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Citation: Vlachos, Ilias (2002) Paradigms of the factors that impinge upon business-to-business e-commerce evolution. *Electronic Markets*, 2 (1). pp. 82-89. ISSN 1019-6781

Published by: Springer

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EM – Electronic Markets

the International Journal of Electronic Commerce & Business Media

Article Identification Number:	<Click to Change> (Only if provided by EM – Electronic Markets)
Full Title of Article:	Paradigms of the Factors that Impinge upon B2B Evolution
Subtitle (optional):	
Preferred Abbreviated Title for Running Head:	Paradigms of the Factors that Impinge upon B2B Evolution
Key Words (for indexing and abstract services – up to 6 words):	B2B e-commerce, Electronic Data Interchange (EDI), Innovations, Critical Mass, Organizational Behavior, Adoption Factors
Word Count	6050
Word Processing Program Name and Version Number:	MS Word 2000

Abstract

The advent of the Internet and web technologies has open up new ways of conducting business operations. Business-to-Business (B2B) is the greatest part of e-commerce, yet there is little scholar research on the factors that impinge upon its evolution. This study shows that three major paradigms, namely the adoption of innovations, the organizational behavior, and the critical mass theory, can be used to understand why organizations adopt of reject B2B technologies. By reviewing the factors that impinge upon the adoption of Electronic Data Interchange (EDI), which is the precursor of B2B e-commerce, it is shown that the perceived relative advantage of the new systems play a significant role in explaining adoption/rejection decisions. However, independently of how large the advantages of B2B technologies can be, it is the existence of a critical mass of trading partners that make these technologies beneficial to the adopting organizations. Further, few businesses do gain a competitive advantage from B2B technologies; most businesses choose to adopt them out of a competitive

necessity. Thus, although the overt advantages of B2B e-commerce may appear enormous, businesses need to estimate the level of its current and potential acceptance among their trading partners, e.g., customers, suppliers, etc., before engaging in it.

Introduction

Recent advances in the field of computer networks and telecommunications have created a huge potential for automating business-to-business communications. There is consensus that business-to-business relationships would never be the same again, which implies that businesses need to reconsider their business relationships in terms of those new technological advances (Riggins & Mukhopadhyay, 1994; Barnes & Claycomb, 2001). The advent of electronic commerce brought a radically new way of trading, procuring, buying and selling, and communicating that every business would potentially adopt. Gattiker et al. (2000) observed that empirical studies on electronic commerce abound but are seldom linked to conceptual schemes, typologies, or theories. Thus, businesses lack a conceptual framework of those technologies in order to take advantage of them. This paper uses the theory of the adoption of innovations, organizational behavior, and critical mass to develop such a framework that can be useful to explain the adoption of B2B technologies.

Background on B2B technologies

E-commerce has received a plethora of operational definitions, which supports the observation that this is an area of business in continuous change (Vlachos et al., 2001) Electronic commerce (e-commerce) can literally refer to any use of electronic technology relevant to a commercial activity. Kalakota & Whinston, (1997) pointed out that e-commerce includes a number of functions such as buying and selling of information, products, and services via computer networks. In USA, the National Telecommunications and Infrastructure Administration (NTIA) declared e-commerce has the following core functions:

- Bring products to market (e.g. research and development via telecommunications).
- Match buyers with sellers (e.g. electronic brokers, or electronic funds transfer).
- Communicate with government in pursuit of commerce (e.g. electronic tax filings).

- Deliver electronic goods and services (e.g. information about electronic goods).

Business-to-business e-commerce (B2B) is the largest portion of transactions performed online, including Electronic Data Interchange (EDI). Approximately 90-95% of the total e-commerce revenues are attributable to B2B. Business-to-business procurement activities amount to approximately \$5 trillion annually worldwide and growth is expected to continue at a fast pace (Tully, 2000). Estimations of the tremendous potential growth of B2B e-commerce are attributed to the fact that businesses in every industry are replacing paper-based systems with a suitable type of electronic communication. For example, shippers in transportation industry replace phone and fax with Internet when communicating with customers. In addition to tangible cost savings, shippers perceive intangible benefits from better real-time tracking and delivery information. Estimations indicate that the US business will conduct \$2 trillion by 2003 and \$6 trillion by 2005 in B2B purchases from \$336 billion now. Internet trade will represent about 42 % of all B2B commerce, compared to 3 % today (Kardaras & Papathanassiou, 2000; Whyte, 2000).

B2B e-commerce has evolved from close EDI networks to open networks (Figure 1). EDI is the electronic exchange of business data and information using a common protocol over a communication means. Barnes & Claycomb (2001) have identified the following models of B2B e-commerce: 'One Seller to Many Buyers', 'Many sellers to a broker to many buyers', 'One seller to one broker to many buyers', and 'Many Sellers to One Buyer' (see Table 1). Traditionally, EDI systems have been one-to-one technology: A large organization, e.g., a big retailer or manufacturer, performed substantial work to create electronic link with its trading partners. A big retailer often forced its suppliers to adopt EDI systems with the threat of discontinuing paper-based procurements. This pattern of diffusion, which is known as 'hub and spokes', has been observed in many industries (Jimenez & Polo, 1996).

B2B e-commerce is considered the evolution of EDI systems. There are two major limitations of EDI systems that current B2B technologies seem to have made substantial progress to overcome them. First, EDI systems have usually been developed over a dedicated Value-Added-Network, which is far more expensive than the Internet. This is a major shortcoming of EDI systems as the factor mostly associated with the explosion in Internet-based B2B is economics. Second, EDI transactions need to be codified in advance. This makes difficult any modification in EDI transactions as companies need to considerably redesign their information systems i.e. when a new invoice has to be exchanged electronically. On the

contrary, B2B are developed on flexible designs which do not tie up companies in a specific technology to conduct their business operations.

<<Insert Figure 1 about here>>

<<Insert Table 1 about here>>

In order to take full advantage of B2B e-commerce organizations need to conceptualize the impact of those technologies before implementing them (Kuechler, 2001). Next section discusses in detail the three major paradigms that explain the adoption of EDI and the factors associated with it. In doing so, the importance of a theoretical framework is highlighted in order to understand the diffusion of B2B technologies.

Major Paradigms explaining the adoption of EDI

A first screening of the literature on EDI reveals that out of the plethora of articles and reports, an overwhelming number of articles aimed to promote EDI benefits rather than to understand its adoption or diffusion process. For instance, Wrigley (1991) reported that out of 900 EDI-related articles, only 32 of them (3.5%) were based on primary data. Jones & Beatty (1998) pointed out that the majority of EDI articles were descriptive or anecdotal of success stories.

The EDI adoption literature can be classified into three research streams based on different theoretical paradigms taking different assumptions (Vlachos, 2000). One views the adoption of EDI as an innovation adoption, another as an information system implementation, and the third as an organizational behavior, with respect to inter-organizational relationships.

The adoption of innovations' paradigm assumes that the adopting organizations perceive B2B solutions as innovations developed by a third party (B2B is an external innovation). The attributes of the innovation (i.e. its relative advantage, its compatibility, etc) determine to a large extent its adoption or

rejection. As a consequence, the diffusion of B2B within one or more industry sectors depends on the technology itself.

According to the organizational behavior' paradigm there are certain organizational factors that play a significant role in the adopting behavior. Particularly, a business may have criteria such as cost, return on investment, contribution to competitive advantage, etc., when evaluating a certain B2B technology, but there are other factors as well that impinge upon its adoption, e.g. the top management support and availability of resources.

According to the critical mass' paradigm, B2B technologies are considered to be collective innovations, which means that their adoption depends on the collaboration among potential adopters if any adopting organization is to receive any benefit. The critical mass theorists argue that the adopting organizations base their decisions on their perceptions of what the group is doing. Their decisions are influenced by how many others have already adopted the innovation, how much others have committed themselves and/or who has participated. In contrast to adoption of innovations' paradigm, the attributes of the innovation while important are insufficient to explain adopting behavior. Table 2 lists these paradigms and the associated factors in detail, while Table 3 lists EDI adoption studies and their major findings.

<<Insert Table 2 about here >>

<<Insert Table 3 about here >>

The Adoption of Innovations

Research on the adoption of innovations has examined numerous perceived attributes or characteristics of innovations as predicting factors of their adoption (Rogers, 1995). In a meta-analysis of innovation adoption studies conducted by Tornatzky & Klein (1982), the following three factors had the most consistent significant relation to adoption, in order of significance: (a) the perceived relative advantage, (b) compatibility, which is the degree to which an innovation is perceived as consistent with the

existent systems and practices and (c) complexity, which is the degree to which an innovation is perceived as relatively difficult to comprehend and implement. The majority of EDI studies have addressed the first two characteristics as the major predicting factors of the adoption of EDI.

Relative advantage of EDI more often than not is defined as the degree to which EDI is perceived to be better than the existing systems it supersedes. Perceived relative advantage has been found to be positively related to EDI adoption (e.g., Banerjee & Golhar, 1994; Crum et al., 1996; Scala & McGrath, 1993). The operational definitions given to the relative advantage of EDI do not limit themselves to economic issues but also include improvements in trading partner relations, information flow, and customer service. Perceived benefits included consequences on: economic gains (Scala & McGrath, 1993; O'Callaghan et al., 1992), communication (Banerjee & Golhar, 1994; Premkumar et al., 1994), supply chain (Jones & Beatty, 1998; Vijayasarathy & Tyler, 1997) and trading partners' relations (Bouchard, 1993; Jun et al. 2000; Premkumar et al., 1997).

Cost has attracted considerable attention as an EDI adoption factor. Some studies have conceptualized cost as part of the relative advantage and others as an independent variable that organizations perceived as such. In the early years of EDI development, cost was perceived as a major barrier to adoption (e.g., Davis, 1989). However, the cost of EDI is decreasing over time, and organizations can substantially reduce it by the use of Internet-based systems (Keen et al., 1998; Ramaseshan, 1997).

Compatibility, which is the degree to which EDI is perceived as consistent with the existent systems and operations, is assumed to be positively related to EDI adoption (Ramamurthy & Premkumar, 1995). Two types of compatibility have been proposed: technological and operational. Technological compatibility refers to the extent to which EDI is compatible with existing hardware, software, and IS procedures; whereas operational compatibility refers to the degree to which it is compatible with existing operational procedures. However, the evidence for whether or not those two types of compatibility relate to the adoption of EDI is not conclusive for either type. Bouchard (1993) found that organizations exhibited average interest in overall EDI compatibility with in-house systems. Premkumar et al. (1994) and O'Callaghan et al. (1992) found technological but not operational compatibility to relate to EDI adoption. On the other hand, Jones & Beatty (1998) focused on operational compatibility and successfully developed a set of scales to assess this construct. However, the tremendous evolution of information technology in recent years, particularly with the advent of the Internet as a facilitator of EDI may render some of the above studies obsolete.

Other innovation attributes such as *complexity*, defined as the degree to which EDI is perceived as relatively difficult to understand and use, *trialability*, defined as the availability to experiment with EDI on a limited basis, and *observability*, which is the visibility of EDI's results, have received less attention. Premkumar et al. (1994) examined perceived complexity as an inhibitor of EDI adoption but found no support for such a relationship. Bouchard (1993) found complexity, trialability, and observability to have moderate importance to EDI adoption decisions.

Organizational Behavior

Out of the plethora of organizational characteristics, *organizational size* was the only variable that found support in the majority of studies which basically concluded that “larger organizations are more innovative” (Sillince et al., 1998). However, this conclusion has received criticism arguing that organizational size is no more but a surrogate measure of various factors, which, although hard to identify and measure, do explain organizational innovativeness. For example, such factors can be either slack resources or technical expertise (Kwon & Zmud, 1987; Rogers, 1995). Nevertheless, size was found to be a facilitator of EDI adoption in various studies (e.g. Banerjee & Golhar, 1994; Premkumar et al., 1994). Since the cost of adopting and operating EDI is decreasing, Fink (1998) argues that small and medium enterprises (SMEs) can now afford EDI implementation. Iacovou et al. (1995) examined seven small businesses and proposed that *organizational readiness*, defined as the availability of required resources to implement EDI, affected the adoption of EDI. Cragg & King (1993) in a six-case study of computing in small firms found that inadequate resources and limited education of personnel restricted IT growth. In contrast, in the same study, the dominant motivator was found to be the owners' enthusiasm, a variable known as *championing* in innovation diffusion parlance that is, the existence of a charismatic individual who supports the innovation to overcome plausible resistances towards its adoption. In the context of EDI in the US transportation industry, Premkumar et al. (1997) found that “champions” were not a significant factor in order to shift rejecters to adopters. In large organizations, *top management support* could enthuse and motivate champions and personnel. Premkumar & Ramamurthy (1995) examined large organizations but found no support for top management support as an explanatory variable of EDI adoption. On the contrary, Dhillon & Caldeira (2000) studied Portuguese SMEs and found that the lack of senior management support is a significant

constraint of EDI adoption. Raymond & Bergeron (1996) noted that SMEs need to continually support to EDI is crucial in order to attain anticipated benefits.

There is a growing interest in whether organizations adopt EDI in order to gain *competitive advantage* (Mukhopadhyay, et al., 1995). Generally, there is consensus that information technology helps businesses to gain competitive advantage (Dearing, 1990) and succeed in time-based competition (Bytheway, 1994). Recent EDI adoption studies indicate that organizations did not perceive EDI to add to their competitive advantage, as it was initially anticipated (Reekers, 1994). Benjamin et al. (1990) and Janssens & Cuyvers (1991) concluded that most EDI adoptions are caused by competitive necessity, providing little, if any, sustainable competitive advantage for the majority of adopting organizations. Farbey et al. (1995) developed a taxonomy of information systems applications and classified EDI one rung below strategic information systems which can offer competitive advantage to the adopting organization. Riggins & Mukhopadhyay (1994) went one step further and suggested that EDI offers a unique opportunity for business partner reengineering which will unfold mutual benefits to the adopting organizations. Cox & Ghoneim (1998) argued that the implementation of EDI may still provide strategic advantages to the adopting organization, but is dependent on the type and structure of the industry sector the organization is operating and its position within that sector. Contrasting evidence was given by O'Callaghan (1992) who studied the impact of EDI on marketing channels and found that organizations prognosticated competitive advantage as a consequence of EDI adoption.

Critical Mass

Socio-political factors have been found to play an important role in the adoption of inter-organizational systems, the family of information systems where EDI is the dominant "offspring". For instance, in sharp contrast to the findings of O'Callaghan's (1992) study, which examined insurance agents, Iacovou et al. (1995), in a study of small organizations, reported evidence that indicated *external pressure* was the strongest explanatory variable of EDI adoption.

Bouchard (1993) tested the hypothesis that "organizations' decisions to use EDI are primarily based on what their business partners are doing, and not on the characteristics of EDI". That hypothesis assumes that EDI does not yield advantages per se to its adopting organization but it becomes advantageous only when all involving organizations gain mutual benefits. Bouchard (1993) found supportive evidence for his hypothesis from a survey of 175 US retailers with two follow-up case studies.

Bouchard concluded that adopting organizations based their decisions on what their major business partners were doing. The “hub and spokes” phenomenon is a term coined to characterize such patterns of diffusion in which a “hub” firm initiates the adoption with its trading partners who become the “spokes” (Barber, 1991; Hwang et al., 1991). The hub may use its power over its trading partners to initiate the electronic bonds. Jimenez & Polo (1996) found evidence that EDI diffusion in Europe has initially followed the “hub and spokes” pattern.

External pressure are commonly measured by two variables: *power*, which is the capacity of a firm to exert influence on another firm to act in a prescribed manner, and *dependency*, which is being in the position not to exert control over transactions, (Philip & Pedersen, 1997; Premkumar et al., 1997; Ratnasingam, 2000). In order to operationalize external pressures, Premkumar & Ramamurthy (1995) coined a new term, “net dependence”, which they defined as the dependence of an organization on its trading partners minus the dependence of trading partners on it. Norris (1990) used peer support as a facilitating factor of the adoption of EDI. Trust between trading partners (also examined as mutual trust, transaction climate, and faith) (Hart & Saunders, 1997; Ratnasingam, 2001), vendor relations (Vijayarathy & Tyler, 1997), and customer and peer pressure (Banerjee & Golhar, 1994) belong to the socio-political factors that may relate to the adoption of EDI.

Conclusions

The advent of the Internet and web technologies has been a great challenge to businesses to evolve their ‘traditional’ operations to e- business operations. B2B e-commerce appears to have the power to impact relationship marketing, customer service, supply chain management, pricing, branding etc. (e.g., Gattiker et al., 2000; Reynolds, 2000). Although there is a proliferation of successful cases in B2B e-commerce, businesses lack a sound conceptual framework of those technologies in order to strategically conceptualize them and operate them appropriately. By examining the literature on the adoption of EDI, which is the precursor of many B2B technologies, it becomes evident that three major theoretical paradigms provide a solid conceptual framework for understanding why businesses adopt or reject B2B technologies. These paradigms, namely the adoption of innovations, the organizational

behavior, and the critical mass theory, can be useful to business that need to have a perspective of B2B technologies.

According to the adoption of innovations' paradigm, businesses have to perceive a clear relative advantage of the innovation they evaluate to adopt before taking any adoption/rejection decisions.

Traditional EDI systems are more suitable for business-to-business communication, particularly when it involves high volumes in relatively small numbers of data items. This attribute of EDI, combined with the capacity of sending messages instantly without errors, was a sound advantage in relation to paper-based systems. However, the cost for implementing EDI is high, thus only large corporations could afford to take advantage of it.

Information exchange systems based on the Internet are highly adaptable, with relatively low costs for installation and updating. Thus, businesses equipped with web-based systems are more capable to deal with the requirements of a rapidly changing competitive landscape (Borders, 2001). B2B e-commerce costs less than traditional EDI systems, but B2B communications suffers from the lack of standardization of the message formats and contents for business communication. Internet-based systems are an alternative solution to traditional EDI systems, but as the Internet consists of a large number of decentralized networks, security becomes a big issue, which may trade-off any potential advantage. Removing those barriers would result in creating a relative advantage of B2B e-commerce that businesses of all sizes would want to realize.

Organizational behavior' paradigm showed that although many organizations turn to technology as a source of competitive advantage, only few of them can gain a true competitive advantage of it. The majority of organizations adopt the technology as a competitive necessity. It appears that managerial support is a critical success factor of the adoption of B2B technologies.

Although new B2B technologies bring more advantage at the operational level, their successful implementation depends on the existence of a critical mass among the adopting organizations' trading partners. Without a sufficient number of trading partners, B2B e-commerce becomes disused and too expensive even for large organizations. For a large organization only few trading partners can be enough to create a critical mass, but for a SME a lot more trading partners are needed to create a sufficient critical mass. Therefore, success in e-operations demands collaboration with trading partners which reshapes business-to-business relationships.

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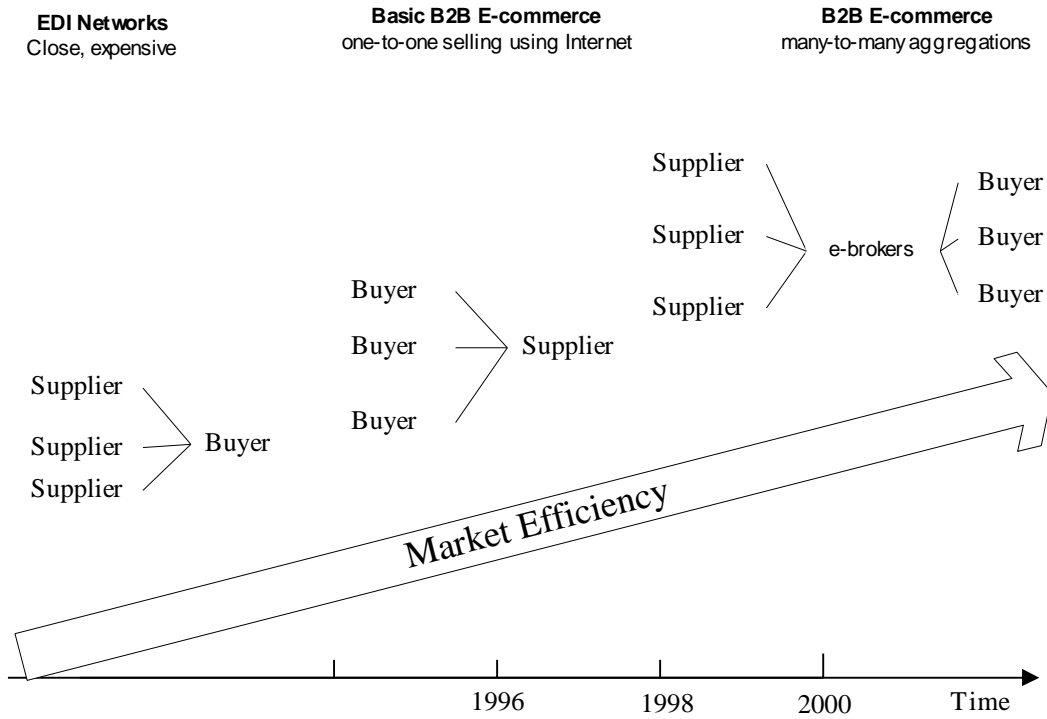
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Figure 1. Business-to-Business E-commerce Evolution



Source: Adopted from Vlachos (2001)

Table 1 Business-to-Business E-Commerce Models

Models	Description – Applications.
One Seller to Many Buyers	Lack of online intermediaries strengthens business-to-business relationships. Focus on Customer satisfaction and Retention.
Many sellers to a broker to many buyers.	A e-broker is an intermediary which is also called content aggregator, 'hub' or 'portal'.
One seller to one broker to many buyers	It resembles an online auction. Applied to highly differentiated or perishable products and services that can be marketed to disparate buyers and sellers with varying perceptions of product value.
Many Sellers to One Buyer	It is an extension of pre-existing EDI models based on Internet and Web Technologies

Source: Adapted from Barnes and Claycomb (2001)

Table 2 Summary of factors impinging upon the adoption of EDI

Theory	Factors	Description
Adoption of Innovations	Compatibility	The degree to which EDI is perceived as being consistent with existing technologies (technological compatibility) and operations (operational compatibility)
	Complexity	The degree to which EDI is perceived as relatively difficult to understand and use
	Cost	Cost includes implementation, and operational, transaction costs
	Observability	Visibility of EDI's results.
	Relative advantage	The degree to which EDI is perceived better than the system it supersedes
	Trialability	Availability to experiment with EDI on a limited basis
Organizational Behavior	Championing	The existence of a charismatic individual who supports EDI to overcome plausible resistances towards its adoption
	Competitive advantage / necessity	The desire to gain an advantage over competition as a result of EDI adoption / the pressure to adopt EDI as a result of competition.
	Inadequate resources	Lack of resources often restrict SMEs from adopting EDI
	Limited education	Personnel might need further training in EDI systems
	Organizational size	Size is commonly measured in terms of number of employees, revenues, and profits.
	Organizational readiness in SME	The availability of the needed organizational resources for EDI adoption
	Productivity	An increase of productivity will be the result of lowering inventories levels, reducing transaction costs, and facilitating supply chain management.
	Top management support	In large corporations top management often has to support initiatives like EDI adoption
Critical mass	Dependency	Being in a position not able to exert control over transactions.
	External pressure	EDI is adopted as a result of pressure from business environment (trading partners, suppliers, customers)
	Power	The capacity of an organization to exert influence on another organization to act against its will.

Table 3 EDI – Related Studies

No	Author(s)	Year	Major Findings
1	Banerjee & Golhar	1994	EDI is not viewed as a cost savings tool. Customer request to use EDI is the main reason to implement or not EDI.
2	Barber	1991	“Hub and spokes” phenomenon applies in the case of big retailers and automotive manufacture.
3	Benjamin et al.	1990	Most EDI adoptions are caused by competitive necessity.
4	Bouchard	1993	Organizations act strategically when they reject EDI.
5	Cox & Ghoneim	1998	The implementation of EDI may provide strategic advantages to the adopting organization.
6	Cragg & King	1993	Inadequate resources and limited education of personnel restricts IT growth. Championing is the dominant motivator of EDI adoption.
7	Crum et al.	1996	Relative disadvantages of EDI may explain adoption decisions.
8	Davis	1989	Cost is as a major barrier to EDI adoption.
9	Dhillon & Caldeira	2000	The lack of senior management support is a significant constraint of EDI adoption by SMEs.
10	Farbey et al.	1995	EDI is classified one rung below strategic information systems.
11	Fink	1998	SMEs can afford EDI implementation due to Internet developments.
12	Hart & Saunders	1997	Trust between trading partners determines EDI adoption behavior.
13	Iacovou et al.	1995	Organizational readiness, defined as the availability of required resources to implement EDI, affects the adoption of EDI particularly by SMEs. External pressure was the strongest explanatory variable of EDI adoption.
14	Janssens & Cuyvers	1991	EDI is probably adopted out of competitive necessity.
15	Jimenez & Polo	1996	EDI diffusion in Europe has initially followed the “hub and spokes” pattern.
16	Jones & Beatty	1998	Develop a measurement of the perceived benefits of EDI
17	Jun et al.	2000	Trading partners’ relations determine EDI adoption.
18	Keen et al.	1998	Internet EDI costs less than Value-Added-Networks.
19	Mukhopadhyay et al.	1995	Organizations adopt EDI in order to gain competitive advantage.
20	Murphy & Daley	1999	There is more interest in the positive consequences of EDI than in the negative ones.
21	Norris	1990	Peer support is facilitating factor of the adoption of EDI.
22	O’Callaghan	1992	Relative advantage, compatibility and external influences relate to EDI adoption. Organizations prognosticate competitive advantage as a consequence of EDI adoption.
23	Philip & Pedersen	1997	External pressure explains to a significant extent EDI adoption.
24	Premkumar & Ramamurthy	1995	Net dependence helps explain EDI adoption.
25	Premkumar et al.	1994	Found technological but not operational compatibility to relate to EDI adoption. No support for complexity.
26	Premkumar et al.	1997	Trading partners’ relations relate to EDI adoption.
27	Ramamurthy & Premkumar	1995	Compatibility assumed to relate positively to EDI adoption.
28	Ramaseshan	1997	The cost of EDI is decreasing over time particularly for Internet-based systems.
29	Ratnasingam	2000	Power and dependency are commonly used to operationalize external pressure.
30	Ratnasingam	2001	Trust between trading partners also examined as mutual trust transaction climate and faith.
31	Raymond & Bergeron	1996	Continual support to EDI is crucial for SME to attain anticipated benefits
32	Reekers	1994	External pressure was a significant motivator of EDI adoption. Competitive factors were perceived of limited importance in US and Germany.
33	Riggins & Mukhopadhyay	1994	EDI offers a unique opportunity for business partner reengineering.
34	Scala & McGrath	1993	Cost/savings is the common theme in the perceptions of EDI advantages and disadvantages.
35	Sillince et al.	1998	Larger organizations are more innovative.

