THE BENEFITS OF USING E-BUSINESS TECHNOLOGY: THE SUPPLIER PERSPECTIVE

by

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INTRODUCTION

Information technology (IT) has made possible the sharing of large amounts of information along the supply chain, and is often referred to as an essential enabler of supply chain management (SCM) activities (Kearns and Lederer 2003). Of all the information technologies, the Internet and the Web may have had the most profound impact on business integration and collaboration (Rabinovich, Bailey, and Carter 2003). Information technologies that use the Internet, Web, and Web-based applications for communication are termed in the literature as e-business technologies (Balakrishnan and Geunes 2004; Vakharia 2002). These technologies have had a particularly significant impact on managerial practices as they use an open and non-proprietary network for the transfer of data between multiple organizations (Rabinovich, Bailey, and Carter 2003). In fact, the Internet has surpassed information technologies such as electronic data interchange (EDI), a technology available for more than 20 years, in its information sharing capabilities and cost (Chopra, Dougan, and Taylor 2001).

Today almost all organizations are in the process of adopting some type of e-business technology to streamline SCM activities, such as joint forecasting, purchasing, and collaborative planning (Vakharia 2002). For example, e-procurement has automated and streamlined many corporate purchasing processes (Sengupta 2001). The Web is being used for collaborative processes such as Collaborative Planning, Forecasting, and Replenishment or CPFR (Steerman 2003). In the auto industry, supplier firms are using Internet features such as e-mail and discussion forums to understand details of the automaker's requirements not completely conveyed in formal documentation (Takeishi 2002).

Studies have found overall IT capability to be positively linked to firm performance (Bharadwaj 2000; Kearns and Lederer 2003) and shown to have the potential of providing a significant competitive advantage to firms (Earl 1993; Ives and Jarvenpaa 1991; Kathuria, Anandarajan, and Igbaria 1999). Similarly, firm coordination has been shown to have a positive impact on performance (Stank, Keller, and Daugherty 2001; Vickery et al. 2003). However, research specific to e-business technologies, within the context of the supply chain, has primarily focused on the facilitation of consumer transactions, such as those between final customers and Internet retailers (Bailey and Rabinovich 2001; Bakos 1997; Brynjolfsson and Smith 2000; Rabinovich 2004). There has been a lack of studies that provide evidence on how the use of e-business technologies specifically impacts supplier performance and what types of benefits they might attain from its use.

The decision to invest in e-business technologies is particularly important for supplier firms that are typically disproportionately smaller in size compared to their buyers and must appropriate larger portions of their budgets to develop this technological capability (Benton and Maloni 2005; Lee 2004; Subramani and Venkatraman 2003). In fact, a study by Angeles and Nath (2001) found manufacturing firms to be significantly larger than supplier firms both in terms of net sales and the number of employees. Their study of buyer-supplier dyads found that nearly 52% of the buying firms employ more than 1,000 employees whereas the percentage of supplier firms employing more than 1,000 employees is only 20%. Similarly, 23.5% of the buying firms were found to show net sales below $1 billion, whereas for supplier firms this number was 54.7%. Further, Maloni and Benton (2000) showed that an imbalance of power exists between manufacturers and suppliers, in favor of manufacturers. Finally, Lee (2004) has underscored the financial difficulties of supplier firms to raise capital compared with manufacturers, due to their smaller size. Therefore, a greater understanding of the benefits that these technologies provide to supplier firms is an issue of interest to both managers and researchers.

The goal of this research is to extend knowledge on how e-business technologies impact buyer-supplier coordination and supplier performance, from the viewpoint of supplier firms. Specifically, we test a model of the relationship between supplier use of e-business technologies to communicate with their primary buyer, extent of buyer-supplier coordination, and strategic and operational benefits accrued to the supplier. The model and constructs used are directly derived from the literature.

Our study differs from previous research in a number of important ways. *First*, unlike past studies of e-business technologies that focus on benefits to retailers, our study focuses on benefits to suppliers of OEM firms. The difference in the focal point is important as retail firms use this technology differently and, as a result, may derive different types of benefits (Boyaci and Gallego 2004). Retailers, to a large extent, use the technology to attract customers and enhance sales. As a result, they must focus on aspects of the technology that includes providing attractive web sites and enabling easy customer searches for products (Dadzie, Chelariu, and Winston 2005; Rabinovich and Bailey 2004). By contrast, suppliers primarily use the technology for business planning purposes, often sell in bulk and may operate under purchasing agreements. Retailers are the supply chain's link to the final customer and are solely responsible for the type and quality of customer data captured. Suppliers are dependent on the type and quality of information passed on to them by manufacturers. Further, unlike retailers, suppliers typically have the option to use competing information technologies to communicate with manufacturers, such as EDI, fax, or telephone. In today's consumer oriented environment, many retailers do not. Therefore, the benefits attained in the retailer-consumer relationship cannot automatically be assumed to exist in the supplier-manufacturer relationship. In fact, a recent evaluation of IT on supply chain performance finds some results to be counter-intuitive result (Robinson, Sahin, and Gao 2005), underscoring the need to test all relationships.

Second, unlike past studies that primarily focus on financial performance measures, market share measures, or a narrow range of operational performance measures, our study focuses on both strategic and operational benefits. Strategic and operational benefits are considered first-order benefits, which in turn generate second-order benefits for the firm (Barua, Kriebel, and Mukhopadhyay 1995; Mukhopadhyay and Kerke 2002). First-order benefits are a result of the firm's actions and can be directly influenced by the firm (Subramani 2004). In contrast, second-order benefits are competitive outcomes that are influenced by external factors such as competitor's actions and changes in

the environment, and include outcomes such as financial performance. Studies to date have either measured select first-order benefits or select second-order benefits. In contrast, our study looks at a complete set of first-order benefits and, as such, provides a more comprehensive evaluation of supplier performance.

Third, unlike the majority of past studies that focus on benefits of overall IT use, our study focuses specifically on e-business technologies. As a category, IT encompasses a broad range of technologies that greatly differ in terms of cost and capability. In addition to the Internet, IT includes technologies that range from the traditional, such as EDI, fax, and telephone, to the more recent, such as global positioning systems (GPS) and radio frequency identification (RFID). The use of e-business technologies in particular is becoming ubiquitous in the business community. As such, it is important to isolate this type of IT and assess its unique performance benefits.

Our findings show that supplier use of e-business technologies to communicate with their primary buyer has a positive and significant impact on supplier performance both directly and indirectly, mediated by buyer-supplier coordination. The benefits accrued to the supplier are shown to be both strategic and operational. The positive impact on strategic measures is particularly significant given that suppliers are a few stages removed from the final customer and are dependent upon the manufacturer for the quality and type of information provided. This study shows that suppliers are able to derive strategic benefits from the use of this technology despite their dependence on manufacturers. These results have important implications for both managers and researchers as they provide evidence of the benefits of e-business technology use has on supplier performance.

LITERATURE REVIEW

E-Business Technologies Versus IT

IT can be defined as technological capability used to acquire, process, and transmit information for more effective decision making (Grover and Malhotra 1997). This includes the necessary computer hardware, peripheral devices, and software used for organizational communication. IT systems can include telephone, fax, EDI, enterprise resource planning (ERP) systems, as well as the Internet. IT systems also include newly emerging technologies such as RFID, GPS, voice e-mail, and enhanced specialized mobile radio (ESMR) cell phones that can be used as low cost long-range walkie-talkies.

IT systems differ significantly based upon cost and capability. Consider that RFID is an IT that provides a huge capability in capturing and transferring inventory data, yet currently is considered too costly to implement by many companies (Rutner, Waller, and Mentzer 2004). On the other hand, many companies are considering the long-term capability benefits relative to initial cost. The decision to switch to a particular IT is an important one. IBM recently decided to replace PCs of its sales support force with Blackberry devices – hand held wireless devices that are e-mail enabled and can transfer data in real time. Although IBM initially considered the cost prohibitive, a cost-benefit analysis suggested that the long-term cost per use would result in significant savings (Shankar and O'Driscoll 2002).

E-business technologies are a type of IT that uses the Internet and the Web for communication. As such e-business technologies are subsumed under the broader term of IT. Many researchers

consider e-business technologies to have had the greatest impact on information exchange between buyers and sellers due to their large capability and low cost (Bailey and Rabinovich 2001; Rabinovich, Bailey, and Carter 2003; Vakharia 2002). E-business technologies differ from other information technologies in that they provide real-time versus batch processing. With batch processing all transactions are collected and then processed together as a "batch" at a later time. By contrast, real-time processing of transactions is made immediately. In addition, e-business technologies are not restricted to the format of the data they can process (e.g. graphics, forecasts, computer-aided design or CAD drawings), and use a non-proprietary network. Accessing real-time demand information and achieving inventory visibility was virtually impossible prior to the Internet, and was pieced together from information accessed via telephones, faxes, and EDI, a technology widely used for the past twenty years.

The Internet has now surpassed information technologies such as EDI in its information sharing capabilities and cost. According to Chopra, Dougan, and Taylor (2001, p. 53): "The magnitude of the savings from e-commerce will vary depending on each company's specific situation. i2 Technologies, for example, estimates that companies can achieve transaction savings of close to 2% of sales by using the Internet. Eastman Chemical estimates transactional savings of close to 4% of sales, while British Telecom claims to have reduced transaction costs associated with procurement by 90% using e-commerce." Unlike the Internet, EDI permits sharing of limited content with a few remote partners at a relatively high cost. Further, EDI is an information technology that uses computer-to-computer transmission of standardized business transactions and is based on industry protocols. In contrast, the Internet enables real-time sharing and integration of information between supply chain partners at a relatively low transaction cost and does not require adherence to industry standards. EDI has been widely used in many industries, particularly the auto industry, and many companies are facing the decision of whether to abandon these systems and move to using e-business technologies. Consequently, the study of the benefits of e-business technologies per se is important for both managers and researchers.

E-Business Technologies and Buyer-Supplier Coordination

Advancements in IT have significantly improved coordination among supply chain partners permitting strong customer and supplier collaboration for inventory planning, demand forecasting, order scheduling, and customer relationship management (Feeny 2001). In a London School of Economics survey, CEOs rated IT as the firm's top strategic tool, but asserted that the source of competitive advantage was not technology per se, but superior information sharing provided by these systems (Compass Group 1998).

The relationship between IT use and SC coordination has been evaluated in past studies. Burgess (1998) was one of the first to identify IT as a critical component of logistics strategy, noting that information technologies can provide integration between supply chain firms and can consequently improve customer service and lower costs. A study by Stroeken (2000) showed that IT has a direct impact on coordination and leads to supply chain innovation. Vickery et al. (2003) further showed a direct link between integrative information technologies and supply chain integration for supplier firms in the auto industry. Other comparable studies focused on the benefits of EDI and showed that it provides benefits to companies by providing speed of information flow and fostering value-

added partnerships (Holland, Lockett, and Blackman 1992; Ragatz, Handfield, and Scannell 1997; Shoembar 1992).

The argument that IT promotes supply chain coordination is further supported by transaction cost economics. The premise of the literature in this area is that cooperation and coordination among firms is limited by the transaction costs of managing the interaction (Coase 1937; Stroeken 2000; Williamson 1975). As transaction costs increase, market transaction efficiency decreases. These inefficiencies may result in higher market prices and may lead to vertical integration in the supply chain. IT has been shown to decrease transaction costs, comprised of coordination costs, that include direct costs of integrated decisions (Nooteboom 1992), and transaction risk, the risk of being exploited in the relationship, by providing greater transparency (Clemons and Row 1992; Clemons, Reddi, and Row 1993). Transaction cost economics suggests that IT should promote firm cooperation and collaboration given that it reduces transaction costs.

Research in this area, however, has been restricted to either general use of IT or has focused on EDI, an older form of IT. Studies specific to e-business technologies have focused to a large extent on retailers or manufacturing firms. This is illustrated in Table 1, where research is segmented based on type of IT and the focal point of the study. We note that the studies in Table 1 are limited to buyer-supplier supply chain coordination. Table 1 illustrates that research on e-business technology use for supply chain coordination from the focal point of supplier firms remains to be been conducted. The research on e-business technologies has focused on Internet retailers and the facilitation of consumer transactions (Bakos 1997; Brynjolfsson and Smith 2000; Rabinovich 2004). Little, if any, attention has been paid to the unique impact of the Internet and the Web on buyer-supplier coordination from the viewpoint of supplier firms. Although research supports the idea of IT as an enabler of SCM activities, studies have not directly associated higher use of e-business technologies with greater involvement in specific SCM practices, such as collaborative planning or partnering. In fact, e-business technologies may have a particularly strong impact on coordination due to their open standards, high capability of data transfer, and low cost.

e-Business and Firm Performance

Research regarding the direct impact of IT on specific performance measures has resulted in inconsistent results, suggesting that a 'productivity paradox' exits (Lim, Richardson, and Roberts 2004; Sriram and Stump 2004). Numerous explanations have been offered for this paradox, such as management's failure to leverage the full potential of IT (Dos Santos and Sussman 2000), ineffective implementation (Stratopoulos and Dehning 2000), poor measures of performance (Bharadwaj, Bharadwaj, and Konsynski 1999), and the presence of a time lag between IT investment and its actual impact on performance (Deveraj and Kohli 2000; Rai, Patnayakuni, and Patnayakuni 1996). Researchers have also tried to explain the apparent paradox by drawing attention to the differences between the research methodologies that may exist between different disciplines (e.g. economics, production, and strategy) from which the studies are derived (Sircar, Turnbow, and Bordoloi 2000; Sriram and Stump 2004).

TABLE 1

SEGMENTATION OF RESEARCH BASED ON IT TYPE AND FOCUS OF STUDY [1]

	TYPE OF IT TESTED	
FOCUS OF STUDY	***GENERAL IT OR EDI***	***E-BUSINESS***
SUPPLIERS	*Narasimhan and Kim (2001)* *Subramani (2004)* *Vickery et al. (2003)*	*None*
MANUFACTURERS/ RETAILERS	*Bharadwaj, Bharadwaj, and Konsynski. (1999)* *Dröge and Germain (2000)* *Hammer and Mangurian (1987)* *Hill and Scudder (2002)* *Holland, Lockett, and Blackman. (1992)* *Rabinovich, Dresner, and Evers (2003)* *Brynjolfsson and Hitt (1996)* *Kathuria, Anandarajan, and Igbaria (1999)* *Kearns and Lederer (2003)* *Narasimhan and Kim (2001)* *Ragatz, Handfield, and Scannel. (1997)* *Raghunathan (1999)* *Sanders and Premus (2005)* *Santhanam and Hartono (2003)* *Sheombar (1992)* *Wen, Yen, and Lin (1998)*	*Dadzie, Chelariu, and Winston (2005)* *Frohlich (2002)* *Rabinovich, Bailey, and Carter (2003)* *Rabinovich and Bailey (2004)* *Rabinovich (2004)* *Rabinovich (2005)* *Olson and Boyer (2003)*

[1] Studies are limited to those within the supply chain context.

Studies evaluating the performance of IT have typically focused on either financial performance measures (e.g. ROI, ROA or profitability), market share growth, or select operational measures (e.g. inventory levels, customer service, or reductions in lead time). Only one study to date (Subramani 2004) has evaluated overall IT performance based on both strategic and operational performance measures. Studies specifically focused on e-business technologies have similarly not evaluated a full set of performance measures. To date, there are no studies of e-business technologies that have looked at a complete set of first-order performance measures as defined by Mukhopadhyay and Kerke (2002). Table 2 illustrates this point by segmenting research in this area based on the type of IT studied and performance measures tested.

Another view of IT's impact on performance is that IT improves firm performance indirectly by fostering inter-firm relationships (Hammer and Mangurian 1987). Wen, Yen, and Lin (1998) consider that the benefits of IT may be "qualitative, indirect, and diffuse" and suggest that IT may ultimately impact performance by influencing relational outcomes. For example, a study of extranet investments made by Fujifilm in Canada showed that the e-business technologies allowed the firm to provide a wider range of information to dealers and resellers, and also enabled the company's salespeople to build online relationships with these intermediaries (Gilbert 2002). This suggests that it may be important to simultaneously consider both the direct and indirect impact of IT on performance, though no studies to date have done so with a focus on e-business technologies.

Buyer-Supplier Coordination and Firm Performance

Supply chain management takes a systems view regarding all activities and functions that are needed to bring a product or service to market. This view recognizes that the value creation process extends beyond the boundaries of the firm, and involves integrated business processes among entities of the chain, such as suppliers, manufacturers, and customers (Stevens 1989; Tan, Kannan, and Handfield 1998). The theoretical foundation for this view can be traced back to Porter's Value Chain model (Porter 1980, 1985) that advocates exploitation of "linkages" within a firm's value chain and between the value chains of its suppliers and customers. Exploitation of these "linkages" is expected to lead to superior performance (Frohlich and Westbrook 2001; Tan, Kannan, and Handfield 1998) and promulgates the idea that individual organizations that comprise the supply chain must ultimately be managed as a single entity or one complete system. This requires integration, collaboration, and coordination across individual firm functions and throughout the supply chain.

Research consistently supports the idea that coordination between firms improves firm performance (Anderson and Katz 1998; Frochlich and Westbrook 2001; Hines et al. 1998; Johnson 1999; Lee, Padmanabhan, and Whang 1997; Lummus, Vokurka, and Albert 1998; Metters 1997; Narasimhan and Jayaram 1998; Stevens 1989). Problems of nonintegration have been well documented beginning with Forrester's (1961) seminal work (Frochlich and Westbrook 2001; Hammel and Kopczak 1993; Lee and Billington 1992). Lack of coordination has been shown to create the classic magnification of demand up the supply chain, known as the bullwhip effect, resulting in alternating excess inventory and stock-outs (Metters 1997). Having an integrated supply chain has been shown to provide a significant competitive advantage relative to both price and delivery (Lee and Billington 1992).

TABLE 2

SEGMENTATION OF RESEARCH BASED ON PERFORMANCE MEASURES TESTED AND IT TYPE

PERFORMANCE MEASURES TESTED BASED ON IT TYPE	
E-BUSINESS	***GENERAL IT OR EDI***
I. ROI, ROA, Profitability, or Sales	**I. ROI, ROA, Profitability, or Sales**
Frohlich (2002) *Rabinovich, Bailey, and Carter (2003)* *Rabinovich (2004)* *Rabinovich and Bailey (2004)* *Rabinovich (2005)*	*Brynjolfsson and Hitt (1996)* *Dröge and Germain (2000)* *Kudyba et al. (2002)* *Im et al (2001)* *Hitt et al. (1996)* *Lim, Richardson, and Roberts (2004)* *Narisimhan and Kim (2001)* *Santhanam and Hartono (2003)* *Sircar et al. (2000)*
II. Select Operational Measures [2]	**II. Select Operational Measures**
Dadzie, Chelariu, and Winston (2005) *Frohlich (2002)* *Olson and Boyer (2003)*	*Dröge and Germain (2000)* *Hill and Scudder (2002)* *Rabinovich, Dresner, and Evers (2003)* *Vickery et al. (2003)*
III. Strategic and Operational Measures	**III. Strategic and Operational Measures**
None	*Subramani (2004)*

[2] Typically include measures such as delivery lead time, transaction costs, and inventory turns.

Today's most successful manufacturers have tight coordination with their supply chain partners, enabling real-time information to travel immediately up and down the supply chain and well coordinated movement of inventories. The result is products that are delivered quickly and reliably when and where they are needed, high responsiveness to short lead times, the elimination of the bullwhip effect, and improved firm performance (Lee, Padmanabhan, and Whang 1997). Consider the recent collaborative relationship between Sears and Michelin using CPFR, which has resulted in a 25% reduction in inventories for both companies (Steerman 2003). Similarly, General Motors' new collaborative relationship with its suppliers has reduced vehicle development cycle times from four years to eighteen months (Gutman 2003).

Although research consistently shows that buyer-supplier coordination improves firm performance, most of these studies have focused on integration from the viewpoint of the buying firm and consider a narrow range of performance measures, such as inventory turnover, customer service, or cost reductions. Little evidence has been provided on the impact buyer-supplier coordination has on a complete range of supplier benefits, providing a more comprehensive evaluation.

RESEARCH HYPOTHESES

Based on conclusions from the extant literature we propose and test relationships between four constructs: supplier use of e-business technologies, buyer-supplier coordination, and both strategic and operational benefits to the supplier. As defined earlier, e-business technologies are information technologies that use the Internet and Web-based applications for communication (Balakrishnan and Geunes 2004; Vakharia 2002). The second construct, buyer-supplier coordination, is defined as an effective, shared process where two or more departments work together, have mutual understanding, have a common vision, share resources, and achieve collective goals (Schrage 1990). Our third construct, strategic benefits, includes benefits that arise through the firm positioning itself to take advantage of opportunities arising from its external relationships (Subramani 2004). Finally, operational benefits are those that arise from lowered transaction and production costs (Subramani 2004). Our study is conducted from the viewpoint of the supplier in relation to their primary buyer, where the primary buyer is defined as the buyer responsible for generating the largest net sales profit for the supplier.

We begin by proposing that the use of e-business technologies has a positive impact on buyer-supplier coordination, from the supplier's perspective. The relationship between IT use, in the broader sense, and buyer-supplier coordination has been examined in past studies (Raghunathan 1999; Subramani 2004; Vickery et al. 2003). Studies have also tested the relationship between general IT use and other constructs that are related to coordination (Gaski 1984; Mohr and Nevin 1990), such as relationship commitment (Kent and Mentzer 2003). Further, the use of EDI has been shown to have a positive impact on SC integration (Holland, Lockett, and Blackman 1992; Ragatz, Handfield, and Scannell 1997; Sheombar 1992). In addition, researchers have demonstrated that IT use can decrease coordination costs (Clemons and Row 1992; Clemons, Reddi, and Row 1993), expected to bring about increased coordination (Vickery et al. 2003). Although studies have not specifically focused on the impact of e-business technologies on coordination, the literature on IT collectively supports the development of our first hypothesis:

H_1: Supplier use of e-business technologies (EB) to communicate with their primary buyer has a direct and positive impact on buyer-supplier coordination (SC).

We further propose that buyer-supplier coordination has a direct impact on both strategic and operational supplier benefits. Higher levels of coordination are expected to contribute to improved organizational performance. Vickery et al. (2003) provide empirical support for the link between SC coordination and customer service performance. Their study finds a significant impact of coordination on elements of customer service performance for firms in the auto industry. Similarly, Stank, Keller, and Daugherty (2001) find collaboration to positively impact firm performance. This leads us to our next two hypotheses:

H_2: Buyer-supplier coordination (SC) has a direct and positive impact on supplier strategic benefits (SB).

H_3: Buyer-supplier coordination (SC) has a direct and positive impact on supplier operational benefits (OB).

Finally, numerous studies have independently tried to assess the IT business value, a term commonly used to refer to its organizational performance impact (Melville, Kraemer, and Gurbaxani 2004). A review of this literature reveals mixed results (Hu and Plant 2001). A study by Hitt and Brynjolfsson (1996) finds that the inconsistencies observed among various studies can be attributed to variations in methods and measures used in the analyses. Most recent studies, however, have found support for the impact of IT on firm financial performance (Bharadwaj 2000; Kearns and Lederer 2003; Santhanam and Hartono 2003). Although our study does not look at financial performance per se, based on the literature it is reasonable to expect that supplier use of e-business technologies has a significant and positive impact on both strategic and operational performance measures. This leads to our last two hypotheses:

H_4: Supplier use of e-business technologies (EB) to communicate with their primary buyer has a direct and positive impact on strategic benefits to the supplier (SB).

H_5: Supplier use of e-business technologies (EB) to communicate with their primary buyer has a direct and positive impact on operational benefits to the supplier (OB).

RESEARCH METHODOLOGY

The Sampling Procedure

The research methodology used is based on empirical data collected through a questionnaire survey of first-tier suppliers to OEM firms in the electronic computer industry. We wanted to focus on an industry that is a leader in information technology use. Most studies of this type have been conducted in the auto industry (Dröge, Jayaram, and Vickery 2004; Maloni and Benton 2000; Vickery et al. 2003), which primarily relies on EDI as a means of communication between supply chain firms (Lewis and Talalayevsky 1997; Van Hoek, Commandeur, and Vos 1998). We specifically chose the electronic computer industry as its members are firms that pioneer the development of information

technology. The industry is dominated by well known corporations, including IBM, Hewlett-Packard (HP), Sun Microsystems, Fujitsu, Toshiba, Dell, and Xerox. As such, we expect the use of e-business technologies to be widespread in this industry.

The survey instrument was initially pre-tested by four executives and five academics for content, readability, and ambiguity (Dillman 2000). Based on results of the pretest, minor changes were made to select questionnaire items, and the instrument was mailed to 1,000 U.S. first-tier OEM suppliers. We targeted the survey to CEOs as they would either be most likely to have the required knowledge or would have the credibility to route the survey to the most knowledgeable individual. This is supported by a study by Phillips (1981) that indicates that high ranking informants tend to be more reliable sources of information than low ranking. Rather than subjectively developing the sample frame, the database was purchased from an outside firm with the above criteria specified.

In order to ensure an adequate response rate a variation of Dillman's total design method was used in the survey process (Dillman 2000). The initial mailing included a cover letter and the survey instrument, with the latter designed to be merely folded and returned, with postage pre-paid. Reminder postcards were sent approximately ten days following the initial mailing, followed by a second survey mailing approximately 30 days later. Those that had already responded were told to ignore the mailing. Fourteen incomplete responses were discarded. The mailings yielded 241 usable responses, for a response rate of 24.1%, in line with past surveys of this type (Byrd and Turner 2001; Wisner 2003).

Specific demographic information of the responding firms is shown in Table 3, showing a broad range of companies based on annual sales and number of employees. Further, the sample was tested for diversity of processes (job shop – 35%; manufacturing cell – 23%; continuous flow – 42%) and diversity of products produced (customized – 46%; standardized – 54%). In addition, the respondents represent a wide variety of products (e.g. circuit boards, telephone equipment, computer storage devices, batteries, etc.). Thus the conclusions from this study can be generalized to a variety of industries. Further, Table 4 shows the distribution of survey respondents with the typical respondent holding the title of President, CEO, Senior Vice President, Vice President, or Director, and shows completion of the survey by a senior ranking officer of the company.

Test for Non-Response Bias

The adequacy of the response sample is a concern any time a survey methodology is used. An important part of ensuring adequacy is to test for non-response bias. One method of doing this, advocated by Armstrong and Overton (1977), is to test for significant differences between early and late respondents. In order to ensure adequacy of our data we compared the first and second wave of survey respondents. T-tests were performed on all questionnaire items used in this study, with no significant differences found between the two samples (t-value range: 3.87 to 18.78). Chi-square differences were also calculated between respondents and non-respondents for annual sales revenues ($\chi 2 = 4.23$, $p > 0.05$) and number of employees ($\chi 2 = 5.75$, $p > 0.05$), and found to be insignificant. The sent surveys were not anonymous, permitting the identification of respondents and non-respondents. These results collectively suggest that non-response bias is not present in the data (Sabherwal 1999; Teo and King 1997).

TABLE 3

FREQUENCY DISTRIBUTION OF SALES AND NUMBER OF EMPLOYEES

(A) FREQUENCY DISTRIBUTION OF ANNUAL SALES

Annual Sales (US$ million)	Number of Firms	Percentage
1-249.99	77	32.0
250-499.99	69	28.6
500-999.99	44	18.3
1000-1499.99	37	15.3
1500 and above	14	5.8
	241	100 %

(B) FREQUENCY DISTRIBUTION OF NUMBER OF EMPLOYEES

Number of Employees	Number of Firms	Percentage
1-999	64	26.6
1000-1999	68	28.2
2000-2999	52	21.6
3000-3999	20	8.3
4000-4999	28	11.6
5000 and above	9	3.7
	241	100%

Construct Measures

Table 5 shows the four model factors and the multiple variables used to measure each factor. The scale items used to measure these factors are derived from past studies and are described in this section. The development of the scale items is described here.

Factor 1 measures supplier use of e-business technologies. Four scale items were used to evaluate firm use of e-business technologies: use relative to industry standards, relative to key competitors, relative to key customers, including the primary buyer, and extent of reliance on e-business technologies in conducting business operations. The scale items are comparable to those used in studies by Kent and Mentzer (2003) and Sanders and Premus (2005). While the scale items in the Kent and Mentzer (2003) study asked respondents whether the company is a "leader" or "on the leading edge" of information technology, our study asks how the company compares relative to industry standards and competition in the use of e-business technologies.

TABLE 4

PROFILE OF SURVEY RESPONDENTS

Respondent Title		Frequency	Percentage
1.	President	11	4.6
2.	CEO	25	10.4
3.	Senior Vice President	97	40.2
4.	Vice President	87	36.0
5.	Director	17	7.1
6.	Other	4	1.7
TOTAL		**241**	**100%**

Factor 2 measures buyer-supplier coordination, which should enhance competitive performance through the linking of internal functions across organizations (Monczka et al. 1998; Vickery, Calantone, and Dröge 1999). Our study considers three scale items to measure this factor: partnering with buyer, cross-functional teams with buyer, and engaging in collaborative planning with buyer. The first scale item relates to partnering with the buyer from the beginning of the product life cycle to ensure that each are providing input into each others' processes. The second scale item, cross-functional teams with buyers, addresses issues of using joint task force teams to engage in activities that support strategic objectives. The last scale item, collaborative planning with buyer involves the joint development and planning of strategic objectives. These scale items have been used by other studies to measure buyer-supplier coordination (Vickery et al. 2003), though from the viewpoint of the buyer rather than supplier.

The last two factors, F3 and F4, measure firm performance. Firm performance has been measured in numerous ways in past studies (Handfield and Nichols 1999; Narasimhan and Das 1999; Wisner 2003). Most studies have typically measured performance as a composite of operations performance measures (Narasimhan and Das 2001; Scannell, Vickery, and Dröge 2000). In this study we choose to separate the performance measure into two constructs, one measuring strategic benefits and another operational benefits (Subramani 2004) in order to test for a complete set of first-order benefits. Three scale items are used to measure each factor and are the scale items used in the Subramani (2004) study.

TABLE 5

VARIABLE AND FACTOR LISTING

Factors and Scale Items		Standardized coefficient	Standard error	t-Value[3]
F1:	**Use of eBusiness Technologies (EB) [4]; α = 0.792**			
Please indicate the extent to which your firm uses e-business technologies in communicating with your *primary* buyer:				
EB1:	Use of e-business technologies relative to industry standard	0.482	0.022	11.32*
EB2:	Use of e-business technologies relative to key competitors	0.419	0.019	11.21*
EB3:	Use of e-business technologies relative to key customers	0.512	0.024	11.46*
EB4:	Reliance on e-business technologies in conducting business processes	0.533	0.023	12.28*
Scale: Significantly below standard - Comparable to standard - Significantly above standard (1-7)				
F2:	**Buyer-Supplier Coordination (SC); α = 0.748**			
Please indicate the extent of involvement of your firm in the following activities with your *primary* buyer:				
SC1:	Partnering with buyer	0.422	0.022	16.01*
SC2:	Cross-functional teams with buyer	0.523	0.025	16.19*
SC3:	Collaborative planning with buyer	0.537	0.029	16.05*
Scale: Somewhat involved-Moderately involved-Significantly involved (1-7 Scale)				
F3:	**Strategic Benefits (SB): α = 0.842**			
Please indicate the extent to which you are receiving the following benefits as a result of your relationship with your *primary* buyer:				
SB1:	Learning about customers and markets for our products	0.743	0.034	14.36*
SB2:	Creation of new products, product enhancements	0.724	0.039	14.71*
SB3:	Development of new business opportunities	0.676	0.051	15.22*
Scale: Little benefit-Some level of benefit-High level of Benefit (1-7 Scale)				
F4:	**Operational Benefits (OB): α = 0.762**			
Please indicate the extent to which you are receiving the following benefits as a result of your relationship with your *primary* buyer:				
OB1:	Cost efficiencies from higher sales volumes	0.714	0.025	12.26*
OB2:	Improvements to current processes or creation of new processes	0.623	0.021	13.35*
OB3:	Increased profitability	0.615	0.033	12.11*
Scale:	Little benefit - Some level of benefit - High level of benefit (1-7 Scale)			

[3] Significance at the $p \leq 0.01$ level

[4] We focus on the extent of use of e-business technologies as the Internet, intranets, extranets, and web-based applications in conducting business transactions.

Measure Development and Purification

The measures used in this study were developed based on procedures outlined by Churchill (1979) and DeVellis (1991). In this section we describe the procedure used to purify the measurement scales and ensure scale adequacy. Summary statistics for the scale items are also shown in Table 5.

Scale adequacy was initially tested through the measurement of scale reliability. Scale reliability is the percent of variance in an observed variable that is accounted for by the true score of the latent factor or underlying construct (DeVellis 1991). When scale reliability is high then all variables that measure a single factor share a high degree of common variance. Cronbach's coefficient alpha is the most commonly employed statistic to measure internal consistency. Specifically, the coefficient measures the degree of inter-item correlation in each set of items and indicates the proportion of the variance in the scale scores that is attributable to the true score. Alpha levels below 0.7 are considered unacceptable (DeVellis 1991).

Prior to purification of scales, the alpha levels in this study indicated that some values were below the acceptability level. Purification of scales was then performed through the use of confirmatory factor analysis. Scale items exhibiting insignificant factor loadings or high residuals were then identified and eliminated from the factor measurement (DeVellis 1991).

Standardized coefficients, standard errors, and t-values for variable items are shown in Table 5. All the coefficients are found to be significant at the $p < 0.01$ level. The table also shows coefficient alpha values for each factor following the purification process. The coefficient alphas ranged from 0.748 to 0.842, all in the acceptable range (DeVellis 1991).

RESULTS

The Measurement Model

Evaluation of the proposed model was made using structural equation modeling (SEM), following the two-step approach recommended by Anderson and Gerbing (1988). The first step involved the development of an acceptable measurement model through the use of confirmatory factory analysis (CFA). At this first stage the latent factors of interest are identified, and the relationship between the observed variables and their respective latent factors is tested.

All SEM analyses were conducted using EQS (Bentler 1997). Table 6 presents results of the measurement model. As recommended by researchers, multiple fit criteria are considered in order to rule out measurement biases (Hu and Bentler 1999). The fit indices considered are those most commonly recommended for this type of analysis (Bagozzi and Yi 1998; Byrne 1994). All the indices were within the recommended range, including ratio of chi-square to degrees of freedom ($\chi 2/ df = 1.95$, where $\chi 2 = 115.0$ and $df = 59$), root mean square error of approximation (RMSEA = 0.04), root mean square residual (RMR = 0.04), goodness of fit index (GFI = 0.98), normed fit index (NFI = 0.97), comparative fit index (CFI = 0.96) and (IFI = 0.96). Collectively these statistics lead us to judge the overall measurement model fit as satisfactory (Byrne 1994).

Convergent Validity

In order to perform meaningful analysis of the causal model, measures used need to display certain empirical properties. The first of these is convergent validity, which is the degree to which individual questionnaire items measure the same underlying construct. One way to test for convergent validity is to evaluate whether the individual item's standardized coefficient from the measurement model is significant, namely greater than twice its standard error (Anderson and Gerbing 1988). An analysis of the statistics in Table 5 reveals that coefficients for all items greatly exceed twice their standard error. Also, considering that coefficients for all variables are large and significant provides evidence of convergent validity for the tested items.

TABLE 6

FIT STATISTICS FOR MEASUREMENT MODEL

Overall Fit Measures			
Fit Statistic	**Notation**	**Model Value**	**Acceptable Value[5]**
Chi-Square to Degrees of Freedom	χ^2/ df	1.95	≤ 2.0
Root Mean Square Error of Approximation	RMSEA	0.04	≤ 0.06
Root Mean Square Residual	RMR	0.04	≤ 0.05
Goodness of Fit Index	GFI	0.98	≥ 0.95
Normed Fit Index	NFI	0.97	≥ 0.95
Comparative Fit Index	CFI	0.96	≥ 0.95
Incremental Fit Index	IFI	0.96	≥ 0.95

[5] Values set by Bagozzi and Yi (1998)

Discriminant Validity

In addition to convergent validity, to ensure adequacy of the measurement model it is important to measure that groups of variables intended to measure different latent constructs display discriminant validity. Discriminant validity addresses the extent to which individual items intended to measure one latent construct do not at the same time measure a different latent construct (DeVellis 1991). We test for discriminant validity in two ways. First, inter-factor correlations are computed for

TABLE 7

CORRELATION RESULTS

	Use of e-Business Technologies	Buyer-Supplier Coordination	Strategic Benefits	Operational Benefits
Use of e-Business Technologies	1.00			
Buyer-Supplier Coordination	0.301	1.00		
Strategic Benefits	0.294	0.343	1.00	
Operational Benefits	0.286	0.256	0.322	1.00

all factors and shown in Table 7. Very high inter-factor correlations, say approaching 1.00, indicate that the items are measuring the same construct, although significant inter-factor correlations may be observed between theoretically related constructs. An analysis of Table 7 reveals the inter-factor correlations to be quite low.

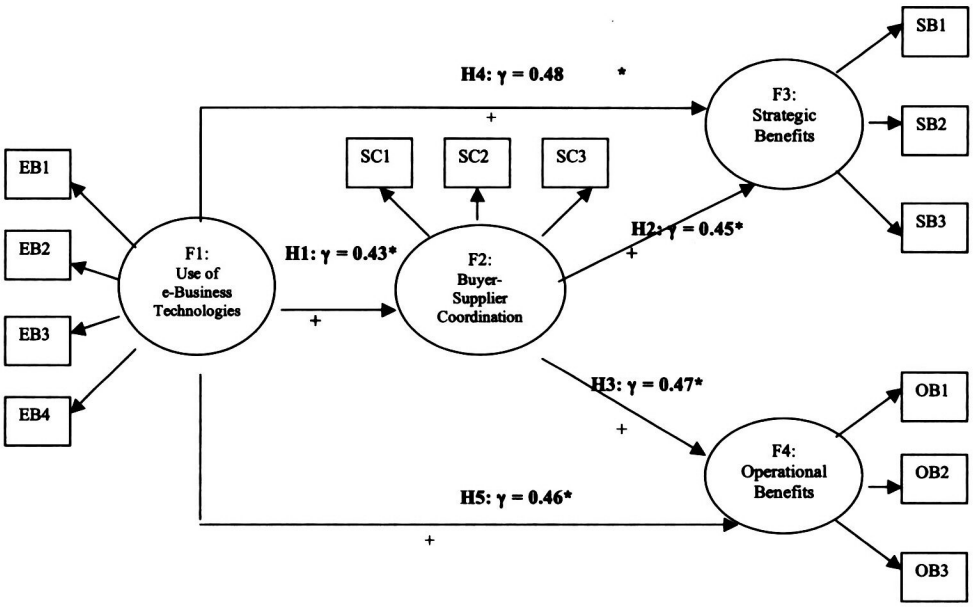
Following the recommendation of Anderson and Gerbing (1988), discriminant validity was further evaluated through a confidence interval test. A confidence interval of 95% was computed around the correlation estimates between the factors by adding and subtracting twice the standard error of a correlation between the two factors. The range of the confidence intervals, which did not include 1.0, further demonstrated discriminant validity.

Structural Model Test Results

Figure 1 and Table 8 present the results of the structural model tested. Overall model fit indices are as follows: ratio of chi-square to degrees of freedom ($\chi 2$/ df = 1.93, where $\chi 2$ = 115.8 and df = 60), root mean square error of approximation (RMSEA = 0.05), root mean square residual (RMR = 0.04), goodness of fit index (GFI = 0.98), normed fit index (NFI = 0.98), comparative fit index (CFI = 0.97) and incremental fit index (IFI = 0.97). A comparison of these values against those recommended in the literature suggests that the model is satisfactory (Hu and Bentler 1999). All paths are statistically significant at the 0.05 level.

FIGURE 1

THE STRUCTURAL MODEL



* All coefficients are significant at $p \leq 0.05$

TABLE 8

GOODNESS OF FIT OF THE STRUCTURAL EQUATION MODEL

Overall Fit Measures			
Fit Statistic	**Notation**	**Model Value**	**Acceptable Value [6]**
Chi-Square to Degrees of Freedom	χ^2/ df	1.93	≤ 2.0
Root Mean Square Error of Approximation	RMSEA	0.05	≤ 0.06
Root Mean Square Residual	RMR	0.04	≤ 0.05
Goodness of Fit Index	GFI	0.98	≥ 0.95
Normed Fit Index	NFI	0.98	≥ 0.95
Comparative Fit Index	CFI	0.97	≥ 0.95
Incremental Fit Index	IFI	0.97	≥ 0.95

[6] Values set by Bagozzi and Yi (1998)

This serves as the basis of evaluation for our hypotheses:

H_1: Supplier use of e-business technologies (EB) to communicate with their primary buyer has a direct and positive impact on buyer-supplier integration (SC). This hypothesis is supported, as the parameter estimate (0.43) is significant.

H_2: Buyer-supplier coordination (SC) has a direct and positive impact on supplier strategic benefits (SB). This hypothesis is supported, as the parameter estimate (0.45) is significant.

H_3: Buyer-supplier coordination (SC) has a direct and positive impact on supplier operational benefits (OB). This hypothesis is supported, as the parameter estimate (0.47) is significant.

H_4: Supplier use of e-business technologies (EB) to communicate with their primary buyer has a direct and positive impact on strategic benefits to supplier (SB). This hypothesis is supported, as the parameter estimate (0.48) is significant.

H_5: Supplier use of e-business technologies (EB) to communicate with their primary buyer has a direct and positive impact on supplier operational benefits (OB). This hypothesis is supported, as the parameter estimate (0.46) is significant.

In addition to the proposed model, alternative structural models were tested during the analysis. A test was made of combining the performance scale items into one versus two factors, however Chronbach's alpha for one single factor was below the 0.7 threshold. The presented model proved to have the best fit based on the above measures. The model and analysis show e-business technology to have both a direct and indirect impact on both measures of performance, with indirect effects on strategic and operational performance measures both significant at the $p \leq 0.05$ level (0.20 and 0.21 respectively).

DISCUSSION AND IMPLICATIONS

A number of important findings emerge from this study that have both theoretical and managerial implications. One contribution is the empirical documentation of the impact that supplier use of e-business technologies has on buyer-supplier coordination and on a complete set of first-order benefits to the supplier. As discussed earlier, e-business technologies have primarily been studied from the viewpoint of either manufacturing firms or retailers, with a segmentation of this research presented in Tables 1 and 2. Both tables show empty research cells for studies of the value of e-business technologies from the viewpoint of suppliers, within the context of the supply chain. Empty research cells are also shown for a test of broad range of performance benefits. The current research fills this void.

It is an important decision for supplier firms to invest in the capability needed to fully use e-business technologies. This is particularly true for companies that rely heavily on EDI. Although e-business technologies provide greater capability at lower cost than EDI, many firms have invested in an EDI capability and may be skeptical of the benefits e-business technologies can offer. This is particularly important for supplier firms as they are often smaller in size than manufacturers and must appropriate larger portions of their budgets to acquire the needed technology and skill. This includes purchases of additional hardware and software, staff training and time allocation, as well as resources in developing firewall protection and security of information. The findings in this study provide support for the benefits that supplier firms gain when using e-business technologies.

The benefits accrued to suppliers from the use of e-business technologies are shown to be both strategic and operational. Although operational benefits are not unexpected given that the technology should streamline operational requirements, the strategic benefits are indeed significant. The reason is that supplier firms have less control over how they use the technology compared to manufacturers and retailers. Suppliers use this technology primarily for planning purposes and are dependent upon the type and quality of information passed given to them by manufacturers. This research demonstrates that although suppliers are a few stages removed from the final customer in the supply chain and are dependent upon the manufacturer for the information, they are still able to derive strategic types of benefits from the use of this technology.

The use of e-business technologies impacts the tested performance measures both directly and indirectly. This latter finding supports the contention that e-business technologies, like IT in general, effect performance by influencing relational outcomes (Wen, Yen, and Lin 1998), in this case buyer-supplier integration. Past studies have shown buyer-supplier integration to result in financial and operational performance benefits. This current study demonstrates that buyer-supplier integration leads to a broad range of benefits for suppliers.

LIMITATIONS AND FUTURE RESEARCH

The current study has limitations that should be noted and that provide opportunities for future research. This study focuses on the types of benefits attained by suppliers when using e-business technologies to communicate with their primary buyer. One limitation of the current study is that it considers only the use of e-business technologies, rather than comparing the effect of different types of IT. As discussed earlier, there are many types of IT and different classifications, each potentially having a different impact on performance. For example, one functional classification of IT is provided by Barki, Rivard, and Talbot (1993), where IT is aggregated into six categories: transaction processing systems, decision support systems, interorganizational systems, communication systems, storage and retrieval systems, and collaborative work systems. Another classification of IT is provided by Kendall (1997), where IT is divided into two categories: production-oriented information technologies and coordination-oriented information technologies. Regardless of classification, it can be assumed that some of these technologies have a more direct impact on collaboration and integration than others. It can be assumed that some information technologies have a greater impact on coordination and performance than others. Also, new types of information technologies are emerging rapidly. One example of this are "wireless" IT, which are information technologies that use wireless devices, sensors, positioning locators, and networks to provide real-time communication with anyone at any time. Research studies should consider evaluating the relative effectiveness of different types of IT on performance in order to help guide practitioners in their IT selection.

Another limitation of the current study is that it looks at use of e-business technologies and benefits only from the viewpoint of the supplier. Although this viewpoint is important given the lack of studies focused on suppliers, it may be valuable to compare benefits of such technologies to both suppliers and buyers. Given the large expenditures IT investments require, it may be important for future work to consider the impact of different types of information technologies on SC integration and performance, from the standpoint of multiple chain participants. This would better enable firms to make educated decision whether to invest in a particular IT throughout their supply chain network.

Some studies have suggested that to achieve supply chain integration the use and development of information technology should follow a preset sequence (Narasimhan and Kim 2001).[7] These studies suggest that in order for information technology to be implemented successfully there needs to be coordination and a functional relationship between the stage of supply chain integration and the utilization of IT. This type of analysis suggests the complexity of this issue. The model tested in our current study is somewhat simplistic. Future studies should consider expanding the relationships studied herein to include the stage of supply chain integration.

Our research considers first tier OEM suppliers from the computer industry. Although studying this industry provides the advantage of gaining data from companies on the frontiers of IT use and samples a broad range of companies, it is possible that benefits may vary by industry needs or even type of business. For example, job shop environments may have different information needs than continuous flow environments. Future research should expand this type of analysis to include these types of comparisons.

[7]Four SC integration stages are proposed: Independent Operation of each function; Functional Integration; Internal Integration; and External Integration.

Our study also has limitations due to the nature of empirical data that it is based on. Empirical data inherently contains random errors. As such, this may cause differences in scale results when different data sets are used. We tried to minimize the potential of this by using scale items from past studies. Nevertheless, scale development, purification, and validation is an ongoing process that needs to be developed longitudinally and across multiple data sets.

Despite these limitations, our research document the benefits gained by suppliers when using e-business technologies and builds on current research in this area. The findings show that supplier use of e-business technologies positively impacts first-order benefits both directly and indirectly by promoting buyer-supplier coordination. The benefits to suppliers are found to be both operational and strategic. Although suppliers are a few stages removed from the final customer in the supply chain, they are still able to derive strategic types of benefits from the use of this technology.

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