The role of Information Technology in Supply Chain Integration

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Abstract

Outsourcing has increasingly been recognized as a source of great competitive advantage. By moving away from vertical integration and towards outsourcing, firms face a new challenge in integrating the various activities of the supply chain. The advent of novel information technologies, however, has made the integration of supply chain activities more manageable. In this study, we evaluate the effects of the usage of different information technologies on supplier and logistics integration in supply chains. A cross-sectional mail survey of ISM members in the United States was utilized to collect empirical data. ANOVA analysis was conducted to delineate the differences in the integration constructs across different levels of information technology usage. The results provide empirical evidence supporting the fact that information technology engenders supplier as well as logistics integration.

1. Introduction

Supply chain management (SCM), an integrated approach to the planning and control of materials, services, and information flows from suppliers through factories to the end-customer, represents one of the most significant paradigm shifts of modern business management; it recognizes that individual businesses no longer compete as solely autonomous units, but rather as supply chains (Chen and Paulraj, 2004a). Today, outsourcing of materials, services, and components to external suppliers is increasingly seen as a source of competitive advantage for firms. Through strategic collaboration, suppliers can have a direct and profound impact on cost, quality, delivery and responsiveness of buying firms.

Recent advances in communication and information technology (IT) have provided firms with an opportunity for significant savings in costs by coordinating the planning of various stages of supply chain management (Peters 1992). The results of these advanced technologies have made today's supply chains more dynamic and flexible. More than ever before, information technology (IT) is permeating the supply chain at every point, transforming the way exchange-related activities are performed (Palmer and Griffith, 1998). Ideally, the goal of these systems is to replace inventory with perfect information, which equates to zero transaction cost as indicated in neoclassical economics (North, 1990).

According to the resource-based view (RBV), competitive advantage is largely derived from idiosyncratic resources/capabilities that are not readily replicable by other firms (Barney, 1991). Since IT is readily available in the software and hardware markets, however, firms cannot expect it to produce sustainable competitive advantage on its own (Powell and Dent-Micallef, 1997). Overshadowing this less optimistic view and further supporting the strategic importance of IT, the "strategic necessity" perspective, with its origin in RBV, provides a solid theoretical foundation for realizing conditions under which IT can foster competitive advantage (Clemens and Row, 1991). This novel perspective proposes that information technology provides value to the firm by (1) increasing external coordination efficiency, (2) leveraging relational intangible resources, and ultimately (3) producing sustainable competitive advantage (Clemens and Row, 1991; Kettinger et al., 1994).

Grounded on this strategic necessity perspective, we set forth to empirically investigate the relationship between the usage of information technology and the integration of exchange-related supply chain activities. We believe that such an investigation will go a long way in addressing concerns over the strategic importance of information technology and its contribution to the firm's competitive advantage. Specifically, it will enable us to address the extent to which information technology fosters the integration of supply chain activities, including supplier and logistics integration, two most important types of integration in supply chain management (Chen and Paulraj, 2004b).

The rest of this paper is structured as follows. In section 2, we develop a synthesis of the literature to provide a conceptual foundation for our study. Then, we develop the logic of the substantive relationships among the study variables and state hypotheses. In section 3, we explain the research methodology and analysis, including the data collection procedure and measurement instrument development. Section 4 presents results of the hypotheses testing, discussion and implications of the study findings. In the concluding section, we highlight limitations of the study along with suggestions for future research.

2. Literature Review

2.1 Supply Chain Information Technology

Inter-organizational systems are information and communication technology-based systems that transcend legal enterprise boundaries (Bakos 1991, Konsynski 1993). Research has shown information technology to be an effective means of promoting collaboration between collections of firms, such as groups of suppliers and customers organized into networks. Effective coordination of supply chain activities, by means of excellent information technology processes, has recently been identified as essential to organizational performance (Lewis & Talalayevsky, 1997). One of the primary goals of these systems is to replace inventory with perfect information. For example, Xerox provides master production schedules (MPS) online to suppliers to facilitate just-in-time delivery, leading to reduced inventory costs and improved buyer-supplier relationships (Powell and Dent-Micallef, 1997).

Inter-organizational information systems may be simple electronic data interchange (EDI) systems for exchanging data such as purchase orders, advice of delivery notices, and invoices, or may involve more complex transactions such as integrated cash management systems, shared technical databases, internet, intranet, and extranet (Min and Galle 1999). Electronic data interchange (EDI) is not just an electronic ordering system; it helps to integrate stocking, logistics, materials acquisition, shipping and other functions to create a more proactive and effective style of business management and customer responsiveness (Mische, 1992) and thereby improve competitive advantage (Calza and Passaro, 1997). It helps in sharing information about markets, materials requirements forecasts, inventory levels, production and delivery schedules (Webster, 1995). The EDI-enabled Wal-Mart/Proctor & Gamble relationships illustrate how retailer-supplier relationships have been revolutionized for mutual benefit.

Enterprise resource planning (ERP) encompasses functions such as human resource planning, decision support applications, distribution and manufacturing, supply chain management, sales and marketing, etc. (Yusuf and Little, 1998). The development of ERP systems was a result of the increasing demand for re-engineering, combined with the advent of client/server technologies (Earl, 1997). There was also a desire to replace Materials Requirement Planning (MRP) systems which fell short of supporting multiple plants, multiple suppliers and multiple currencies, and did not include functions of inventory control, plant management and order processing (Kalakota and Whinston, 1997). ERP systems can be considered as an information technology infrastructure that is able to facilitate the flow of information between all supply chain processes in an organization (Martin, 1998). The ERP systems represent an optimum technology infrastructure that, when integrated properly with a process-oriented business design, can effectively support supply chain management systems (Chen, 2001).

Given that the web is a flexible, interactive, and relatively efficient medium through which various business partners and consumers can communicate, the potential that it offers for improvement of efficiency in the channel functions is enormous (Griffith and Palmer, 1999). In addition, innovations in technologies such as intranets and extranets are critical in integrating and coordinating cross-functional teams across organizational boundaries (Grover and Malhotra, 1997). Extranets connect enterprises to their partners and the internet links the enterprises to their customers and other agencies (Shaw, 2000). Intranets merge the advantages of internet with those of local area networks (Chellappa et al., 1996) to provide support for electronic connections between intra-organizational partners and electronic access to operational data. Intranets use web-based and internet technology to easily and inexpensively share data across a private network, and are capable of providing information in a way that is immediate, cost-effective, easy to use, rich in format, and versatile. For instance, Cisco recently created e-hub, which connects suppliers and the company via the Internet. This allows all the firms to have the same demand and supply data at the same time, to spot changes in demand or supply problems immediately, and to respond in a concerted fashion (Lee, 2004).

2.2 IT Effect on Supply Chain Integration

Researchers have found that a key enabler for effective supply chain management is information sharing among linked partners, which has been greatly facilitated by recent advances in information technology (e.g., Lee and Whang, 2000; Jharkharia and Shankar, 2005). The reported benefits of information sharing include improved ordering function, increases in sales, and lower inventory and/or shortage costs through better inventory allocation, because information sharing mitigates the information distortions along the vertical supply chain linkages. In addition, poor information technology infrastructure, whether caused by lack of funds or lack of awareness and commitment of top management, has also been identified as a major barrier to successful supply chain integration (Bender, 2000).

Because of the wide range of supplier problems, potentially addressed by better supplier relationships, expertise is required from various functions (Narus and Anderson 1995, Krause and Elram 1997). Teams dedicated to supplier development have been organized either around the material being purchased or according to supplier’s needs so team members can interact with their supplier counterparts (Hahn et al., 1990). A considerable amount has been written documenting the integration of suppliers in the new product development process (Clark and Fujimoto 1991; Helper 1991; Ragatz et al., 1997; Shin et al., 2000). The involvement may range from giving minor design suggestions to being responsible for the complete development, design and engineering of a specific part of assembly (Wynstra et al., 2000). This practice can be attributed to the fact that suppliers accounted for approximately 30% of the quality problems and 80% of product lead-time problems (Burton 1988). Extensive research has documented the benefits of integrating suppliers in the new product development process as well as in business and strategic planning (Aleo 1992; Ragatz et al., 1997). Aleo (1992) discussed Kodak's early production supplier involvement program that involved suppliers in its new R&D efforts. Clark (1989) and Clark and Fujimoto (1991) discuss the use, by Japanese manufacturers, of suppliers in the new product development process and the potential benefits of such supplier involvement.

Research has shown information technology to be an effective means of promoting collaboration between collections of firms, such as groups of suppliers and customers organized into networks. Moreover, information technology is touted as having a profound effect on collaborative relationships by facilitating cross-functional interactions between the supply chain partners (Grover and Malhotra, 1997). It eliminates the barriers between functional areas and among firms for a smooth information flow. It also facilitates the integration of suppliers into new product development and joint planning (McIvor et al., 2000). Thus,

H_1: Information technology has a positive impact on supplier integration.

Logistics provides industrial firms with time and space utilities (Caputo and Mininno, 1998). According to the traditional interpretation, it has been defined as the process of planning, implementing and controlling the efficient flow and storage of goods, services and related information as they travel from point of origin to point of consumption. A more recent interpretation calls for logistics to guarantee that the necessary quantity of goods is in the right place at the right time. The recent trend in using strategic partnerships and cooperative agreements among firms further forces the logistics integration to extend outside the boundaries of the individual firm (Langley and Holcomb, 1992). Some of the activities that are included in the logistics domain include transportation, warehousing, purchasing and distribution. A high level of logistics integration would involve intensified logistics-related communication, greater coordination of the firm's logistics activities with those of its suppliers and customers, and more blurred organizational distinctions between the logistics activities of the firm and those of its suppliers and customers (Stock et al., 2000).

The reduction of organizational slack, of which inventory is a typical example, requires a close coordination as well as intensive information exchange between the supply chain partners (Caputo, 1996). Information technology is vital in supporting strategic and operational logistics decisions. It enhances supply chain logistics efficiency by providing real-time information regarding product availability, inventory level, shipment status, and production requirements (Radstaak and Ketelaar, 1998). In particular, it has a vast potential to facilitate collaborative planning among supply chain partners by sharing information on demand forecasts and production schedules that dictate supply chain activities (Karoway, 1997). Furthermore, information technology can effectively link downstream customer demand information to upstream supply chain functions (e.g., purchasing and manufacturing) and subsequently facilitate "pull" (demand-driven) supply chain operations (Min and Galle, 1999). In addition, all non-value adding activities can be eliminated by avoiding congestion in different supply chain partner firms. Therefore, we hypothesize that information technology will lead to better integration of the logistics activities.

H_2: Information technology has a positive impact on logistics integration.

3. Research Design

3.1. Data Collection

The supplier integration and logistics integration constructs are based on a thorough review of the literature and are well grounded in existing theory (Chen and Paulraj, 2004b). A 7-point Likert scale with end points of "strongly disagree" and "strongly agree" was used to measure the supplier and logistics integration constructs. A 7-point Likert scale with end points of "do not use" and "used extensively" was used to measure the usage of different IT systems. A cross-sectional mail survey within the United States was utilized for data collection. The target sample frame consisted of members of the Institute for Supply Management (ISM) drawn from firms covered under the two-digit SIC codes between 34 and 39. The title of the specific respondent being sought was typically Vice President of Purchasing, Supply Chain Management, and Materials Management or Director/Manager of Purchasing, Material Management, and Operations.

In an effort to increase the response rate, a modified version of the methodology of Dillman's total design method was followed (Dillman, 1978). All mailings were sent via first- class mail to the respondents. The initial mailing included a cover letter, the survey, and a postage-paid return envelope. Two weeks after the initial mailing, reminder postcards were sent to all potential respondents. For those who did not respond, a second mailing of surveys, cover letters, and postage-paid return envelopes were mailed approximately 28 days after the initial mailing. Of the 1,000 surveys mailed, 46 were returned due to address discrepancies. From the resulting sample size of 954, 232 responses were received, resulting in a response rate of 24.3%. A total of 11 were discarded due to incomplete information, resulting in an effective response rate of 23.2% (221/954). Considering the length of the survey, this response rate is quite satisfactory. The response rate also correlates well with other empirical studies within operations management (e.g., Chen et al., 1997, 20%; Krause et al., 2001,19.6%).

3.2. Respondent and Firm Profile

The final sample included 35 presidents/vice presidents (16%), 138 directors (62%), 33 purchasing managers (15%), and 15 others (7%). The respondents worked primarily for medium to large firms with nearly 36% working for firms employing more than 1,000 employees. Nearly 60% of the firms had a gross income greater than $100 million. In general, with respect to the annual sales volume, the respondents were evenly distributed among the different groups. The respondents were also distributed evenly among the six SIC codes selected. The distribution of the samples with regard to respondent and firm profile is presented in Tables 1 and 2 respectively.

Table 1: Respondent Profile

Title	Count	Percent
President/Vice President	35	15.8
Supply Chain Management		
Materials Management		
Purchasing		
Director	138	62.5
Purchasing		
Procurement		
Materials Management		
Supply Management		
Operations		
Manager	33	14.9
Purchasing		
Supplier Development		
Operations		
Others	15	6.8
Purchasing Supervisors		
Purchasing Agents		
Senior Buyers		

Table 2: Company profile

Number of Employees	Count	Percent
Less Than 25	9	4.1
25 – 100	29	13.1
101 – 250	29	13.1
251 – 500	38	17.2
501 – 1000	34	15.4
More than 1000	80	36.2
No Response	2	0.9

Annual Sales Volume (in $ millions)	Count	Percent
Less Than $1	4	1.8
$1 – $49	56	25.3
$50 – $99	28	12.7
$100 – $499	62	28.1
$500 – $999	21	9.5
More than $1000	45	20.4
No Response	5	2.3

SIC Code	Count	Percent
34-Fabricated Metal Industries	49	22.2
35-Industrial Machinery and Equipment	31	14.0
36-Electronic/Other Electric Equipment	49	22.2
37-Transportation Equipment	21	9.5
38-Instruments and Related Products	16	7.2
39-Miscellaneous Mfg. Industries	55	24.9

3.3. Measures

The indicators used to measure the theoretical constructs are based on an extensive review of related literature. Items tapping the construct “Supplier Integration” measure the extent to which the dyadic firms share ideas and information, address key issues using joint planning committees, encourage teamwork through (a) co-location, (b) joint-planning committees, (c) task forces, and (d) ad hoc teams (Krause and Ellram, 1997), and the participation of key supplier in (e) project teams, (f) new product design and development, and (g) strategic planning (Ragatz et al., 1997; Shin, et al., 2000).

The construct of “Logistics Integration” measures the extent to which the logistics activities between dyadic firms are (1) closely coordinated, (2) seamlessly integrated, and the extent to which (3) information and material flow smoothly, and (4) logistics integration is characterized by excellent distribution, transportation and warehousing facilities (Stock et al., 1998, 2000). The three types of information technology that are most commonly used to facilitate supply chain integration include (1) electronic data interchange, (2) enterprise resource planning systems, and (3) internet, intranet, and extranet (Iacovou and Benbasat, 1995; McIvor et al., 2000).

3.4. Instrument Development

As indicated earlier, multi-item scales were developed to measure the constructs of supplier as well as logistics integration. Before testing for construct validity and reliability, the scales were tested for normality and outliers using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett test of sphericity. A KMO score of greater than 0.80 and a high value of the Bartlett test are considered preferable. For the theoretical constructs in this study, the KMO score was 0.894 and the Bartlett test of sphericity was 2837.23 with a significance level of $p < 0.0001$. These numbers suggest that the data could be reliably tested for reliability and validity. Reliability was operationalized using internal consistency method, which is estimated using Cronbach's alpha (Cronbach, 1951; Nunnally, 1978). Typically, reliability coefficients of 0.70 or higher are considered adequate (Cronbach, 1951; Nunnally, 1978). As can be seen from Appendix 1, both constructs had a Cronbach's alpha greater than 0.90, thereby establishing their reliability. Construct validity was established using principal component factor analysis from SPSS. The results of these analyses are provided in Appendix 1. As anticipated, most of the indicators loaded onto their underlying constructs during factor analysis. The eigen values for these factors were above the 1.0 cut-off point, while the percentage of variation was around 60%. The factor loadings were also above the cut-off point of 0.30 (Hair, et al., 1998). These analyses for validity and reliability suggest that the theoretical definitions of supplier and logistics integration exhibit good psychometric properties.

4. Results and Discussion

4.1 Information Technology Usage

Table 3a presents the results for the usage of information technology. Inter-organizational information systems have been documented to be of great importance for successful supply chain integration. A preliminary analysis reveals that Internet, Intranet, and Extranet were used widely (mean = 4.93; S.D. = 1.82). More sophisticated and advanced technologies such as ERP and EDI were used only moderately. This result appears to contradict with current literature that stresses the pressing need for using information technology to facilitate superior communication and integration of the supply chain activities. To reveal further insights into this counter-intuitive result, we split the data based on firm size and conducted additional analysis. The results indicate that the usage of all three types of information technology was significantly higher in larger firms. More specifically, usage of more advanced information including ERP and EDI by larger firms was above the moderate level and significantly different from small firms. These results, as shown in Tables 3b and 3c, demonstrate that the adoption of information technology appears to be a function of firm size. It also suggests that larger firms are more likely to have the resources to adopt and support the use of more sophisticated and advanced information technologies for supply chain integration.

[Insert Tables 3a, 3b, and 3c about here]

The data for each of the three different types of information technology was further split into three groups. Responses of 1 and 2 on the 7-point Likert scale were put together into Cluster A (low usage). Responses of 3, 4 and 5 were combined to form Cluster B (moderate usage), while Cluster C (extensive usage) consisted of responses of 6 and 7. The effect of information technology on supplier and logistics integration was tested using analysis of variance (ANOVA). We further adopted the Scheffe method to test for any significant differences in the mean levels of the various indicators within the clusters. From Table 4, it is evident that both supplier and logistics integration were significantly different across the three groups at or above the 95% confidence interval. In general, the result supports the notion that the adoption of IT plays a vital role in engendering supplier as well as logistics integration initiatives. It also reveals that more extensive information technology usage is generally associated with increased levels of supply chain integration and, in particular, improved cooperation and collaboration between the buying firm and its key suppliers.

[Insert Tables 4a and 4b about here]

4.2 IT and Supplier Integration

The hypothesis that IT usage will have a positive effect on supplier integration (H_1) was strongly supported across all three types of information technology. In case of EDI technology, the means were significantly different across all three levels of usage (Scheffe's comparison). For ERP and Internet technologies, the means of the second and third cluster (moderate vs. extensive) were not significantly different (Scheffe's comparison). In contrast to firms using extensive IT resources, firms in the first cluster (low usage) had very low mean values across all three types of information technology. In general, this result suggests that in order to achieve supplier integration, firms need to step up their adoption of various information technologies. Perceived as an act of faith, these increased relationship-specific investments eventually can foster increased trust and commitment between internal customers and external suppliers, thereby ultimately leading to better supplier integration. Our result also illustrates that that increased levels of IT usage can help to (1) share information with suppliers, (2) integrate key suppliers in product design, and (3) develop joint committees that support the new product development.

4.3 IT and Logistics Integration

Hypothesis H_2 was also supported by the underlying data. It is clear that IT usage has a positive impact on logistics integration between the supply chain partners. The mean value for this construct was at least significantly different (Scheffe's comparison) between the first and the third clusters (low vs. extensive) across all three types of information technology. Firms with more extensive IT usage appear to be in a better position to seamlessly integrate logistics activities including distribution, transportation and/or warehousing. This result provides additional empirical support to the growing consensus that firms using advanced IT are better able to work closely with their suppliers as well as to eliminate obstacles that may cause delays in obtaining materials and services from suppliers. Moreover, it also demonstrates that IT is responsible for unblemished integration of inbound materials or service need of the organization.

Although "coordination theory" has provided some early support for IT's capability to improving coordination between the strategic alliance partners (Malone et al., 1987), both empirical and theoretical findings have continuously challenged this finding (e.g., Barney, 1991; Kettinger et al., 1994). Moreover, while firms cannot expect IT to produce sustainable competitive advantage on its own (Powell and Dent-Micallef, 1997), RBV's *strategic necessity* and *resource complementarity* perspectives advocate that firms could instead merge IT with other firm-specific, intangible resources in order to provide distinctive advantages. Our results support this so called "commodity view" and further illustrates that IT can leverage other human and organizational resources within the supply chain (Clemens and Row, 1991). More specifically, it shows that IT is capable of improving the integration of supply chain activities by facilitating the dissemination and sharing of information and/or knowledge between the partners. Thus, the synergy accrued from IT-supplier integration and IT-logistics integration represents a great potential advantage that produce *complementarity* for firms.

5. Conclusions

The recent advances in information technology have provided firms with an opportunity for significant savings in costs through coordination and integration of the various players in the supply chain. Although various information technologies have made today's supply chains more dynamic and feasible, there has been a profusion of conflicting success/failure stories concerning the adoption of these technologies. Therefore, in this study, we set forth to illustrate the strategic importance of IT by explicating its significant impact on integration among the supply chain partners. More specifically, we investigate the effect of IT usage on supplier and logistics integration. Using a survey instrument, we have captured the extent of (1) the adoption of different types of IT, (2) supplier integration, and (3) logistics integration. A cross-sectional mail survey of ISM members was utilized to collect empirical data. Analysis of variance (ANOVA) was conducted to delineate the effect of IT usage on the integration constructs. Although based on a simple analysis, the results of this study provide additional insights on the differing levels of information technology usage by firms for their supply chain integration.

In general, the results support the notion that information technology serves to coordinate activities in the supply chains. They further illustrate that the increased level of IT usage facilitates closer working relationships with suppliers and better integration of supply chain activities (Chen and Paulraj, 2004c). One of the surprising outcomes from this study is the limited or moderate usage of various information technologies by the responding firms, as shown in Table 3. Though we have identified firm size as one of the predictors of IT adoption, we recognize that this does not completely explain the phenomenon. More detailed and advanced analysis could be employed in finding out the various control variables that affect the adoption of advanced IT systems. Moreover, the effect of IT usage was studied by just comparing the means across different groups. Therefore, we encourage future studies to conduct more detailed and advanced analyses that would reveal the causal effect of IT usage on the integration constructs. Since supply chain integration is a multi-dimensional construct, we suggest that future research include other aspect of supply chain integration (e.g., information integration). [Additional tables and Appendix I are available upon request].

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References

Aleo Jr., J.P. (1992). "Redefining the manufacturer-supplier relationship." *Journal of Business Strategy,* vol. 13, pp. 10-14.

Bakos, J.Y. (1991). "Information links and electronic marketplaces: the role of interorganizational systems in vertical markets." *Journal of Management Information System*, vol. 8, no. 2, pp. 31-52.

Barney, J. (1991). "Firm resources and sustained competitive advantage." *Journal of Management*, vol. 17, no. 1, pp. 99-120.

Bender, P.S. (2000). "Debunking 5 supply chain myths," *Supply Chain Management Review*, Vol. 4, no. 1, pp. 52-58.

Burton, T.T. (1988). “JIT/repetitive sourcing strategies: trying the knot with your suppliers.” *Production and Inventory Management Journal*, vol. 29, no. 4, pp. 38-41.

Calza, F., and Passaro, R. (1997). “EDI network and logistics management at Unilever-Sagit.” *Supply Chain Management*, vol. 2, no. 4, pp. 158-170.

Caputo, M. (1996). “Uncertainty, flexibility and buffers in the management of the firm operating system.” *Production Planning and Control*, vol. 7, no. 5, pp. 518-528.

Caputo, M., and Mininno, V. (1998). “Configurations for logistics co-ordination: a survey of Italian grocery firms.” *International Journal of Physical Distribution and Logistics Management*, vol. 28, no. 5, pp. 349-376.

Chellappa, R., Barua, A., and Whinston, A.B. (1996). “Intranets: looking beyond internal corporate web servers,” In: Kalakota, R., and Whinston, A.B. (Eds.), *Readings in Electronic Commerce*, Reading, MA: Addison-Wesley.

Chen, I.J. (2001). “Planning for ERP systems: analysis and future trends.” *Business Process Management Journal*, vol. 7, no. 5, pp. 374-386.

Chen, I.J. and Paulraj, A. (2004a). “Understanding supply chain management: critical research and a theoretical framework,” *International Journal of Production Research*, vol. 42, no. 1, pp. 131-163.

Chen, I.J. and Paulraj, A. (2004b). “Towards a theory of supply chain management: the constructs and measurements,” *Journal of Operations Management*, vol. 22, no. 2, pp. 119-150.

Chen, I.J. and Paulraj, A. (2004c). “Strategic purchasing, supply management, and firm performance,” *Journal of Operations Management*, vol. 22, no. 5, pp. 505-523.

Chen, I.J., Paetsch, K.A., and Paulraj, A. (1997). “Quality manager involvement and quality performance.” *International Journal of Operations and Production Management*, vol. 17, no. 4, pp. 399-412.

Clark, K.B. (1989). “Project scope and project performance: the effect of parts strategy and supplier involvement on product development.” *Management Science*, vol. 35, no.10, pp. 1247-1263.

Clark, K.B., and Fujimoto, T. (1991). *Product development performance*. Harvard University Press, Boston, MA.

Clemens, E., and Row, M. (1991). “Sustainable IT advantage: The role of structural differences.” *MIS Quarterly*, September, pp. 275-292.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, vol. 16, pp. 297-334.

Dillman, D.A. (1978). *Mail and telephone surveys: the total design method*, Wiley, New York.

Earl, M. (1997). Bets of times, agreed. worst, too? *Information Week,* December, no. 660, pp. 64-66.

Griffith, D.A., and Palmer, J.W. (1999). “Leveraging the web for corporate success.” *Business Horizons*, vol. 42, no. 1, pp. 3-10.

Grover, V., and Malhotra, M. (1997). “Business process re-engineering: a tutorial on the concept, evolution, method, technology and application.” *Journal of Operations Management*, vol. 15, pp. 192-213.

Hahn, C.K., Watts, C.A., and Kim, K.Y. (1990). “The supplier development program: a conceptual model.” *International Journal of Purchasing and Materials Management*, vol. 26, no.2, pp. 2-7.

Hair, J.F., Anderson, R.E. Tatham, R.L., and Black, W.C. (1998). *Multivariate data analysis*. Prentice Hall, Englewood Cliffs, New Jersey.

Helper, S.R. (1991) “How much has really changed between US automakers and their suppliers.” *Sloan Management Review*, Summer, pp. 15-28.

Iacovou, C.L., and Benbasat, I. (1995). “Electronic data interchange and small organizations: adoption and impact of technology.” *MIS Quarterly*, vol. 19, no. 4, pp. 465-485.

Jharkharia, S. and Shankar, R. (2005). “IT-enablement of supply chains: understanding the barriers,” *Journal of Enterprise Information Management*, vol. 18, no. 1, pp. 11-27.

Kalakota, R., and Whinston, A. (1997). *Electronic commerce – a manager’s guide*. Wokingham: Addison-Wesley.

Karoway, C. (1997). “Superior supply chains pack plenty of byte.” *Purchasing Technology*, vol. 8, no. 11, pp. 32-35.

Kettinger, W., Grover, V., Guha, S., and Segars, A. (1994). “Strategic information systems revisited: A study in sustainability and performance.” *MIS Quarterly*, pp. 31-58.

Konsynski, B.R. (1993). “Strategic control in the extended enterprise.” *IBM Systems Journal*, vol. 32, no. 1, pp. 114-120.

Krause, D.R., and Ellram, L.M. (1997). “Critical elements of supplier development.” *European Journal of*

Purchasing and Supply Management, vol. 3, no. 1, pp. 21-31.

Krause, D.R., Pagell, M., and Curkovic, S. (2001). "Toward a measure of competitive priorities for purchasing." *Journal of Operations Management*, vol. 19, pp. 497-512.

La Londe, B.J. (1983). "A reconfiguration of logistics systems in the 80s: strategies and challenges. " *Journal of Business Logistics*, vol. 4, no. 1, pp. 1-11.

Langley Jr., C.J., and Holcomb, M.C. (1992). "Creating logistics customer value." *Journal of Business Logistics*, vol. 13, no. 2, pp. 1-27.

Lee, H.L. (2004). "The Triple-A Supply Chain," *Harvard Business Review*, vol. 82, no. 10, pp. 102-112.

Lee, H.L. and Whang, S. (2000). "Information sharing in a supply chain," *International Journal of Technology Management*, vol. 20, no. 3/4, pp. 373-387.

Lewis, I., and Talalayevsky, A. (1997). "Logistics and information technology: a coordination perspective." *Journal of Business Logistics*, vol. 18, no. 1, pp. 141-157.

Malone, T., Yates, J., and Benjamin, R. (1987). "Electronic markets and electronic hierarchies." *Communications of the ACM*, vol. 30, no. 6, pp. 484-497.

Martin, M. (1998). "Enterprise resource planning." *Fortune*, vol. 137, no. 2, pp. 149-151.

McIvor, R., Humphreys, P., and Huang, G. (2000). "Electronic commerce: re-engineering the buyer-supplier interface." *Business Process Management Journal*, vol. 6, no. 2, pp. 111-138.

Min, H., and Galle, W.P. (1999). "Electronic commerce usage in business-to-business purchasing." *International Journal of Operations and Production Management*, vol. 19, no. 9, pp. 909-921.

Mische, M. (1992). "EDI in the EC: easier said than done." *The Journal of European Business*, vol. 4, no. 2, pp. 19-22.

Narus, J.A., and Anderson, J.C. (1995). "Using teams to manage collaborative relationships in business markets." *Journal of Business-to-Business Marketing*, vol. 2, pp. 17-47.

North, D.C. (1990). *Institutions, institutional change and economic performance.* Cambridge University Press, Cambridge, UK.

Nunnaly, J.C. (1978). *Psychometric theory*. McGraw-Hill, New York.

Palmer, J.W., and Griffith, D.A. (1998). "Information intensity: a paradigm for understanding web site design." *Journal of Marketing Theory and Practice,* vol. 6, no. 3, pp. 38-42.

Peters, T. (1992). *Liberation management*, Alfred A. Knopf, New York, NY.

Powell, T.C., Dent-Micallef, A. (1997). "Information technology as competitive advantage: The role of human, business, and technology resources." *Strategic Management Journal*, vol .18, no. 5, pp. 375-405.

Radstaak, B.G., and Ketelaar, M.H. (1998). *Worldwide logistics: the future of supply chain services*. Hague, The Netherlands: Holland International Distribution Council.

Ragatz, G.L., Handfield, R.B., and Scannell, T.V. (1997). "Success factors for integrating suppliers into new product development." *Journal of Production Innovation Management*, vol. 14, pp. 190-202.

Sheth, J., and Eshghi, G. (1989). *Global operations perspective*, South-Western Publishing, Cincinnati, OH.

Shaw, M.J. (2000). Information based manufacturing with the web. *The International Journal of Flexible Manufacturing Systems*, vol. 12, pp. 115-129.

Shin, H., Collier, D.A., and Wilson, D.D. (2000). "Supply management orientation and supplier/buyer performance." *Journal of Operations Management*, vol. 18, pp. 317-333.

Stock, G.N., Greis, N.P., and Kasarda, J.D. (1998). "Logistics, strategy and structure: a conceptual framework." *International Journal of Operations and Production Management*. vol. 18, no. 1, pp. 37-52.

Stock, G.N., Greis, N.P., and Kasarda, J.D. (2000). "Enterprise logistics and supply chain structure: the role of fit." *Journal of Operations Management*, vol. 18, pp. 531-547.

Webster, J. (1995). "Network of collaboration or concflict? Electronic data interchange and power in the supply chain." *Journal of Strategic Information Systems*, vol. 4, no. 1, pp. 31-42.

Wynstra, F., Axelsson, B., and van Weele, A. (2000). "Driving and enabling factors for purchasing involvement in product development," *European Journal of Purchasing and Supply Management*, vol. 6, pp. 129-141.

Yusuf, Y.Y., and Little, D. (1998). "An empirical investigation of enterprise-wide integration of MRPII." *International Journal of Operations and Production Management*, vol. 18, no. 1, pp. 66-85.