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Examining the Impact of Interorganizational Systems on Process Efficiency and Sourcing Leverage in Buyer–Supplier Dyads

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ABSTRACT

Manufacturing firms are increasingly seeking cost and other competitive advantages by tightly coupling and managing their relationship with suppliers. Among other mechanisms, interorganizational systems (IOS) that facilitate boundary-spanning activities of a firm enable them to effectively manage different types of buyer–supplier relationships. This study integrates literature from the operations and information systems fields to create a joint perspective in understanding the linkages between the nature of the IOS, buyer–supplier relationships, and manufacturing performance at the dyadic level. External integration, breadth, and initiation are used to capture IOS functionality, and their effect on process efficiency and sourcing leverage is examined. The study also explores the differences in how manufacturing firms use IOS when operating under varying levels of competitive intensity and product standardization. In order to test the research models and related hypothesis, empirical data on buyer–supplier dyads is collected from manufacturing firms. The results show that only higher levels of external integration that go beyond simple procurement systems, as well as who initiates the IOS, allow manufacturing firms to enhance process efficiency. In contrast, IOS breadth and IOS initiation enable manufacturing firms to enhance sourcing leverage over their suppliers. In addition, firms making standardized products in highly competitive environments tend to achieve higher process efficiencies and have higher levels of external integration. The study shows how specific IOS decisions allow manufacturing firms to better manage their dependence on the supplier for resources and thereby select system functionalities that are consistent with their own operating environments and the desired supply chain design.

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Subject Areas: Buyer–Supplier Relationships, Interorganizational Systems, Supply Chain Design, and Survey Research/Design.

INTRODUCTION

The increasing trend toward purchasing inputs and other raw materials from outside the firm has raised the importance of supply chain management. The resultant decrease in vertical integration has provided an impetus for managers to place greater emphasis on managing buyer–supplier relationships in manufacturing firms. Conner and Prahalad (1996), in supporting this contention, argue that one source of differential performance between firms is the way they organize exchange activity. For effective management of buyer–supplier relationships, organizations need to choose appropriate relationships ranging from arm's length to coordinated relationships, and adapt management practices to fit those relationships (Bensaou, 1999). In addition, facilitating technologies that consistently support these relationships are needed. Interorganizational systems (IOS) such as electronic data interchange (EDI), electronic trading systems, Web-based procurement systems, and supplier relationship management systems have emerged as important technologies that support boundary-spanning activities associated with effective management of buyer–supplier relationships. These IOS offer various functionalities that need to be aligned with the nature of the desired relationship (Choudhury, 1997). An interesting question that arises is how can such an alignment be achieved? Also, what is the contingent effect of competitive environment and product characteristics on how firms use IOS in a buyer–supplier relationship context? This study addresses these questions at the dyadic level in an attempt to enhance our understanding of choices a firm makes regarding these systems, their alignment with desired performance outcomes, and their contingent context.

The next section provides the broad background for the study leading up to the research objectives. This is followed by a review of the different thrusts taken in this area by the operations management (OM) and information systems (IS) fields, respectively, and a discussion on the need to integrate them. The research framework, including the hypotheses, is then defined. The research method section describes the process followed in empirically testing the hypotheses. The results of the study and their implications for both research and practice are then described.

GENERAL BACKGROUND AND RESEARCH OBJECTIVES

Effective management of buyer–supplier relationships is an important research domain (Monczka, Trent, & Callahan, 1994; Tan, 2001). Heide (1994) proposes that sourcing from the market is a heterogeneous phenomenon. Building on this thesis, various typologies and taxonomies have been developed over time to categorize buyer–supplier relationships. Lambert, Emmelhainz, and Gardner (1996) propose that relationships with suppliers can range from an arm's length association to complete functional coordination. Similarly, Bensaou (1999) proposes market exchange, captive buyer, captive supplier, and strategic partnerships as distinct types of relationships with varying characteristics. An interesting insight that emerges is the contrasting performance outcomes that firms often aim to achieve from instituting different types of relationships. For example, firms may aspire to enhance their sourcing leverage through accessing detailed information on market prices and exploiting competitive conditions prevalent in the market in which the supplier is operating (Hennart, 1993; Ramsay, 1996; Heriot & Kulkarni, 2001). Alternatively, firms may strive to enhance process efficiencies by forging collaborative relationships through close coupling of processes and extensive information exchange between the firms (Mohr & Spekman, 1994; Monczka, Peterson, Handfield, & Ragatz, 1998).

Transaction cost economics proposes that the decision to adopt a particular relationship configuration depends primarily on cost consideration. Firms sourcing inputs from other firms incur transaction costs, which may relate to search-related costs emanating from exploring the marketplace to identify the best alternative. In the context of enduring relationships, the need for continuous adaptation and evaluation contribute to transaction costs. Different types of relationships also pose varying information processing requirements. For example, in an arm's length association, firms follow the procedure dictated by the standard market transaction. However, pretransaction information processing requirements that involve identifying potential alternatives are relatively high. Similarly, partnership-type relationships require extensive information processing to facilitate mutual adaptations and process synchronization. Firms need to put in place appropriate mechanisms that provide the required information processing capacity for effective market mediation manifested in either building sourcing leverage or enhancing process efficiency.

IOS offer various functionalities that allow firms to achieve these diverse objectives and performance outcomes within the context of different types of buyer–supplier relationships. Cash and Konsynski (1985) define an IOS as "an automated information system shared by two or more companies." In examining the impacts of IOS within a buyer–supplier context, Johnston and Vitale (1988) propose a theoretical framework, which argues that using IOS can provide firms with comparative efficiency and bargaining power. They argue that IOS can support tightly coupled processes between firms. For example, availability of precise and timely information through the IOS can enable production scheduling to be aligned with actual usage rather than sales or shipments. This provides comparative efficiency through lower inventory costs, lower costs of coordination, and shorter, more reliable response times (Bakos & Brynjolfsson, 1993; Clemons, Reddi, & Row, 1993; Dai & Kauffman, 2002). On the other hand, IOS can enable firms to establish one-to-many linkages and enhance sourcing leverage through altering search-related costs (Bakos, 1991; Choudhury, Hartzel, & Konsynski, 1998; Subramaniam & Shaw, 2002). For example, one-to-many links lower the cost of shopping as well as increase the odds of getting the best prices available. Thus, due consideration needs to be given to various facets of IOS that support supply chain strategies of a firm (Dai & Kauffman, 2002). Such an approach is likely to provide a conceptual outline of the various design features that can be incorporated into an IOS. It also allows for a better understanding of how design and use of IOS can impact performance outcomes associated with different types of buyer–supplier relationships, thereby providing prescriptive implications to managers for effective deployment of IOS.

Another important aspect in using IOS is the distinction between those firms that initiate the system (called the "initiators") and those that participate in the system (called the "participants"). Initiators tailor the IOS to their benefit and exert more control over the participants. Research indicates that initiators are the primary beneficiaries of IOS (Webster, 1995; Riggins & Mukhopadhyay, 1999). Thus, it is important to consider initiation issues in evaluating how IOS enable firms to achieve performance outcomes associated with their supply chain strategies (Hwang, Pegel, Rao, & Sethi, 1993). Finally, research indicates that competitive conditions in which a firm is operating and characteristics of the product being manufactured by the firm are two important issues that must be considered within the context of supply chain management (Fisher, 1997; Ramadas & Spekman, 2000). Limited guidance, however, is available on what roles competitive conditions and product characteristics play in a firm's decision to use different facets of IOS to support different types of interfirm relationships.

Based on the above review, this study has three key research objectives:

- To examine the impact of various facets of IOS and initiation of the system on process efficiency and sourcing leverage—the two performance outcomes that firms aim at achieving within the context of better managing their relationships with suppliers.
- To explore differences in the use of IOS between firms operating under different competitive conditions and producing products with different characteristics.
- To provide a broader and more contemporary conceptualization of IOS that focuses on its design elements (which when configured appropriately meet organizational needs), rather than focusing on a specific type of IOS (such as an EDI). Such an approach is also consistent with the emergence of Web-based technologies that provide firms with more options in selecting and configuring systems developed by different vendor companies.

The next section reviews literature in this area in both the OM and IS fields.

MAJOR RESEARCH STREAMS

Research in buyer–supplier relationships and IOS has been addressed from different vantage points in the OM and IS fields. Researchers in the logistics and operations area have focused primarily on buyer–supplier relationships and supply chain issues, with the IOS underemphasized, while the IS literature predominantly focuses on the nature and types of IOS. The theoretical perspectives used also show divergence. IS literature predominantly builds its case on transaction cost economics by asserting that information technology (IT) reduces coordination costs, ultimately resulting in efficiency gains. Game theory, micro-economic theory, and industrial economics lenses have also been employed to examine the electronic marketplace phenomenon. On the other hand, research in operations draws heavily from information economics, strategic management literature, and coordination theory. Even though some recent work has attempted to provide a more integrative view of IOS in a supply chain context (e.g., Premkumar, 2000; Ahmad & Schroeder, 2001; Frohlich & Westbrook, 2002; Hill & Scudder, 2002), the research domains have by and large been disparate.

OM Perspective

Literature in the OM domain expounds on various sourcing strategies available to firms for sourcing inputs and raw materials. Kraljic (1983) offers a classification framework for categorizing sourcing situations and the appropriate sourcing strategy. Landeros and Monczka (1989) propose vertical integration, taper integration (a strategy wherein a firm partly manufactures the product in house and partly buys the same product from outside suppliers), long-term cooperative relationships, and competitive spot bidding as some alternatives that are available to a firm. An important theme that emerges from this work is that for effective management of the supply chain, a firm needs to choose appropriate relationships with suppliers and structure management processes such that they fit the nature of those relationships. For example, in the case of competitive spot bidding, a firm needs to put in place processes that will enable it to scan the market thoroughly and shop around for the best possible price. In contrast, long-term cooperative relationships require coordination mechanisms that can facilitate extensive information sharing to optimize the efficiency of the linkages.

Research in the OM area views IOS as a facilitator of coordination between supply chain partners (Tan, 2001). Edwards, Peters, and Sharman (2001) argue that in order to gain efficiencies, companies need to exchange large amounts of planning and operational data, ranging from information on annual contracts and periodic progress reporting to real-time delivery and invoicing data. IOS, especially supply chain software along with enterprise application integration software (EAI), provide the opportunity to move toward an extended enterprise business model. Frohlich and Westbrook (2002) found that using Web-based technologies to support supply and demand integration enables firms to achieve higher levels of performance. Hill and Scudder (2002) contend that using EDI can facilitate frequent and automatic bidirectional information flows between supply chain partners, thus enhancing degree of coordination between them. They found that the depth of EDI use, captured in terms of the extent of use of 11 different transaction sets, each facilitating different types of information exchange, enables firms to better coordinate activities with their suppliers. In order to gain process efficiencies through collaborative or partnership-like relationships, firms need to expand information flows in the supply chain by instituting IOS that are integrated and facilitate exchange of a comprehensive set of information.

While the major thrust of this work has been on the creation of more efficient supply chains, there is recognition that the notion of fit between the technology and supply chain processes is important to yield better outcomes.

IS Perspective

Transaction cost economics has been the dominant theoretical lens in evaluating the impact of IOS in IS literature. There is considerable agreement among researchers on the role of IOS in reducing coordination costs and transaction risk (Malone, Yates, & Benjamin, 1987; Clemons et al., 1993). However, disagreement exists on the eventual impact. Some researchers argue for a move toward more market-type relationships, while others propose more integrated buyer–supplier relationships (Hess & Kemerer, 1994). Recently, researchers have pointed out that IOS can enable mixed-mode governance structures, which combine the elements of markets and hierarchies (Holland & Lockett, 1997; Kambil, Nunes, & Vitale, 1999). IOS can simultaneously support collaborative relationships and also enable an internalized market by allowing firms to establish one-to-many links to retain competition. For example, integration of systems across organizational boundaries at multiple process and functional levels can result in effective coordination that may allow organizations to increase responsiveness and reduce costs (Holland & Lockett, 1997). On the other hand, an electronic trading system can allow an organization to compare prices and evaluate alternative sources of supply, which may enhance its sourcing leverage (Bakos, 1991). Riggins and Mukopadhyay (1994) describe an automatic vending system for which an important component is a database that contains information on open agreements, quality ratings, and price performance of suppliers. Similarly, Holland and Lockett (1997) provide an example of an IOS whereby a bank closely coordinates links with two banks, but also maintains links with four other banks selected from a large pool of banks. Such a system permits them to check prices and induce competition.

Researchers have presented various classification schemes for categorizing IOS. Choudhury (1997) proposes electronic markets, electronic dyads, and electronic monopolies as three distinct types of IOS that can support different types of buyer–supplier relationships. The differentiating factors among these types of IOS are the number of firms with whom the electronic linkage is established, and the extent to which electronic integration is supported by the IOS. Researchers thus argue that a trade-off exists between electronic brokerage and electronic integration effects that are enabled by IOS. Kambil et al. (1999) argue "to achieve benefits of integration effect, participating companies have to forgo most of the benefits of participating in an open market."

Studies in the EDI domain show that intensity in use of EDI technology (depicted as synchronization of item identification codes and number of processes and functions that are electronically linked between the two firms through EDI) can significantly reduce order-processing costs, improve inventory management, and support just-in-time processes (Mukhopadhyay, Kekre, & Kalathur, 1995; Mukhopadhyay & Kekre, 2002). But when IOS is used to closely couple operations between firms, it raises switching costs from the buyer's perspective and reduces the buyer's sourcing leverage. On the other hand, having electronic linkages with a large set of potential suppliers may enable organizations to enhance their sourcing leverage (Holland & Lockett, 1997). Thus, the extent to which the IOS enables closely coordinated structures between the buyer and the suppliers, and the extent to which it supports electronic linkages with a broad set of suppliers, constitute two facets of IOS that may impact performance differently.

In sum, the main thrust of the IS literature is on characteristics of the IOS and its effect on the nature of the relationship. There is recognition that the way the IOS is implemented could lead to outcomes that involve not only efficiency improvements, but also greater sourcing leverage.

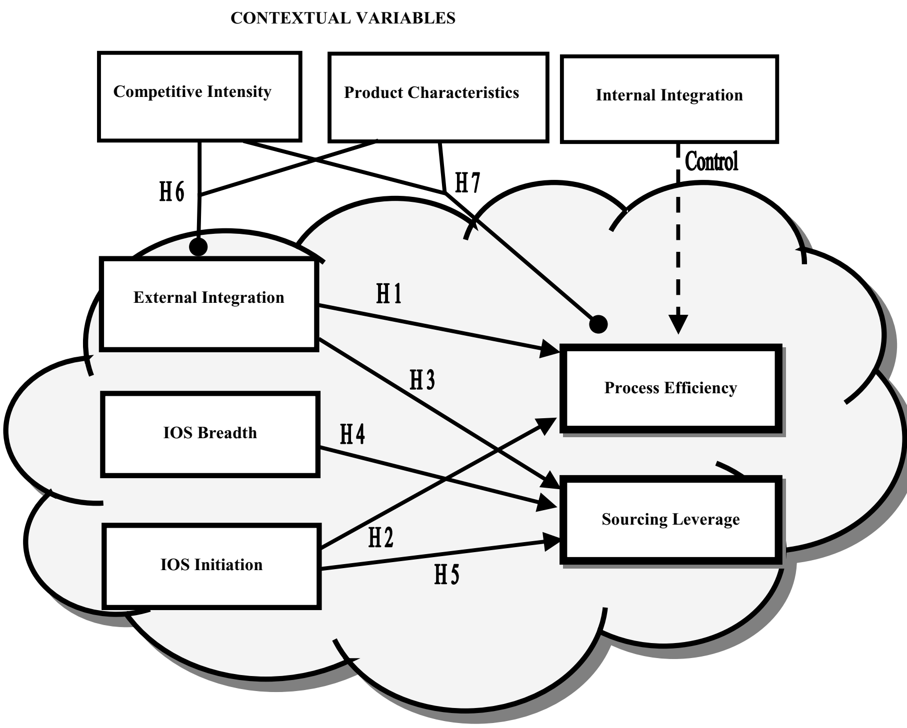
Synthesis of Literature

Both streams reviewed above provide useful insights. The OM literature examines sourcing strategies and the use of better information flows to create more efficient supply chain processes. The IS literature focuses on governance structure and the role and characteristics of the IOS in influencing this structure. Both streams recognize that for effective management of buyer–supplier relationships, firms need to maintain a portfolio of relationships that may have different characteristics and objectives. The two domains are also in agreement regarding the importance of IOS in facilitating collaborative relationships through improved information flows.

The Johnston and Vitale (1988) framework on impact of IOS effectively captures the issues emphasized in both research streams. They contend that leveraging certain functionalities of IOS can enable firms to achieve comparative efficiency and enhance sourcing leverage. One component of comparative efficiency relates to reduction of costs and enhancement in the reliability of boundary spanning processes, and is called process efficiency. IOS that facilitate comprehensive information flows through a system-to-system linkage can reduce inventory costs and provide the benefits of vertical integration (more control, coordination, and lower costs) (Johnston & Vitale, 1988). Sourcing leverage relates to an increase in monopsony power through instant and efficient access to alternative sources of supply. Bakos and Treacy (1986) assert that "in most game theoretic situations, each side can improve its position, that is develop competitive advantage, by increasing the number of alternatives available. This number is limited by the cost of the search process." IOS that facilitate instant access to alternative sources of supply and market intelligence can enable a firm to resolve bargaining situations to its advantage. We draw on the complementary aspects present in the IS and OM literature, and peg it to the Johnston and Vitale (1988) framework to develop our research framework.

Two other facets have also been suggested. First is the notion of system initiation. It has been pointed out that the company that initiates, owns, and controls the IOS may dictate its functioning, which in turn puts the company in a better position to achieve its performance objectives (Webster, 1995). The use of power to coerce a supplier to adopt EDI systems has been well documented (Webster, 1995; Crook & Kumar, 1998; Hart & Saunders, 1998). Thus, in evaluating the performance impact of IOS use, it is important to consider initiation and the hub-and-spoke nature of electronic networks (Riggins & Mukhopadhyay, 1999; Mukhopadhyay & Kekre, 2002). Johnston and Vitale (1988) also indicate that outcomes associated with comparative efficiency and sourcing leverage could be influenced by who initiated the IOS and how that initiation enables a firm to control participation and access to information. The second facet is the context in which the firm operates. Researchers have argued that both the nature of competition in the marketplace, and the types of products manufactured could influence not only the nature of the IOS adopted, but the performance outcomes as well (Grover, 1993; Fisher, 1997; Magretta, 1998; Kumar, 2001).

Figure 1: Research framework.



RESEARCH FRAMEWORK

Figure 1 represents the main research model. Process efficiency and sourcing leverage are the two performance outcomes that firms aim at achieving through instituting different types of relationships with suppliers. In proposing the determinants of performance, researchers have highlighted the importance of IOS functionalities and capabilities and IOS initiation issues (Johnston & Vitale, 1988; Boyette et al., 2002; Hill & Scudder, 2002; Mukhopadhyay & Kekre, 2002). It has also been suggested that the extent to which internal systems of an organization are integrated enables a firm to enhance efficiencies of boundary-spanning activities. A large body of research highlights the beneficial impacts of having internal integration among systems within the organization (Duncan, 1995; Weill & Broadbent, 1999). However, in the interorganizational context, researchers have proposed that internal integration may be an important control variable in order to isolate the performance impacts of IOS (Srinivasan, Kekre, & Mukhopadhyay, 1994) more precisely. In order to enhance model precision, we include the extent to which internal systems of a firm are integrated as a control variable. The two other contingent factors driving our inquiry are the competitive environment in which a firm operates and the type of products it manufactures (Figure 1). Subsequent subsections elaborate on the model variables, their measurement, and the rationale for related hypotheses.

Process Efficiency

Process efficiency is the likely objective in buyer–supplier relationships that entail close coordination between buyers and suppliers. The need for adaptation and synchronization of process in these types of relationships is high. Firms either need to keep buffers or slack resources to compensate for lack of information (which adds to the cost), or develop mechanisms for effective coordination. Transaction cost economics proposes that hierarchy-type structures are cost efficient in high-coordination conditions. Such structures facilitate extensive sharing of information required for effective coordination.

A large body of literature in the IS domain argues that using IOS enables a firm to reduce coordination costs by facilitating explicit coordination (Clemons et al., 1993). IOS reduce costs of communicating and processing information. When information can be readily exchanged and processed, excess capacity or slack resources can be replaced with real-time information that is often much cheaper. Thus, automation of transactions along with visibility into production, scheduling, inventory, and delivery status can lower transactions costs and safety stock requirements, and enhance delivery reliability. Clemons et al. (1993) conclude:

> These technologies permit remote access to partner's databases in support of one's own operations and scheduling; that is, a buyer can verify a supplier's product availability before placing an order for a critical part, or a supplier can verify the customer's demand forecasts and manufacturing scheduling before beginning a large production run.

One aspect within the context of IOS that has received considerable attention is electronic integration. Zaheer and Venkatraman (1994) propose that electronic integration has the characteristics of vertical integration but without ownership. Premkumar (2000) proposes communication, cooperation, and collaboration as three levels of sophistication in IOS use. At the first level, firms just focus on automation of the communication process with minimal attention toward integration of systems. As the firms progress to higher levels of sophistication, they start paying attention to integration of external and internal systems. In addition, the information flows between companies increase to encompass inventory, planning, and scheduling information. Similarly, EDI diversity, depth, penetration, embeddedness, and integration with internal systems of the company have been proposed to contribute toward enhanced performance (Mukopadhyay et al., 1995; Massetti & Zmud, 1996; Chatfield & Yetton, 2000; Truman, 2000; Hill & Scudder, 2002). Establishing integrated EDI links enhances the "procedural specificity" through redesign of processes and establishing unique information exchange routines (Zaheer & Venkataraman, 1994). Mukopadhyay and Kekre (2002) assert:

> The integrated EDI allows the customer production department to directly release electronic orders to PMI without verification. In the absence of integration, the order has to be further verified by the customer procurement department as well as engineering department. The integration also eliminates the need for the order to be printed at PMI and reentered after verification, thus reducing time and errors. Clearly, integration substantially improves the order processing at each end, therefore increasing procedural specificity.

Taken together, these prior conceptualizations of systems integration between buyers and sellers capture the extent of electronic links between various functional units in the two firms, high level of system integration between the firms and with internal systems of the firms, and extensive bidirectional sharing of information on production schedules and inventory levels. We call this overall construct of systems integration between two firms as *external integration* and argue that high levels of external integration will allow a firm to gain process efficiencies in terms of reduced coordination costs, improved inventory management, and reliable lead times (Clemons et al., 1993; Frohlich & Westbrook, 2002). This leads to our first hypothesis.

H1: The extent of external integration is positively related to process efficiency.

Hwang et al. (1993) found that initiators of IOS carefully planned technology, attained higher levels of internal integration, and achieved greater benefits from the electronic network. Webster (1995) provides examples of Fordnet and a British company that mandated the use of EDI systems to their suppliers. By dictating communication protocols, message standards, product coding, and information handling procedures through electronic systems, these companies were able to achieve relatively greater benefits. As a result, the initiating firms may be able to structure the IOS to their advantage to better serve their needs, and thus enhance their process efficiency.

H2: The extent to which the IOS is initiated by the buyer firm is positively related to process efficiency.

Sourcing Leverage

Significant literature highlights the ability of an IOS to establish one-to-many relationships. Establishing electronic linkages with a large number of suppliers may allow a firm to get market intelligence, expand its sourcing leverage, and allow it to negotiate better contracts (Bakos, 1991). It has been pointed out that electronic markets enable many-to-many interactions, thus providing search cost benefits and reduced prices (Choudhury et al., 1998). One-to-many links from a buyer's perspective fulfill a similar purpose. By establishing electronic linkages with the suppliers that constitute its consideration set, the buying firm can create an internalized market in which multiple suppliers can compete for its business. This concept, which we call *IOS breadth*, reflects the second functionality (apart from external integration described above) of the IOS, and refers to the extent to which the IOS can interface with multiple suppliers. It is similar to the EDI breadth dimension proposed by Massetti and Zmud (1996). The IOS breadth functionality can enable a firm to expand the search space and induce competition among a large number of suppliers through the IOS, thereby providing the focal buyer greater sourcing leverage.

Sourcing leverage is important in purchase situations in which the firm needs to compare alterative sources of supply and the offerings of different suppliers. Expanding search space to identify alternatives is constrained by search-related costs, which ultimately limit the sourcing leverage of the firm. Because high search costs enable the sellers to extract extra rent from the buyers by pricing products above marginal costs (Bakos & Tracey, 1986), a firm's ability to scan the market to gather intelligence and identify possible sources of supply through greater IOS breadth can save substantial time and costs. IOS breadth can enable the buyer to explore the market more thoroughly with minimal search costs, constrain the supplier from extracting extra rent, induce competition, and eventually lower purchase prices for the buyer. Thus, the presence of IOS breadth facilitates a greater degree of sourcing leverage, and forms the basis of our third hypothesis.

> *H3: The extent of IOS breadth is positively related to sourcing leverage.*

The relationship between external integration and sourcing leverage seems to have equivocal evidence. Researchers argue that in many industries, firms have coerced their suppliers to establish electronic links or lose business (Webster, 1995). By using IOS to establish closely coordinated processes, these firms were able to get visibility into the suppliers' operations and used it as a bargaining tool (Crook & Kumar, 1998). As more suppliers get electronically linked to the buyer, this can increase the sourcing leverage for the buyer.

On the other hand, it has been argued that closely integrated systems increase switching costs from a buyer's perspective (Johnston & Vitale, 1988). Integrated electronic linkages result in procedural specificity (Mukhopadhyay & Kekre, 2002). Thus, when a firm uses information systems to develop partner-specific processes and information exchange routines, it increases switching costs, which in turn results in reduced sourcing leverage.

We believe that the latter argument will prevail, as there is an inherent trade-off between benefits of electronic integration and those of electronic brokerage (Malone et al., 1987). It is our contention that firms utilizing systems that facilitate external integration will do so to gain the efficiency benefits of integration, and, in the process, will forgo the market-based strategic benefits of sourcing leverage.

> *H4: The extent of external integration is negatively related to sourcing leverage.*

Initiation of the IOS allows a firm to configure its functionalities and features to its advantage (Webster, 1995). Thus, initiator firms have leverage to dictate the network characteristics, which enables them to achieve greater benefits as compared to the follower firms. In those purchase situations where gaining more sourcing leverage may be the dominant performance objective, the initiating firm may be able to structure the IOS to achieve this performance outcome.

> *H5: The extent of IOS initiation is positively related to sourcing leverage.*

Competitive Intensity and Product Characteristics

As previously highlighted, the environment in which a firm operates has been presented as an important determinant of IOS adoption. Researchers argue that by facilitating real-time information access along with automation of business processes, IT systems can enable organizations to respond to dynamic environmental settings (Kambil & Short, 1994). However, little research has focused on how use of IOS differs among organizations faced with different levels of competitive intensity. Research in the IOS adoption domain concludes that firms faced with high competitive pressures are more likely to adopt EDI systems (Grover, 1993; Premkumar, Ramamurthy, & Sree, 1994). It has also been shown that EDI systems, which increase efficiencies within the industry, can provide an effective response to the competitive environment (Chwelos, Benbasat, & Dexter, 2001). Based on this presumption, it can be argued that external integration (mechanism for creating efficient processes) and process efficiency will vary across firms operating under different levels of competitive intensity.

Product characteristics impact the type of buyer–supplier relationships, procurement processes, and supply chain management practices. Fisher (1997) proposes that firms can produce functional products or innovative products and that different supply chain strategies and designs are appropriate in each condition. Another categorization often is made between firms producing standardized products versus customized products (Safizadeh, Ritzman, & Mallick, 2000). We follow this approach and argue that product characteristics are likely to play a role in a firm's supply chain strategy and operationalization of IOS. Kumar (2001) argues that current uses of IOS within a supply chain context mainly support optimization of the supply chain. Optimization works best in relatively static supply chains that have a stable set of supply chain partners and standardized products. Firms operating in such stable conditions and producing standardized products may reap greater benefits by using IOS to closely couple operations with a stable set of suppliers. This can allow firms to collaborate on planning, forecasting, scheduling, and applying various optimization techniques that use historical data. More formal relationships aimed at maximizing process efficiencies can be sustained with the vendors. Customized products, on the other hand, are subject to changing customer preferences. There is minimal historical data available for planning. Even the requirements placed on the buying and manufacturing functions shift rapidly over time. Moreover, Kumar (2001) contends that "in demand-driven networks temporary supply chains emerge, operate for the lifespan of the market opportunity, and then dissolve again." So, under these conditions, using the IOS to closely couple processes may not be appropriate (Moshowitz, 1997). Thus, it can be argued that firms producing different types of products may show divergence in using IOS as well as its outcome—process efficiency.

Typically, firms making standardized products will be operating in mature industry segments in which pressure on profit margins is strong and competitive intensity is high. In contrast, customized products will be made in an environment of low competitive intensity because there are few players in the market who compete on the basis of innovation and product variety. These environmental combinations on product type and competitive intensity are used to examine the joint impact of competitive intensity and product characteristics on desired IOS features. However, given the lack of prior theoretical bases for examining this issue, we do not presuppose directionality and only argue that external integration and process efficiency will be different across firms facing varying levels of competitive intensity and producing products with different characteristics.

H6: There will be a difference in the level of external integration between firms operating under conditions of high competitive intensity and producing standardized products as compared to *firms operating under conditions of low competitive intensity and producing customized products.*

H7: There will be a difference in process efficiency between firms operating under conditions of high competitive intensity and producing standardized products as compared to firms operating under conditions of low competitive intensity and producing customized products.

RESEARCH METHOD

Survey methodology was chosen given the context of the study. The data were collected from manufacturing firms on organizational-level variables, as well as on the characteristics of the IOS that support their interaction with the suppliers. This information relates to the dyadic linkages established between the firms and their suppliers. Subsequent methodological issues related to construct measurement, data collection, and construct validity are discussed next.

Measurement

Table 1 shows the operationalization and measurement of various constructs represented in our research framework (Figure 1). With respect to dependent variables, we are interested in measuring two aspects of performance. First, *process efficiency* was evaluated by asking respondents to rate the extent to which electronic linkages allowed the firm to reduce transaction costs, inventory costs, and uncertainty in lead times (Mukopadhyay et al., 1995; Narasimhan & Das, 1999; Frohlich & Westbrook, 2001; Frohlich & Westbrook, 2002). Improvements in process efficiency would tend to reduce manufacturing costs and thus flow directly to the bottom line. Second, *sourcing leverage* was measured by asking the respondents to rate the extent to which electronic linkages enabled the firm to get leverage over the firm's suppliers, explore alternative sources of supply, and search for alternative products. (Johnston & Vitale, 1988; Choudhury et al., 1998). The items for these two measures were adapted from the work of Mahmood and Soon (1991), Mukhopadhyay et al. (1995), Choudhury et al. (1998), and Narasimhan and Das (1999).

Extent of systems integration, bidirectional information flows, and electronic linking of various business functions captured *external integration* and its various aspects. It was measured by asking the respondents during our empirical data collection to classify their existing electronic linkages into four progressive stages (Figure 2). Building on previous conceptualizations, we have captured increasing levels of unidirectional and bidirectional information flows. The arrows in Figure 2 capture electronic linkages between various business functions in the firms (Massetti & Zmud, 1996; Chatfield & Yetton, 2000) as well as bidirectional information flow of different types of information between the firms (Massetti & Zmud, 1996; Chatfield & Yetton, 2000; Truman, 2000; Hill & Scudder, 2002). At Stage 1, the buyer firm transmits orders or requests prices. At Stage 2, the vendor can electronically transmit back inventory status and order completion status and provide feedback on price checks. However, at both levels, only the purchasing function of the buyer firm is interacting with the supplier. The combination

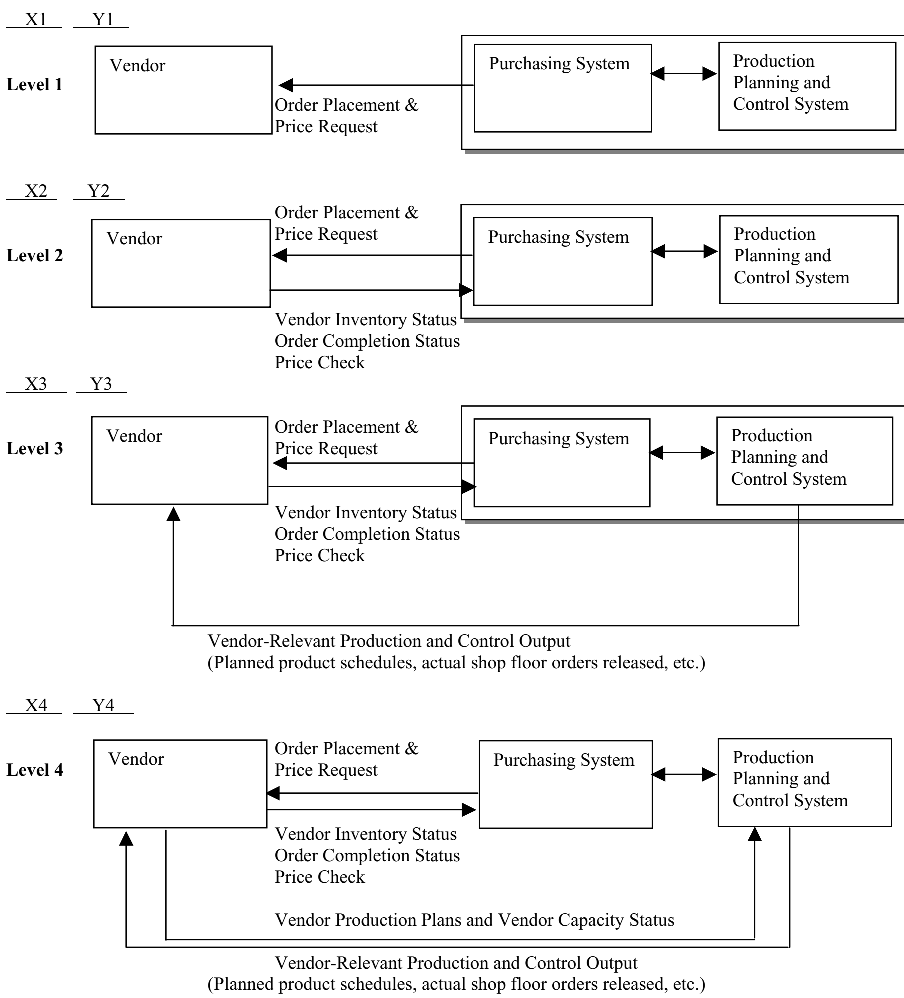
Table 1: Construct operationalization and measurement.

Variables	Operationalization	Source
External Integration Level 1 (EI-L1)	$((X1 + Y1)/(X1 + X2 + X3 + X4 + Y1 + Y2 + Y3 + Y4))^{*}\ 1 + ((X2 + Y2) / (X1 + X2 + X3 + X4 + Y1 + Y2 + Y3 + Y4))^{*}\ 2)$ (see Figure 2)	Objective
External Integration Level 2 (EI-L2)	$((X3 + Y3)/(X1 + X2 + X3 + X4 + Y1 + Y2 + Y3 + Y4))^{*}\ 3) + ((X4 + Y4) / (X1 + X2 + X3 + X4 + Y1 + Y2 + Y3 + Y4))^{*}\ 4)$ (see Figure 2)	Objective
IOS Breadth (IOB)	Number of suppliers with whom the firm has electronic linkages/Total number of suppliers with whom the firm routinely interacts	Objective
IOS Initiation (IOI)	Number of electronic links initiated by the firm/The total number of electronic links the firm has established $(X1 + X2 + X3 + X4)/(X1 + X2 + X3 + X4 + Y1 + Y2 + Y3 + Y4)$	Objective
Internal Integration (II)	• We encourage sharing of databases across functional areas of the firm. • We have extensive networking facilities within our firm.	Duncan (1995) Truman (2000)
Process Efficiency (PE)	• Electronic linkages with vendors reduce transaction costs for our firm. • Electronic linkages with vendors reduce inventory costs by facilitating inventory replenishment process. • Electronic linkages with vendors reduce uncertainty in leadtime.	Mahmood and Soon (1991) Narasimhan and Das (1999) Mukhopadhyay et al. (1995)
Sourcing Leverage (SL)	• Electronic linkages with vendors help our firm gain leverage over our vendors. • Electronic linkages with vendors help our firm identify alternate sources. • Electronic linkages with vendors help our firm locate alternative products/services.	Mahmood and Soon (1991) Johnston and Vitale (1988) Choudhury et al. (1998)
Competitive Intensity (CI)	• Firms in our industry spend more of each sales dollar on marketing due to increased competition. • Firms in our industry aggressively fight to hold on to share of the market. • Competition in our industry is intense.	Boulding and Staelin (1990) Grover (1993)
Product Characteristics (PC)	Production in your firm can be best characterized as: Standard Products (1) 2 Standard products (3) 4 modified to customer specification (5) 6 Customized products (7) Standard Products · Standard products · modified to customer specification · Customized products 1 2 3 4 5 6 7	Safizadeh et al. (2000)

Note: II, PE, SL, CI, and PC were all measured using a Likert scale (1–7).

Figure 2: External integration of interorganizational systems.

The following levels describe different electronic linkages that your firm may have with your suppliers. Examples of the direction and type of information flows that can exist along the linkages are also illustrated within each level. Please estimate below in column X the number of vendors with whom such links have been initiated by your firm, and in column Y the number of vendors with whom links have been initiated by the vendor.



of these two stages represents an electronic ordering system or an electronic procurement system that automates the ordering process. We call the combination of Stage 1 and Stage 2 External Integration Level 1, that is, representative of the procurement process between the buyer and supplier firms.

At Stages 3 and 4, the planning function also gets involved. Information related to plans and schedules is exchanged between the supply chain members, first in one direction (Stage 3) and eventually in both directions (Stage 4). Aggregation of Stages 3 and 4 provides better information for closed-loop planning (e.g., Orlicky & Plossl, 1994) for the buying firm, enables production plans and schedules of the two firms to mesh well with each other, and facilitates implementation of manufacturing resource planning (MRP) II systems. The MRP II systems and advanced planning systems (APS) offered by software vendors implement this configuration, which we call External Integration Level 2.

The distinction between Level 1 and Level 2 external integration represents a transition for the buying firms from using procurement systems to employing more sophisticated and enterprise-wide APS. Also, Level 1 and Level 2 external integration corresponds to actual procurement systems, ordering systems, MRP II systems, and APS that are available in the marketplace from different software vendors. Specifically, the base ordering systems offered by I2 and Manugistics include order queries and processing and inventory checks. Additional modules can be added to facilitate exchange of information necessary for forecasting, capacity planning, inventory, and replenishment. Shah, Meyers, and Ward (2002) and Riggins and Mukhopadhyay (1994) have also used level-based approaches for capturing integration. Shah et al. (2002) used a three-level approach wherein they included an IOS capable of only supporting procurement activities in Level 1. IOS classified as Level 2 incorporated shared ordering and scheduling systems, while completely integrated systems were categorized as Level 3. Similarity to existing systems available in the marketplace, along with evidence that prior studies have also used a similar approach, were the main rationales for collapsing the four stages into two levels.

A score for each firm was computed based on its response, whereby higher stages of integration were progressively assigned higher weights. Subsequently, Stages 1 and 2 were aggregated to represent External Integration Level 1, and Stages 3 and 4 were combined to capture External Integration Level 2. Table 1 illustrates the actual computation for each level in greater detail.

IOS breadth was measured in our study as the number of suppliers with which the firm has existing electronic linkages, divided by the total number of suppliers with which the firm may routinely interact. Here the main objective was to capture the potential consideration set the firm uses when making sourcing decisions, and within this set, to see how many vendors have established electronic links with the firm. This measurement approach has been suggested or used in other studies as well (Jelassi & Figon, 1994; Massetti & Zmud, 1996; Mendelson & Pillai, 1998).

IOS initiation was evaluated as the number of electronic linkages initiated by the firm, divided by the total number of electronic linkages that a firm has established. Previous conceptualization has mostly investigated this issue as a dichotomous variable. In our case, firms were involved in both self-initiated systems and systems initiated by their suppliers. Thus, the proportion approach was deemed as more appropriate, because it reflects the firm as the focal unit of analysis.

The extent to which information systems internal to the firm are integrated captures *internal integration*. This is similar to the concept of internally integrated supply chain. It goes beyond context-specific conceptualization (Truman, 2000), and captures the extent to which the firm has network facilities to boost connectivity, and the extent to which sharing of databases across functional areas is enabled within the firm.

Competitive intensity was measured in terms of the intensity of rivalry among firms in the industry and employed the scale used by Boulding and Staelin (1990). Competitive rivalry depicts the extent of brand switching, level of market growth, variance in the size of competition, number of players in the industry, frequency of introduction of new products, and level of exit costs (Boulding & Staelin, 1990; Grover, 1993). We measured competitive intensity as the extent to which the firm perceives its competition to be intense and the extent to which it competes to retain its market share. The main objective in using this measurement approach was to focus on the extent to which the firm is pressured by its environmental conditions to be efficient.

The type of product being produced by the company was used to capture *product characteristics*. The single-item scale ranged from manufacturing standard products at one end to manufacturing customized products at the other. This scheme is consistent with the product-process matrix paradigm prevalent in OM literature. In addition, Safizadeh et al. (2000) have also used a similar approach in their study to measure the extent of product standardization or customization.

Data Sources and Method

Standard and Poor's Corporation Description (Standard and Poor's Corporation, 1999) was used to select vice presidents of manufacturing or operations as key target respondents for the study. The main reason for their selection is based on their position in the organization and knowledge of issues related to coordination with the suppliers, and the use of information technology in managing their supplier relationships.

Manufacturing firms in the rubber, plastics, and metal fabrication industries constituted our sample frame. Only companies with sales of $50 million or higher were included in the sample in order to ensure that firms of sufficient size that were likely users of an IOS system were considered. Lists of firms in the Standard Industrial Classifications (SIC) 30 (rubber and plastics) and 34 (metal products) were obtained from the Harris manufacturers directory (Dun & Bradstreet Inc., 2002). A total of 600 firms were randomly selected for large-scale data collection. In the first round of mailings, a survey questionnaire was mailed to these 600 companies; 11 questionnaires were returned due to address changes. After a few weeks, follow-up telephone calls were made to a random sample of non-respondents. In the second round, 111 additional questionnaires were mailed to companies randomly selected within the same sample frame. From a total of 700 questionnaires thus mailed, 110 were completed and returned, thereby providing a response rate of approximately 16%. Out of these 110 responses, 39 companies had established electronic links with their suppliers (one firm was dropped later due to incomplete information). While small, an IOS adoption rate of 35% (39/110) represented in our sample is typically representative of the adoption rate of IOS systems reported in other studies (Chwelos et al., 2001).

Previous research suggests that one way to test for non-response bias is to compare early and late respondents (Newman, 1962). Tests conducted to compare study variables between early and late respondents showed only internal integration

Table 2: Sample characteristics.

Sales Range ($ in Millions)	Number of Companies
50–100	5
101–250	12
251–500	6
501–1,000	2
1,001–2,000	6
>2,000	6
Missing	1
Total	38

($p = .008$) to be significantly different. It has also been suggested that late and non-respondents show similar characteristics (Newman, 1962). Tests showed no significant difference in sales volume ($p = .22$) between early and late respondents, thereby confirming to a certain extent that non-response bias was not an issue in our sample. Data from the 38 companies that had established electronic linkages were used for testing the research framework. The sales profile of the sample firms is shown in Table 2.

Construct Reliability and Validity

As described previously, some constructs were measured using objective data, while measures for other constructs were adapted from previous studies. Table 3 shows the mean values and standard deviations of all the variables and performance measures, while Table 4 presents the reliability and first-order correlations among the variables. Cronbach α values were found to be within the acceptable range. Data were also tested for conformance to conducting ordinary least squares regression. We found no outlying observations, no multicollinearity among the variables, and no violation of the assumption about constant variance of error terms (Neter, Kutner, Nachtsheim, & Wasserman, 1990).

Table 3: Descriptive statistics.

Variable	Mean	Standard Deviation
External Integration Level 1	.89	.61
External Integration Level 2	.79	1.25
IOS Breadth	.12	.09
IOS Initiation	.75	.34
Internal Integration	5.04	1.43
Process Efficiency	5.38	1.26
Sourcing Leverage	3.42	1.14
Competitive Intensity	5.34	1.04
Product Characteristics	4.36	1.87

Table 4: Correlation matrix.

Variable	Reliability Cronbach's α	External Integration Level 1	External Integration Level 2	IOS Breadth	Internal Integration	IOS Initiation	Process Efficiency	Sourcing Leverage
Competitive Intensity	.75							
External Integration Level 1	Objective Data	1						
External Integration Level 2	Objective Data	$-.52^{**a}$	1					
IOS Breadth	Objective Data	−.21	.12	1				
Internal Integration	.72 (Correlation)	.17	.24	.25	1			
IOS Initiation	Objective Data	.30	−.01	.26	.18	1		
Process Efficiency	.88	−.08	.38*	.18	.31*	.55**	1	
Sourcing Leverage	.82	−.01	−.08	.56**	.24	.41**	.47**	1

$^{*}p < .05$; $^{**}p < .01$.

[a]It is logical to expect that Level 1 and Level 2 integration should be positively related with each other. However, when capturing Level 1 and Level 2 integration, an effort was made to make them mutually exclusive and thus avoid double counting. Even though, in theory, a higher level of integration should subsume a lower level of integration, in this study this was not the case due to the measurement approach used. Table 1 also shows that a firm's electronic linkages could be categorized at either Level 1 or Level 2. If a firm had all the electronic linkages at Level 2, it received a score of 0 for Level 1, even though Level 2 subsumes Level 1. This was done to keep the integration levels distinct so that their impact could be effectively delineated and measured separately.

Table 5 provides the results for exploratory factor analysis with Varimax rotation for those variables that were measured by multi-item scales. Distinct factors pertaining to competitive intensity, internal integration, process efficiency, and sourcing leverage were obtained with little evidence of cross-loading. One measurement item capturing sourcing leverage cross-loaded on internal integration (Table 5). Cross-loadings raise issues regarding discriminant validity. However, these constructs are conceptually distinct; one is an antecedent, while the other is a dependent variable. This minimizes the seriousness of the problem as compared to cross-loadings between items that constitute only independent variables. The results show that the scales displayed acceptable levels of convergent validity (high items loading on the construct) and reliability.

RESULTS

Three models were specified in order to test the hypotheses. These models use regression analysis, clustering, and use of non-parametric tests. Models 1 and 2 are used to test *H1–H5*, while Model 3 tests *H6* and *H7*.

Proposed Research Models

Model 1

$$PE = \beta_0 + \beta_1 EI(L1) + \beta_2 EI(L2) + +\beta_3 IOI + \beta_4 II + \varepsilon$$

Model 2

$$SL = \beta_0 + \beta_1 EI(L1) + \beta_2 EI(L2) + \beta_3 IOB + \beta_4 IOI + \varepsilon$$

where *PE* = Process Efficiency, *SL* = Sourcing Leverage, *II* = Internal Integration, *EI* (*L1*) (*L2*) = External Integration, *IOB* = IOS Breadth, and *IOI* = IOS Initiation.

Table 5: Factor analysis.

Item	Internal Integration	Process Efficiency	Sourcing Leverage	Competitive Intensity
II 1	**.95**	.08	.04	.08
II 2	**.91**	.27	.18	−.07
PF 1	.12	**.87**	.19	.15
PF 2	.20	**.90**	−.01	.23
PF 3	.19	**.85**	.08	.13
SL 1	.40	−.13	**.60**	−.02
SL 2	.13	.13	**.92**	.14
SL 3	.06	.11	**.94**	.03
CI 1	−.07	.04	.004	**.76**
CI 2	.11	.07	.31	**.80**
CI 3	.50	.08	.05	**.64**
Variance Explained	18%	29%	20%	16%

Note: Total variance explained 83% and eigen value = 1.07.

Table 6: Cluster solution means.

Groups/Variables	Competitive Intensity	Product Characteristics
Group 1 ($N = 17$)	4.88	6
Group 2 ($N = 21$)	5.94	2
t-Test Sig. Level	.012	.000

Model 3

To test for differences in external integration and process efficiency between organizations facing varying conditions of competitive intensity and product characteristics, the sample was segmented into groups. Cluster analysis was used for identification of group membership. The driving factor in using cluster analysis was to identify groups that would be as heterogeneous as possible in terms of competitive intensity and product characteristics. Once distinct groups were identified, we could then test for differences between the groups on variables of interest (i.e., external integration and process efficiency). First, hierarchical cluster analysis was used to identify the number of groups. The solution based on Ward's method (Sharma, 1996) suggested a two-group solution to be appropriate (Table 6). The results were compared to the group assignments obtained through non-hierarchical clustering. The comparison between the group assignments suggested by the two procedures revealed a 93% agreement on group membership. Due to small sample size within each group, we used the Mann Whitney test (Conover, 1999) (a non-parametric test) to test for differences. Conover (1999) argues that the asymptotic relative efficiency of the Mann Whitney test is never bad as compared to the two-sample t test. Thus, the Mann-Whitney test is more reliable.

Model Results

Model 1 focuses on evaluating the impact of IOS facets on process efficiency. Table 7 provides the results for Model 1. The results show support for the positive influence of External Integration Level 2 ($p = .008$) and IOS initiation ($p < .005$)

Table 7: Results for Model 1 (process efficiency).

Variable	Stage 1	Stage 2
Internal Integration	.205	−.012
	(.112)	(.439)
External Integration Level 1		.107
		(.292)
External Integration Level 2		.477**
		(.008)
IOS Ownership		.508**
		(.005)
R^2	(.042)	(.365)
Change in R^2		.323
F Value		5.248**

*$p < .05$; **$p < .01$.

Table 8: Results for Model 2 (sourcing leverage).

Variable	Stage 1	Stage 2
External Integration Level 1	−.070	−.12
	(.36)	(.26)
External Integration Level 2	−.111	−.19
	(.29)	(.13)
IOS Breadth		.50**
		(.001)
IOS Ownership		.34*
		(.017)
R^2	(.007)	(.387)
Change in R^2		.380
F Value		6.742**

*$p < .05$; **$p < .01$.

on process efficiency, thus supporting *H2* and partially supporting *H1* after accounting for the variance explained by internal integration. Model 2 investigates the impact of IOS characteristics on sourcing leverage (Table 8). The results show significant relationship between IOS breadth and sourcing leverage ($p < .001$), and IOS initiation and sourcing leverage ($p = .017$), thus supporting *H4* and *H5*. The relationship between external integration and sourcing leverage, although negative, is not significant. Thus, *H3* was not supported. Overall, the results point toward differential impact of IOS facets on performance. In addition, if the firm initiated the electronic links, it is able not only to enhance process efficiency but also to increase sourcing leverage. The results of the regression analysis show that R^2 for the two models is .365 and .387, respectively, which falls in the medium-size effect. The observed power for the overall regression analysis is computed at .90 and .91, above the recommended guideline of .80 (Cohen, 1988).

Model 3 examines differences in external integration and process efficiency between groups facing different levels of competitive intensity and producing products with different characteristics (Table 9). Group 1 contains firms operating

Table 9: Results for Model 3 (competitive intensity and product characteristics) (the Mann-Whitney test).

Groups/ Variables	External Integration Level 1	External Integration Level 2	Process Efficiency
Standard Products/High Competitive Intensity ($N = 17$)	19.24	25.09	25.59
Customized Products/Low Competitive Intensity ($N = 21$)	19.71	14.98	15.57
Mann-Whitney Test $\sim Z$ (*p* value)	−.134	−2.805	−2.340
	(.908)	(.005)	(.009)

in high competitive intensity environments and producing standardized products. Group 2 includes companies operating in low competitive intensity conditions and producing customized products. The results for external integration use show that Group 1 had significantly higher External Integration Level 2 and process efficiency than Group 2. However, the difference in External Integration Level 1 was not significant.

DISCUSSION

IOS are becoming a dominant technology that impacts the management and execution of boundary-spanning activities that firms undertake to manage relationships with suppliers. Our study proposes that the various facets of IOS need to be taken into consideration when exploring these impacts. The study found that the level of external integration is an important determinant of process efficiency. However, it is evident from the analysis that a firm needs more than a traditional ordering system or a procurement system to enhance efficiency. An integrated IOS that not only automates the ordering process but also enables the firms to undertake joint planning and forecasting is pivotal for gaining efficiency benefits.

This logic is also supported by research in the supply chain area, in which researchers have consistently found that *extensive* sharing of information enhances performance (Cachon & Fisher, 2000; Krajewski & Wei, 2000). Cachon and Fisher (2000) argue that within a supply chain context, open information exchange policy can allow organizations to reduce batch sizes and also reduce lead times for material flows. Increasing the information exchange between buyers and suppliers on multiple levels such as planning, ordering, and inventories can result in significant process improvements. Thus, external integration at a higher level can support better management of collaborative relationships and enable firms to achieve higher efficiency. However, external integration was not related to sourcing leverage, whereas a negative relationship was predicted. A plausible reason for such a finding could be due to two countervailing forces at work. On one hand, integration as argued earlier may increase switching costs, thereby reducing sourcing leverage for the buyer. On the other hand, powerful buyers who drive integration may increase information visibility and compel suppliers to change their processes and information-sharing routines. This could in turn increase sourcing leverage for the buyer. The positive correlation between process efficiency and sourcing leverage (Table 4) may indicate support for this perspective. While our data do not have the granularity to separate these effects, the dyadic power structure could affect this relationship.

Results show a positive association between IOS breadth and sourcing leverage. Establishing links with a large number of potential suppliers allows a firm to gather market intelligence and explore alternative sources of supply (Bakos, 1991; Choudhury et al., 1998). The predominant impact of this facet of IOS, therefore, is on search-related activities that enable a firm to expand the alternatives that are considered and enhance sourcing leverage. These results support the brokerage effect of IOS. The significant results for IOS initiation are in line with previous studies. As an initiator of the IOS, the firm has control over the design of the system. Hwang et al. (1993) found that initiators carefully planned the IOS and, therefore, were able to achieve greater benefits. Thus, structuring of the system by implementing functionalities may enable firms to enhance both process efficiencies and sourcing leverage over the suppliers.

Due to increases in outsourcing activity in recent years, firms are relatively more dependent on their suppliers. Performance in terms of cost, quality, and customer responsiveness to some extent depends on the supplier base of a firm. Within this context, results for the joint role of competitive intensity and product standardization on IOS use (to support supply chain management activities) portray an interesting picture. As shown in Table 9, we found that Group 1 (standard product/high competitive intensity) gained significantly higher process efficiencies and also depicted higher levels of external integration as compared to Group 2 (customized products/low competitive intensity). Firms operating in highly competitive environments and producing standardized products need to consistently focus on process improvements to reduce costs and stay competitive. A plausible approach in such conditions is to closely integrate activities with the supplier base (Zhu & Kraemer, 2002). This constitutes an effective interorganizational structural response to reducing slack in the supply chain.

Firms in Group 1 have more to gain from sharing planning, scheduling, and inventory information with the suppliers. For example, the link between Wal-Mart and Warner-Lambert for a product such as Listerine provides an illustration in this regard (Bresnahan, 1998; Manugistics Inc., 2003). Both companies extensively use information technology in managing this relationship and thereby gain process efficiencies.

The case of DDM plastics, a company producing bumpers and instrumental panels for automotives, provides further insights into the results. The company was founded in 1989 in Ontario, Canada and employs 600 employees (Agilisys Inc., 2000). DDM produces relatively standardized products and operates in a highly competitive environment. These conditions pose consistent pressure on margins. On the other hand, producing standard products means that plans and forecasts are relatively accurate. Thus, DDM provides a good case in which a supply chain optimization approach can lead to process efficiencies.

DDM identified that it had to keep a high level of safety stock due to lack of information sharing with the suppliers. In addition, data accuracy was severely compromised due to manual exchange of documents and reentry of data. This also led to lack of trust on information residing in the internal system and redundant coordination through exchange of faxes between DDM and its suppliers. The company realized that efficiency gains could be achieved by using IOS to support collaborative practices with the suppliers. In 1999, the company introduced a system called SupplyWEB. It was an Internet-based system that was managed by the company and totally integrated with its enterprise resource planning (ERP) system. The suppliers could access the SupplyWEB through a standard Web browser. The system enabled the suppliers to access planning information, purchasing information, material releases, in-transit information, cumulative receipt information, defective part notices, purchase part approval status, Kanban pull signal, and shipment history. The system also enabled the suppliers to send corrective action plans, shipment information, and advanced shipment notices. Integration between SupplyWEB and DDM's ERP system allowed automatic data exchange between the two systems. The reduction in data entry errors and automation of the purchasing processes allowed DDM to significantly reduce transactions costs. The high level of information sharing allowed DDM to lower its inventory levels and also reduce uncertainty in lead times. For example, advanced shipment notices (ASN) sent by the suppliers alerted DDM regarding which order would arrive at what time. Once the order arrived, bar codes were scanned and that information was automatically matched with the ASN. Thus, SupplyWEB enabled DDM to optimize supply chain processes through supporting collaborative practices with its suppliers. DDM has plans to add additional functionalities that would allow the company to share other critical information with its suppliers.

CONTRIBUTIONS TO PRACTICE AND RESEARCH

Our study shows that higher levels of external integration and IOS initiation significantly contribute toward enhancing process efficiencies, while IOS breadth and IOS initiation allow firms to gain sourcing leverage over their suppliers. Firms can squeeze out slack from the dyadic linkage by increasing the intensity of interaction and bidirectional information flows through external integration. Higher levels of IOS breadth may enable firms to gather market intelligence and compare different options and thus gain sourcing leverage. We also provide evidence that firms producing standardized products and facing a highly competitive environment can gain process efficiency by using IOS with higher levels of external integration, while merely linking at a lower level through simple procurement systems will not suffice in meeting the stated objective. Cumulatively, the results support our hypotheses that various facets of IOS allow firms to achieve different performance objectives related to buyer–supplier relationships. Managers need to carefully consider the underlying objectives they intend to achieve by employing various facets of IOS to support relationships with their suppliers.

It has been argued that using IOS to institute multiple trading mechanisms may allow organizations to quickly tailor systems to their transactional needs (Kambil et al., 1999). This is a complex issue. Firms may be able to increase sourcing leverage by electronically linking with potential suppliers to gain market intelligence. However, process improvements can be achieved only if sufficient depth in electronic links is established through integrated systems that support extensive information flows. Recommendations offered here can assist managers in recognizing the various facets of IOS and making appropriate decisions regarding the adoption and use of IOS that offer different functionalities.

While the results of our study point toward the heterogeneity in IOS use, generalization of these findings outside the industries represented in the sample frame should be done cautiously. Researchers investigating adoption and impact of IOS also need to broaden their conceptualization of IOS to include a much broader repertoire of the latest Web-based procurement systems and supplier relationship management systems. This will not only enrich our understanding of various facets of IOS, but also will lead to more specific insights and prescriptive implications. For example, the study by Hart and Saunders (1998) investigated two facets of EDI use, and found that different factors affect each facet. Similarly, researchers endeavoring to explore adoption and impact of Web-based procurement systems need to give due consideration to the functionalities of such systems. In addition, future studies can build on this work by exploring the differences between IOS use and their impacts based on Fine's (1998) notion of environmental dynamism called clockspeed and Fisher's (1997) categorization of functional versus innovative products. Another interesting issue that can be addressed is to simultaneously explore the performance impact of information systems and organizational based mechanisms, and determine whether one substitutes for or synergistically reinforces the other. [Received: August 2003. Accepted: March 2005.]

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