

**Performance Implications of Internet-based Information Technology in Supply Chain
Management**

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ABSTRACT

Internet-based information technology (IT) has grown in its importance to value chain of firms. This research tests variations of previous IT models that suggest performance is affected by technology characteristics, organizational technology, resources and system utilization variables. Data from 165 firms that use the Internet to manage value chain functions suggest that performance depends on the type of industry and the type of supply chain function involved.

Introduction

Information technology (IT) has been considered an integral part of a firm's effort to sustain competitive advantage or competitive parity based on the assumption that it adds economic value to a firm (Mata, Fuerst, & Barney, 1995). Some theorists have suggested the advent of Internet-based commerce presents a strong case for the confluence of entrepreneurship and strategy (Amit & Zott; 2001; Hitt & Ireland, 2000; McGrath & Mac Millan, 2000). Despite the recent rash of dot-com failures, projections of growth in e-business worldwide indicate businesses continue to seek opportunities to use the Internet as an application of information technology to develop virtual markets within the value chain framework (Porter, 1985). More specifically, IT has been increasingly used in the business-to-business (b2b) realm of electronic commerce as the basis for inter-organizational information systems (IOS) that enable firms to transcend organizational boundaries, facilitate the flow of information, and manage linkages between suppliers and customers in the supply chain. In this regard, prior research has focused on the strategic benefits of private networks of electronic commerce such as electronic data interchange (EDI) (Clark and Stoddard, 1996; Angeles & Nath, 1998; Mukhopadhyay, Kekre, and Pokorney, 1998; Chatterfield & Yetton, 2000; Ahmad & Schroeder, 2001). As the proliferation of Internet-related information technology increases dramatically, it is imperative that theory relative to IOS in value chain management is expanded and applied to web-based electronic commerce.

This study presents and tests a model of the performance impact of Internet-based information technology used in supply chain activities. Based on extant organizational theory, information systems theory and resource dependency theory, a contextual model proposes that organizational performance is influenced by a firm's organizational technology, system

utilization, technology characteristics, and resource investment (Thompson, 1967; Goodhue, & Thompson, 1995; Mata et al., 1995; Stabell and Fjeldstad, 1998; Li & Ye, 1999; Chatterfield & Yetton, 2000; Afuah and Tucci, 2001). This model is similar to Goodhue and Thompson's (1995) model they referred to as the Technology-to-Performance Chain (TPC), in the sense that it presumes that there must be a fit between task and technology and that the technology must be utilized to maximize performance. However, this study extends this model in a number of ways. First it builds on the basic structure of the TPC model by proposing IT resource investment (Li & Ye, 1999; Chatterfield & Yetton, 2000) and organization technology (Thompson, 1967; Stabell & Fjeldstad, 1998; Afuah & Tucci, 2001) as predictors of performance. This study also extends this research stream to organizational performance, rather than individual performance and to Internet-based information technology, rather than EDI technology. After describing the theoretical framework supporting the proposed model, this paper will test these relationships with data from over 165 firms using Internet-based information technology to manage supply chain activities. The results are expected to provide management with an understanding of which supply chain IT functions maximize organizational performance within the context of their respective task environment and level of resource commitment.

Literature Review

Min and Galle (1999) defined electronic commerce as “an interorganizational information system that is intended to facilitate business-to-business electronic communication, information exchange and transaction support through a web of either public access or private value-added networks.” Electronic commerce (EC) can be facilitated through a variety of media such as electronic data interchange (EDI), direct link-ups with suppliers, Internet, Intranet, Extranet, electronic catalog ordering, and e-mail. Much of the literature has investigated EDI, which, in a broad sense of electronic commerce, involves the movement of paper-based instruments through

private dyadic electronic telecommunications channels (Kumar & Crook, 1999). With the advent of the Internet, many companies are migrating their information technology (IT) functions to the publicly accessible and cost effective World Wide Web as their preferred infrastructure for electronic commerce.

The evolution of virtual markets, created by Internet-based information technology, is an innovation that spans firm and industry boundaries while creating value through new exchange mechanisms, unique transaction methods, and new forms of collaborations among firms. As such IT is a critical component of the value chain framework, which decomposes the firm into strategically important primary and support activities to determine how value is created (Stabell & Fjeldstad, 1998). As a support function information technology creates value by supporting differentiation strategies at various steps of the value chain by lowering costs or raising revenue (Amit & Zott; 2001). Conceptual models that explain the context of organizational and environmental variables that influence performance in supply chain activities have been limited.

Supply chain activities are distinguished by the degree business processes are integrated between suppliers and end users, and whether movement of information is across functional boundaries within the firm or transcend inter-organizational boundaries of firms within the value chain functions (Walton and Gupta, 1999). EC can enhance internal supply chain efficiency by providing real-time information on product availability, production planning, inventory management, purchase order generation, and shipment status. Internet-based information systems can automate internal and/or external procurement functions such as: issuing requests for proposals and purchase orders; information on purchasing pricing; and offering management tools, supplier interface, and supply chain control (Walton and Gupta, 1999).

The extant literature on IT performance models has established a very preliminary theoretical framework. Li and Ye (1999) found that IT investment had an impact on financial performance when there are greater environmental changes, a proactive company strategy, and closer CEO/CIO ties. Goodhue and Thompson (1995) developed a model designated as the Technology-to-Performance Chain (TPC), concluding that performance maximization requires a fit between task and technology and a degree of technology utilization.

This study proposes a performance model that considers the effects of technology characteristics, organizational technologies, resource investments, and system utilization on profit expectations and productivity. This model builds on Goodhue and Thompson's (1995) TPC model by addressing a macro perspective of supply chain functions. Using a synthesis of typologies in prior research (8, 1993; Lummus and Duclos, 1995; Massetti & Zmud, 1996) technology characteristics explored in our model, are associated with purchasing functions in the supply chain. In contrast to Goodhue and Thompson's (1995) perspective of individual use of technology, we look at organizational level technology using the seminal theories of Thompson (1967). Considering the prominence of resource theory in prior models (Li & Ye, 1999), this study investigates whether the effects of IT resources may be limited in their ability to provide a sustained competitive advantage (Mata, Fuerst, & Barney, 1995). These factors are discussed in the following sections and then tested for their incremental contribution to firm performance.

Information Technology Characteristics

Electronic commerce research has used several classification typologies of EDI implementation to describe strategic benefits of IT in various inter and intra-organizational operational functions (Swatman and Swatman, 1992; Chatfield & Yetton, 2000; 8, 1993; Lummus and Duclos, 1995; Massetti & Zmud, 1996). 8 (1993) set forth three EDI implementation levels

that generate strategic benefits: at level one, simple data is exchange without integration into the firm's internal process; at level two, data is exchanged between applications of the firms; and at level three, business processes are reengineered, changing the way the firm performs its activities. Similarly, Lummus and Duclos (1995) used a three-tier classification of EDI systems based on depth and breadth dimensions. At level one, the supplying firm exchanges a limited number of EDI transactions with a few customers. At level two, the supplier's EDI system is linked with its manufacturing planning system. At level three, EDI transactions between buyers and suppliers are integrated with other applications in their respective firms.

Massetti and Zmud's (1996) classification comprised of four distinct characteristics of EDI implementation: volume, breadth, diversity, and depth. In this typology volume of EDI usage was defined as the extent to which an organization's document exchanges are handled using electronic and telecommunication media, and reflects the firm's progress toward implementation of electronic operational functions (Massetti & Zmud, 1996). High levels of electronic transaction volume indicate the degree of change the firm is committed to in business process transformation. Massetti and Zmud (1996) defined breadth of EC usage as the extent to which EDI connections are made with trading partners. Breadth is an indication of how successful and willing a firm appears to be in establishing electronic linkages with customers, suppliers and other stakeholders and adapting to the use of new technology for competing in the electronic marketplace. EC diversity was defined as the number of distinct document types an organization handles via EC connections (Massetti and Zmud, 1996). Diversity indicates whether a firm has implemented a comprehensive approach toward handling transactions electronically. The variety of documents used in a firm complicates standardization and measurement issues. According to Massetti and Zmud (1996), diversity must be assessed based on separate functions

and number of formats. Depth was defined by the degree or nature of electronic consolidation between the business processes of the trading partners.

Depth as operationalized by Massetti and Zmud (1996) is similar to the typology of Emmelhainz (1993) and Lummus and Duclos (1995). The level of implementation involves the electronic transmission of documents between trading partners such as issuing requests for proposal and purchase pricing. The second level involves the electronic transmission of documents and the automatic electronic processing by the trading partner such as purchase orders. The more sophisticated level involves the integration of computerized applications and business process between trading partners such as offering customized web interfaces supplier interfaces, coordinating product orders and forecasting needs with suppliers, and supply chain control functions.

Goodhue and Thompson's (1995) operationalization of technology characteristics was similar to EDI implementation schema mentioned previously (Emmelhainz, 1993; Lummus and Duclos, 1995; Massetti & Zmud, 1996). The levels of EDI implementation (Emmelhainz, 1993; Lummus & Duclos, 1995) and depth (Massetti & Zmud, 1996), establishes a hierarchy of integration complexity relative to the business processes of the firm. The concept of technology characteristics was captured in the TPC model (Goodhue and Thompson, 1995) by weighting the use of specific information technologies, to capture inherent differences between technologies as a proxy for unspecified system characteristics. This weighting approach also captured the concept of diversity used by Massetti and Zmud (1996) to determine the number of separate supply chain functions, while still determining the level of integration complexity for each. Goodhue and Thompson (1995) concluded that user evaluations of task-technology fit were a function of systems characteristics and task characteristics. They did not actually measure the fit

between task environment and IT technology characteristics and its effect on performance. Their operationalization of task-technology fit was based on user perceptions at the individual level, which is not necessarily applicable at the organizational level. Based on Goodhue and Thompson's conclusion that characteristics of technology impact individual performance we propose that:

Hypothesis 1: Firm performance is influenced by technology characteristics.

Organizational Technologies

Organizational theory research suggests that value creation activities vary based on the organizational technologies associated with different industries (Thompson, 1967; Porter, 1985; Stabell & Fjeldstad, 1998; Afuah & Tucci, 2001). Thompson (1967) articulated three types of value creating organizational technologies: long linked, mediating and intensive. Long linked technology involves serial and interdependent activities in a repetitive production process requiring standardized resources. Mediating technologies link multiple interdependent clients and customers requiring standardized processes. Intensive technology requires a variety of customized techniques that are determined based on feedback from the application.

Stabell and Fjeldstad (1998) expanded Porter's (1985) concept of the value chain, proposing a value configuration analysis based on Thompson's (1967) description of value creation technology. Stabell and Fjeldstad (1998) argued that these value configuration activities are not generic, but are contingent upon the characteristics of the industry, concluding that the value chain model suggested by Porter (1985) only applies to long-linked technology. Stabell and Fjeldstad (1998) offered two other categories: value shop, based on intensive technologies, and value networks, which rely on mediating technologies (Thompson, 1967). Afuah and Tucci

(2001) articulated this value configuration typology as a business model for assessing how primary and secondary value creation activities are affected by the new information technology of the Internet. This typology provides a theoretical framework for assessing the task environment from the organizational perspective, rather than the individual perspective used by Goodhue and Thompson (1995), which was based on Thompson (1967) individual task constructs of non-routineness and interdependence. Therefore we propose that:

Hypothesis 2: Performance will vary based on organizational technologies employed by the firm.

System Utilization

Goodhue and Thompson (1995) proposed in their TPC model that system utilization was a predictor of individual performance. The utilization focus is similar to the concept of volume proposed by Massetti and Zmud (1996), and presumes that increased utilization will lead to positive individual performance impact. Although they suggested that utilization should be operationalized as the proportion of times users choose to utilize systems, their study limitations prevented this approach. Instead they conceptualized utilization as the extent to which the information systems have been integrated into an individual's work routine based on manager's perception of their system dependence. They found that utilization alone did not predict performance but was instead a joint function of task-technology fit and utilization. This implies that certain contextual factors such as the organizational technology and functional technologies must be considered in the model. Since Goodhue and Thompson did not find a direct impact of utilization, we include system utilization as a control variable.

Resource-based View

The resource-based view has become a popular perspective for explaining sustainable competitive advantage (Barney, 1991). The basic premise of resource-based theory is that firms are a bundle of resources that are used to seek economic rents, defined as excess return to a resource over its opportunity cost (Rumelt, 1987; Oolavarrieta, & Enllinger, 1997). These bundles of superior resources can be classified in terms of input factors, assets, and capabilities (Wernerfelt, 1984). Firms seek new opportunities to generate economic rents that can be sustainable over a period of time to achieve sustainable competitive advantage and superior performance (Porter, 1985). Strategic resources are valuable, scarce, and imperfectly imitable, and can therefore differentiate a company with competitive advantage and distinctive firm-specific capabilities. Results are considered valuable when they enable a firm to initiate strategies that result in improved performance as evidenced by exploiting market opportunities or neutralizing impending threats. The concept of scarcity suggests limited availability of the resource to competitors, while the element of imitability implies a lack of understanding by competitors of how the resource is linked to performance advantages (Barney, 1991).

This sustainable advantage has been discussed in terms of the logistic functions in the supply chain, as well as their application to inter-organizational information systems used in the value chain. Resource-based theory provides a theoretical framework to reassess the traditional view of logistics and thereby portray logistic capability as a key strategic resource when it is valuable scarce and inimitable (Stock, 1990; Olavarrieta & Ellinger, 1997). Resource theory has also been suggested as a meaningful theoretical framework for pursuing competitive advantages through the development of IOS in value chain activities because of the required diffusion of new technology assets (Angeles et al., 1998; Kumar & Crook, 1999). Although Angeles et al., (1998) suggested that higher levels of IOS implementation have definite resource implications; their

study of EDI implementation success factors did not measure resources specifically. They suggested that resources embodied in appropriate technical infrastructure include hardware, software, communications support, and personnel skills. This infrastructure is mostly reflected in the firm's investment in web-based technology.

Resource theory as it relates to using IT to establish a sustainable competitive advantage has been equivocal. Particularly, the resources involved in web-based EC may not be a source of competitive advantage. Resources must be heterogeneous and immobile to contribute to a sustained competitive advantage (Mata, et al., 1995). Although the high costs of private value added networks have impeded the diffusion of EDI, the inception of web-based electronic commerce has made IOS available to firms with fewer resources. Internet-based information technology has become generic and widely available to competing firms, thereby eliminating distinct cost disadvantages in developing, acquiring, or using the technical infrastructure of the Internet. Consequently, resources in this technical context can at best be viewed as a temporary source of competitive advantage or a source of competitive parity. In fact, except for managerial IT skills, Mata et al. (1995) concluded that IT can not be a source of sustainable competitive advantage. Because IT resources are mobile and imitable, firms can only expect to have a temporary competitive advantage, and should view IT as necessary to maintain competitive parity. We therefore use resource as a control variable in the model.

Methods

Data Collection

Using a database of firms doing business on the Internet, survey data were gathered using a key informant technique from chief information service officer or the manager of information technology by Activmedia, an Internet research firm (Poppo & Zenger, 1998). Specifically, a population was extracted from a global directory of 550,000 publicly listed URLs. Once the database was purged to eliminate duplication, an nth name random sample was drawn from English-language directory systems, which accounts for 80% of Web URLs overall. The instrument was a multi-part web-based survey, introduced by e-mail invitation to 4,604 businesses in the year 2000, giving them 48 hours to respond, promising a copy of the final report with responses from. From the 1,013 firms that responded, the sample was segmented by business model, of which 449 respondents who use the Internet for business-to-business supply chain transactions, of which 165 firms provided usable data, representing an acceptable response rate of 36% from the sub-segment of the sample.

The multi-part, web-based survey requested key informant perceptions on levels of electronic commerce implementation, performance variables and resource variables. Perceptual measures are commonly used in organizational research based on research that indicates executives are ideally positioned to act as key informants in the qualitative assessment of information technology (IT) efficacy (Poppo & Zenger, 1998). Manager's perceptions and attitudes toward IT have also been found to be associated with the use of IT in support of business strategy (Tallon, Kraemer, & Gurbaxani, 2000; DeLone & McLean, 1992).

Dependent Variables

IT adds economic value by either reducing a firm's costs of operations or increased revenues by differentiating products or services (Meta et al., 1995). Rather than using corporate level measures that may not be appropriate for measuring business level activities (Nickell, 1996; Geroski, 1998; Stuart, 2000) this paper used key informant perceptions of performance at the business level: web-generated productivity and web site profitability. Although objectives measures are more popular, Venkatraman and Ramanujam (1986) found a high degree of correlation between perceptual and objective performance measures and concluded that perceptual measures are acceptable operationalizations of business economic performance. To measure the benefits of cost reduction respondents were asked to describe their firm's level of website profitability based on their experience or expectations. "Profitable now" was coded "5", "profitable in 12 months" was coded "4", "profitable in 12 to 24 months" was coded "3", "profitable in 2 to 5 years" was coded "2", "may never be profitable" was coded "1", and "not intended to generate profit" was coded "0". To measure increased productivity respondents were asked to provide an estimate of web-generated revenue each year, from 1999 to 2002. Internet sales growth for the year 2000 was calculated by subtracting year 1999 Internet revenue from year 2000 Internet revenue. Productivity was calculated by dividing Internet sales growth by the number of total employees.

Independent Variables

Organizational technologies are classified using Thompson's (1967) typologies of long linked, mediating and intensive. Respondents were asked to choose their primary business activities that account for at least 25% of revenues from a list provided. Responses were dummy coded 1 (if applicable) and 0 (no response). Respondent with a summary value from all

categories equal to 1 were further classified as long linked, mediating or intensive based on how the business activity matched Thompson's (1967) definition of the technology.

In this study technology characteristics of the value chain are conceptualized by measuring the functional complexity of procurement systems integration (Massetti & Zmud, 1996). Specifically, respondents were asked which purchasing functions are currently performed online: 1) requests for proposals; 2) providing management tools for staff; 3) offering customized web interfaces for suppliers; 4) coordinating product orders and forecasting needs with suppliers 5) supply chain control and 6) online inventory status. Each variable was dummy coded as 1 (if used) or 0 (if not used). Following Goodhue and Thompson (1995), weighted proxies for technology characteristics were developed, by dividing the dummy variable, by the number of systems used. Rather than just measuring dichotomous technology implementation this approach measures the diversity of implementation. It also captures inherent differences between technologies without explicitly defining the differences (Goodhue & Thompson, 1995).

Control Variables

This study included two control variables: resource and system utilization. The first is based on the resource theory that IT serves as source of competitive advantage or competitive parity. Since it is more likely to serve as a source of competitive parity because of lack of sustainable value we use technical resources as a control variable. The basis for technical resources is the firm's investment in web-based technical infrastructure, such as hardware, software, and communications support (Angeles, Nath, & Hendon, 1998). Therefore, technical resource investment was measured as the self-reported investment in web-based hardware and software, converted to US dollars. We computed the log transformation of the result to limit the

variance in the distribution of the values and minimize scaling problems among independent variables (Simerly & Li, 2000; Ahmad & Schroeder, 2001). Researchers have used firm size as a proxy for the availability of resources, in supply chain research based on the assumption that larger firms have more resources to deploy (Walton and Gupta, (1999). In this study we used the log of total employees to limit the variance in the distribution of the values and thereby minimize scaling problems among independent variables. System utilization was measured as the ratio between online transaction and offline transactions for the current year, as reported by the respondents.

Data Analysis

Data on the 165 firms were analyzed using hierarchical linear regression. This first generation analysis technique was used because the related theory is in its early stage of development (Fornell, 1984; 9, 1995). The relationship between the dependent variables of firm performance and the independent variables of implementation level and firm resources was modeled as follows:

$$Y_i = b_0 + b_1X_1 + b_2X_2 + \text{control variables} + e,$$

where Y_i is firm performance measured by managers' perceptions of web site profitability and Internet productivity growth. X_1 represents three discrete types of organizational technologies; X_2 represents six discrete system characteristics; and the control variables are log of web investment, log of system utilization, and the log of total employees. The variables were introduced into the regression model in stages. Stage one introduced the control variables; stage two introduced organizational technologies; and stage three introduced technology characteristics. The hierarchical approach allows us to measure the incremental value of each set of predictor variables for explaining organizational performance.

Results

Table 1 presents the means and standard deviations, as well as the Pearson correlation coefficients between variables. The results indicate there are significant linear relationships between dependent and independent variables, but there is no indication of multicollinearity based on VIF indices not exceeding the threshold of 10 (Lomax, 1992). Computing the log transformation of the control variables reduced possible violations of linearity assumptions based on a skewness test. Although the some of the system characteristic variables exceed the normal skewness threshold of two (Lomax, 1992) the range of the values between 0 and 1 suggested there were no outliers.

Insert Table 1 about here

Table 2 presents the results of the regression analyses estimating the effects of the organizational technologies and technology characteristics variables on Internet profitability in the first model and productivity in the second model.

Insert Table 2 about here

The results for the first model regressing profit expectations indicate that the group of control variables was marginally significant ($F = 2.51, p < .10$), with an R^2 of .047, providing sufficient support for controlling for their effects. More specifically, size was significant ($p <$

.01) in predicting profit expectations. In the second stage the three organizational technology types introduced contributed significantly to predicting profit expectations ($\Delta F = 2.51$, $p < .05$). The second stage model was significant ($p < .05$) with an R^2 of .10, supporting hypothesis 1. More specifically, mediating technologies had a positive and significant impact on profit expectations. Long-link technologies had a significantly negative ($p < .10$) impact on profit expectations. In the third stage the six purchasing IT functions were introduced and contributed significantly to the prediction of profit expectations as predicted in hypothesis 2 ($\Delta F = 2.39$, $p < .05$). The model R^2 was .177 and significant at the $p < .05$ level, supporting hypothesis 2. More specifically, the use of staff management tools was positively related to profit expectations ($p < .001$). Although the proportion of variance was low (17.7%) it is in line with similar studies (9, 1995).

The results for the second model regressing Internet-generated productivity improvement indicate that the control variables had a significant impact as a group ($F = 14.08$, $p < .001$; $R^2 = .348$). Individually, there were significant results for size ($p < .001$), resource investment ($p < .10$) and system utilization ($p < .05$) providing support for the need to control for these variables. The second stage of the second model introduced the organizational technology variables that were not significant as a group. Only mediating technology had a significantly positive impact on productivity improvement. In the third stage the weighted values of functional technologies used made a significant incremental contribution to the model ($\Delta F = 2.65$, $p < .05$, $R^2 = .499$). Specifically the weighted use of request for proposal was positively significant ($p < .01$), the use of supplier interfaces was positively significant ($p < .05$), and the use of supply chain controls was negatively significant ($p < .05$).

Discussion and Conclusions

One of the purposes of this paper was to apply IOS theory related to the strategic implementation of traditional EDI to Internet-based electronic commerce. This study also builds on the basic structure of the TPC model (Goodhue & Thompson, 1995) by proposing IT resource investment and organization technology as predictors of organizational performance. This research also extends this model to organizational performance and to Internet-based information technology used in supply chain management. Using two different measures of organizational performance this study was able to distinguish how different technologies and systems achieve different performance outcomes.

As discussed earlier, value chain activities implement business level strategies. Consequently normal corporate and business level performance measures are not applicable. Instead, efficiency and cost reductions are more effective measures of business strategic benefits. In terms of organizational technologies we found that as a group, they provided significant incremental explanatory power for profit expectations, supporting hypothesis one. These results also confirm Stabell and Fjeldstad's (1998) proposition that each organizational technology represents a different set of assumptions related to the nature of value chain activities and their cost effectiveness. Specifically, this study found that profit expectations are greater for firms that use mediating technologies and less for firms employing long-linked technologies. These results suggest that firms such as banks, utilities, and insurance firms can effectively use Internet-based

information technology, while manufacturing and processing firms may not find Internet-based IT profitable.

In terms of specific value chain functions the results suggest that using the Internet as a management tool for staff purchasing functions may impact profitability expectations. The direction of the beta coefficient suggests that staff management tools should be used separately and not part of a diverse set of value chain functions.

Using the efficiency measure of organizational performance we found that organizational technologies did not provide significantly greater explanatory power as a group. However the results did suggest firms with mediating technologies had positive productivity improvement. Coupled with the positive finding for profitability expectations, these results provide strong evidence to support banks, insurance companies, and utilities will experience positive results using Internet-based IT. The technology functions employed in the value chain activities had a significant incremental impact on explaining productivity improvement. Specifically using the Internet for issuing requests for proposals, which is a low level function that requires minimal system integration, was significant. The positive direction of the results suggests that this function should be used independent of other value chain IT functions. The use of customized supplier interfaces also had a positive impact suggesting profit expectations were higher when used in a less diverse value chain IT environment. Customized supplier interfaces also reflect a higher level of value chain integration. Finally the negative significance of supply chain control as an IT function indicates that profit expectations were higher when it is used as part of a more diverse set of functions. Of course this function represents a higher level of system integration.

The results have to be interpreted within the context of some limitations. The perceptions of key informants were measured using the survey method, which is not as fine-grained as in-depth case studies or scenario construction. However the use of a large sample, which includes a

variety of industries, enhances the generalizability of the findings (Goll & Rasheed, 1997). The study relied on a single respondent from each firm and the research design was cross sectional. Causal inferences must therefore, be based on a priori theory, as well as rejection of alternate explanations. Although there is some theoretical support for organizational technologies and Internet-based IT value chain functions, their performance implications at the organizational level are relatively new. Therefore, this preliminary evidence for task and technology effectiveness needs to be confirmed with future research.

In conclusion, this study has provided evidence that managers using different organizational technologies and different Internet-based value chain IT functions will experience different levels of success. Firms that link interdependent clients and customers needing standardized processes should have strong expectations of success using the Internet. Firms needing standardized products in repetitive process should perhaps investigate more tightly linked IT such as EDI since the log of resource investment in web infrastructure, was not significant as a control variable in predicting profit expectations. We can also conclude that internal functions such management tools, and inter-organizational systems such as request for proposals, supplier interfaces, and supply chain control functions can affect success differently. Therefore depending on their performance objectives, this research can provide managers with insight on which IT value chain function they should focus on and how diverse and integrated their functional approach should be for maximizing performance outcomes.

References

Afuah, A. & Tucci, C.L. Internet Business Models and Strategies. New York: New York: McGraw-Hill Irwin (2000).

Ahmad, S. & Schroeder, R. The impact of electronic data interchange on delivery performance, *Production and Operations Management*, 10(1) 16-31.

Amit, R. & Zott, C. (2001) Value creation in e-business. *Strategic Management Journal*, 22, 493-520.

Angeles, R. & Nath, R. An empirical study of EDI trading partner selection criteria in customer-supplier relationships. *Information & Management*, 37, (1999) 241-255.

Angeles, R. Nath, R. & Hendon, D. An empirical investigation of the level of electronic data interchange (EDI) implementation and its ability to predict EDI system success measures and EDI implementation factors. *International Journal of Physical Distribution & Logistics Management*, 28, (1998) 9-21.

Barney, J. Resource Based View. *Journal of Management*, 40, (1991) 137-146.

Chatterfield, A. & Yetton, P.. Strategic payoff from EDI as a function of EDI embeddedness. *Journal of Management information Systems*, 16, 4, (2000) 195-224.

Clark, T. & Stoddard, D. Interorganizational business process redesign: Merging technological and process innovation. *Journal of Management Information Systems*, 13, 2, (1996) 9-28.

Emmelhainz, M., EDI: A Total Management Guide, Van Nostrand Reinhold, New York, NY (1993).

Geroski, P.A. 1998. An applied econometrician's view of large company performance. *The Review of Industrial Organization* 13: 271-293.

Goll, I. & Rasheed, A. 1997. Rational decision-making and firm performance: The moderating role of environment. *Journal of Business Ethics*, 49(1) 41-53.

Goodhue, D. & Thompson, R. Task-technology fit and individual performance. *MIS Quarterly*, 19, 2, (1995) 213-236.

Hitt, M. & Ireland, R. 2002. The essence of strategic leadership: Managing human and social capital. *Journal of Leadership & Organizational Studies* 9(1) 3-15.

Kumar, R. & Crook, C. A multi-disciplinary framework of the management of interorganizational systems. *Database for Advances in Information Systems*, 30, 1, (1999) 22-37.

Li, M. & Ye, L. Information technology and firm performance: Linking with environmental, strategic and managerial contexts, *Information & Management*, 35,1, (1999) 43-51.

Lomax, R. G. (1992). *Statistical Concepts: A Second Course for Education and the Behavioral Sciences*. White Plains, NY: Longman.

Lummus, R. & Duclos, L. 1995. Implementation of EDI systems, *Journal of Systems Management*, 46(5) 42-49.

Masseti, B. Zmud, R. Measuring the extent of EDI usage in complex organizations: Strategies and illustrative examples. *MIS Quarterly*, 20, (1996) 331-45.

Mata, F., Fuerst, W. & Barney, J. Information technology and sustained competitive advantage: A resource-based analysis. *MIS Quarterly*, 19, (1995) 487-504.

McGrath. R. MacMillan, I. 2000. Assessing technology projects using real options reasoning. *Research Technology Management*. 43(4), 35-50.

Min, H. & Galle, W. Electronic commerce usage in business-to-business purchasing. *International Journal of Operations & Production Management*, 19, (1999) 23-31.

Mukhopadhyay, T., Kekre, S. & Pokorney, T. Strategic and operational benefits of electronic data interchange. Working paper GSIA, Carnegie Mellon University, (1998).

Nickell, S.J. 1996. Competition and corporate performance. *Journal of Political Economy* 104:4, 724-746.

Poppo, L. & Zenger, T. Testing alternative theories of the firm: Transaction cost, knowledge-based, and measurement explanations for make-or-buy decisions in information services. *Strategic Management Journal*, 19, (1998) 853-877.

Riggins, F.J., and Mukhopadhyay, T. Interdependent benefits from interorganizational systems: opportunities for business partner reengineering. *Journal of Management Information Systems*, 11, 2 (fall 1994), 37-57.

Simerly, R. & Li, M. 2000. Environmental dynamism, capital structure and performance: A theoretical integration and an empirical test. *Strategic Management Journal*, 21(1) 31-45.

Stabell, C. & Fjeldstad, O. Configuring value for competitive advantage: On chains, shops, and networks, *Strategic Management Journal* 19, (1998) 413-437.

Stuart, T. Interorganizational Alliances and the performance of firms: A study of growth and innovation rates in a high-technology industry. *Strategic Management Journal*. 21, (2000) 791-811.

Tallon, P., Kraemer, K. & Gurbaxani, V. Executives' perceptions of the business value of information technology, *Journal of Management Information Systems*, 16,4, (2000) 145-173.

Thompson, J. (1967). *Organizations in Action*. McGraw-Hill, New York.

| Venkatraman, N. & Ramanujam, V. Measurement of business economic performance: An examination of method convergence. Journal of Management, 13,1, (1987) 109-122.

Walton, S. & Gupta, J. Electronic data interchange for process change in an integrated supply chain. International Journal of Operations & Production Management. 19, (1999) 4-21.

Table 1. Means, standard deviations and Pearson correlations

	Mean	s.d.	1	2	3	4	5	6	7	8	9	10	11	12	13
1. PROFIT	.97	1.40	---												
2. PRODUCTIVITY	.46	2.34	-.02	---											
3. LOGEMP	.86	.88	.23	.37	---										
4. LOGWEBIN	3.96	1.03	.01	.34	.33	---									
5. TECHM	.11	.32	.17	.02	.05	.01	---								
6. TECHL	.07	.26	.01	-.04	.10	.06	.23	---							
7. TECHI	.09	.28	-.10	.15	.00	.02	.21	.14	---						
8. RFP	.28	.38	-.02	.03	.04	.05	.09	.07	.03	---					
9. MGTOOL	.05	.16	.44	-.02	-.03	.06	-.03	.02	.06	.08	---				
10. SUPINT	.03	.11	-.06	.06	.01	.13	-.03	.01	.01	.05	.13	---			
11. PO	.08	.22	-.05	-.03	-.04	.03	-.01	-.01	-.05	.01	.08	.05	---		
12. CHAIN	.04	.14	-.01	.00	.12	.01	-.00	-.03	-.05	-.01	.09	.13	.10	---	
13. PURPRICE	.14	.29	.03	-.01	.03	.01	-.03	.02	.03	.10	.02	.04	.01	.01	---

Note: correlation factors above .06 are significant at the $p < .05$ level; above .08 are significant at the $p < .01$ level.

Table 2. Hierarchical Regression Analysis

Independent 3 Variables	Profit			Productivity		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model
<u>Control:</u>						
Log Transactions	-.05	-.06	-.05	.20*	.19*	.16*
Log web investment	-.04	-.04	-.02	.19*	.19*	.10
Log employees	.24**	.25**	.22**	.40***	.42***	.51***
<u>Organization Tech:</u>						
Mediating		.20**	.24**		.20**	.16*
Long link		-.14*	-.18*		-.05	-.00
Intensive		.05	.01		-.01	.00
<u>Technology:</u>						
R.F.P.			-.11			.23**
Purchase Pricing			-.01			-.12
Management Tool			.26***			-.04
Supplier Interface			-.03			.17*
P.O.			-.50			-.01
Chain management			-.05			-.18*
R ² Δ	.051	.048	.083	.348	.037	.114
Adjusted R ²	.028	.058	.108	.324	.337	.413
F Δ ₁	2.51*	2.61*	2.39*	14.08***	1.54	2.65*
df	3,152	3,149	6,143	3,79	3,76	6,70

*p<0.05, **p<0.01, ***p<0.001