulation of benefits from e-trading system use can be supported by actions of singular agents. Evidence is accumulated on companies making unilateral adjustments to more fully benefit from the e-trading system in question. In Paper II certain suppliers (in Dyads 4 and 5) had made investments to integrate VMI-based information to their internal information systems to increase the efficiency of their production operations, an approach termed synchronized VMI. In Paper III some suppliers to CDRC pursued the update of system-to-human link to full system-to-system data exchange to further reduce manual work in transactions with CDRC. In Paper IV MobInfra, the focal supplier, implemented a dedicated software tool to restructure and append data received through the e-trading system towards its customers in order to process order-related data without the need of human interventions. These kinds of unilateral adjustments appeared particularly necessary in instances of unilateral e-trading systems where the systems are designed only from one trading partner's perspective, thus necessitating further actions by the other trading partner(s) to more fully benefit from the electronic exchange of data.

5.3 On the role of newer e-business standards

Finally, RQ3 of this dissertation reads: what is the role of newer e-business standards in supply chain management? On this question we find that the RosettaNet e-business standard does not fully compensate for the weaknesses of older EDI-based e-business standards (Finding 5) and that dyad-level application of e-business standards calls for dyadic adjustments amongst the trading partners (Finding 6).

Finding 5: The RosettaNet e-business standard does not fully compensate for the weaknesses of older EDI-based e-business standards.

Our findings point to the limits of integration with newer XML-based standard. This finding stems from the study RosettaNet-based integrations (Paper IV). The paper concludes that the matter is more complex than just putting the standard messages as given by RosettaNet in place. Paper IV discovers that the RosettaNet standard alone is insufficient for creating system-to-system integrations that benefit both implementing parties at the dyadic level. This finding is important in light of the suggestion that newer e-business standards, such as the RosettaNet, would overcome the challenges of EDI standards (Reimers 2001, Goldfarb and Prescod 2004). In particular, Paper IV concludes that the relative benefits of the RosettaNet

standard are greater in business processes previously unexplored in the industrial context of the transacting parties. In the context of organizational studies, March (1991) has proposed two basic modes of learning: exploitation and exploration. Exploitation, according to March, is "the refinement and extension of existing competences, technologies, and paradigms [with] positive, proximate, and predictable" returns (p. 85). Exploration, on the other hand, means "experimentation with new alternatives [with] uncertain, distant, and often negative" returns (p. 85). Paper IV concludes that the key issue is whether or not the planned interorganizational system-to-system information exchange expands to a previously unexplored territory. If yes, newer e-business standards, such as the RosettaNet, being more up-to-date and under more active industry-led development, the paper suggests, are more valuable. On the other hand, in areas where integrations have already been done and prior standards exist—such as basic order messaging—it is less valuable to do the integration with a newer standard, and questionable to replace an older standard only for the purpose of replacing data exchange within a previously working exploitative implementation to be done with a newer standard.

Finding 6: Dyad-level application of e-business standards calls for dyadic adjustments amongst the trading partners.

As evidenced in Paper III, the efficiency benefits on micro-level process improvements in terms of issues such as manual work content reduction and data quality realize maximally only under system-to-system e-trading system designs. Yet, the work reported within this dissertation suggests that organizations still struggle with these matters (Paper III, Paper IV). Paper IV explicates challenges related to utilization of the RosettaNet e-business standard in system-to-system integration with consequent operational efficiency gains. In particular, the paper reports a specific e-trading system implementation case (MobInfra-Alpha) where the mere implementation of the system-to-system link in itself did not result in the full benefits desired. Only agreeing on the use of a simpler product structure secured message integrity and thus a fluent data exchange process. Paper IV denotes this kind of dyadic adjustment as dyad-level standardization of trade item packages. With this the paper refers to an unambiguous definition of item code data of the exchanged products in the interorganizational context on the least complex level. Standardizing the trade item codes between the trading partners is a key enabler of truly beneficial system-to-system information exchange for operational level business processes (Vermeer 2000). However, Paper IV elaborates this finding by observing a situation where the customer-desired end products are configurable from numerous low level trade items which are unnecessarily fine-grained to the other trading partner, in this case the

customer. In such a situation, Paper IV proposes, the definition of preconfigured packages of trade items is an effective means to simplify related interorganizational data exchange by hiding unnecessary data complexity (Baldwin and Clark 1999) within these packages of trade items.

Overall, Finding 6 elaborates microeconomic research on the productivity implications of information technology (Brynjolfsson and Hitt 2000, Dedrick et al. 2003). Brynjolfsson and Hitt conclude that complementary investments are paramount in realizing benefits of the application of IT. In this dissertation we find empirical examples of such complementary investments: dyadic adjustments, such as trade item standardization, to the interorganizational business process.

6 DISCUSSION

The objective of this work has been to contribute to the question how to effectively utilize contemporary electronic trading systems in supply chain management. This goal has been pursued by investigating three descriptive research questions: how electronic trading systems are used (RQ1), what benefits do they provide (RQ2), and what is the role of newer e-business standards (RQ3). Taken together, this dissertation has provided six findings on these questions (summarized in Table 4). The final chapter the summary of this dissertation consists of three parts. First, the contribution of the work conducted is discussed in Section 6.1. Second, the limitations to the findings of this dissertation are discussed in Section 6.2. Finally, three promising areas for further research building on this dissertation are discussed in Section 6.3.

Table 4: Overall findings of the dissertation

RQ1: Ways to utilize electronic trading systems	
	Finding 1: Electronic trading system utilization realizes on two levels: relationship mode (unilateral or bilateral) and technical design (function, architecture, automation, and communication standards and networks).
	Finding 2: Effective utilization of electronic trading systems is characterized by differentiation over transaction instances (partner and task combinations).
RQ2: Benefits of electronic trading system utilization	
	Finding 3: Cooperative, operational, and commercial supply chain integration are distinct results of electronic trading system utilization in supply chain management.
	Finding 4: Unilateral adjustments supplement benefit generation from electronic trading system utilization.
RQ3: Role of newer e-business standards	
	Finding 5: The RosettaNet e-business standard does not fully compensate for the weaknesses of older EDI-based e-business standards.
	Finding 6: Dyad-level application of e-business standards calls for dyadic adjustments amongst the trading partners.

6.1 Contribution

In Chapter 2, prior research on electronic trading systems was found incomplete in terms of providing in-depth case evidence on how to effectively utilize modern electronic trading systems in supply chain management. Ilkka Niiniluoto (1993, p. 12), following von Wright (1963), has suggested that scientific research pursuing knowledge intended to be useful for a

given practical domain codifies knowledge as technical norms. These are normative statements in the form of "if you want A, and you believe that you are in a situation B, then you ought to do X." Closely related, Mario Bunge (1967) has proposed that research bearing relevance on effective human action should focus on the study of technological rules. A technological rule is an instruction to perform a number of acts "in a given order and with a given aim" (p. 132). Bunge emphasizes grounded technological rules; such rule is "based on a set of law formulas capable of accounting for its effectiveness" (pp. 132-133). More recently, Denyer et al. (2008) have suggested that practically relevant business research should focus on the study of design propositions with the CIMO-logic: (1) Context of an intervention, (2) the content of this Intervention, (3) Mechanism accounting for the effectiveness of this intervention, and (4) Outcome of the application of this intervention. Importantly also, Holmström et al. (2009) have suggested what they designate as means-ends propositions be used in various levels of detail and formalism to structure an entire research program around a novel tool intended to solve practical operations management problems. Our overall contribution lies in providing empirical evidence on the means-ends-situation triangle of electronic trading system utilization in supply chain management. We have laid less focus on the question why the application of electronic trading systems lead to intended benefits as we took the *modus operandi* of e-trading system utilization, the improvement of interorganizational business process coordination via reduced coordination costs, as given. Thus the nature of our contribution lies in the question of "how" – how to utilize e-trading system effectively, a question of interest both to research and in practice – instead of the commonly perceived legitimate focus of academic efforts, the pursuit of "why" – the development and testing explanations on given phenomena.

More specifically, this work contributes to prior research on electronic trading systems in supply chain management as follows. Firstly, our work highlights the importance of relationship level considerations in electronic trading system utilization, complementing prior electronic trading systems research. Webster (1995) reports how Ford Europe pursued, through e-trading systems, raw market-power games and dominance ends. Webster concludes: "In developing a proprietary interorganizational network, Ford [had] a basic objective – to gain competitive advantage by locking its suppliers and customers into its systems" (p. 34). In contrast, Chatfield and Yetton (2000) elaborate the concept of high embeddedness of EDI use, found "in a cooperative relationship with established strategic links and people links" (p. 201) and further elaborate that "what matters here is that information flows are bidirectional and

information sharing is reciprocal" (p. 202). Contrasting this with low embeddeness ("likely found in an arm's length relationships, where the initiator-adopter relationship establishes EDI links without having either strategic links or ongoing, close people links" [p. 201] – corresponding to unilateral e-trading system use), Chatfield and Yetton show through a cross-case study how Honda had deployed within its supply system highly embedded EDI-solutions, and through this, reached strategic payoffs (advantage over competitors).

The studies reported herein provide further data on the unilateral and bilateral modes and their implications to benefits received. Prior work has shown that e-trading systems offer various kinds of benefits, in terms of reduction of inter-organizational coordination costs (Elgarah et al. 2005, Narayanan et al. 2009). However, our results indicate that it is relevant to ask which parties actually receive these benefits. We find that the recipients of the benefits from a given e-trading system depend centrally on the distinction of unilateral versus bilateral deployment of electronic trading systems. This is particularly visible in Paper II and Paper IV but also in Paper III; the matter is further touched upon in Paper I in the discussion of the last reported finding (Paper I, pp. 95-96). Taken together, this dissertation exhibits how unilateralism emphasizes the desire and realization of single party operational efficiency benefits while bilateralism nurtures the formation of operational efficiency benefits on the dyadic level. In addition, in some instances operational level efficiency benefits were noted to be negligible in unilateral e-trading modes (e.g. in Paper II, meager operational efficiency improvements for Dyad 1 and 2 suppliers). Moreover, unilateralism was observed distinctively, in contrast to bilateralism, being associated with commercial supply chain integration ends. In Paper II the dyads with a basic VMI and in Paper IV the dyads under adverse integration the suppliers' primary area of benefit was to retain and increase the business with the customer.

Secondly, this dissertation points to the need to decouple cooperative, operational, and commercial supply chain integration aspects in the analysis of electronic trading system utilization in supply chain management. For instance, the VMI-model is commonly presented as a cooperative buyer-supplier scheme. The SCOR 7.0 reference book (Supply-Chain Council 2005, p. 362) defines VMI as a model in which the "supplier takes responsibility for the operational management of the inventory within a mutually agreed framework of performance targets, which are constantly monitored and updated to create an environment of continuous improvement." Our work, especially as reported in Paper II, suggests de-coupling operational integration, as realized in operational efficiency measures such as reductions in

manual work and inventory levels at the buyer, from buyer-supplier cooperation. Thus, a deeply cooperative buyer-supplier supply chain management aspect can, but does not have to, be related to electronic trading system utilization. Furthermore, we provide evidence that in some implementations of electronic trading systems the commercial needs outweigh supply chain development considerations. These elaborations are an important addition to the body of literature on supply chain management associating integrative practices, such as VMI, invariably with a deeply cooperative supply chain improvement approach (Cooper et al. 1997, Mentzer, DeWitt, Keebler, et al. 2001, Chen and Paulraj 2004).

Thirdly, we have contributed with the two-level synthesis also to research on electronic trading systems. As noted above in Section 2.3.3., Narayanan et al. (2009, p. 146) suggest that future researchers should try to better understand configurations of structure, process, and context of effective utilization of electronic trading systems. And further, as noted, most recent syntheses still omit either technical (Chatterjee and Ravichandran 2004a) or relationship aspects (Banerjee and Kumar 2002) of electronic trading system use within a single framework. The synthesized two-level framework (Figure 5 and Table 3) and the observation of the requisite transaction-instance –based differentiation for effective electronic trading system utilization complements the prior work by discussing both relationship mode and technical design questions of e-trading system deployment within a single conceptualization. The framework also provides an elaboration on the means to enforce and realize hybrid forms of governance in the domain of supply chain management. Carter and Hodgson (2006) evaluate a set of noted studies on TCE published in prestigious organization theory journals between 1981 and 1997. They find that while empirical works on the relationship of asset specificity and vertical integration are consistent with hypotheses derived from TCE, studies on hybrid governance forms give much more ambiguous results, implicating hybrids as a promising area of research. We elaborate the nature of hybrid governance forms in the supply chain management context by mapping one category of means to enforce and realize hybrid transaction governance, that is, electronic trading systems.

Finally, we contribute to research on e-business standards by raising the question of limitations of newer XML-based e-business standardization approaches. EDI standards date back to the 1980s (Emmelhainz 1990). Impacts and adoption of EDI have been studied extensively (Elgarah et al. 2005) and a common current view is that EDI has fallen short of original expectations. In particular, traditional EDI has been criticized for its complexity, high

implementation costs, and reliance on proprietary networks (VANs) (Goldfarb and Prescod 2004, Wigand et al. 2005, Johnston et al. 2007), making it available first and foremost to larger organizations. In addition, evidence exists that EDI-enabled information flows have been implemented in several instances only in a half-automated way, thus forgoing the benefits of a fully automated information exchange process (Benjamin et al. 1990, Riggins and Mukhopadhyay 1994, Angeles et al. 1998, Markus 2000, Truman 2000, Mukhopadhyay and Kekre 2002). Recently, it has been suggested that newer e-business standards, such as the RosettaNet, would overcome the challenges of older EDI standards (Reimers 2001, Goldfarb and Prescod 2004). Our findings point to the limits of RosettaNet-based integration. Essentially, this dissertation finds that RosettaNet standard alone is insufficient for creating system-to-system integrations that benefit both implementing parties at the dyadic level. In particular, RosettaNet does not remove the need for interorganizational agreements and business process adjustments.

6.2 Limitations

There are three notable limitations to the findings of this dissertation. Firstly, the question of external validity is a signature challenge to case study research (Eisenhardt 1989, Yin 1994, Gibbert et al. 2008). Each case and case study can always be seen idiosyncratic to various extents thus raising the question to what extent generalized knowledge claims beyond the studied cases are warranted. There is no guarantee that our findings as reported in Table 4 hold universally. In fact, it is reasonable to assume that further research should provide clarifications, elaborations, and even for some parts falsifications of the findings in the form presented. However, in order to be as externally valid as possible we have employed the classic case study tactic to address this concern: the utilization multiple-case research designs with purposeful case selection. This approach has been employed in Paper I, Paper II, and Paper IV (the latter of which being a single-case study research design incorporating embedded units constituting a cross-case setup between the embedded units). Moreover, our approach to accumulate evidence from multiple contexts of electronic trading system utilization has supported external validity of the overall findings. Furthermore, consistency with mainstream supply chain management and electronic trading system literature supports the validity of the knowledge claims.

Secondly, much of our evidence on the impacts of electronic trading system utilization is based on perceptual accounts. Paper I rests on interviews with supply chain management

experts intimately knowledgeable of 18 specific instances of electronic trading system utilization within their companies. Paper II rests chiefly on interviews with representatives of 9 organizations involved with implementing the VMI models studied. Paper III accumulates a major piece of evidence – the efficiency figures of system-to-human versus system-to-system integration – from self-reports of work content by suppliers in supply chain processes towards CDRC, the focal company of the study. Paper IV relies on the perceptions of 32 informants in three organizations within the telecommunications industry. Thus, the findings on the effectiveness of electronic trading system should be taken against these characteristics of our data. However, employing triangulation in data collection (multiple informants on same topics, backing up with quantitative data where possible) and selecting informants knowledgeable to the topic of each interview provides support for the validity of our claims.

Finally, for evidence on newer XML-based e-business standards we have studied only the RosettaNet. Examples of other such standards include ebXML, CIDX, papiNET, and PIDX, among others (Nurmilaakso and Kotinurmi 2004, Nelson et al. 2005, Chituc et al. 2008). However, RosettaNet is often mentioned as an example of newer XML-based e-business standard (Linticum 2001, Bussler 2003). Moreover it has gained significant penetration within semiconductor and electronic components manufacturing industries (Damodaran 2004, Rosettanet 2004, Cartwright et al. 2005, Löwer 2006, Boh et al. 2007, Chituc et al. 2008). Thus, while our findings on newer e-business standard should are RosettaNet-specific, they should be at least indicative on its XML-based siblings.

6.3 Further research

Three promising areas for further research are motivated by our work. Firstly, there is a need for systematic analyses of inhibitors for fully automated data exchange within electronic trading systems. As evidenced in this work, the efficiency benefits on micro-level process improvements in terms of issues such as manual work content reduction and data quality is realized maximally only under system-to-system e-trading system designs. Yet our work suggest it is still hard for organizations to realize operational efficiency -wise truly beneficial system-to-system links, in particular in instances of unilateral relationship modes. Paper III observes how even if full system-to-system integration was in given transaction instances a preferred alternative at both ends of certain dyads, suppliers' limited backend system capabilities prohibited such approach within several dyads. A good research design to study the matter would be a multiple-case study of the polar kind (Eisenhardt 1989), contrasting

successful and unsuccessful system-to-system integration instances and in particular identifying reasons for failures. Another implicated research stream falls into the technical domain. As found in this dissertation, with over three decades of attempts to provide standards for effective system-to-system data exchange, further work is still needed. There is a need on the one hand to push standards and other e-trading systems technologies further. On the other hand, there is a need to understand better the conditions of efficient use of third-party integration service providers, such approach being a potential solution to the integration problem (Paper I and Paper IV). Such work would need both design science approaches of the "build and evaluate" kind (March and Smith 1995, Hevner et al. 2004) as well as classic empirical methods in operations management research including case studies, surveys, and experiments (Handfield and Melnyk 1998). The methods of the latter kind would suit particularly well for the theme of outsourced management of system-to-system data exchange.

Secondly, further work should look in more detail to the implications of having to operate multiple electronic trading systems with various supply chain trading partners. As implied by our suggestion of transaction-instance –based differentiation, companies need to deal with multiple electronic trading systems. Willingly done – such as providing system-to-human and system-to-system alternatives to data exchange to a set of suppliers – it should be efficient for the focal company. However, unwillingly imposed – having, for instance, to comply with diverging requests from multiple customers – diversity of electronic trading systems could compromise operational cost-efficiency of the focal company. There is a need to describe systematically to what extent this is a problem and to understand in what ways – management practices, smart application of technologies, for instance – this problem can be countered. Again, both in-depth case studies and large sample studies of organizations are needed; case studies to describe and map the territory as well as to build relationships between identified constructs (Eisenhardt 1989, Handfield and Melnyk 1998, Stuart et al. 2002); survey research and experiments to test theoretical propositions (Handfield and Melnyk 1998).

Finally, the issue of contextual factors of electronic trading system utilization needs to be pursued more rigorously. Prior research has identified a range of exogenous determinants on the use of e-trading systems. Thompson ([1967] 2003) and Williamson (1985) have proposed in the context of organization studies that interorganizational interdependence and asset specificity are relevant factors in the analysis of economic organizations. The relevance of these two factors should pertain also to the analysis of e-trading-system utilization (Malone et

al. 1987, Holland et al. 1992, Bensaou and Venkatraman 1995, Hart and Saunders 1997, Holland and Lockett 1997, Premkumar et al. 2005, Son et al. 2005). Further, the implications of the nature of the interorganizational relationship should be studied systematically. In particular, the concept of relationship mode, with the dual interpretation into the bilateral and the unilateral, is well exhibited in prior works: as buyer-supplier closeness/trust (Bensaou and Venkatraman 1995, Chatterjee and Ravichandran 2004a, Premkumar et al. 2005, Son et al. 2005), as buyer-supplier power balance (Holland et al. 1992, Hart and Saunders 1997, Banerjee and Kumar 2002, Chatterjee and Ravichandran 2004a), as expected opportunism (Son et al. 2005), and as buyer-supplier cooperation (Son et al. 2005). In particular, the proposition that the deeper the relationship, the more sophisticated the e-trading system use should be needs to be evaluated. A further suggested factor implicated in the TCE framework is environmental uncertainty pushing the need for higher caliber governance structures (Williamson 1985). Further, product specific features have also been suggested to bear relevance. Both Bensaou and Venkatraman (1995) and Premkumar et al. (2005) relate the attributes of products to specific patterns of e-trading system use, for example high levels of product complexity to deeper EDI-based bilateral links. Finally, Banerjee and Kumar (2002) have further suggested that competitive and regulatory environment, technical performance factors, organizational readiness, existing electronic trading systems use, and security requirements should influence choices on electronic trading systems.

To conclude, there is a need in future research to study with broad application of empirical operations management research methods (Swamidass 1992, Handfield and Melnyk 1998) the factors of transaction-instance –based differentiation. Such research should aim, first, to identify relevant factors driving differentiation within different contexts of electronic trading system utilization. More importantly, in the spirit of research bearing relevance on practical action, such research should investigate in detail in what ways these factors are reflected or should be reflected in the relationship mode and technical design aspects of electronic trading system utilization in supply chain management.

APPENDIX A: AUTHOR CONTRIBUTION

This dissertation comprises four original peer-reviewed publications. The author of this dissertation has contributed to these works as follows:

Paper I

The related study is based on commission of the Finnish Funding Agency for Technology and Innovation (Tekes), wanting evidence to base their further funding decisions within the ELO Research and Development program[4]. The author of this dissertation designed the study and its instrumentation and was responsible for the collection of the data. Several members of the Logistics Research Group of Aalto University School of Science and Technology supported the conduct of the empirical phase. The author of this dissertation was responsible for the first phase data analysis in close collaboration with Ms. Jaana Auramo (Kauremaa and Auramo 2004). The second stage data analysis was lead by Ms. Auramo, assisted by the author of this dissertation and Prof. Kari Tanskanen. In particular, Ms. Auramo had an important role in developing the five propositions as presented. However, the resulting five propositions are as much a result of close collaboration between the author of this dissertation, Ms. Auramo, and Prof. Tanskanen. In addition, the author of this dissertation was responsible for the literature review and preparing the exhibited case descriptions. Paper I was initially published in the proceedings of the NOFOMA conference (Auramo et al. 2004).

Paper II

The related study originated from the observation that only few case-based systematic empirical evaluations on vendor-managed inventory models existed within academic literature. The initial idea of the study was heavily influenced by the thoughts of Dr. Johanna Småros and Prof. Jan Holmström The study was funded by Tekes through the ELOCORE-project[5]. The author of this dissertation was responsible in finalizing the research design by amending the initial versions prepared by Dr. Småros. In addition, the author completed the research instrumentation and executed the empirical part of the study. Several members of the Logistics Research Group of Helsinki University of Technology supported the conduct of the empirical phase. The author of this dissertation conducted all subsequent work on the paper,

[4] http://akseli.tekes.fi/opencms/opencms/OhjelmaPortaali/ohjelmat/ELO/fi/etusivu.html
[5] http://www.lrg.tkk.fi/elocore.html

including further literature reviews, data analyses, and conceptual developments. Prof. Holmström contributed to the paper by commenting the data analysis results, conceptual proposals as well as several prior versions of the paper manuscript. An early version of the paper was published in the proceedings of the NOFOMA conference (Kauremaa et al. 2007).

Paper III

The related study originated from discussions with representatives of CDRC, the focal case company. CDRC had the practical interest in understanding the viewpoints of its suppliers to CDRC's supplier-facing electronic trading system. The author of this dissertation designed and executed the study. Comments and help were provided by representatives of CDRC and Dr. Mikko Kärkkäinen. The author of this dissertation conducted all subsequent work on the paper, including further literature reviews, data analyses, and preparation of the key findings as presented. Dr. Kärkkäinen and Mr. Timo Ala-Risku supported the conduct of the literature reviews and also commented on several prior versions of the paper manuscript.

Paper IV

The related study originated from discussions with representatives of MobInfra, the focal case company. MobInfra had the practical interest in understanding the viewpoints of its customers to the RosettaNet standard in interorganizational business process integration. The author of this dissertation designed and executed the study in close collaboration with Dr. Juha-Miikka Nurmilaakso. Comments and help during the empirical part of the study were provided by numerous representatives from MobInfra, as well as Prof. Tanskanen and Prof. Holmström The author of this dissertation conducted all subsequent work on the paper, including further literature reviews, data analyses, and preparation of the propositions as presented. Dr. Nurmilaakso and Prof. Tanskanen provided comments for several prior versions of the paper manuscript and through that work, helped to develop the paper and its argumentation further.

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PART II:
ORIGINAL PAPERS

PAPER I

Auramo, J., Kauremaa J., Tanskanen, K., 2005. Benefits of IT in Supply Chain Management: An Explorative Study of Progressive Companies. *International Journal of Physical Distribution and Logistics Management*. Vol. 35, No. 2, pp. 82-100.

PAPER II

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PAPER III

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PAPER IV

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