1-9-2009

Exploring the Relationship between Supply Network Configuration, Interorganizational Information Sharing and Performance

Marcia Daley

Permission to Borrow

In presenting this dissertation as a partial fulfillment of the requirements for an advanced degree from Georgia State University, I agree that the Library of the University shall make it available for inspection and circulation in accordance with its regulations governing materials of this type. I agree that permission to quote from, or to publish this dissertation may be granted by the author or, in his/her absence, the professor under whose direction it was written or, in his absence, by the Dean of the Robinson College of Business. Such quoting, copying, or publishing must be solely for scholarly purposes and does not involve potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential gain will not be allowed without written permission of the author.

Marcia Daley

Notice to Borrowers

All dissertations deposited in the Georgia State University Library must be used only in accordance with the stipulations prescribed by the author in the preceding statement.

The author of this dissertation is:

Marcia Daley
Decision Sciences Department
College of Business Administration
Clark Atlanta University
223 James P. Brawley Drive
Atlanta, GA 30314
USA

The director of this dissertation is:

Dr. Subhashish Samaddar
Managerial Sciences Department
J. Mack Robinson College of Business
Georgia State University
35 Broad Street
Atlanta, GA 30303
USA

Users of this dissertation not regularly enrolled as students at Georgia State University are required to attest acceptance of the preceding stipulations by signing below. Libraries borrowing this dissertation for the use of their patrons are required to see that each user records here the information requested.

Name of User	**Address**	**Date**

EXPLORING THE RELATIONSHIP BETWEEN SUPPLY NETWORK CONFIGURATION, INTER-ORGANIZATIONAL INFORMATION SHARING AND PERFORMANCE

By

MARCIA DALEY

A Dissertation Submitted in Partial Fulfillment of the Requirement for the Degree
of
Doctor of Philosophy
in the J. Mack Robinson College of Business
of
Georgia State University

GEORGIA STATE UNIVERSITY
J. MACK ROBINSON COLLEGE OF BUSINESS
2008

ACCEPTANCE

This dissertation was prepared under the direction of Marcia Daley's Dissertation Committee. It has been approved and accepted by all members of that committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor in Philosophy in Business Administration in the Robinson College of Business of Georgia State University.

_____

Dean – H. Fenwick Huss
J. Mack Robinson College of Business

Dissertation Committee:

_____
Chair: Dr. Subhashish Samaddar

_____
Dr. Craig Hill

_____
Dr. Satish Nargundkar

_____
Dr. G. Peter Zhang

_____
Dr. Kofie Dadzie

ACKNOWLEDGEMENTS

There are so many people who have contributed to my success, that, given time and space constraints, it would be impossible to mention them by name. First, though, I would like to avail myself of this opportunity to thank the Institute of Supply Management for a doctoral dissertation grant which provided me with the financial assistance to conduct my empirical work. Your assistance will always be appreciated.

I gratefully acknowledge the help of my dissertation committee comprising Dr. Subhashish Samaddar, Dr. Craig Hill, Dr. Satish Nargundkar, Dr. H. Peter Zhang and Dr. Kofie Dadzie. Its members directed me when I felt directionless. Special thanks to Dr. Nargundkhar and Dr. Hill who steered me when I needed clarity on a variety of topics.

To my committee chair and advisor, Dr. Samaddar, I benefited greatly from your wisdom and foresight: I knew I would. Special thanks are in order for knowing when to pull and when to push; how and when to encourage and when to stop encouraging.

My research thought process will never be the same. I learnt a lot about our subject material and myself from our interactions and I am hopeful that you learned a “little” something from me, as well.

To my family and friends who encouraged me to enter the doctoral program after I was in corporate for so many years, I thought you were crazy--after two weeks into the program I knew I was. Your confidence in-and patience with-me never faltered. As the program developed and time passed I realized that this was as much an achievement for me as it was for you. My thanks for your support, prayers and just “being there”.

ABSTRACT

EXPLORING THE RELATIONSHIP BETWEEN SUPPLY NETWORK CONFIGURATION, INTER-ORGANIZATIONAL INFORMATION SHARING AND PERFORMANCE

By

MARCIA DALEY

August 2008

Committee Chair: Dr. Subhashish Samaddar
Major Department: Decision Science

Critical to the success of a firm is the ability of managers to coordinate the complex network of business relationships that can exist between business partners in the supply network. However many managers are unsure on how best to leverage their resources to capitalize on the information sharing opportunities that are available in such networks. Although there is significant research on information sharing, the area of inter-organizational information sharing (IIS) is still evolving and there is limited research on IIS in relation to systemic factors within supply networks.

To help fill this gap in the literature, a primary focus of this dissertation is on the relationship between the design of the supply network and IIS. The design of the supply network is characterized by the supply network configuration which is comprised of (1) the network pattern, (2) the number of stages in the supply network, and (3) where the firm is located in that supply network. Four different types of IIS are investigated, herein. These types of IIS are a function of the frequency with which information is shared and the scope of information shared. Type 1 (Type 2) IIS is the low (high)

frequency state where only operational information is shared. Similarly, Type 3 (Type 4) is the low (high) frequency state where strategic information is shared. The argument is that the type of IIS varies depending on the configuration of the supply network and that this relationship is influenced by the coordination structure established between firms in the network.

The second focus of this dissertation deals with the relationship between IIS and performance. Research findings on the benefits to be gained from IIS have been ambiguous, with some researchers claiming reduced cost in the supply network with IIS, and others finding minimal or no benefits. To add clarity to these findings, the role that uncertainty plays in the relationship between IIS and performance is examined. The thesis presented is that the positive relationship between IIS types and the performance of the supply network is impacted by process uncertainty (i.e. the variability in process outcomes and production times), and partner uncertainty.

Social network theory and transaction cost economics provide the theoretical lens for this dissertation. A model is developed and will be empirically validated in a cross-sectional setting, utilizing a sampling frame randomly selected and comprised of supply management executives from various industries within the United States.

Keywords: Supply network, inter-organizational information sharing, coordination structure, partner uncertainty, process uncertainty, supply network performance, supply network design

Exploring the Relationship between Supply Network Configuration, Inter-Organizational Information Sharing and Performance

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

Supply networks (SNs) can involve extremely complex configurations and interdependencies between firms that require proper coordination in order to be effective (Choi et al. 2001; Choi et al. 2002; Lamming et al. 2000; Nassimbeni 1998). Such networks are often associated with "*lateral links, reverse loops, two-way exchanges and so on encompassing the upstream and downstream activity, with a focal firm as the point of reference"* (Lamming et al. 2000). The supply network configuration (SNC) defines the structure of the inter-organizational arrangement existing between transacting parties. These configurations are associated with strategic activities that can impact the success of companies and even industries thus it is very important that supply networks be managed properly (Fine 2000).

Supply networks offer opportunities to gain improved performance and mitigate inefficiencies (Corbett 2001; Corbett et al. 1999; Dyer et al. 2000; Kotabe et al. 2003; Zhao et al. 2002b). To achieve these benefits, managers need to understand the causes of competitive pressures, and be willing to implement innovative strategies to correct them (Lee et al. 1997a; Lee et al. 1997b). Managers that are interested in having their firms included in the top echelon of their industry must recognize that:

> "*Top-performing companies distinguish themselves from the ordinary by their ability to anticipate where in the chain lucrative opportunities are likely to arise and to invest in the capabilities and relationships to exploit them…superior market and technological forecasting ability and superior competency portfolio management (that is, supply chain design) are critical functions for the organization.* "(Fine 1998: 76).

One source of achieving this 'ability to anticipate' opportunities is inter-organizational information sharing (IIS). Inter-organizational information sharing refers to the sharing of information across firm boundaries, and is needed since organizations are unable to generate all of their requisite resources internally. The information shared can be operational or strategic.

Operational information is quantitative and is associated with short-term issues such as advanced shipping notices, order status, production schedules and inventory levels (Moberg et al. 2002; Van de Ven et al. 1980). Such operational information is used to make decisions which tend to contribute incrementally to the overall long-run success of an organization (Ganesan 1994; Mentzer et al. 2000). *Strategic information*, on the other hand, is firm specific, incorporates sensitive and qualitative information, and deals with issues that have a long-term time horizon (Mentzer et al. 2000; Moberg et al. 2002). Decisions made utilizing strategic information include pricing strategies, new target markets, capacity allocation, outsourcing, facility layout, new product development, distribution and promotional strategies (Moberg et al. 2002; Van de Ven et al. 1980).

The efficiency with which information is used depends on how information is distributed within the organization (Aoki 1986) and this logic can be extended to information distribution across firm boundaries. Distribution is accomplished through the coordination structure, which identifies where the locus of authority for making decisions resides and the type of information that is available for use in the decision-making process. The coordination structure can enhance the information sharing strategies that take place between firms in the supply network (Yu et al. 2001) by allowing these firms to manage the flow of activities (goods, services and information) within the network more effectively (Anand et al. 1997; Dyer et al. 2000; Lee et al. 1997b). Additional benefits to the overall network include lower costs, and increased responsiveness (Kopczak et al. 2003; Stevenson 1994; Yu et al. 2001). This is particularly important in the present environment where rapid technological and economic changes and the pressures of globally competitive markets have led to increased uncertainty and complexity. Sources of this complexity include multiple product offerings to meet the eclectic demands of customers, shorter

product life cycles, and a multitude of interactions across firm boundaries. Concomitant with this complexity is uncertainty due in part to imperfect information about market exchanges and environments, and asymmetry of information owing to the unwillingness of parties to share their private information (Clarke 1983).

Uncertainty is one of the key variables used to explain organizational behavior (March et al. 1958) and is a prominent construct in many of the organization, marketing and strategy theories. Proponents of Transaction Cost Economics (Williamson 1985) argue that the presence of internal or external uncertainty exacerbates the limited information processing and communication ability of human actors and results in high transaction costs, which ultimately impacts the type of governance structure used to conduct economic activities. External uncertainty can result from unpredictable environments or technology while internal uncertainty is reflected in information asymmetry and performance evaluation problems.

According to Knight (1964), uncertainty exists where the decision-maker is unable to assign probabilities when confronted with random events, and this has also been expressed as:

> "*a property of the decision environment within which transactions take place and refers in a general sense to a situation in which the relevant contingencies cannot be spelled out ex ante*" (Heide et al. 1995).

Since probabilities cannot be assigned to the outcomes of the states of nature, adaptation mechanisms are required in order to offset some of the potential costs associated with these situations.

Fortunately, IIS can mitigate the impact of uncertainty which has been identified as one of the primary drivers of inefficiencies, such as the "bull whip" effect, in the supply network (Lee et al. 1997b). The "bull-whip" effect occurs when there is a lack of collaboration as information flows through the supply network and can contribute to discrepancies between

orders to the suppliers and sales to the buyers. These distortions tend to amplify as the number of intermediaries in the supply network increase resulting in demand patterns that are much less predictable to upstream members of the supply chain.

Although IIS can lead to improved performance of the supply network (Cachon et al. 2000; Chen 1998; Gavirneni et al. 1999; Lee et al. 2000a), reaping the potential strategic benefits from using external resources requires that managers realize that:

"*No corporation is an island. Every company is dependent on others in large supply chains and distribution chains. As a result, limiting strategy to within the corporate enterprise is as meaningless as the purported boundaries of such entities"* (Fine 1998).

The transition from a focus on intra-organizational to inter-organizational strategies, particularly as it relates to supply networks, is filled with many challenges. Some firms (Home Depot, Wal-Mart, and JC Penney) have, however, been successful at implementing strategies that can effectively capitalize on external resources. For example, Wal-Mart, recognized as an innovative leader in the retail industry, shares point-of-sale (POS) information with its suppliers and transmits orders electronically to the relevant supplier when inventory for an item falls to a predetermined minimum level of stock (Lancioni et al. 2000).

Implementation of these strategies presents a real challenge for many firms and can lead to inertia unless managers are given the proper guidance enabling available resources to be channeled to the appropriate knowledge and information sharing activities.

1.1 Problem Statement

Critical to the success of a firm is the ability of managers to coordinate the complex network of business relationships that can exist between business partners in the supply network (Drucker 1998; Lambert et al. 2000). Despite the acclaimed benefits that can be derived from

IIS, firms that are actively participating in IIS are in the minority. In fact, the vast majority of firms have been unable to fully leverage these capabilities in their supply chains. Although 9 out of 10 business and IT executives surveyed by InformationWeek Research (McDougall 2001) believe that collaboration will increase sales, and 50% that it will result in lower costs, only 13% of these companies are actually sharing such point-of-sale data, and only 37% share information with suppliers on a regular basis.

The notion that IIS improves supply network performance, as discussed earlier, has wide support in the literature (Sahin et al. 2002). Some studies using analytical models show that information sharing results in higher performance (Gavirneni et al. 1999) while others base their conclusions on empirical studies (Dyer 1996; Jap 2001) where improvements are observed in the firm's competitive advantage as well as its economic performance. However, current research on the link between IIS and the performance of firms has not been conclusively established. A few researchers point to incremental improvements (Cachon et al. 2000), while other researchers (Clarke 1983; Graves 1999) find inadequate support for such arguments.

Based on the purported benefits that can be derived from IIS, it is expedient that firms capitalize on the information sharing opportunities that are available. But the question naturally arises on how to accomplish this without having some understanding of the dynamics that make it a feasible task. Although there is burgeoning literature that addresses information sharing, the area of IIS is still evolving and is more focused on studies that examine how sociological characteristics such as trust, and commitment influence inter-organizational behavior. Clearly these are important attributes, and studies along this vein have helped significantly in illuminating inter-firm dynamics inclusive of information sharing.

Extant literature has however paid far less attention to the impact of systemic factors on IIS. Currently, there exists limited theoretical research development to assist organizations in dealing with this phenomenon. Storey (2002) has argued for pragmatic approaches that focus on some of the challenges faced in managing supply networks and has suggested further study on topics such as the structure, and processes associated with supply chain management. These are areas that offer rich research opportunities for academics to reduce the current gap in the literature, and provide guidance to managers as they struggle with the challenges associated with managing their dynamic supply networks.

A better understanding of IIS, one of the key processes associated with an inter-organizational relationship (IR), can be gleaned by incorporating the framework suggested by Van de Ven (1986) where such relationships are assessed from the standpoint of social action systems. According to Van de Ven, this assessment is germane to an IR due to the following three characteristics which are commonly found in collective behavior:

1) Members behave so as to achieve collective and self-interest goals.
2) There is interdependence between members.
3) The IR can function as a unit with an identity that is unique and different from that of its members.

Van de Ven describes these systems in terms of situational, structural, process and outcome factors. Situational factors are used to examine why and how inter-organizational relationships are formed. Structural factors explore the governance mechanisms associated with different inter-organizational structures and their relationships. Process factors describe the flow of information and resources between involved parties. Information flow is concerned with the transmission of messages between members and is needed to maintain and integrate the IR

activities while resource flow deals with any valued transaction of tangible (e.g. money, equipment) or intangible (e.g. goodwill, prestige, technical assistance) resource between units. The outcome factors measure the effectiveness of the relationship.

A modified version of this framework is presented by focusing on the supply network configuration (structural factor) that influences IIS (process factor) and ultimately impacts supply network performance (outcome). Situational factors are excluded since the focus is on inter-organizational relationships that are already in effect. Trust, although extremely important in interorganizational settings is not explicitly examined in this study. The assumption is that trading parties will, at a minimum, enter into cooperative relationships where operational information is shared. This is a strong indicator that trust exists (Axelrod 1984; McAllister 1995).

Several studies on supply network design (Beamon 1998; Choi et al. 2002; Fisher 1997; Harland et al. 2001) have been conducted, but how it relates to IIS has not been empirically established in the literature. The primary purpose of this study is to address this gap in the literature by taking a more holistic approach and examine the impact of the supply network configuration on IIS. We depart from the predominant conceptualization of IIS in the literature as a uni-dimensional construct, and instead classify IIS using the two-dimensional typology developed by Samaddar et al (2004) –(See Appendix A) that considers both the scope (or type) of information shared (operational vs. strategic), and the frequency of IIS (low vs. high).

1.2 Research Question

This research effort investigates the following questions:

- *What impact does the configuration of the supply network have on IIS?*
- *How does the coordination structure influence the relationship between the configuration of the supply network and IIS?*
- *What is the role of uncertainty in the relationship between IIS and performance?*

This study employs the survey research design method (a non-experimental design approach), and quantitative techniques to investigate the factors that influence IIS and ultimately supply network performance. Traditionally, empirical research on IIS has adopted the firm or the dyad as the unit of analysis. In this dissertation the above questions[1] are investigated from a broader perspective than is customary in the stream of research on IIS, by extending the inquiry to the supply network comprised of the focal firm and its upstream and downstream partners.

1.3 Plan of the Dissertation

The remainder of the dissertation is divided into five chapters. Chapter 2 provides the theoretical framework for this study and reviews relevant prior research. In Chapter 3 the theoretical model of the study and related hypotheses are presented. Chapter 4 describes the design and methodology to be used for the empirical portion of the study. Chapter 5 discusses the measurement validation and data analysis. Chapter 6 concludes the study.

[1] See also Samaddar, Nargundkar, and Daley 2006

2. THEORETICAL FOUNDATIONS AND LITERATURE REVIEW

In this chapter, theoretical perspectives from the organizational economics and sociology literature that guide and inform this research on IIS are examined by drawing on the body of literature in Transaction Cost Economics (TCE) and Social Network Theory. Neither of these theoretical lenses is unilaterally adequate, but together they offer unique insights and complementary arguments to build a solid conceptual foundation for the research hypotheses developed in Chapter 3.

TCE is valuable to this research as it provides guidance on why certain transactions occur within the firm while others take place outside the boundaries of the firm. It also addresses how firms in hybrid (e.g. buyer-supplier) relationships can utilize formal (written contracts, dispute resolution bodies, hostage exchanges) and informal governance mechanisms such as trust to manage these inter-organizational arrangements. The primary focus of TCE is on dyadic relationships; however, the study of many buyer-supplier relationships cannot be confined to these exchanges but needs to extend to the network within which they are embedded. The network perspective as provided by Social Network theory goes beyond the economic perspective offered by TCE to consider the interactions in the supply network from a social context. It thus provides an explanation for why firms in supply networks may choose to share information even though economic considerations would suggest otherwise.

Following the theoretical framework discussion, extant academic literature on information sharing is reviewed.

2.1 Transactions Cost Economics (TCE) theory

Coase (1937) originally developed TCE theory to explain the existence of firms and how integration impacted costs and benefits. His conceptualization of the firm superseded that of neoclassical economists who viewed the firm as a production function in which markets were frictionless and information costless. Instead, he argued that there were costs associated with using the price mechanism and that these costs which were later called "transaction costs" made organizing activities within the firm a more efficient choice. Costs include those due to performing safeguarding, adaptation and evaluation activities.

Williamson (1975; Williamson 1985; Williamson 1991) extended this theory to predict governance structures based on efficiency considerations. According to Williamson's (1991) discriminating alignment hypothesis "transactions which differ in their attributes are aligned with governance structures, which differ in their costs and competencies" in a manner that minimizes transaction costs. Clearly, there are rational economic reasons for deciding on how transactions are governed. Two ends of the governance continuum are market and hierarchy with various "networked structures" in between these two endpoints (Powell 1990). The choice of the appropriate governance structure depends on three attributes of a transaction: asset specificity, uncertainty, and transaction frequency. Of these, asset specificity is considered to be the most important attribute influencing governance structure (Grossman et al. 1986; Williamson 1975; Williamson 1979). TCE predicts that exchanges that involve high asset specificity, uncertain conditions, and recur frequently will be internalized within a hierarchical governance structure. Conversely exchanges that involve low asset-specificity, stable conditions, and are non-repetitive will be more aligned with a market governance structure. Hybrid structures are recommended when these attributes are present to a moderate degree.

In the context of a supply network, the transaction is the sharing of information (an asset) between firms that are independent entities. For some firms, transactions between buyers and suppliers involve arms-length relationships typically found in a market governance structure. The market governance structure is characterized by a low degree of vertical coordination, with decentralized control through the price mechanism. In this traditional "arms-length" approach, market transactions are discrete, entailing relationships that are short-term (Ring et al. 1992) and involve products that are standardized. Minimal information sharing is required in these situations. For instance, at the Big Three automobile manufacturing companies, Internet exchanges (e.g. electronic auctions) are used to purchase some commodity items (Flynn et al. 2001).

Today, the trend is towards more collaboration and information sharing in buyer/supplier relationships (Handfield et al. 1999a; Hoyt et al. 2000). These networked (or hybrid) structures include joint ventures, alliances, franchising and licensing agreements, and inter-firm networks in which "parties to the transaction maintain autonomy but are bilaterally dependent to a nontrivial degree" (Williamson 1991). With networked structures contracting transactions may be recurrent or relational (Ring et al. 1992). As described by Ring and Van de Ven (1992) the former are relatively short-term with repeated exchanges that have moderate degrees of transaction specificity and ones where the terms of the exchanges are fairly certain except for some contingencies that are resolved after the contract agreement date. The information shared includes information that is not openly available to the public and requires the addition of private information in order to have value to a firm such as production schedules. By contrast, the relational contracting transactions entail highly specified long-term investments in which it is virtually impossible to fully specify trading conditions ex ante and ones in which the exposure to

trading hazards is very high (Ring et al. 1992). For the latter transactions, vertical integration is not a viable option to safeguard these idiosyncratic assets in supply networks owing to raison d'être such as economies of scale from sharing inputs, and opportunities for learning from external exchange partners.

In order to safeguard the assets and reduce the potential for opportunistic behavior, two possible options can be considered. Firstly, if there is a high degree of trust and commitment between all transacting parties, they can behave as if they are one firm, working jointly in order to achieve goals that are mutually beneficial. Alternatively, one firm may exercise control over the other firms in the exchange relationship. For example one firm (a buyer or supplier) may control key procedures and have the power to make decisions for the whole SN on issues such as product design and quality control. In both of these scenarios the contract can be less complete (Williamson 1991), but the operational and coordination costs to make these relationships function effectively are high (Gurbaxani et al. 1991). This "single organization perspective" contrasts with the "nexus of contract" perspective found in markets where each firm is concerned with maximizing its own profit (Whang 1995). Information that has high security concerns such as proprietary information would be handled in these quasi-vertical integration structures.

TCE has been used extensively in the literature to study inter-firm relationships (Balakrishnam et al. 1993; Dyer et al. 2003; Heide et al. 1990; Pfeffer et al. 1978; Stump et al. 1996) and thus has relevance to this present study on IIS in supply networks. Two major components of transaction costs are coordination costs and transaction risks (Clemons et al. 1993). The costs associated with exchanging information, and utilizing that information in decision processes are denoted as coordination costs. These costs have also been referred to as information costs (Choudhury et al. 1997). Transaction risks occur when the behavior of

transacting parties ex post is not in keeping with ex ante agreements. The likelihood of these risks increases when there is information asymmetry.

A discussion of the three attributes of a transaction (asset specificity, uncertainty and transaction frequency) follows:

Asset specificity

Asset specificity refers to the extent to which investments made to support a particular transaction (idiosyncratic investments) have a higher value than if they were switched to alternative transactions (Lonsdale 2001). Types of asset specificity include 1) sites in which for example, a physical plant is located in close proximity to a raw material source in order to reduce inventory and shipping costs; 2) physical assets such as customized parts needed to produce an item; 3) dedicated assets, which are separate investments made solely to facilitate the request of one customer; 4) human asset attributed to learning by doing; 5) brand name capital; 6) temporal; and 7) information specificity, which is "the extent to which the value of information is restricted to its use and/or acquisition by specific individuals [knowledge specificity] or during specific time periods [time specificity]" (Choudhury et al. 1997).

As asset specificity increases it creates bilateral dependency, and with that the need for more coordinated responses to any disturbance, however disagreements and self-interested bargaining prohibit timely and simple responses leading to maladaptation costs (Williamson 1991). This can occur, for instance, when circumstances change and requests for adaptation by one party in a dyadic relationship, is met with unreasonable demands by the other party who realizes that the partner is locked-in to the arrangement owing to high switching costs (Rindfleisch et al. 1997; Williamson 1996). Parties can institute measures ex ante to prevent one party from behaving opportunistically but these measures incur safeguarding costs. Alternatively,

if all parties to the relationship invest in specific assets there is little incentive for opportunism due to the existence of reciprocal dependence (Dyer 1996).

Uncertainty

External and internal conditions create uncertainty that can affect how transactions are conducted between parties. Williamson (1985) attributes some of this uncertainty to exogenous "disturbances" and makes a distinction between (1) environmental or external uncertainty, (2) organizational and (3) strategic uncertainty (Williamson 1985; Williamson 1989).

Environmental uncertainty, which is *external* to the relationship*,* is caused by an inability to anticipate ex ante the exchange conditions that arise from random acts of nature. This results in adaptation problems and increased transaction costs, owing to the difficulties associated with alterations to existing agreements as environmental conditions change. In contrast, both organizational uncertainty and strategic (or behavioral) uncertainty are internal to the relationship. *Organizational uncertainty* arises when there is asymmetric information between decision makers and communication does not flow in a timely manner. This is caused by the limited information capacity and bounded rationality of decision makers. *Strategic uncertainty* occurs when there is strategic misrepresentation, nondisclosure, disguise or distortion of information (Williamson 1989: 144) which leads to the inability to monitor ex post behavior of transacting parties (Rindfleisch et al. 1997) creating performance evaluation problems. A combination of uncertainty and opportunism can lead to information impactedness, that is, transacting parties have asymmetric information and there are high costs associated with providing the same level of information to all parties.

The impact that uncertainty has on the choice of governance structure is only relevant when there is asset specificity. As uncertainty increases, market governance becomes less

desirable owing to the high haggling and maladaptation costs, thus rendering hybrid and hierarchical governance structures more suitable (Williamson 1985). When however uncertainty reaches a high level, the midrange of asset specificity, where hybrid governance is the best choice, diminishes and may ultimately disappear. This is attributed to the requirement for mutual assent in the case of hybrid adaptations as opposed to unilaterally (with market governance) or by fiat for hierarchy (Williamson 1991). Consequently in situations of high uncertainty both hierarchical and market governance are better alternatives than hybrid governance.

The results from studies investigating the role of environmental uncertainty on governance are ambiguous. Some studies show that under certain circumstances environmental uncertainty increases the likelihood that firms will vertically integrate (Walker et al. 1987) while other studies indicate that it can decrease the likelihood (Harrigan 1986). Much of these inconsistencies have been attributed to how the environmental uncertainty construct is operationalized in empirical studies (Rindfleisch et al. 1997). Internal uncertainty on the other hand is not subject to these ambiguities and has been supported in many empirical studies.

TCE's treatment of internal uncertainty provides useful insights into its influence on performance when information is shared across firm boundaries. In the context of the supply network, internal uncertainty can arise from the difficulty a buyer has in monitoring ex post the behavior of a supplier and ascertaining whether obligations will be met consistently as per the agreement. The TCE perspective suggests that while IIS can lead to improved performance of a SN, uncertainty arising from not knowing how the partner will behave, or the reliability of processes and their capabilities ex post (discussed in Section 2.5) lead to suboptimal decisions, which are costly.

Transaction frequency

Transaction frequency refers to the rate of recurrence for transactions between specific parties. The importance of transaction frequency on the choice of governance structure depends on asset specificity (Williamson 1985). Hierarchy is more efficient when transactions are recurrent and require highly specified assets. With frequent transactions, the transfer of tacit knowledge is enhanced (Jones et al. 1997; Williamson 1991) and parties are less likely "to seek a narrow advantage in any particular transaction" (Williamson 1985). On the other hand, the preference is for market governance when transactions occur infrequently or when they occur frequently but asset specificity is low. In the latter case, continuous attention and the bureaucratic costs associated with hierarchical governance is unnecessary.

While only a few empirical studies have examined transaction frequency, it has relevance to supply networks owing to the nature of transactions between network members. Where transactions occur frequently and there are highly specified assets it is expected that supply network members will establish relational contracts where there is a high level of trust and commitment.

Two behaviors contribute to the preference for exchange transactions occurring in hierarchies rather than in firms when conditions of high asset specificity, uncertainty and recurring transactions: bounded rationality and opportunism (Williamson 1975; Williamson 1985).

Bounded rationality

Humans have limitations to their cognitive and computational ability that prevent them from being able to arrive at the optimal decision in most situations despite their best intentions to behave rationally (Simon 1947). Owing to this bounded rationality, that is inherent in humans, it

is more difficult for firms to negotiate contracts that are truly comprehensive as not only are the outcomes uncertain but the complexity involved makes it virtually impossible to specify all eventualities ex ante. To deal with these limitations, contracts between a buyer and supplier, for instance, often a) include clauses that allow them to renegotiate in the event that conditions are different than those that maintained when the contract was initially signed, or b) are open-ended enough to facilitate interpretations that are relevant to the existing situations. Under these circumstances, the best alternative is to internalize transactions within the firm thus eliminating the need for complex contracts and the associated bargaining costs to arrive at consensus.

Opportunism

One of the central tenets of TCE theory is opportunism, defined by Williamson as "self-interest seeking with guile". Opportunism involves the "propensity for mutually reliant parties to mislead, distort, disguise, obfuscate or otherwise confuse" for purposes of wealth expropriation (Williamson 1985). Although not necessarily true for all individuals, opportunistic behavior is so costly to identify ex ante that TCE presumes its existence and proposes that firms protect themselves against the likelihood of its occurrence in their interactions with other firms.

Opportunistic behavior is possible when all transacting parties do not have access to the private information possessed by some. This information asymmetry can be exhibited either ex ante (adverse selection) or ex post (moral hazard) the transaction. Such opportunistic behavior by one party, which sometimes occurs in a buyer-supplier relationship, reduces the motivation to share information and to fully commit to that relationship. Consequently, it is extremely difficult to coordinate activities and to reap the performance benefits of joint cooperative effort (Jap, 2001).

Adverse selection is shown, for example, in the following summary concerning Lear Corporation's behavior in their relationship with Motor Company:

"..Ford wanted to form long term relationships with a few suppliers. One key element in the new car model was the seats. In the case of the new Taurus, Ford decided to outsource the whole process to one single supplier, Lear Corporation. As it turned out, in promising to design and manufacture seats for two sedans, a station wagon and a high-performance model, Lear deliberately committed to a contract they knew they would not be able to fulfill. Among other problems, Lear had a severe shortage of engineering talent…..According to Ford, Lear missed deadlines, failed to meet weight and price objectives and furnished parts that did not work" (Walton 1997; Wathne et al. 2000).

The risk of opportunism is magnified under situations in which small numbers bargaining problems (i.e., limited exchange alternatives available) are present (Williamson 1979). If a buyer for instance has only few alternate sources of supply it is easier for the current supplier to make unreasonable demands or charge exorbitant prices (Dutta et al. 1995; Rindfleisch et al. 1997). A buyer, on the other hand, may be the one with the power and this can also lead to bargaining problems leaving very few alternatives open to the seller in the event that the buyer wants to sever the present arrangement (Pisano 1990).

To provide safeguards against the hazards of opportunistic behavior, TCE recommends a hierarchical governance structure where better capabilities exist for monitoring and surveillance of activities and one can "settle many disputes by appeal to fiat"(Williamson 1975). In real life other governance structures may be preferable to a hierarchical form when other factors such as strategic concerns, which has been ignored by TCE, and production costs which have been given scant attention in much of the empirical studies are considered (Bello et al. 1997).

While the emphasis of the TCE framework on opportunism has been criticized by many researchers (Ghoshal et al. 1996; Rindfleisch et al. 1997; Uzzi 1997) its occurrence both ex post and ex ante is far from isolated in supply networks, consequently it is germane to the present study. For a fuller discussion on opportunism in interfirm relationships see (Wathne et al. 2000).

In addition to concerns on TCE's predictive capability under some scenarios and the emphasis on opportunism, one of the fundamental issues is its inadequacy to explain inter-organizational relationships. Scholars have noted that TCE ignores the role that social relations play in shaping organizational behavior by basing arguments solely on economic considerations (Granovetter 1985). In other words:

"*By neglecting the dependence of meaning on interaction and the generation of perception, understanding, and preference by interaction, TCE neglects what may be the most crucial feature of transactions. This feature derives not from the isolated transaction but the transaction relation in which it is embedded" (Nooteboom 1992).*

Thus although TCE alludes to the influence of social relations (Williamson 1975) this aspect is not pursued aggressively as it is construed to be an exception rather than the norm (Granovetter 1985).

Another point of contention is the range of relationships for which TCE is applicable. Extensions to the TCE framework consider bilateral relationships (Williamson 1991), however, by not going beyond dyadic relationships the theory gives "short shrift" to network relations (Williamson 1994). Situations such as the manner used by a buyer to effectuate centralized control over multiple tiers of suppliers may be appropriately considered in terms of a series of dyadic relationships (Choi et al. 2001). Even so, the nature of dyadic relationships cannot be assumed in all instances to inductively apply to the network (Anderson et al. 1994; Wathne et al. 2004).

TCE requires a complementary theoretical lens that considers the social context of relationships, and the influence that these relationships have on overall performance in order to provide plausible arguments for these hypotheses. To do this, the TCE perspective is integrated with social network theory, an approach that has been used in several network studies (Jones et al. 1997; Wu et al. 2004) and one that provides a powerful framework to explicate IIS between

transacting parties within supply networks. In particular, the strength-of-ties literature is utilized to help explain why ties are built between exchange parties.

2.2 Social Network Theory

Originally developed to examine how an individual's behavior is influenced by embeddedness, social network theory has since been extended to include organizations (Burt 1982; Dyer 1996). Embeddedness is characterized as a 'logic that shapes motives and expectations and promotes coordinated adaptation' (Uzzi 1996). Early research focused on techniques to effectively capture social relationships, while the focus in later work was more on understanding the key dimensions associated with the characteristics of social structure.

These structures, defined as 'the arrangement of the differentiated elements that can be recognized as the patterned flow of information in a communication network (Rogers et al. 1981), are more useful in explaining the behavior of an exchange partner than more formal hierarchical structures. According to Uzzi (1996), there are significant differences between the logic of exchange found in social networks and the economic logic associated with market behavior. Consistent with this line of reasoning, social network theory (SNT) argues that economic actions are best understood within the social context in which they are embedded and such actions can be influenced by the network structure and position of actors in social networks (Gulati 1998; Gulati et al. 1998; Oliver 1996; Uzzi 1996).

The search for information to reduce uncertainty is one of the primary drivers of organizational action (Granovetter 1985). When organizations form networks, for instance, they can get this information. The benefits of networks can be more fully understood by examining two mechanisms: relational and structural embeddedness (Granovetter 1992).

Relational embeddedness, the logic of exchange that develops when a relational bond forms between social actors, can explain how information sharing activities are impacted by this bond (Granovetter 1973; Uzzi 1999). These bonds (or ties) form when resources (e.g. data, information, goods) are exchanged. The strength of these ties are on a continuum from weak to strong and depend on a "combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the ties" (Granovetter 1973). Granovetter (1973) suggests that when social actors are linked by direct connections, strong ties develop. With these ties, a high degree of closeness and reciprocity results and creates an environment in which fine-grained information is shared. In such situations it is more likely that actors will trust each other, be more willing to develop and share common information which ultimately reduces uncertainty (Gulati 1995; Podolny 1994). Strong ties provide a unique source of information concerning the capabilities and the reliability of the partners. Additionally, strong ties increase the probability that social actors will share sensitive information and work jointly on problem-solving. The potential for opportunistic behavior, as presumed in TCE, is dramatically reduced under these situations.

Weak ties represent links between parties that interact infrequently (Granovetter 1973). In these situations, there is more non-redundant information available, providing opportunities to gain access to more diverse and a larger amount of information. However, weak ties are not effective at transferring information where there is some ambiguity and uncertainty, or where there is a mismatch between the prior knowledge possessed by exchange partners (Nahapiet et al. 1998). It is expected, therefore, that the sharing of strategic information is most likely to occur when there are strong ties between exchange partners and these interactions will occur much more frequently than in relationships that are not as tightly connected.

Structural embeddedness refers to the structural positions that actors occupy in a network (Burt 1982). Several studies have shown that where firms are located in an inter-organizational network can influence both firm behavior and the resulting outcomes (Powell et al. 1996; Walker et al. 1997). Any advantage that a firm has because of where it is located in the network results in social capital which is defined as:

"the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet et al. 1998).

Although actors may have similar positions they may not be tied together but may be instead tied to the "same set of other actors or to similar sets of other actors"(Gulati et al. 1998). For instance, in cases where there are multiple suppliers for a product or service, each supplier may interact with a totally different set of exchange partners. In these arrangements suboptimal exchanges may occur since actors transact with those trusting partners in their social circle and are not linked to those that can provide the most benefit. This disconnect represents a structural hole that provides an opportunity for a third party to take a position between the disconnected parties (Burt 1992; Burt 1997). It is likely that this third party who is in a more central position will have greater control over information flows and access to information thereby gaining greater influence over the other actors. The result is that in a supply network, a focal company can utilize multiple disconnected parties upstream and downstream with whom direct links have been established to gain control and information above that available to others. This is also true for a first tier supplier that can utilize its position which has direct links to both the focal company and the second tier suppliers to its advantage.

The complementary perspectives provided by TCE and social network theory allow an integrative approach for developing the theoretical framework in this study. The absence or low

incidence of opportunistic behavior in some collaborative relationships between the independent firms comprising the supply network, and the presence at times of governance structures contrary to that predicted by TCE's discriminating alignment hypothesis begs for alternative explanations beyond those offered by TCE. Social network theory, by considering the social context within which exchanges occur, allows plausible explanations for IIS phenomena that cannot be explained solely by efficiency concerns, the cornerstone of the TCE perspective.

2.3 Literature Review – Information Sharing

Inter-organizational Information sharing (IIS) involves the sharing of information across firm boundaries and is needed so that firms involved in such relationships can compete effectively in their environment (Yuchtman et al. 1967). Knowledge, an intangible resource has been identified as the most critical competitive asset that the firm possesses (Grant 1996). Intricately tied in with knowledge is information, which is an asset that also provides competitive advantage to organizational networks when it is shared.

There are multiple views on the nature of information. Several researchers have attempted to distinguish between data, information, and knowledge. For instance, data is defined as "structured records of transactions", and information as "data that makes a difference …..by changing the way that the receiver perceives something". Knowledge is viewed as being at a higher level and is defined as:

> *" a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices, and norms." (Davenport et al. 1998)*

In this perspective, the progression is from data to information to knowledge.

Others however argue that in order to make sense of data and create relevant information one has to have knowledge, thus reversing the order of progression. Still another view is that knowledge is always evolving and is actually what occurs in-between data and information, and previous knowledge and belief (Wood 2002). Notwithstanding the merits of these differing philosophical views this manuscript adopts the stance of several researchers (Alavi et al. 2001; Bartol et al. 2002; Earl 2001) who make no distinction but instead treat knowledge as:

> *"information possessed in the mind of individuals: it is personalized information (which may or may not be new, unique, useful, or accurate) related to facts, procedures, concepts, interpretations, ideas, observations, and judgments"* (Alavi et al. 2001).

Within the purview of this definition IIS is envisioned as the sharing across firm boundaries of personalized information, and one that incorporates data as well as experiences and judgment. IIS can result in a more efficient flow of goods and services (Anand et al. 1997; Dyer et al. 2000; Lee et al. 1997b), thus enabling better coordination and planning (Lee et al. 2000b) in inter-organizational networks. This benefits the overall network and is therefore an important concept that should be fully understood.

IIS has generated considerable interest across several research streams including economics, operations research, marketing, and strategic management. Several themes have emerged from these streams:

- Private information and incentives to share
- Perspectives on information sharing
- Influence of uncertainty on information sharing
- Information distortion
- Performance implications of information sharing
- Role of coordination structure

2.3.1 Private Information and the Incentives to Share

There has been a rich stream of research on information sharing in the economics literature. Much of this research has focused on the incentives to share private information by firms operating in oligopoly markets where firms behave as Cournot competitors by setting quantities (Clarke 1983; Farmer 1994; Gal-Or 1986; Hwang 1994; Li 1985; Novshek et al. 1982; Shapiro 1986; Ziv 1993), or as Bertrand competitors by setting prices (Spulber 1995), or a comparison of both the Cournot and Bertrand strategies (Gal-Or 1985). In many cases concern centered on whether or not the sharing of information led to collusion and how the resulting dynamics affected consumer surplus and social welfare.

There is some reluctance by transacting parties to share all the available information (Clarke 1983; Gal-Or 1985; Li 2002). Some of this reluctance has been attributed in the context of a supply network to three reasons: 1) decreasing marginal value of the information shared, i.e. as higher levels of information are shared the value derived from each additional unit shared is less, 2) loss of relative bargaining power by one party, and 3) fear of leakage of information to competitors, which can affect the competitive position of the buyer or the supplier in relation to their industry rivals (Seidmann et al. 1998).

For instance, Clarke (1983) demonstrates using an analytical framework that universal information sharing will not take place in a competitive world. Information sharing according to this researcher will only occur in situations where firms have perfect information or where they are completely ignorant and indifferent to pool sharing. He shows that firms can improve their profits if those with more accurate information share it. However since this information gives those possessing it an advantage, there has to be some incentive for sharing, such as a monetary payment. Once firms behave cooperatively, then profits of the industry, as a whole will improve

with information sharing and joint action. Society as a whole benefits when information is shared between competing firms unless this information sharing leads to collusion.

2.3.2 Perspectives on Information Sharing

Ineffective IIS can lead to "misunderstandings, incorrect strategies, and mutual feelings of frustration" (Etgar 1976), consequently decisions regarding IIS are very important. However questions still remain on the best strategies to optimize supply network performance in light of the barriers to effective IIS. High lock-in costs oftentimes arising from huge investments and commitment make it difficult to change IIS decisions. Thus two critical decisions that transacting parties must address prior to the actual sharing of information across firm boundaries are a) the nature of the information to share (i.e. what to share) and b) the manner in which this sharing will take place (i.e. how to share). Several perspectives have been used to assess IIS but to date none of these have addressed both of these dimensions simultaneously.

Perspectives used include the degree or amount of information shared (Aviv 2002; Gavirneni et al. 1999), the scope of information shared (Seidmann et al. 1998) and the level of intensity of the relationship between partners (Spekman et al. 1998).

Seidmann and Sundararajan (1998) identify four levels of IIS that can exist in virtually integrated organizations, such as across firm boundaries, where advances in information technology enable coordination of information flows between partners. These levels are labeled as transactional, operational, strategic, and strategic and competitive. Each higher level incorporates information from the lower levels. The lowest level involves the exchange of only transactional type of information such as prices and order quantities utilizing EDI or similar technology. At this transactional level, no advantage is gained from information sharing related

to firm-specific operations, since the focus is on logistic process improvements, which can be accomplished effectively by each partner acting independently. The next level incorporates the sharing of operational information, which usually occurs in situations where another partner can more effectively utilize valuable information possessed by one partner, since the receiving partner has the requisite expertise and/or resources. For instance, the use of a VMI system facilitates the transfer of the responsibility for inventory management from the buyer to a supplier who has more experience managing large product inventories and has first-hand knowledge of the production schedule for the products.

The sharing of information leads to strategic benefits, in addition to operational benefits, above the second level. At the third level, the information shared has minimal value to the partner owning the information but can provide strategic benefits when used by another party and also operational benefits for the donating partner. This is evidenced when a supplier is given access to a retailer's POS data of all product sales from that supplier. Such information allows the supplier to increase demand forecasting accuracy, and gather information on sales patterns. As a result, operations are more efficient for both parties and plans for new product development and sales expansion strategies in the case of the receiving partner are better. At the topmost level the information shared is strategic and competitive. Here, the partner possessing the information can gain minimal benefit from the information if it is not shared. However the other party can gain strategic and competitive benefits. This can occur for instance when the supplier has access to the buyer's POS information on sale of products from other suppliers in addition to information on their own product sales.

The arguments posited by Seidmann and Sundararajan (1998) provide some useful insights on understanding how the scope of information shared can benefit the buyer/supplier

relationship, but by taking an ex post stance how these benefits are achieved is unclear. For instance can one attribute the benefits to the type of information shared or the frequency with which information is shared or some other factor? Although decisions surrounding the type of IIS is outside the scope of their classification, its importance in supply networks warrants further study and will be addressed in this dissertation.

Another scale-based study considers three different types of IIS (Gavirneni et al. 1999): no information sharing, partial information sharing and full information sharing. With no information sharing the supplier only has information on the orders received from the buyer and must utilize historical data to augment the order information when preparing demand forecasts. In the case of partial information sharing the demand distribution faced by the retailer and the retailer's inventory policy are known. Finally with full information sharing, the supplier also receives instantaneous information on the retailer's demand. This real-time sharing of information essentially is concerned with the frequency with which information is shared, thus can provide answers on questions dealing with "how to share".

In another study Spekman et al. (1998) analyze the level of intensity in buyer-supplier relationships. Intensity is characterized by the strategic importance and the complexity of the relationship (financial, commercial) between the parties. The sharing relationship evolves from one of cooperation (low strategic importance, high level complexity) to one where there is full collaboration (high strategic importance, high complexity). When both the strategic importance and complexity are low, no information is shared resulting in an arms-length relationship in which there are open-market negotiations. At the cooperation level only essential pieces of information are exchanged and there is the tendency for longer term contracts to be established. The co-ordination phase (high strategic importance, low complexity) involves the exchange of

workflow and information. This facilitates the smooth flow of operations between the partners thus allowing provisions for Just-in-time and EDI systems. As trust and commitment deepen, the intensity level of the relationship increases further, to the point where collaboration occurs. At this level, the information shared incorporates strategic plans, future designs and R&D.

Although this is an evolutionary process, Spekman et al (1998) argue that it is unnecessary for all relationships to strive for collaboration since the relationship may not require that high level of intensity to accomplish the common goals of the partners. Their study answers questions on "what information is shared" by looking at the intensity of information shared, however questions still remain on how to share.

The above review on information sharing perspectives though not exhaustive is representative of much of the existing literature where we find a lack of consideration of both the type of information shared and the frequency with which it is shared, factors that this study intends to address.

2.3.3 Influence of Uncertainty on Information Sharing

Several research studies have investigated how conditions of uncertainty influence information sharing between firms. These are examined in the context of horizontal relationships as exist between oligopolies (Gal-Or 1985; Li 1985; Shapiro 1986; Spulber 1995; Ziv 1993) or vertical relationships between a manufacturer and one or more retailers (Anand et al. 1997; Cachon et al. 2000; Corbett 2001; Gal-Or 1991).

Uncertainty conditions typically examined are demand (Anand et al. 1997; Cachon et al. 2000; Clarke 1983; Gal-Or 1985; Li 1985), and supply in terms of costs (Clarke 1983; Corbett 2001; Li 1985; Shapiro 1986; Spulber 1995; Ziv 1993), and less frequently capacity (Farmer

1994). Gal-Or's (1985) study models the incentives for firms to share information when demand is uncertain. The results indicate that private information will not be revealed in situations of demand uncertainty where oligopolistic firms behave as Nash competitors when setting output levels. This occurs regardless of the firm's ability to make inferences about the signals that are observed by others. Gal-Or's derivation is based on a symmetric environment so may not be generalizable to situations where there is a dominant firm. Also she considers only demand uncertainty so the incentives for firms to share information may be different when technology or supply is the uncertain parameter. Furthermore no interaction is considered between vertical parties.

Both cost and demand uncertainty are investigated in Li's (1985) study that examines within a theoretical framework the incentives for multiple firms engaged in Cournot oligopoly to share information when these uncertainties exist. While both Gal-Or (1985) and Clarke (1983) assume that the signals are normally distributed, Li on the hand assumes that the signals are linear and that the signals are received with equal precision thus are symmetric. Interestingly there is a difference in the results between a firm's willingness to reveal information that has common value (demand in this case), and information that has private value (cost information in this study). When firms face uncertainty in demand that is common to all firms, no information is shared between firms however, when the private cost function is uncertain, firms are willing to share information. As the total amount of information increases (measured by the increase in total number of firms) firms are indifferent between pooling and non-pooling of information. His results, for information sharing when there is demand uncertainty, are consistent with that found by Clarke and also by Gal-Or in the case of a duopoly.

In a later study Li (2002) extends the concept of information sharing when there is uncertainty to examine what happens when information is shared vertically in a supply chain and there is horizontal competition among the retailers. This is one of the few studies that look at both vertical information sharing and horizontal competition. The model assumes that there is a three stage non-cooperative game as follows: 1) retailer decides whether to share private information about uncertainty with manufacturers who then decide whether to get this information, 2) price for the goods are set by the manufacturer, 3) retailers send in orders and the manufacturer produces to meet these orders. The common parameters, demand and private cost uncertainty situations are examined. Results indicate that retailers have no incentive to voluntarily share their demand information. One reason is that the competitors on learning of this information (leakage effect) will make adjustments to their strategy. At the same time they are unwilling to share any information with the manufacturer (direct effect) because such information will be used to get more economic and information rent, which will hurt the retailer.

When information on costs is shared, the benefits to all retailers from sharing with the manufacturer are greater than the unwanted direct effects thus retailers will share cost information. The overall profit to the supply chain will increase with information sharing only if there are a large enough number of retailers (greater than 2 retailers) or when each retailer's information is considered relatively informative, statistically. If all retailers share their demand information with the manufacturer, consumers are worse off as manufacturers have to pay a price to get this information since retailers are not willing to share this voluntarily. However they are better off when cost information is shared or when there are no side payments for the information.

In this dissertation, how the relationship between IIS and performance is impacted when there is internal uncertainty (i.e. the type of uncertainty that plays a critical role in the TCE literature) is investigated. This is discussed in Section 2.5.

2.3.4 Information Distortion

Researchers have studied the information distortion resulting from delays, oscillations and amplifications as demand information flows through the supply chain. This began with work by Forrester (1958) and more recently by researchers such as Lee et al (1997b). This distortion is characterized as the bullwhip effect, and looks at the variance between orders to the suppliers and sales to the buyer. Sources identified for this effect are demand signal processing, rationing game, order batching and price variations. In Lee et al's (1997b) paper the researchers assume that the decision makers are rational and propose that corrections to the bullwhip effect should involve adjustments to organizational and institutional infrastructure and their processes. They suggest that members in the supply network share information on sell-through and inventory status data, coordinate orders across retailers and simplify the pricing and promotional activities of manufacturer. Some suggestions on information sharing strategies that can contribute to the significant reduction of the "bullwhip effect" are provided but these researchers (Lee et al. 1997b) do not provide much detail on how these strategies can impact the performance of the supply network.

2.3.5 Performance Implications of Information Sharing

The impact of information sharing on performance has been investigated in several research studies, however as mentioned in Section 1.1 the results have been ambiguous. Some

researchers claim that information sharing significantly benefits the overall performance of the supply network (Gavirneni et al. 1999; Lee et al. 2000a; Novshek et al. 1982)
while others point to minimal improvements (Aviv 2002; Cachon et al. 2000; Chen 1998) or to no impact (Clarke 1983; Graves 1999).

Gavirneni et al (1999) investigate the value of information sharing when the parameters of the retailer's ordering policy are shared with the supplier who is the only source of inventory and has limited capacity. They analyze three cases: 1) supplier has no information except prior orders from retailer, 2) supplier knows demand distribution faced by retailer and the inventory policy, 3) supplier also receives frequent updates on retailer's demand. Savings when case 1 and case 2 are compared ranged from 10% to 90% in situations where the additional information relates to capacity. No benefit is found at low capacities when case 2 and case 3 are compared, since in those situations there is very little opportunity for flexible production. At higher capacities, savings range from 1% to 35%. Their study only looks at cases where the demand processes are independent and identically distributed over time which is not necessarily true in the real world and is only modeled based on a dyadic relationship.

Cachon et al (2000) compare the value of information sharing to that of reduced lead times and reduced batch sizes in a model with one supplier and multiple retailers where demand for each retailer is assumed to be independent. Since each retailer has an exclusive territory there is no competition among the retailers. Their results show that the greatest reductions in costs (proxy for value of shared information, thus supply performance improvements) are from reduced batch size (22%) and reduced lead times (21%), with information sharing contributing only 2.2% on average to reduced costs although it can be as high as 12.1%. The researchers recommend that Information Technology implementation be focused on improving the physical

flow of goods rather than the information flow through the supply chain. Only the direct effects of vertical information are considered. Also not covered are the effects of information sharing when retailers are not identical, or how firms behave when they do not have the same objectives?

Investigation on which parties stand to gain from information sharing indicate that the manufacturer gains through inventory and cost reduction (Lee et al. 2000a). While the manufacturer gets direct benefit from information sharing, this is not the case for the retailers since their gains from cost savings and inventory reduction are derived from reduction in lead times. Implementation of lead-time reduction and information sharing strategies concurrently are recommended for a win-win situation.

Raghunathan (2001) refutes the claim made by Lee, So, and Tang (2000a) that there are significant benefits to the manufacturer when the retailer shares information on Point-of-Sale (POS) demand, claiming instead that the benefits of information sharing are overstated by Lee et al. They assume that the manufacturer uses the retailer's order history to forecast order for the next period. Results indicate that information sharing has value to the manufacturer, only in the situations where the demand parameters are unavailable and cannot be deduced from the parameters that are available.

Another perspective is obtained from Yu et al's (2001) study. They develop a cost-minimizing mathematical model involving a two stage decentralized supply chain with one retailer and one manufacturer to show the benefits of information sharing in a supply chain. Three levels of information sharing are studied: 1) no information shared except orders, 2) demand information shared, 3) EDI used to access demand information and may use a Vendor Managed Inventory system. Results show that while both the retailer and the manufacturer receive benefits, the manufacturer stands to gain more as the level of information sharing

increases, owing to a reduction in demand uncertainty. Benefit accrues only to the manufacturer with level 2 information sharing, but at level 3 there is less variability in inventory levels and overall inventory costs are minimized which benefits the retailer. The performance of the supply chain shows an overall improvement with information sharing. Only one retailer is studied which limits the practical application of this study.

Similar to Yu et al's study, several research studies examine different levels of information sharing. These are generally classified in terms of none, partial and full information sharing (Anand et al. 1997; Aviv 2002; Chen 1999; Gavirneni et al. 1999; Li 1985; Zhao et al. 2002a) along a continuum. With no information sharing the only communication on demand for instance is through order requisition, while with full information sharing, parties have access to all the information that is needed for their decision making endeavors.

2.3.6 Role of Coordination Structure

As shown in Yu et al's study, the coordination structure can facilitate better sharing of information between the supply chain partners and is thus a critical element with respect to information strategies. Coordination structures range from decentralized where decisions are made independently, to fully centralized structures where decisions are made by a single entity (Anand et al. 1997; Chen et al. 2000; Corbett 2001; Yu et al. 2001). Information sharing and physical flow coordination are identified as critical prerequisites for supply chain integration (Sahin et al. 2002). Based on an extensive review of the literature on physical flow coordination and information sharing in a supply network, Sahin & Robinson (2002) classify this literature stream into three categories: no information sharing and no physical flows coordination, partial and full information sharing with no physical flow coordination, and full information sharing and

full system coordination. They suggest that a richer understanding of supply chain integration can be obtained if the problem scope studied is broadened to include environments, structures and processes that are more representative of the industrial context than the simple analytical models typically used to explore many of these phenomena. Towards this end, empirical studies provide one avenue for accomplishing this goal, assuming that the proper metrics are used to operationalize the variables being studied.

In summary, the various research streams on IIS allude to the complexities associated with this phenomenon and the importance of having a clear understanding of the underlying forces that are involved. Theoretical and empirical evidence from these studies highlight the importance of structures, processes and the resulting outcome measures, within environments that are subject to uncertain conditions. Prior studies have investigated this partially with respect to IIS but a synthesized view that assimilates these linkages has not been established. In this study, a move towards filling this void in the literature is made by examining, within the context of the supply network, how the supply network configuration (a structural factor) influences IIS and in turn how this impacts the performance of the supply network in the face of certain internal uncertainty conditions.

2.4 Factors Influencing IIS

In the economics literature there is an extensive body of work that uses mathematical models to study equilibrium conditions under which information sharing occurs in competitive markets. Typical parameters that have been analyzed for their influence are the characteristics of the product, the type of uncertainty, and the type of information shared (public, private, cost, demand). The ensuing analysis of IIS within a supply network is guided by some of these

findings in addition to studies in other fields such as strategic management, sociology, marketing, and operations research.

2.4.1 Supply Network Configuration

Traditionally the supply network configuration is viewed as one that is primarily concerned with the collaboration between firms on facility selection and allocation of products to selected sites. However a broader perspective envisions it as a "dynamic process of assembling chains of capabilities and not just collaborating organizations" (Herer et al. 2002).

The strategic importance of networks has led to the expansion of the supply chain concept to incorporate supply networks (Lamming et al. 2000). A supply network can be defined as:

> *"[a network] nested within wider inter-organization[al] networks and consists of interconnected entities whose primary purpose is the procurement, use and transformation of resources to provide packages of goods and services." (Harland et al., 2001)*

or as

"*a complex adaptive system: it is emerging, self-organizing, dynamic, and evolving" where "a complex adaptive supply network is a collection of firms that seek to maximize their individual profit and livelihood by exchanging information, products, and services with one another." (Choi et al. 2001)*

Both definitions indicate the complex nature of these supply networks; however, the latter definition goes a step further by introducing the concept of a flexible system that changes in response to the needs of the business, and one in which firms take a more active role in facilitating the change process. The supply network can have multiple stages and in each stage it is possible to reduce duplication of effort and unnecessary activities by focusing on congruent objectives. Thus the potential for success is enhanced when critical information is shared between supply network partners (Spekman et al. 1998).

The supply network configuration can range from simple inter-organizational sets to more complex network arrangements involving many stages. The structural dimensions frequently used in the literature to describe complex supply networks are: vertical structure, horizontal structure, and location in the network (Harland 1996; Lambert et al. 1998; Randall et al. 2001; Spens et al. 2002). Applying these dimensions to a wider organizational set that includes both single and multi-stage arrangements, the *network pattern* and l*ocation in the network* are examined.

Both the structure of a firm's network, and where each firm and its contacts are located in the structure determine the likelihood of a firm gaining benefit from the network (Burt 1992). Thus a study of these factors and the ensuing interactions between network partners provides some useful insights that can contribute towards a better understanding of IIS and the overall behavior of transacting parties. Within the supply network, goods and services flow in one direction; payments flow in the opposite direction; and information flows in both directions.

Network Pattern

Three different network patterns can be used to study inter-organizational relationships: dyadic, multiple dyadic and multi-channel networks (Van de Ven et al. 1980). The patterns for a single stage relationship between two layers of the network are depicted as follows:

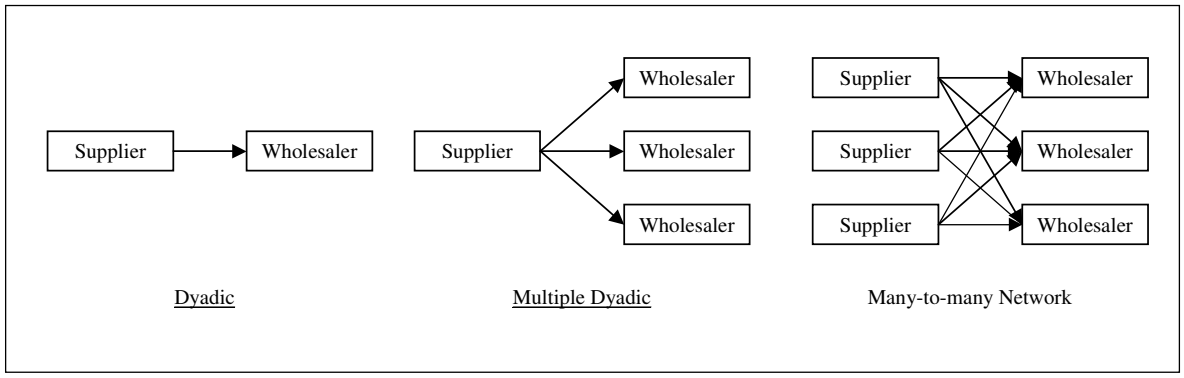


Figure 1. Network Patterns – Single Stage

a) Dyadic network refers to the interaction between two firms (e.g. 1 supplier and 1 wholesaler).

b) Multiple dyadic network refers to the interaction of one firm with several other firms (1 to N or N to 1). This can take the form of 1 supplier and N-wholesalers or N-suppliers and 1 wholesaler, for example. Here the N-participants can also be competitors. An example of the 1 to N interaction is the relationship between an airline and several independent travel agencies.

c) Multi-channel network denotes relationships in which several firms interact with several other firms (M to N or many to many). Possible interactions include M-suppliers linked to N-wholesalers with competition possible within the M and the N – groups.

The number of suppliers contributes to the complexity of the supply network (Beamon 1999). Complexity is reflected in the load on the network for coordination purposes, and this is based on the degree of differentiation among the firms in the SN and the level of coupling (Choi et al. 2002). Ceteris paribus, the least complexity will be experienced in the dyadic network and the most in the multi-channel network.

Number of stages

In addition to the single-stage it is also possible to have multi-stage relationships. In its simplest form, denoted as the multi-stage dyadic network, a single firm is connected to one other firm at the next stage in a chain that extends from the initial raw material supplier to the end consumer. In this arrangement relationships exist primarily between firms that are adjacent to each other along the chain although exceptions may occur during initial startup when relationships may involve interactions between firms from noncontiguous stages.

A more complex pattern exists for the multi-stage network as shown in figure 2:

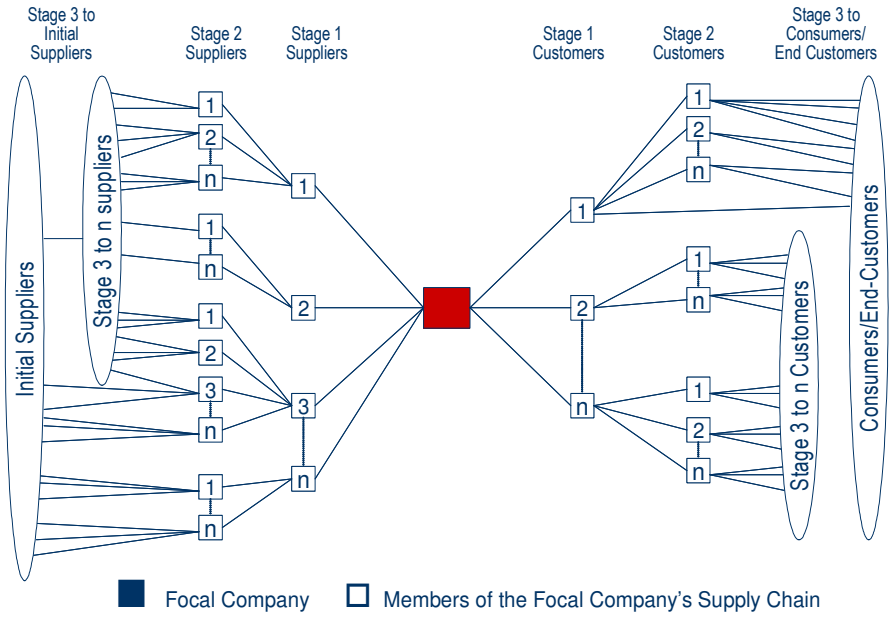


Figure 2. **Network Pattern – Multi-stage Network (Source: Adapted from Lambert & Cooper, 2000)**

In this pattern there is both a vertical and a horizontal dimension. The horizontal dimension depicts the number of firms at each stage. For instance in the supply network for the Accord center console there are two suppliers (CVT and JFC) who have a direct relationship with Honda and each of these suppliers have several second suppliers with whom they in turn have direct relationships (Choi et al. 2002). The vertical dimension depicts the number of stages extending from the initial raw material, located furthest upstream from the focal firm, to the consumer/end customer located furthest downstream from the focal firm. The level of integration between the focal firm and upstream (suppliers) and downstream (customers/buyers) entities will vary depending on their perceived importance to the focal firm (Lambert et al. 2000).

Location of the firm in the Supply network

The third factor in the supply network configuration is the location of a firm in the network. Here the focus is on the sub-network comprised of one buyer and one supplier. Each participant has a location in the supply network that can range from a location at the initial source of raw materials to one at the consumer, or somewhere in between (Lambert et al. 2000). A firm's location in the supply network can affect its experiences and consequently its interactions with others in the network.

For instance, the pace of technological change, "clockspeed", differs dramatically in industries and is also uneven across the supply network (Fine 1998). He notes that the entertainment industry has one of the fastest "clockspeeds", with the half-life of motion pictures ascertained just days after launch. On the other hand the automobile industry has a much slower "clockspeed" of four to eight years before retooling of a model. According to Fine, firms further downstream, that is, closer to the consumer experience greater "clockspeed" amplification. In markets with fast "clockspeeds", low barriers to entry and low switching costs can dramatically reduce first mover competitive advantage as competitors quickly produce close substitutes.

Demand volatility also differs depending on a firm's location in the network. This volatility arises from the failure to accurately forecast future requirements causing production schedules to be inefficient. According to Lee et al (1997a) the further upstream a firm is in the supply network (away from the consumer), the greater the demand volatility and this is attributed to an amplification of the distortion of information. For instance, in a network with a retailer, manufacturer of finished goods, and parts supplier, the retailer will have the least demand volatility and the parts supplier will have the most. Such volatility can be reduced if members in

the supply chain provide upstream members with access to sell through data, and information on the status of inventory (Lee et al. 1997b).

2.4.2 Coordination Structure

One of the challenges for organizations is how to accomplish "purposeful, coordinated action from organizations comprising many individuals" (Grant 1996). The coordination structure plays an integral role and is particularly important in the sharing of information across firm boundaries. Coordination structure has been defined as "a pattern of decision-making and communication among a set of actors who perform tasks in order to achieve goals" (Malone 1987). Two of the key determinants of a firm's coordination structure are decision rights and information structure (Anand et al. 1997).

Decision Rights

Decision rights determine where the locus of authority resides for making decisions, that is, 'who' makes the decision. Two extremes on this continuum are centralization and decentralization. In a highly centralized structure the locus of authority resides at a single point, while in a highly decentralized structure the locus of authority is dispersed (Robbins 1990). For example, the degree of centralization in a supply network context can be determined by the amount of authority that the final assembler has over the suppliers in the network (Choi et al. 2002). When the locus of authority for making decisions resides with the final assembler, the supply network is centralized. In the decentralized structure each supplier can independently make its own decisions. As the supply network evolves and becomes more complex, centralized decision-making can become arduous, as a single point of contact is unable to effectively handle all decision-making activities.

Information structure

The second determinant of coordination structure is information structure and is concerned with identifying the type of information that is available for decision-making purposes. Decisions within a SN can be based on local information, global information or a hybrid of the two (Anand et al. 1997). A SN with centralized authority is associated with the use of global information, while a decentralized one will rely on local information for decision-making, even though mismatches can occur as studied by Anand and Mendelson (1997). These combinations of decision and information structure can be thought of as 'centralized coordination structure' and 'decentralized coordination structure' respectively (Samaddar et al. 2006).

Several researchers suggest centralization as the primary structural mechanism to achieve the integration needed to coordinate complex systems (John et al. 1984; Russell et al. 1992; Tsai 2002). According to Robbins (1990) the decision on the appropriate level of centralization will depend on situational factors. In a decentralized coordination structure firms are able to respond quickly to changes at their individual location, which is an important capability to have when the local environment is susceptible to rapid changes. Such a structure offers opportunities for the decision maker to incorporate the local information when making decisions. A decentralized structure is also more appropriate when there are characteristics that are unique to a particular location or firm, such as local nuances, which need to be considered before making a decision. As such, it cannot be easily captured in a centralized system owing to the specific (or tacit) nature of its knowledge. For instance, in some liquor stores sales data on each store is collected and that information is used to analyze store performance, and forecast reorder amounts cognizant of local drinking habits and tastes. One of the drawbacks of a decentralized structure is

the likelihood for misalignment between the interests of an individual firm and those of the network. Thus the costs incurred in inducing the firm to adjust its interest to match those of the network can be high (Anand et al. 1997).

In contrast, the centralized coordination structure is more appropriate when the decision maker needs to take actions that benefit the total network, rather than the special interests of individual firms. This structure is also more suitable when there are distinct economies of scale, or a need for using standard products and procedures. For example, a large department store, used POS data from all of their stores for centralized demand trend analysis and to make purchasing decisions (Anand et al. 1997).

The centralized coordinated structure also has its challenges. It is costly to gather information that is tailored to meet the needs of individual firms. Such information is however necessary to get optimal performance in the supply network. For instance a supplier may receive POS data from retailers but also needs to be told about a promotion that a retailer is planning to mount in the near future, so that the correct replenishment decision can be made (Aviv 2002). Another challenge with a centralized structure is that entities that are under the control of the central authority tend to display more loyalty to the authorized body, which makes it difficult to get cooperation between firms in the network on issues such as those related to quality and delivery (Choi et al. 2002).

2.5 The Role of Uncertainty in Supply Networks

Several problems associated with supply networks have been attributed to uncertainty surrounding the network. Uncertainty can be defined as the difference between the information needed to perform a task and the information currently available to an organization (Galbraith

1973). Unpredictable situations and behaviors are likely to result from the many alternative outcomes that are possible. For example, problems such as the “bull whip effect" (Lee et al. 1997a), and expedited orders to meet unplanned demand create suboptimal results for the supply network. A key organizational challenge for managers is how to manage a variety of interdependencies in the face of behavioral uncertainty (McEvily et al. 2003) from this lack or absence of critical information.

Uncertainty has been characterized in several different ways but they can all be considered as arising from sources that are either internal or external to a particular domain. The three main sources (Fig. 3) present in supply networks are:

1) suppliers (e.g. delayed deliveries),

2) manufacturing (e.g. machine breakdowns),

3) customers (e.g. fluctuation in orders)

Ultimately, all of these sources have an adverse effect on customer service and the overall performance of the network (Davis 1993; Yu et al. 2001).

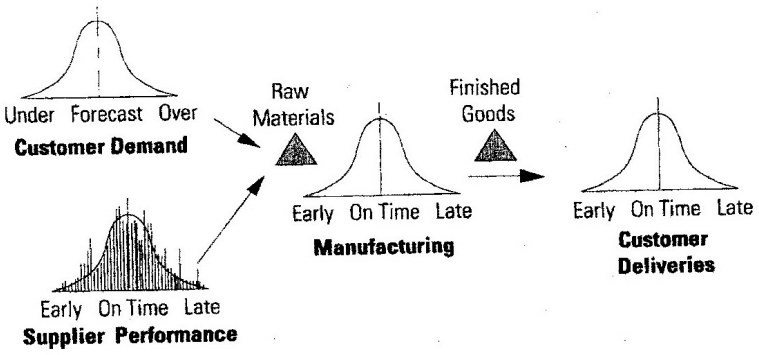


Figure 3. Sources of Supply Network Uncertainty (Adapted from Davis, 1993)

Of key importance to this study of supply networks are two distinct internal uncertainties: partner uncertainty (primary source: supplier) and process uncertainty (primary source: manufacturing).

2.5.1 Partner Uncertainty

Two conditions that impact the level of partner uncertainty are **partner information visibility** and **variability in supplier capability**.

Partner information visibility refers to the extent to which the information provided by a firm within a network to its partners is adequate to assess the present conditions of that firm's (the provider of information) operations. Critical to that assessment is having information that is accurate, timely, complete and comprehensible. When any of those information attributes fall short of the level required to properly assess the partnering firm's operations, the level of partner information visibility is reduced.

Firms react to low partner information visibility by distorting, delaying, providing partial information or obfuscating the information provided. For instance, two of the strategies that firms use when there is low partner information visibility are demand signal processing and shortage gaming (Lee et al. 1997b). In shortage gaming, firms place multiple orders with several suppliers in order to have a higher probability of receiving sufficient quantities of a product that is in short supply. Such actions are oftentimes driven by a lack of adequate operational information from suppliers on matters such as their inventory levels. With demand signal processing, firms artificially raise the size of orders to their suppliers in periods of rising demand as they anticipate that it will continue to increase. Inflated and phantom orders cause the suppliers to overproduce. Long lead times exacerbate this situation as it is virtually impossible to

quickly halt production when the expected demand does not materialize and there are an unusually high number of order cancellations. It is quite likely that the orders would not have been distorted had buyers had access to Just in time (JIT) purchasing or been privy to current information on the production schedules, inventory levels and lead times of their suppliers all of which require the sharing of information.

Low partner information visibility also has a negative impact on the party that withholds information. Buyers, for example, that fail to provide timely information on their volume requirements miss out on the potential for economies of scale that could have been realized had the supplier been able to incorporate that information into his/her plans. Consequently it becomes more costly for those buyers to acquire their products. Overall there are losses for the supply network since adequate IIS is needed to devise plans that can provide optimal performance for the supply network (Sadler et al. 2002).

Variability in supplier capability is defined as the level of uncertainty that exists when a firm is unable to determine if a supplier has the capability to function effectively under circumstances that differ from those that existed when the agreement (formal or informal) was originally established. As firms have become more focused on their core competencies, there has been a greater reliance on external parties to fulfill their other requirements (Handfield et al. 2002). Driving force for doing this is to gain competitive advantage through reduced costs and time to market, improved quality, and access to the technological capabilities of their partners (Handfield et al. 1999b). Since firms rely heavily on their partners to provide the resources that are needed to augment their core functions, the ability of these partners to meet their expectations is of paramount importance.

Uncertainties arise when there is high variability in a supplier's capabilities. Such uncertainties exist despite high partner information visibility as the latter is more focused on the present situation. Even with information that allows an assessment of a firm's operations, questions still remain on whether or not that firm can perform as expected when for instance a product requires significant design changes. Apart from the uncertainty that arises when there are significant product/component changes, variability in supplier capability can also occur when there are significant process or technology interface changes. All these changes can adversely impact the scope or scale of operations of a supplier, which in turn affects the quality and timeliness of the goods and services provided. The ability of a supplier to meet quality and timeliness standards appears to be of some concern to buyers evidenced by the prime importance placed on these two criteria during the supplier evaluation process (Chao et al. 1993).

When suppliers have inadequate capability they tend to show deficiencies in matters such as quality, delivery, product design capability, and the ability to reduce costs and adopt new technology (Monczka et al. 1991). Some of these deficiencies may be attributable to personnel not being trained to keep abreast of new technologies, obsolete or inefficient equipment, and inadequate plant capacity.

Supplier development programs such as those instituted when the manufacturer is able to identify that their suppliers are unable to meet previously established business objectives (Handfield et al. 2000) can be used to improve a supplier's capabilities. Supplier development activities can take several forms including supplier certification programs, supplier training, formal evaluations and site visits (Krause et al. 1997; Monczka et al. 1993). The timely execution of these activities is critical to the overall performance of the supply network. A few firms such as Honda and Toyota have achieved faster improvements in the capability of their

suppliers through direct supplier development involving the provision of capital, technology, personnel and equipment resources to their suppliers (Monczka et al. 1993).

2.5.2 Process Uncertainty

Process uncertainty is defined as "fluctuations in process outcomes and production times due to variable process yields, perishable end-products, machine breakdowns, etc" (Vorst et al. 1998). All of these fluctuations provide some indication of the capacity of an organization to meet their scheduled production commitments (Geary et al. 2002). Process uncertainty within the manufacturing cycle has been categorized (Koh et al. 2002) into three parts as follows:

- Internal supply uncertainty which takes place at the supply chain and leads to lot-sizing and planning horizon uncertainty as well as capacity loading uncertainty (e.g. late arrival of parts from one work station).
- Internal demand uncertainty that occurs at the demand chain and leads to process yield loss or variation in quality (e.g. inconsistencies in the quality of the manufacturing process).
- Internal demand and supply uncertainty that leads to variation in process lead times and scrap, and affects the availability of parts.

One way of dealing with these uncertainties is to institute inventory (e.g. safety stock), capacity (e.g. excess capacity) and time (e.g. lead time) buffers in the production system (Hopp et al. 2004). It is important that managers understand the operational requirements and resource capabilities of their particular organization, and how they impact other firms in the network so that the correct mechanisms can be instituted to reduce costs and increase efficiency. Several costs are incurred when there is a machine breakdown, for example. These costs include those

for inspection, repair, and machine downtime which are measured as lower product quality or lost production capacity (Mann et al. 1995).

Although some researchers (Davis 1993) suggest that demand uncertainty from external sources has the greatest impact on the performance of the supply network, the influence of process uncertainty cannot be ignored. Process uncertainty can affect other activities of the supply network as shown in Figure 4 where the process uncertainty loop (one of the three feedback loops) contributes to the overall instability and chaos (Childerhouse et al. 2003). Uncertain deliveries result from this process uncertainty which in turn adversely affects the supply network, creating distortions in customer orders and further distortions to information flow. This continues in a "vicious circle" (Childerhouse et al. 2003) and is exacerbated by other uncertainties present in the network.

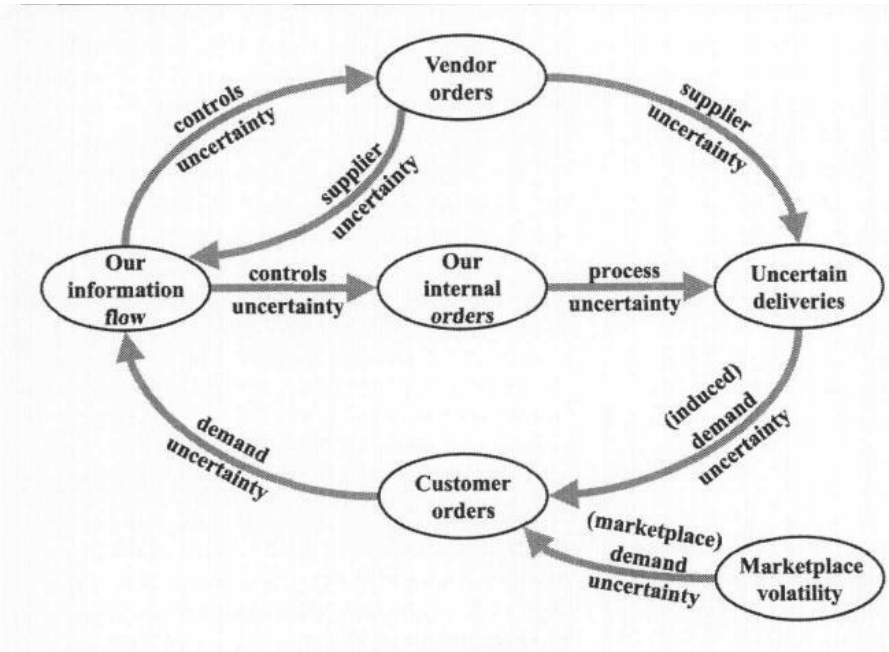


Figure 4. **The "Vicious Circle" Caused from Uncertainty (Adopted from Childerhouse et al, 2003)**

Ultimately the operational performance of the supply network may be adversely affected so it is important that the design of processes incorporate the relevant policies and procedures, and that IIS occurs in a timely manner.

According to Geary et al (2002) uncertainty in the supply network can be alleviated and performance improved if companies try to develop a "seamless supply chain", which they define as:

"*an idealized concept of perfect information flow and perfect material flow, facilitated by all supply chain players thinking and acting as one. Yet although it is an idealized concept, the seamless supply chain is not beyond reach in reality. In fact there is a well-trodden path in that direction that relies on best practices and extended visibility. Supply chain leaders who follow this path will be rewarded with improved business performance.*"

Best practices advocated include lean thinking, value stream management, and smooth material flow while at the same time maintaining simplicity through the use of established and proven solutions.

3. RESEARCH MODEL AND HYPOTHESES DEVELOPMENT

Building on the theoretical foundations presented in the prior chapter, a framework for this dissertation is now developed that addresses the research questions related to IIS in the supply network. The expected relationships between different types of IIS and various configurations of the supply network are postulated. The impact of the degree of centralization on these relationships is also explored. The argument proposed is that the type of IIS will vary depending on these factors and that the impact of IIS on the performance of the network will be influenced by partner and process uncertainty considerations. The research model is presented in Figure 5.

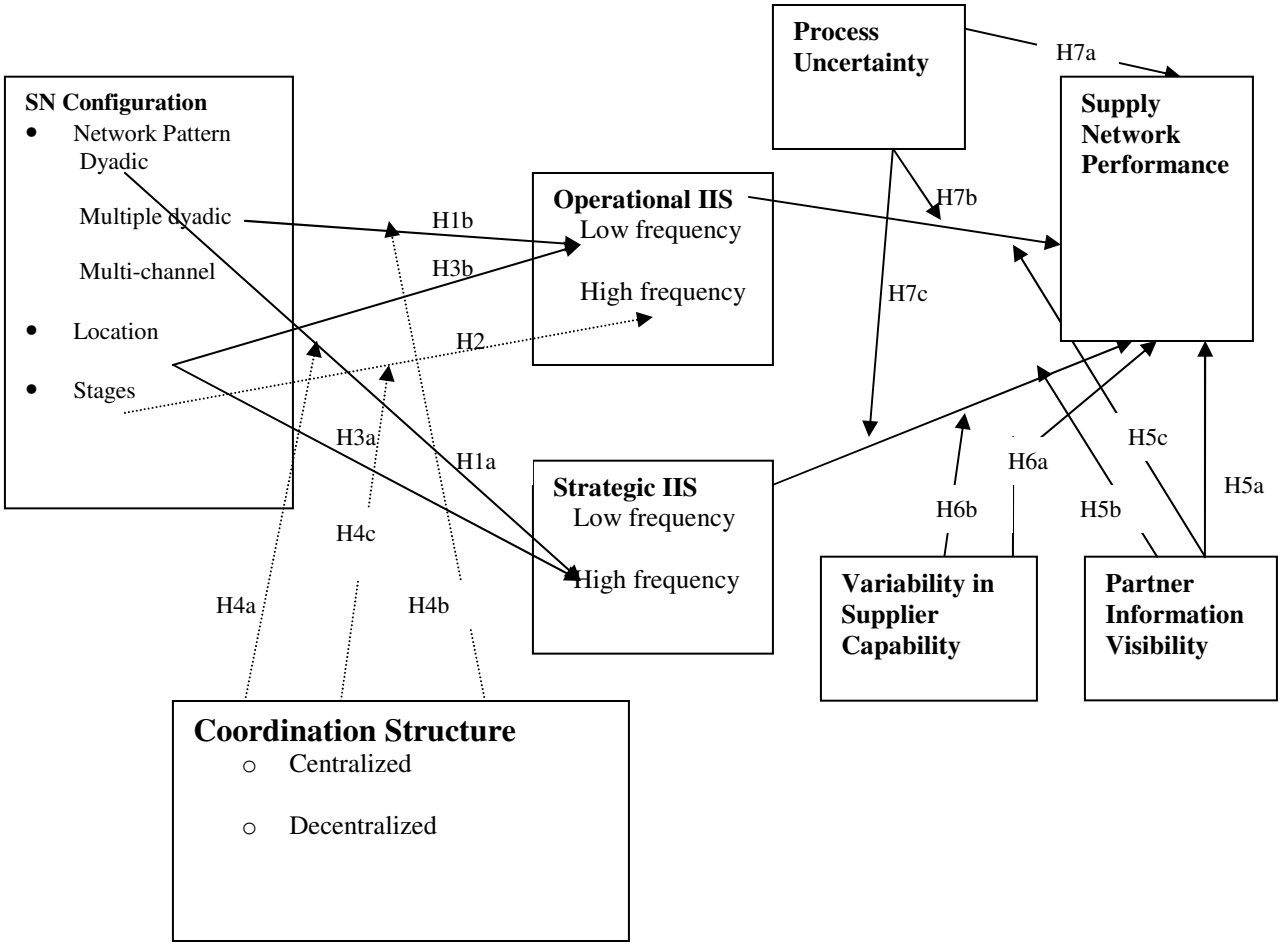


Figure 5. Research Model

In order to study IIS from a broader perspective than is customary in the literature, we use a two-dimensional matrix that looks at both the type of information shared (operational vs. strategic) and the frequency of information sharing (low vs. high) (Samaddar et al. 2004) which is presented in Table 3-1.

Table 3-1. Typology of Inter-organizational sharing

	Type of Information		
Frequency of IIS		Operational	Strategic
	Low	Type 1	Type 3
	High	Type 2	Type 4

Since the focus is on information sharing transactional types of arrangements between partners, which typically involve arms-length relationship in which no information is shared, are excluded. Type 1 (Type 2) IIS is the low (high) frequency state where only operational information is shared. Similarly, Type 3 (Type 4) is the low (high) frequency state where strategic information is shared. Characteristics associated with each of these types are discussed in Appendix A.

3.1 Supply Network Configuration and IIS

In Section 2.4.1 three key dimensions of supply network configuration were identified: network pattern, number of stages, and location in the network. The contention is that the level and type of IIS will vary depending on these factors.

3.1.1 Network Pattern and IIS

Let us first discuss IIS with respect to the dyadic network pattern. A firm investing in highly specified assets is susceptible to opportunistic behavior from an exchange partner unless

protective safeguards are put in place to prevent such behavior from occurring (Williamson 1985). Vertical integration is suggested as the traditional safeguard when asset specificity is substantial and uncertainty is high, as here transaction costs will be minimized (Williamson 1991).

Since the survival of the relationship depends on both parties there is a high level of interdependence. For instance, consider the case where a manufacturer makes high investments in employee training that has applicability only for the products that it makes for a specific buyer and for which no other sources are readily available to provide such products. Given this information specificity (Choudhury et al. 1997) and the lack of alternative sources, both buyer and supplier are interdependent and recognize that mutual cooperation is necessary in order for the venture to succeed. The desire to survive will motivate transacting parties to behave, according to TCE, as if they were one firm (Williamson 1991) showing high levels of cooperation and this will result in lower monitoring costs (Dyer et al. 1998; Nelson 1998; Ouchi 1980).

A similar sentiment is expressed in social network theory where interdependence is associated with direct connections. Characteristics of these direct connections are strong ties between parties, and a high degree of closeness and reciprocity (Granovetter 1973; Haythornwaite 1996; Marsden et al. 1984). As parties develop satisfaction with their exchange processes there will be increased commitment to an ongoing relationship (Dwyer et al. 1987b). In such an environment, there is high relational embeddedness where the sharing of "fine-grained" or strategic information is encouraged (Granovetter 1973; Marsden et al. 1984; Uzzi 1996; Uzzi 1999). Since fine-grained information refers to more detailed information, more frequent information sharing can be expected.

Turning from a dyadic to the single stage one-to-many network structure (multiple dyadic interaction pattern), TCE suggests that as the number of members in the network increases, the chance for costly hold-ups is reduced due to the availability of alternative sources (Williamson 1975; Williamson 1985). Thus parties who are desirous of remaining in the network will not behave opportunistically since they can be easily replaced. However there will be high transaction costs associated with coordinating the activities of an expanded network.

One challenge faced with this type of structure is the potential for competition between network members who are structurally equivalent, "those with a similar pattern of relations in a system" (Gulati 1995), but are not connected directly. Structurally equivalent firms will be reluctant to share private information with a transacting party due to the fear of information leakage (Li 2002; Seidmann et al. 1998). Absent highly specified assets, such fears will outweigh the closeness associated with high relational embeddedness (or strong ties). Thus exchange parties will be connected, as suggested in social network theory, with weak ties characterized by arms length transactions where only operational information is shared (Granovetter 1973; Uzzi 1996).

For instance, a study of several apparel firms found that manufacturers would share information on the designs that were in high demand only with those buyers with whom they had established strong ties (Uzzi 1996; Uzzi 1997). Further evidence on how tie strength affects the type of information shared is given by the following situation. Contractors with whom an apparel manufacturer maintained strong ties and frequent interaction learnt of the closing down of production operations nine months ahead of time, yet that information was not shared with contractors with whom manufacturers had weak ties (Uzzi 1997). Weaker ties are also generally associated with less frequent interactions and a focus on achieving only operational efficiency. A

transaction that involves weak ties has been referred to as "a deal in which costs are everything" or a "one shot deal" (Uzzi 1997) which suggests that with weak ties no strategic information will be shared and that the frequency of interaction will be very low.

Hypothesis 1a*: The single-stage dyadic pattern in a SN is associated with Type 4 IIS (high frequency, strategic).*

Hypothesis 1b: *The single-stage multiple dyadic pattern in a SN is associated with Type 1 IIS (low frequency, operational).*

3.1.2 Number of Stages and IIS

The multi-stage network relationships involve much more complexity and multiple interactions across several stages in the supply network than for the single stage. In these arrangements, it is difficult to identify the optimal state owing to the complex ("rugged") and dynamic nature of the network patterns ("landscape"), that send conflicting signals to the members in the supply network (Choi et al. 2001).

With so many stages and suppliers, maintaining efficient operations becomes very challenging owing to these different levels of interaction, varying informational needs, and incompatible goals. Since not all firms in the network are interested in, or may require maintaining close relationships (Lambert et al. 2000), both strong and weak ties will be in existence (Larson 1992). In this environment it is expected that strong ties will form among subgroups where strategic information will be shared but this information will not extend outside these close groups to firms that do not have these direct links.

Many firms in subsequent stages are unable to ascertain the impact that their actions have on others in the network so may act in their own self-interest thus increasing the transaction costs associated with doing business. Strategic information will not permeate through this seemingly decentralized network. Difficulties in coordinating activities are even more pronounced than for

the single stage and will necessitate sharing information frequently in an attempt to manage the interdependencies between parties.

Using external sources or systems to coordinate the flow through the supply network as complexity increases can mitigate some of these difficulties. For instance, one can use banks to coordinate payments, and inter-organizational systems such as the Sabre airline reservation system to coordinate the flow of information among airlines, travel agencies, customers, rental car companies and hotels (Premkumar 2000).

Hypothesis 2: *As the number of stages in the SN increases, the frequency with which operational information is shared also increases (Type 2 IIS).*

3.1.3 Location in the Network and IIS

Firms located downstream are more likely to share competitive and strategic information since the buyer, who is further downstream, has more relative bargaining power. This is due to the greater possibility that substitutes will be available, thus providing a wider choice of sources from which to procure the required goods (Seidmann et al. 1998). Consequently the potential for costly holdups is greater at locations closer to the initial source of raw material for the buyer. In these situations the buyer, who is in a vulnerable position, is unlikely to transfer decision rights to the supplier and will only share information that is required to improve operational efficiency (Seidmann et al. 1998).

Conversely, at locations closer to the consumer, both the buyer and the supplier have profit maximizing goals that are closely aligned which will deter opportunistic behavior thus lowering transaction costs (Williamson 1985; Williamson 1991). Exchange partners are willing to share decision rights which entail the sharing of strategic information in order to achieve the desired results.

Firms located downstream have closer bonds to the consumer who ultimately drives the demand in the supply network. These firms will therefore share information frequently as they strive to respond to the diverse demands of their customer base. Conversely upstream firms are much further away from the consumer and so have weaker ties to them. As such they are not as attuned to the needs of any one consumer since their outputs may not be geared to any particular market. Consequently they will share only operational information.

Hypothesis 3a: *In the SN, the location of firms close to the consumer (downstream) is associated with Type 4 IIS.*

Hypothesis3b: *In the SN, the location of firms close to the initial source of raw material (upstream) is associated with Type 1 IIS.*

3.2 The Moderating Role of the Coordination Structure

In this section arguments are developed to support the position that within a supply network, the degree of centralization will influence the relationship between the various configurations of the supply network and the associated types of IIS. Centralization facilitates the establishment of a shared language and code (Nahapiet et al. 1998) making it easier for partners to share information (strategic or operational).

For a single stage dyadic supply network, where there is a centralized coordination structure, one party (buyer or seller) will exercise authority and power over the relationship (Choi et al. 2002). The extent of that power is inversely related to the alternatives available to the other party. Where there are few alternatives (reliance is high), the more dependent party will voluntarily comply with the demands made by the other party and work towards accomplishing the goals that are beneficial to the relationship (Lawler et al. 1993). Such is the case in many buyer-supplier dyadic relationships where information specificity exists to a non-trivial degree.

It is expected that strong ties are more likely to develop in a centralized structure owing to the presence of a common language, and such a structure will allow exchange partners to share strategic information more efficiently. For instance, in regards to the Acura product line, Honda as final assembler, is in control of product design through use of a "guest engineer program" in which some of its engineers are on the top-tier suppliers' sites (Choi et al. 2002). An advantage of this program is the interaction that is afforded from co-location of the engineers from each firm, allowing the development of strong ties and, consistent with social network theory arguments, the sharing of strategic information.

On the contrary, in the decentralized coordination structure where both parties in the relationship behave autonomously there will be an absence of shared language and codes making it more difficult to share strategic information efficiently.

Hypothesis 4a*: For a single-stage dyadic SN the association with strategic IIS is stronger with a centralized coordination structure than with a decentralized coordination structure.*

As the complexity increases from dyadic to multiple dyadic up to multi-channel and multi-stage networks, a centralized coordination structure serves as a bridge across structural holes in the network. Such a structure has accessibility to network members even several stages down from the locus of control (Burt 1992). The frequency with which operational information is shared will increase given that there is a focal decision-maker that now has direct access to many members. In this central position the party can more effectively formulate plans that take the whole network into consideration. Although some firms in the network may resent the control by a central authority, the threat of being dropped from the network are sufficient to counteract any thoughts of resisting this type of control.

With a decentralized coordination structure, local suppliers have autonomy and so can respond quickly to the needs of their immediate customers without having to wait for

information to be processed through a central body (Bolton et al. 1990). Should they require operational information from parties outside their immediate domain this can be done through weak ties which can be established quickly. However parties involved in these exchanges will normally act in their own self-interest without any consideration for the goals of their partners (Nelson et al. 1991). Consequently it is unlikely that strategic information will be shared under these circumstances or that the information shared will be done frequently. In situations where there are multiple suppliers of the same product or product line, each firm will consider the other firms as rivals and therefore be unwilling to share private information. It is therefore expected that the relationships as posited in Propositions 1a, 1b will not be changed significantly with decentralization.

Hypothesis 4b*: For a single stage multiple dyadic SN the frequency with which firms share operational information is higher with a centralized coordination structure than with a decentralized coordination structure.*

Hypothesis 4c*: As the number of stages in a SN increases, the frequency with which operational information is shared inter-organizationally is higher with a centralized coordination structure than with a decentralized coordination structure.*

3.3 IIS, Uncertainty and Performance

In a world of perfect certainty, full accessibility to information renders IIS unnecessary for achieving optimal performance in the supply network. However, when there is some element of uncertainty, which occurs in many situations, the value of IIS can appreciate.

There is wide acceptance that IIS can be a source of competitive advantage (Dyer et al. 1998). IIS reduces the level of uncertainty (Reed et al. 1990), lowers information asymmetries, contracting and monitoring costs (Dyer 1997). As discussed in earlier chapters, benefits from IIS

such as reduced inventory levels (Bourland et al. 1996; Cachon et al. 2000) lead to increased efficiencies among members both downstream and upstream in the supply network.

Numerous research studies provide support for the positive relationship between IIS and performance (Cachon et al. 2000; Chen 1998; Gavirneni et al. 1999; Lee et al. 2000a), but the support in the literature is not unanimous. Part of the ambiguity found in the literature on the linkages between IIS and performance can be attributed to the role of uncertainty and this will be investigated. Changes in performance under uncertainty conditions can emanate from several sources such as processes and suppliers (Bhatnagar et al. 2005; Davis 1993). Thus it is expected that both partner uncertainty and process uncertainty will have an influence on the positive relationship between IIS and performance. The focus is on the performance of the supply network as this is more important than the performance of an individual firm (Lee et al. 1992).

3.3.1 The Role of Partner Uncertainty

Recall from Section 2.5 that partner uncertainty can arise from either low partner information visibility or variability in supplier capability. The realization that a partner has provided poor information may be difficult to detect at the time when information is shared. It may only be recognized as such at a later stage when, attempts to make a true assessment of the partner's operations are hampered as a result of the inadequacy of the information.

When partner information visibility is low, the efficiency of the supply network is reduced and the cost of doing business may be elevated. There is a greater likelihood that suboptimal decisions will be made both at the operational (e.g. production scheduling) and strategic level (marketing strategies or outsourcing alternatives) owing to the information asymmetry. Low partner information visibility has a particularly detrimental effect on upstream

firms that are not closely linked to the end consumer owing to the presence of demand uncertainty (Lee et al. 1997b).

Development of alternative strategies can alleviate some of the uncertainty. This may elevate transaction costs such as information, operating, and administrative costs which ultimately leads to lower performance of the supply network. For instance more inventories may be held to hedge against uncertainties but this leads to higher inventory costs thus reducing performance. Firms that develop a more collaborative relationship with their suppliers, where there are strong ties thus a better potential for a high degree of partner information visibility, can gain improved performance not only for their individual firms but for the overall supply network. Since low partner visibility has such detrimental consequences on the performance of the firm, the value of information shared is greater under these circumstances than when partner information visibility is high.

Hypothesis 5a: *The performance of a SN with high partner information visibility will be higher than the performance of a SN with low partner information visibility.*

Hypothesis 5b: *There is a stronger positive association between operational IIS and performance of the supply network in a SN with high partner information visibility than in a SN with low partner information visibility*

Hypothesis 5c: *There is a stronger positive association between strategic IIS and performance of the supply network in a SN with high partner information visibility than in a SN with low partner information visibility*

Supplier capability is also of critical importance to firms. Many firms perform an assessment of their suppliers' capabilities as part of the selection process; however this does not guarantee that those suppliers will be able to perform adequately when conditions change. Given a firm's uncertainty about the ability of a supplier to maintain agreed on standards, that firm will be hesitant to formulate plans that entail large capital investments, particularly when they are locked-in to their present arrangement. TCE suggests that high uncertainty surrounding a

partner's capability will lead to sub-optimal decisions and it is thus expected that the performance of the supply network will be adversely affected.

When there is high uncertainty surrounding a supplier's capability operational IIS will have very little value as the information shared is primarily relevant for assessing the current operations. Strategic IIS on the other hand has much greater value as that information can provide insights on issues such as plant facility expansion, personnel training, and financing alternatives for the supplier. One way to facilitate this type of IIS is through participation in supplier development activities. Through a supplier development program, for instance, firms will be more likely to communicate frequently, share proprietary information and are overall more successful than their counterparts that show little involvement (Krause et al. 1997).

Hypothesis 6a: *The performance of a SN with high variability in supplier capability will be lower than the performance of a SN with low variability in supplier capability*

Hypothesis 6b: *There is a stronger positive association between strategic IIS and the performance of the supply network in a SN with high variability in supplier capability than in a SN with low variability in supplier capability.*

3.3.2 The Role of Process Uncertainty

As suggested in Section 2.5, process uncertainty has implications for the operational efficiency of the supply network. For instance, as process uncertainty increases, the waste associated with that process also increases (Persson 1995). While vertical integration is suggested as providing optimal efficiency when uncertainty is high (Williamson 1985) this may not be possible owing to such factors as the unavailability of expertise or other resources in one firm and the high procurement costs to make such a change. Thus firms may turn to traditional measures such as safety buffers in order to deal with high process uncertainty. Increased operational costs are incurred as firms hold excess inventory to offset uncertainty associated with

deliveries and demand. Increased transaction costs may also be incurred as firms implement more intensive monitoring and performance evaluation procedures to safeguard against network member firms' inefficiencies and to ensure that proper standards are met. Overall, the increased costs arising from process uncertainty will reduce the performance of the supply network.

When process uncertainty is high, both operational and strategic IIS can provide value to firms in the supply network. Operational IIS can allow firms to take proactive action by modifying their own internal schedules thereby reducing the impact on the firm's productivity and ultimately that of the supply network. Similarly strategic IIS can provide firms who are experiencing process uncertainty with, for instance, research information on similar issues that other firms have addressed. This can then be utilized to take corrective action.

Hypothesis 7a: *The performance of a SN with high process uncertainty will be lower than the performance of a SN with low process uncertainty*

Hypothesis 7b: *There is a stronger positive relationship between operational IIS and the performance of the supply network in a SN with high process uncertainty than in a SN with low process uncertainty.*

Hypothesis 7c: *There is a stronger positive relationship between strategic IIS and the performance of the supply network in a SN with high process uncertainty than in a SN with low process uncertainty.*

3.4 Summary

In this chapter the conceptual model was introduced and the typology of IIS, comprised of the frequency of information shared (low vs. high) and the type of information shared (strategic vs. operational)[2], explained. The arguments for the hypotheses in this manuscript were developed, drawing on concepts from transaction cost and social network theories. Table 3.2 presents a summary of the hypotheses.

[2] In an earlier study (Samaddar et al., 2006) propositions similar to hypotheses 1-4 were presented in which IIS was classified in terms of the strategic importance of information shared and the volume of information shared.

Table 3-2. **Summary of Hypotheses**

Hypothesis #	Hypothesis Statement
Direct Effects	
1a	*The single-stage dyadic pattern in a SN is associated with Type 4 IIS (high frequency, strategic).*
1b	*The single-stage multiple dyadic SN, is associated with Type 1 IIS (low frequency, operational).*
2	*As the number of stages in the SN increases, the frequency with which operational information is shared also increases (Type 2 IIS).*
3a	*In the SN, the location of firms close to the consumer (downstream) is associated with Type 4 IIS.*
3b	*In the SN, the location of firms close to the initial source of raw material (upstream) is associated with Type 1 IIS.*
4a	*For a single-stage dyadic SN the association with strategic IIS is stronger with a centralized coordination structure than with a decentralized coordination structure.*
4b	*For a single-stage multiple dyadic SN the frequency with which firms share operational information is higher with a centralized coordination structure than with a decentralized coordination structure.*
4c	*As the number of stages in a SN increases, the frequency with which operational information is shared inter-organizationally is higher with a centralized coordination structure than with a decentralized coordination structure.*
5a	*The performance of a SN with high partner information visibility will be higher than the performance of a SN with low partner information visibility.*
6a	*The performance of a SN with high variability in supplier capability will be lower than the performance of a SN with low variability in supplier capability.*
7a	*The performance of a SN with high process uncertainty will be lower than the performance of a SN with low process uncertainty*.
Moderating Effects	
5b (5c)	*There is a stronger positive association between operational (strategic) IIS and performance of the supply network in a SN with low partner information visibility than in a SN with high partner information visibility*
6b	*There is a stronger positive association between strategic IIS and the performance of the supply network in a SN with high variability in supplier capability than in a SN with low variability in supplier capability.*
7b (7c)	*There is a stronger positive relationship between operational (strategic) IIS and the performance of the supply network in a SN with high process uncertainty than in a SN with low process uncertainty.*

All of the hypotheses except for **2** and **4c** will be tested empirically. The rationale for the omission of these two hypotheses will be discussed in Section 4.1.2.

4. RESEARCH DESIGN AND DATA COLLECTION

4.1 Research Context

In this study, the unit of analysis is a focal firm, with its immediate upstream, and downstream transacting parties across a wide variety of industries in the manufacturing sector. This study goes beyond most empirical studies on supply network relationships, where the unit of analysis is traditionally the buyer, or the seller, or the buyer-seller dyad to a more comprehensive study that investigates the supply network.

When investigating, the supply network one can examine either the total supply network for a firm or a particular product supply network. With the former, the network encompasses all upstream and downstream (direct and indirect) transacting parties from the raw material's original source to the consumer. Examination of the product supply network on the other hand entails investigating only the linkages that are directly involved, that is, from the manufacturing to distribution to sale of the product (Harland et al. 2004). Given cost and time constraints, the more feasible option for this study is the product supply network that addresses only the first tier upstream and downstream linkages. These linkages can be expected to be the ones that are of primary importance to a firm in terms of managing the inter-organizational information sharing needs associated with its products.

4.2 Operationalization of Variables

Multi-item measures were used to operationalize the constructs in the research model and will be discussed in the following subsections. For the inter-organizational information sharing, coordination structure, process uncertainty, and supply network performance constructs, measures from prior research studies were adopted with slight modifications to fit the context of

this research. In the case of the other constructs (variability in supplier capability, partner information visibility and network pattern), measures were developed using a modified version of the procedures suggested by Churchill for developing effective measures (Churchill 1979). For these constructs we generated a pool of items that appeared to be a reasonable representation of the constructs as gleaned from a thorough review of relevant literature.

The questions associated with each measure are presented in Appendix B.

4.2.1 Inter-organizational Information Sharing (IIS) Measures

The study of IIS in the literature has historically been from the perspective of the buyer (Mohr et al. 1996), or the seller (Gavirneni et al. 1999), or the buyer-seller dyad (Ellram et al. 1995; Gavirneni et al. 1999; Lee et al. 2000a; Prahinski et al. 2004; Straub et al. 2004). Many of the studies are theoretical, using analytical (Aviv 2002; Gavirneni et al. 1999; Lee et al. 2000a; Li 2002; Yu et al. 2001) or simulation (Fu et al. 2003; Lin et al. 2002; Zhao et al. 2002a) models to support their arguments. In particular, simulation models have been used extensively when studying supply networks, since they can more easily capture their complexity, as opposed to the utility of mathematical models where the extension of results obtained for the dyad to the network is far from a straightforward inductive process. Very few studies (Malhotra et al. 2005; Spekman et al. 1998) have, however, performed empirical tests beyond the dyad because of the complex and often dynamic nature of these networks which makes it difficult to identify and gather data from all the relevant transacting parties.

Some of the IIS measures that have been used in prior studies are listed in Table 4-1.

Table 4-1. Interorganizational Information Sharing measures

Variables	Measures	Study
Scope of information shared	Order, operational, strategic, strategic and competitive information	Seidmann & Sundararajan (1998)
Channel Information intensity (α=0.87):	Amount of resource flows Frequency of information flows	Vijayasarathy & Robey (1997)
Level of Intensity Commitment	Strategic Importance Complexity	Spekman et al. (1998)
Degree of information shared	Partial, full	Gavirneni et al (1999), Cachon & Fisher (2000), Aviv (2002)
Communication (α=0.86)	We share sensitive information(financial, production, design, research, and/or competition) Suppliers are provided with any information that might help them We keep each other informed about events or changes that may affect the other party We exchange performance feedback Exchange of information takes place frequently, informally and/or in a timely manner We have frequent face-to-face planning/communication	Chen & Paulraj (2004)
Degree-symmetric information sharing (α=0.939) Symmetry of sharing w/partners an degree of information sharing	Inventory, capacity planning, cost structures, margin structures, production schedules, marketing strategies and also Our organization a)Shares substantial strategic info (e.g. prod. schedule etc.) b) shares only minimal transactional info(e.g. contact info etc.) necessary to complete the transaction c) is extremely restrained with respect to sharing strategic firm info (e.g. prod. schedules etc) with the vendor	Straub et al (2004)
Breadth Quality	Information sharing about sensed events, changes, action formulation, feedback concerning the changes Relevance, timeliness,	Gosain et al. (2004/2005)

	completeness, value added	
Operational exchange α=0.6367 Strategic Information exchange α=0.6331	Advanced shipping notice, order status, production schedules, inventory levels Pricing strategies, new target markets, new product development, distribution strategies, promotional strategies	Moberg et al. (2002)

Based on a review of the literature and related discussion in Section 2.4, IIS is evaluated using two measures: (1) the type of information shared (strategic or operational) and (2) the frequency with which information is shared. Both the type and the frequency of IIS are measured with respect to an immediate upstream and an immediate downstream partner for the focal firm.

Operational IIS is reflected in the sharing of advanced shipping notice, order status, production schedules, and inventory levels. Strategic IIS focuses on new target markets, new product development, distribution strategies, promotional strategies, facility layout, capacity planning, sourcing plans and research. Our measures are closely aligned to those used by Moberg, Cultler et al (2002) but have been enhanced in the case of the strategic IIS construct where we include additional items to provide a richer understanding of this construct.

Strategic and operational IIS are not necessarily mutually exclusive as demonstrated in Table 4-2 where within the IIS framework a firm may share either only strategic IIS, or only operational IIS, or both strategic and operational IIS or nothing.

Table 4-2. Interorganizational Sharing (IIS) Options

No IIS	Only Operational IIS	Only Strategic IIS
Both Strategic and Operational IIS		

To measure the frequency of operational IIS and strategic IIS, a slightly modified version of the 5- point scale developed by (Becerra et al. 2003) was used. Two additional items were added to this scale, "never" and "not applicable", changing the measure to a 7-point scale. In the former, information is available but the party possessing the information decides not to share it, while in the latter information is unavailable to any of the transacting parties. The frequency of IIS and the nature of the IIS (operational or strategic) are mapped to the four different types of IIS: Types 1 (2) representing operational low (high) frequency and Types 3 (4) representing strategic low (high) frequency for each of the data points in the sample.

We consider the frequency of operational IIS to be high if it occurs at least weekly, while the strategic IIS is high if it takes place at least 1-3 times month.

4.2.2 Supply Network Configuration Measures

The structure (or configuration) of the supply network has been characterized in several ways. In some studies the network is characterized as a physical structure with the potential for complex linkages (Harland 1996; Lambert et al. 2000). Others take a behavioral approach in which the network design is characterized by the "pattern of relationships" among transacting firms (Choi et al. 2002). Sandwiched in between these two approaches is a mixed characterization that describes both behavioral and physical aspects of the supply network (Stock et al. 2000). Table 4-3 presents a few of these studies.

Table 4-3. Supply Network Structure Measures

Approach	Variable	Measures	Study
Physical	Levels	Dyadic, external chain, network	Harland (1996)
	Location	Raw material producer, fabricator, parts producer, manufacturer/assembler, wholesale/distributor, retailer, consumer	
Physical and Behavioral	Formalization	Explicitness and openness of rules, procedures, and norms	Choi & Hong (2002)
	Centralization	Tiers actively managed (selection, product development, problem resolution) by final assembler	
	Complexity	Number of diff. entities at same level – horizontal Number of levels on the system – vertical Number of operating locations -spatial	
Physical	Horizontal structure	Number of tiers across the chain	Lambert & Cooper, (2000)
	Vertical structure	Number of suppliers/customers within each tier	
	Position of the focal firm within the supply chain	Horizontal position within the supply chain	
Physical and Behavioral	Geographic dispersion	% of suppliers, production facilities, distribution and customers located in each region studied	Stock et al. (2000)
	Channel governance: 1) firms' relation ship with suppliers and customers	Cooperation, interdependence, flexibility, informal relationship, ongoing relationship, information sharing a) with customers and b) with suppliers	
	2) Extent of vertical integration	% of each stage in the supply chain owned by the firm.	

Our research study which focuses on the configuration of the supply network is more similar to the physical perspective although the dynamic nature of networks is fully recognized. The three items used to describe the supply network configuration are: network pattern, number of stages and location in the network. Similar measures were used by Lambert & Cooper (2000).

Network Pattern

Our empirical study focuses on two of the network patterns (dyadic, multiple dyadic) that were presented in Section 2.4.1. Respondents who report transacting with only one other firm will be recorded as dyadic while those engaged in transactions with multiple firms will be recorded as multiple dyadic. Both patterns can be reported for a particular product supply network. For example, a respondent may have multiple suppliers (multiple dyadic) yet the item/component produced may be customized for a particular customer (dyadic).

Number of Stages

Since the domain of our study is the first tier supply network, we collected data as it relates to the focal firm and its immediate upstream and downstream partners. Extant literature reveals that information is normally collected as it relates to either the buyer, the seller or less frequently the dyad. By empirically studying the interaction of a focal firm with both an upstream and a downstream firm, this manuscript contributes significantly to the body of knowledge, on IIS in supply networks that are pursued beyond the conceptual level.

Hypothesis 2 and 4c which requires exploring additional tiers of a supply network is beyond the scope of this study so will not be covered.

Location in the Network

As discussed in Section 2.4.1, where a firm is located in the network spans the spectrum from raw material manufacturer to the final consumer. A firm's location in the network may vary depending on the product/component under query so each respondent firm will be required to indicate where they are located, with respect to a particular product/component. Consistent with New and Payne's (1995) classification, respondents were asked to select from eight options (Fig.6), coded from '1' for raw material manufacturer to '8' for consumer. The higher the

number selected, the closer the location of that firm to the final consumer.

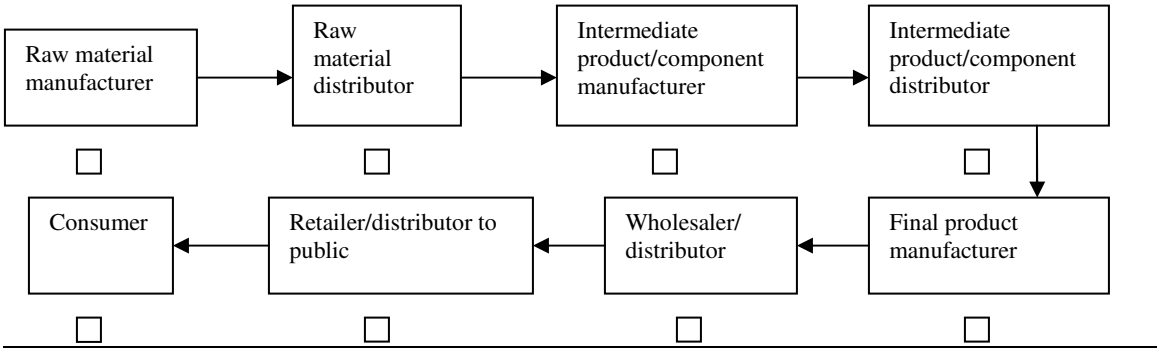


Figure 6. **Supply Network Locations (Adapted from New & Payne, 1995)**

4.2.3 Coordination Structure Measures

Coordination structure refers to the extent to which one entity has control over the decision-making for several entities. Significant research has been conducted on coordination structure at the intra-organizational (Hage et al. 1967), inter-unit (Tsai 2002) and inter-organizational levels (Anand et al. 1997; Choi et al. 2002; Dwyer et al. 1987a; John 1984).

For this study, the two determinants of coordination structure were explored:

1) Decision rights - where the authority for decision-making and communication resides as it relates to interfirm transactions in the supply network (i.e. locus of authority). In other words, does the power reside within one firm or do firms in the supply chain act independently?

2) Information structure – the kind of information used to facilitate this decision-making and is related to the following question:Is the information used to arrive at decisions based on local or global information?

Decision rights is widely used in empirical studies to represent decision-making power (Tsai 2002), and extent of authority (Dwyer et al. 1987a).

A summary of several of these studies is presented in Table 4-4.

Table 4-4. Coordination Structure Measures

Variables	Measures/Questions	Study
Frequency and importance of participation in innovative-related decisions	Degree of autonomy, frequency of participation, and amount of influence in innovative-related decisions	Russell & Russell (1992)
Decision-making power (α= 0.83)	1) Our business transactions with other units should be approved by headquarters 2) Any agreement or dispute over the interunit activities should report to the headquarters and we should let the headquarters settle the issue. 3) The headquarters has the ultimate power to decide whether or not we collaborate with other units in the company Format: 7-point Likert scale strongly disagree to strongly agree	Tsai (2002)
Centralization	Retailer's perception: 1)You go ahead without checking with your supplier(s) 2)You refer marketing matters to your suppliers 3)You yield to the recommendation of your suppliers 4)You rely on your suppliers for an answer Format: 5-point Likert scale: never, seldom, occasionally, rather often, nearly all the time	Dwyer & Welsh (1985)
Extent of Manufacturing authority	1)Need for permission 2) Freedom to make local adaptations 3) "Clout" of supplier recommendations and suggestions 4) Need for higher level approval (later deleted Format: 5-point Likert scale	Dwyer & Oh (1987a)
Locus of authority –(5 items) (α= 0.80) Participation (7 items) (α= 0.87)	Sample questions: 1)We have little real authority in plan formulation activities 2)Important marketing planning decisions are not made by us 1)Plan formulation activities are usually conducted without our assistance 2)We are required to contribute to the formulation of strategies and/or budgets in the plan *Format*: 7 point Likert type scale	John & Martin (1984)

Variables	Measures/Questions	Study
Intra-organizational Degree of participation in decision making	1) How frequently do you usually participate in the decision to hire new staff? 2) How frequently do you usually participate in decisions on the promotion of any of the professional staff? 3) How frequently do you participate in decisions on the adoption of new policies? 4) How frequently do you participate in decisions on the adoption of new programs? *Format*:1-never, 2-seldom, 3-sometine, 4-often, 5-always	Hage & Aiken (1967)
Degree of hierarchy of authority	1) There can be little action taken here until a supervisor approves a decision 2) A person who wants to make his own decision would be quickly discouraged here 3) Even small matters have to be referred to someone higher up for a final answer 4) I have to ask my boss before I do almost anything 5) Any decision I make has to have my boss's approval Format: 4- point scale from 1- definitely false to 4 –definitely true	

Consistent with the discussion in Section 2.4.2, the appropriate measure should distinguish between the centralized coordination structure and the decentralized coordination structure, that is formed from a combination of the decision rights and the information structure.

The 7-items describing the coordination structure measure were adapted from two studies (Dwyer et al. 1987a; John et al. 1984). These measures embody the key differentiating elements between the two types of coordination structure that are relevant for our study and include: need for permission, freedom to make local adaptations, and authority to make strategic decisions.

4.2.4 Process and Partner Uncertainty

One of the major concerns of supply professionals is the uncertainty existing in the supply network. Although there is no question in the literature that it exists, the sources are many and range from internal factors (within the supply network) such as process, supply, demand, control, (Stevens 1989) to external factors such as technological uncertainty. In this study the focus is on two types of internal uncertainty: partner and process.

Partner Information Visibility and Variability in Supplier Capability

Two key sources of partner uncertainty are partner information visibility and variability in supplier capability. Section 2.5.1 indicated that partner information visibility deals with the adequacy of the information received from a transacting firm to assess the present conditions of that firm's (the provider of information) operations. We also discussed, in that section, the variability in supplier capability which refers to uncertainty arising from the inability to determine if a supplier has the capability to function effectively, under circumstances which are different from those prevailing at the time of the contract. New measures were developed for these two constructs to address the key elements that are relevant for our research context.

Three items were developed for partner (supplier and buyer) information visibility to measure the accuracy, timeliness, and overall adequacy of the information shared. For, the supplier capability, six-items were developed to capture the perceived ability of the supplier to maintain timely delivery and product quality in the event that there are significant product/component, process or technology interface changes. These items were reverse coded to reflect the variability in supplier capability construct.

Process Uncertainty

Earlier in this manuscript, process uncertainty was defined as "fluctuations in process outcomes and production times due to variable process yields, perishable end-products, machine breakdowns, etc" (Vorst et al. 1998). Process uncertainty is measured by two items developed by Bhatnagar and Sohal (2005), Cronbach's alpha=0.6955 that capture the extent of the fluctuations. These items are the duration of planned outages and the duration of planned stoppages that significantly affect a firm's operations. A 4-point scale (>10%, 6-10%, 1-5%, <1%) was employed.

4.2.5 Supply Network Performance Measures

Measuring supply network performance in today's environment represents a challenge for many firms. Rather than merely looking internally at profitability and how well forecasted budgets are met, managers must now incorporate metrics that evaluate performance at the operational, tactical and strategic levels and ones that can also evaluate the total supply network (Dreyer 2000). Without these measures it will be virtually impossible to integrate supply chains in a manner that allows effectiveness and efficiency to be maximized thus leading to suboptimal performance of the supply network (Gunsekaran et al. 2004).

Among the measures that have been used to assess supply network performance are costs, time (e.g. lead time), flexibility, customer flexibility, supply chain responsiveness, and quality. A few of these studies are listed in Table 4-5.

Table 4-5. Supply Network Performance Measures

Construct	Variables	Measures/questions	Study
Supply Network Performance (SC Performance)	Level of joint activity (Cohen factor =0.70) Expectation of relationship Continuing (α=0.88) Supplier verification (Cohen factor =0.67)	Range:Minimal to extensive (7-point scale) for several diff. activities The parties expect this relationship to last a long time Fornat:7pt Strongly Agree to Strongly Disagree The parties make plans not only for the terms of the individual purchase but for the continuance of the relationship. Level of surveillance that buyer exercises over the supplier's process Range: Minimal to extensive evaluation (7 pointt)	Heidi and John, (1990)
Supply Network Performance (SC Performance)	Lead Time Inventory Time to market Quality Customer Service Flexibility	Lead Time Inventory Turns Change in level of Inventory write-offs Product development life cycle Defect rate Order item fill rate Stockout situation Set-up times For all variables :assessment of self-improvements and also perceived improvements relative to industry over 3 yrs (much worse, slightly worse, no change, better, much better0	Bhatnagar & Sohal (2004)
Supply Network Performance (SC Performance)	SC Delivery Reliability SC Responsiveness SC Flexibility SC Costs	Delivery Performance Fill Rates Perfect order Fulfillment Order Fulfillment Lead times **SC Response time** Production Flexibility Cost of Goods Sold	Supply chain Council, 2002 - SCOR model; Guimaraes et al. (2002) Items in bold were eliminated from Guimaraes' study

Construct	Variables	Measures/questions	Study
		Total SCM Costs Value-Added Productivity Warranty/Returns Processing Costs	
	SC Asset Management Efficiency	Cash-to-cash Cycle Time Inventory Days of Supply Asset Turns (Cost of Goods Sold/Inventory value)	
Supply Network Performance (Networked Organizational Performance)	Degree-symmetric networked performance (α =0.943)	Symmetry and extent of the following indicators: Tangible (Effectiveness): Increased productivity Lower operating costs: Intangible (Efficiency): More timely information Improved resource control Increased flexibility Improved production planning Improved asset management Reduced workflow Plus Client a)realized tangible improvements in performance outcomes b)realized intangible improvements in performance outcomes c)overall economic situation improved as a result of relationship with vendor Seven point scale: never to always	Straub et al. (2004)

Excluded from the above studies are single performance indicators that although easy to use are inadequate to describe network performance (Beamon 1999). The cost metric for instance, may not include relevant cost categories in addition to other problems such as distortion of some costs and outdated information (Beamon 1999; Maskell 1991a; Maskell 1991b). In general, financial performance measures though widely used to measure organizational success are not appropriate in a network context as they 1) ignore measures that cannot be expressed in financial terms such as customer service quality, 2) pay scant attention to cross-organizational

issues, and 3) have no direct links with effectiveness and efficiency considerations (Bullinger et al. 2002).

A better measure incorporates both financial and non-financial indicators which can be accomplished using the attributes typically associated with the Supply Chain Operations Reference (SCOR) model, a process model that has been used by companies to measure the performance of their operations and make an assessment relative to 'best practices. Drawing on this model, the following five variables that are defined (Stephens 2001) and have been empirically tested (Guimaraes et al. 2002) will be utilized in this study:

- Supply chain delivery reliability – defined as "the performance of the supply chain in delivering: the correct product to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer". Measures for this variable are delivery performance to commit date, fill rates and customer satisfaction with orders.
- Supply chain responsiveness – defined as "the velocity at which a supply chain provides products to the customer" and measured by order fulfillment lead times.
- Supply chain flexibility defined as "the agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage". Since supply chain flexibility involves flexibility on the part of all network members a more inclusive measure, responsiveness to changes in customer demand, is used rather than production flexibility measure used by Guimaraes et al. (2002) .
- Supply chain costs defined as "the costs associated with operating the supply chain". For this variable the items measured are value- added per employee, cost of goods sold, warranty/ returns processing costs.

- Supply chain asset management flexibility defined as the "effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital." To capture this variable the items measured are cash-to-cash cycle time (period during which company finances its inventory), inventory days of supply, net asset turns (cost of goods sold/inventory value).

Respondents were asked to assess their firm's performance in the supply relative to that of their industry using a 7-point Likert scale ("greatly below average" to "greatly above average") to evaluate the following supply network performance indicators: supply chain delivery, supply chain responsiveness, supply chain flexibility, supply chain costs and supply chain asset management flexibility. Utilizing a comparative measure avoids having to ask firm specific questions and eliminates the resistance that some researchers experience from respondents who consider such information confidential (Bhatnagar et al. 2005). Also assessed, from the perspective of the respondent, was the performance of one key supplier.

4.2.6 Control Variables

Three variables, that have been found to have an impact on performance, were included in our model as controls to test for any confounding effects. These variables were 1) the type of industry within which the firm operates, 2) the numbers of years that the focal firm has been doing business with the supplier (or customer) and 3) the size of the firm (number of employees).

Table 4-6 presents a summary of all the constructs in the research model, a description of the measures, the number of items that were included for each measure and the informing source for those measures.

Table 4-6. Summary of Constructs and Operational Measures

Construct/Measures	Measurement Scope	Items	Source
1. Interorganizational Information Sharing –the type and frequency of IIS			
Type of information: Operational Strategic Frequency of information: Operational Strategic	Measures whether operational or strategic information is shared Measures the frequency with which information is shared.	 OIS1-4, SIS1-8 OISF SISF	Adapted from Moberg, Cutler et al (2002) Adapted from Becerra and Gupta (2003)
2. Network Configuration - the structure of the inter-organizational arrangement existing between transacting parties.			
Network Pattern Stages Location	Measures the number of upstream and downstream partners in order to ascertain the type of network (e.g. dyadic or multi-dyadic) Not measured in this study Identifies where the firm is located in the network.	NumTTS, NumTTC FLOC	Adapted from Lambert & Cooper (2000)
3. Coordination structure - a pattern of decision-making and communication among a set of actors who perform tasks in order to achieve goals.			
Coordination structure	Measures where the locus of authority for making decisions resides.	CS1-7	Adapted from John & Martin (1984) and Dwyer and Oh (1987)
4. **Partner Uncertainty** - reflects the inability to predict the operational status or capability of a network member due to information asymmetry between supply network partners. Partner information invisibility - the extent to which the information provided by a firm within a network to its partners is adequate to assess the present conditions of that firm's operations. Variability in supplier capability - the level of uncertainty that exists when a firm is unable to determine if a supplier has the capability to function effectively under circumstances that differ from those that existed when the agreement (formal or informal) was originally established.			
5. Process Uncertainty - fluctuations in process outcomes and production times due to variable process yields, perishable end-products, machine breakdowns, etc.			
Fluctuations in process outcomes and production times	Measures duration of planned shutdown and unplanned stoppages within the firm that significantly affect operations .	PROCU1-2	Bhatnagar and Sohal (2005)

Construct/Measures	Measurement Scope	Items	Source
6. Supply Network Performance - The performance of the product/supply network The indicators below are measured for the supplier (only a, b, and c) and for the firm, relative to its industry.			
a) Delivery reliability supplier, focal firm	Measures the delivery performance to commit date, fill rate and customer satisfaction with orders.	SDREL1-3, FDREL1-3	Guimares, Cook et al (2002)
b) Delivery responsiveness supplier, focal firm	Measures the order fulfillment lead times	SDRESP, FDRESP	
c) Flexibility supplier, focal firm	Measures responsiveness of a firm to changes in customer demand	SFLEX, FFLEX	
d) Cost reliability focal firm	Measures the value added per employee, cost of goods sold and warranties/processing costs.	FCR1-3	
e) Supply chain asset management flexibility focal firm	Measures the cash to cash cycle time, inventory days of supply and net asset turns.	FAMF1-3	

4.3 Questionnaire Validation

4.3.1 Peer Review

Following consultation with colleagues and academicians involved in supply management research, the questionnaire was modified to correct any flaws identified such as poor formatting, complex, ambiguous, biased or incomplete close-ended questions (Dillman 1978; Zikmund 2003). Further refinement of the questionnaire was done based on comments from two Supply Management professionals who were asked to review the questionnaire for clarity of instructions, wording, and appropriateness of questions asked.

4.3.2 The Pilot Study

Mail surveys were sent to forty (40) senior level supply management professionals who are members of the Institute of Supply Management (ISM). These professionals represented a diverse cross-section of companies. Each survey packet contained three (3) coded self-

administered questionnaires, one for the recipient (focal firm), and one each for a key buyer and a key supplier who were part of the same product supply network. As part of the instructions at the beginning of the questionnaire, the focal firm was asked to consider the questions in the context of a) a specific item (part/material/subassembly) that generated a significant portion of the firm's revenue and b) one that was part of the supply network that included both the supplier and the customer that was selected to participate in the survey. Included with the questionnaires was a cover letter explaining the purpose of the survey, and a self-addressed stamped envelope.

The importance of having responses to the survey from all parties (initial recipient, buyer, and supplier) was emphasized in the cover letter. Two options were provided to the informant on how to accomplish this task. For the first option, the recipient was asked to simply enter the contact information for the key buyer and supplier when completing the questionnaire. Provision of this information implicitly granted permission for us to send the appropriate questionnaire to the key buyer and supplier identified by the informant. In the other option, the recipient was instructed to send the two additional surveys provided in the survey packet to the relevant parties. Although the second choice involved more effort on the part of the recipient it would allow the information on the buyer and seller to remain private. Six of the packets were returned as undeliverable, three recipients called to say that they would not be able to fill out the questionnaire because of changed responsibilities/time constraints/company policies. One recipient indicated that a response would be sent in a few weeks following the return from an overseas trip. However, no responses were received even after a second mailing a month later.

During discussions with peers, committee members, and two supply chain professionals some possible explanations for the lack of response were identified. These included the mere size of the packet sent which gave the impression that it would entail a lot of time and effort,

requiring the recipient to sift through three separate sets of questionnaires, and the complexity of the instructions. It was also noted that the additional steps involved for the second option could be a deterrent. The questionnaire was modified and another pilot study initiated. In the modified questionnaire, the respondent was simply asked to include contact information on the supplier and buyer referenced in his/her completed questionnaire. The new version of the questionnaire was sent to a random sample of forty senior level supply management professionals drawn from the ISM list which now excluded the members who had received a questionnaire in the first pilot study. This resulted in a 12.5% response rate which although lower than many mail surveys is fairly consistent with several web-based type surveys (Cousins et al. 2006; Klassen et al. 2001).

Only minor changes were made to the questionnaire prior to conducting the full blown web-based study using e-Rewards (website at http://www.e-rewards.com), a marketing research organization that provides paid access to a diverse and large pool (over 8000) of supply chain professionals. Advantages from using on-line studies include geographic reach, speed, flexibility, convenience to the respondent, and the ease with which data entry and analysis can be accomplished (Evans et al. 2005). It was important for us to find a company that could counteract some of the disadvantages of online surveys, identified by these researchers, such as the potential for the survey invitation to be treated as junk mail, privacy and security issues, and "representativeness" of the sample. We selected the e-Rewards organization as it is reputed to have a high quality panel that is acquired through an "invitation only" process and one that is closely managed to maintain the integrity of its database. Among the claims of the e-Rewards organization is that it practices strict conformance to industry standards and guidelines as it relates to the code of conduct when engaged in survey research.

The initial plan to collect matched pair responses from the focal firm and its key downstream and upstream partner had to be modified to satisfy the requirement for anonymity of the participants involved in the online survey. Consequently, only the informant's view of the transacting parties, both the immediate upstream supplier and the downstream customer, was collected. We would have preferred to have matched pairs or multiple informants (even though the resulting sample size would be smaller) as it has been claimed that this produces more reliable and valid information (Bagozzi et al. 1991; Seidler 1974).While single informants give a one sided view which could lead to some bias, scholars have suggested that single informant bias can be minimized by utilizing knowledgeable managers on the topic of interest (Huber et al. 1985; Kumar et al. 1993). Thus we selected senior level purchasing executives and managers who are actively involved in supply management.

4.4 Data Collection Method

The survey method of inquiry was selected as the most appropriate approach for the present study that focuses on product supply networks. Investigating characteristics for this empirical domain and drawing inferences for the total population can best be analyzed through a well-constructed standardized questionnaire. Also important is a probability sample that has been selected using the appropriate sampling technique (Babbie 1998).

The decision to employ the survey method rather than one of the other methods available for empirical research was based on a comparison of several research strategies. Simulation, surveys and field studies offer the most natural setting; however, since results from field studies are not normally generalizable, that method was removed from the scope of study. Although simulation can be created to mirror "real-world" phenomena being examined and are often

generalizable, the strength and range of variables is not as great as for surveys where data is collected directly from the population being sampled. This is important in this study that looks at the association between variables, since there is a direct relationship between measures of association such as the correlation coefficient and the range of the correlated variables (Stone 1978). Additionally, the survey approach provides the ability to control for the effects of any confounding influences should this become necessary, using statistical techniques.

4.5 Data Sample

E-mails were sent by the e-Rewards firm to supply management professionals in the manufacturing industry who are members of one of their research panels inviting them to participate in our online survey. The manufacturing industry, which represents approximately 61% of workers in the goods producing sector, includes a wide cross-section of companies. The diverse selection of companies in this sampling frame enables external validity and increases the potential for having dyadic and multiple dyadic network patterns in our sample.

The invitation was sent to middle and upper level managers in the purchasing, and supply management divisions, an approach that has been used in prior studies involving buyer-supplier relationships (Carr et al. 1999; Chen et al. 2004). These managers are most likely to generate the highest quality of information since they are answering questions that are within their area of expertise (Campbell 1955). In return for filling out the survey each participant received, from the online survey company, incentives in the form of "currency" that could be redeemed later for products/services such as books, magazines, travel and entertainment.

4.5.1 Screening of Respondents

A screening question was included at the beginning of the survey in an effort to eliminate respondents who only had a minor involvement in activities and decision-making issues related to their firm's supply networks. Those who indicated that they had less than 30% involvement were not allowed to continue with the questionnaire.

4.5.2 Sample Size

Of the 600 survey invitations that were started, 211 were completed (completion rate 35.17%). Thirty eight (38) questionnaires were discarded during the purification process primarily due to either an unrealistic (too short) time to complete the survey, unsuitable respondent based on title (e.g. clerk) , or incorrect information. A questionnaire was considered as having incorrect information if the respondent indicated that no strategic information was shared yet entered the frequency of strategic information sharing as 1 to 3 times per month, for instance. Incidents of missing information were kept to a minimum owing to the design of the questionnaire which forced the respondent to enter a response before moving to the next question. Our final sample comprised data from 173 respondents, each providing two data points, one concerning transactions with first tier suppliers and the other for transactions with first tier customers. As a result our effective sample size was 346 data points.

4.5.3 Adequacy of Sample Size

One concern typically in research that entails hypothesis testing is having a large enough sample size to achieve a desired power based on the significance level selected and the effect size. Our sample size was assessed by referencing the table developed by (Cohen 1992) that

provides the recommended sample size for specific analytical techniques, given the effect size, significance level and the power. For our research model, the decision criteria is 0.05 for the significance level which is typical in behavioral statistical inference tests (Murphy 2002), power is 0.80 as recommended by (Cohen 1992) and we assume a medium effect size. Based on these tables we need a sample size of 87 for a chi-square tests (1 degree of freedom). The multiple regression analysis with up to eight independent variables will require a sample size of 87. In terms of the ability to detect a significant R^2 with multiple regression analysis, (Hair et al. 1998) suggests that with power of 0.80, a significance level of 0.05 and two independent variables we should be able to detect R^2 values of as little as 4% with a sample size of 250 and values of 10% with a sample size of 100. Our sample size of 346 appears adequate for our research models that include for example, regression analysis with two (2) independent variables.

4.5.4 Respondent Information

Respondents had on average between 5 and10 years experience working with their firm The number of years that the firm was involved with the key partner selected was approximately 3.8 years. A summary of the demographics of the respondents and the industries represented and are presented in Tables 4-7 and Table 4-8 respectively.

Table 4-7. Respondent Demographics

Respondent's Job Title	Frequency	Percent
Top Executive (President, CPO, CEO,COO, EVP)	14	8.1
General Manager	18	10.4
Department Head	29	16.8
Director/Assistant Director	5	2.8
Senior Manager/Senior Buyer/Purchasing Manager	50	28.9
Buyer/Assistant Manager	33	19.1
Other	24	13.9
Total	173	100.0

Table 4-8. Summary of Industries and Revenue Data

Industry	Frequency	%
1- Textile	4	2.3
2 - Automotive	7	4.0
3 – Chemicals/Pharmaceuticals	18	10.4
4 – Computer &Peripherals	5	2.9
5 - Electronics	17	9.8
6 – Food and Beverage	21	12.1
7 - Telecommunications	10	5.8
8 - Transportation	35	20.2
9 - Semiconductor	5	2.9
10 - Other	51	29.5
Total	173	100.00
Revenue ($)	Frequency	%
<10 million	44	25.5
10 -49.9 million	17	9.8
50 – 99.9 million	21	12.1
100 – 499.9 million	26	15.0
500 – 999.9 million	20	11.6
1 billion – 5 billion	33	19.1
Over 5 billion	12	6.9
Total	173	100.0

4.5.5 Nonresponse Bias

In order to investigate non-response bias we examined data on firm purchases, and number of employees for early respondents and late respondents under the premise that there is a similarity between non-respondents and those who respond at a later date (Armstrong et al.

1977). ANOVA tests revealed no significant difference ($p>.05$) between the top 10% and the bottom 10% of the respondents.

4.5.6 Selection Bias

One concern with asking a respondent to select a key partner is that the one selected would be one with whom there was a close relationship and by extension strategic IIS. This bias was however not detected in our data set. In fact respondents indicated, for the partners selected, no strategic IIS in 16% of the cases.

4.5.7 Common Method Variance

Perceptual measures and the methods that are used to measure constructs can lead to common method variance defined as "variance that is attributable to the measurement method rather than to the constructs the measures represent" (Podsakoff et al. 2003). This has generated concern from some researchers due to the potential for the misinterpretation of the results (Bagozzi et al. 1990; Lindell et al. 2001; Podsakoff et al. 2003; Podsakoff et al. 1986).

We sought to address these concerns in our research by:

a) undertaking precautionary measures prior to data collection and

b) conducting post hoc tests

During the design phase of our questionnaire we adopted some of the suggestions recommended by Podsakoff et al (2003) such as the use of unambiguous, easy to understand words with very few instances of reverse coded items, and a variety of response formats (for example, Likert and Semantic comparison scales). Additionally, respondents were assured that their responses would be anonymous to reduce the potential for bias.

Following the collection of data, we conducted the Harmon's single factor test, a post-hoc procedural method, (Podsakoff et al. 1986) which is a statistical procedure used to test for common method variance and is used widely in academic research (Kotabe et al. 2003; Lambe et al. 2002; Paulraj et al. 2005; Zhao et al. 2002b). In this test, common method variance is verified if a factor analysis produced only one factor that accounts for the majority of the covariance between the independent and the criterion variables (Podsakoff et al. 1986). The ten factors extracted using principal components factor analysis (eigenvalues greater than 1) explained 70% of the variance extracted of which only approximately 21.9% was accounted for by the first factor.

In addition to the above actions, we also compared the annual sales revenue for 2006 as reported by respondents on the survey to that provided to E-rewards as part of their panel information. This resulted in a fairly strong correlation of 0.56 thus providing some additional indication of the effectiveness of our measures.

Based on the above precautionary measures undertaken a priori, the results of the Harmon's single factor test and the correlation as it relates to annual sales revenue, we conclude that common method variance should not be a major concern for this study.

5. MEASUREMENT VALIDATION AND DATA ANALYSIS

Because of the complexity of our model, our data analysis in this study was conducted in two parts. The first part of the model investigates the relationship between the supply network configuration and IIS (hypotheses 1a-1b). In part two we examine the relationship between IIS and performance (hypotheses 5a–7c). Such an approach is appropriate since the mediating effect of IIS is not being investigated in our study.

Several techniques were used to explore the relationships in our model. Initial examination of the data utilizing univariate (e.g. histograms) and bivariate (e.g, scatter plots and box plots) methods were done to help us understand the distributional aspects of our variables, the relationships between these variables and the identification of extreme outliers and influential cases. We conducted correlational analysis, cross-tabulations and chi-square tests for Part 1 of the research model. Additionally we employed t-tests for assessing the differences between the means of variables in our model (Parts 1 and 2). Regression analysis formed the basis for our assessment on the effects of the moderator variables, as recommended by Baron and Kenny (1986). Interaction plots were also created to graphically display instances where the effect of the moderator was found to be significant.

5.1 Measurement Validation

5.1.1 Unidimensionality, Reliability and Validity Considerations

The assessment of the effectiveness of measures is important to empirical research as it permits researchers to determine their consistency and accuracy. Measures can be assessed in terms of their unidimensionality, reliability and validity.

Unidimensionality is concerned with whether or not all the items included in a construct are measuring only that construct. Typically factor loadings of 0.5 and above are required with loadings being highest on the construct that it represents (Hair et al. 1998). Using SPSS 16.0 we ran a factor analysis with the principal components extraction method and Varimax rotation. Components with eigenvalues greater than one were extracted. Items that had a low factor loading were evaluated and those items that also caused a significant drop in Cronbach's alpha (α) were deleted. Items with high factor loadings were retained.

Reliability relates to how measures are made and involves getting consistent results for measures over repeated trials; *validity* on the other hand relates to what should be measured and is concerned with "the soundness and relevance of a proposed interpretation" (Cronbach 1990; Hair et al. 1998). An appropriate question then for determining the validity of a measure would be:how successful was the researcher at measuring what he/she intended to measure? Similarly an appropriate question for determining reliability would be: how accurate was the measuring instrument used to assess the construct being studied?

The technique selected for examining reliability of the measurement model in this study is internal consistency reliability which is used to assess the consistency of results across items within a test. Cronbach's alpha, is one of the measures that is most frequently used although there are several other measures available such as average inter-item correlation, average item to total correlation and split half reliability (Trochim). Constructs with Cronbach's alpha values above 0.7 indicate high reliability, with values of 0.60 acceptable for newly developed scales (Nunally 1978).

Table 5-1 presents the factor loadings and the Cronbach's alpha measure for each scale.

Table 5-1. Summary of Measures to Assess Reliability and Validity of Constructs

Variable Name	Items	Factor Loadings	Cronbach's α
Operational IIS	OIS1	0.712	0.780
	OIS2	0.815	
	OIS3	0.761	
	OIS4	0.671	
Strategic IIS	SIS1	0.849	0.893
	SIS2	0.739	
	SIS3	0.818	
	SIS4	0.850	
	SIS5	0.596	
	SIS6*	0.415*	*Retained – alpha otherwise 0.879
	SIS7*	0.488*	
	SIS8	0.714	
Partner Information Visibility	PII1	0.774	0.897
	PII2	0.805	
	PII3	0.768	
Variability in Supplier capability	SVPC1	0.717	0.909
	SVPC2	0.741	
	SVPC3	0.779	
	SVPC4	0.749	
	SVPC5	0.797	
	SVPC6	0.814	
Supply Network Measures			
Level of Centralization	CS1	0.733	0.750
	CS2	0.799	
	CS3	0.675	
	CS4	0.729	
Process Uncertainty	PROCU1	0.803	0.623
	PROCU2	0.686	
Performance –Supplier – Measure 1	SDREL1	0.751	0.910
	SDREL2	0.778	
	SDREL3	0.783	
	SDRESP	0.695	
	SFLEX	0.684	
Performance - Focal Firm – Measure 1	FDREL1	0.873	0.879
	FDREL2	0.846	
	FDREL3	0.847	
	FDRESP	0.777	
	FFLEX	0.512	
Performance - Focal Firm – Measure 2	FCR1	0.613	0.843
	FCR2	0.750	0.87 when measure 1 and 2 combined
	FCR3	0.720	
	FAMF1	0.775	
	FAMF2	0.718	
	FAMF3	0.731	

For almost all measures, the individual item loadings were greater than 0.7 and Cronbach's alpha greater than 0.75. Measures with item loadings less than 0.7 were retained based on theoretical considerations.

Construct validity refers to the extent to which a measure represents the theoretical construct of interest and can be tested by examining "1) the extent to which the measure correlates with other measures designed to measure the same thing and 2) whether the measure behaves as expected" (Churchill 1979). Two of the most widely used validities to verify construct validity are convergent validity and discriminant validity. With *convergent validity* all the measures of the same concept should be highly correlated (Hair et al. 1998). *Discriminant validity* on the other hand is reflected when there is low correlation among measures that are not theoretically related (Churchill 1979).

We assessed convergent validity using Cronbach's alpha values (Carmines et al. 1979; Hulland 1999) with values of at least 0.7 indicating that the items used to measure a construct are closely aligned to each other. Such values are shown for all but the process uncertainty construct which had a value of 0.623 but was retained based on theoretical considerations. For discriminant validity the correlation between each construct and its indicators should be greater than the correlation of that construct with any other construct.

A bivariate correlational analysis was conducted using Spearman's correlation for a two-tailed test of statistical significance at two levels ($p<.01$ and $p<.05$). Using Rowntree's (1981) heuristics as reported by Kin-wai Lau (2007) we note that moderate correlations (0.4 -0.7) were obtained for most of the within measures items with low (0.2-0.4) to negligible (0.0-0.2) measures for between item measures. The within measure results are consistent with the findings

from the exploratory factor analysis. Based on our analysis we conclude that the data falls within the required thresholds for construct validity.

Table 5-2. Item-to-Item Correlations - Relationship between SN Configuration and IIS

	NPAT	FLOC	OIS1	OIS2	OIS3	OIS4	OISF	SIS1	SIS2	SIS3	SIS4
NPAT	1										
FLOC	0.024	1									
OIS1	-0.040	-0.009	1								
OIS2	-0.044	-0.052	.532(**)	1							
OIS3	-0.105	0.006	.441(**)	.618(**)	1						
OIS4	-0.101	0.037	.449(**)	.399(**)	.504(**)	1					
OISF	-.135(*)	-0.050	.379(**)	.334(**)	.342(**)	.398(**)	1				
SIS1	0.062	0.075	.158(**)	.118(*)	.155(**)	.217(**)	.217(**)	1			
SIS2	-0.031	-0.018	.338(**)	.213(**)	.253(**)	.252(**)	.248(**)	.563(**)	1		
SIS3	0.027	-0.028	.274(**)	.253(**)	.258(**)	.336(**)	.287(**)	.650(**)	.530(**)	1	
SIS4	0.040	0.088	0.095	.131(*)	.219(**)	.220(**)	.173(**)	.640(**)	.479(**)	.677(**)	1
SIS5	-0.039	0.021	.272(**)	.199(**)	.202(**)	.275(**)	.241(**)	.466(**)	.409(**)	.510(**)	.443(**)
SIS6	-0.033	-0.031	.364(**)	.254(**)	.218(**)	.397(**)	.340(**)	.392(**)	.349(**)	.409(**)	.306(**)
SIS7	-0.051	-0.033	.320(**)	.206(**)	.180(**)	.346(**)	.336(**)	.417(**)	.411(**)	.447(**)	.336(**)
SIS8	0.021	-0.022	.237(**)	.183(**)	.166(**)	.254(**)	.269(**)	.533(**)	.603(**)	.489(**)	.465(**)
SISF	-0.004	-0.030	.246(**)	.158(**)	.146(**)	.191(**)	.559(**)	.375(**)	.280(**)	.396(**)	.324(**)
CS1	0.003	-0.088	-0.072	-0.043	-0.077	-0.092	-.113(*)	-0.027	-0.016	-0.079	0.013
CS2	0.048	0.052	-0.040	0.005	-0.004	-0.023	-.113(*)	-0.002	-0.085	-0.062	0.038
CS3	0.028	0.092	0.101	.109(*)	0.083	0.077	0.023	.117(*)	.115(*)	0.066	0.058
CS4	.149(**)	0.097	.106(*)	.111(*)	0.044	0.002	0.004	0.022	0.061	0.006	0.037

**. Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed)

Table 5-2. Item-to-Item Correlations - Relationship between SN Configuration and IIS (cont'd)

	SIS5	SIS6	SIS7	SIS8	SISF	CS1	CS2	CS3	CS4
NPAT									
FLOC									
OIS1									
OIS2									
OIS3									
OIS4									
OISF									
SIS1									
SIS2									
SIS3									
SIS4									
SIS5	1								
SIS6	.570(**)	1							
SIS7	.492(**)	.739(**)	1						
SIS8	.457(**)	.432(**)	.548(**)	1					
SISF	.264(**)	.358(**)	.401(**)	.380(**)	1				
CS1	-0.094	-0.027	-0.057	-0.042	-.112(*)	1			
CS2	-0.096	-0.018	-0.012	-0.055	-.142(**)	.634(**)	1		
CS3	0.088	.144(**)	.112(*)	0.096	0.011	.272(**)	.338(**)	1	
CS4	0.044	.110(*)	0.087	0.069	0.015	.340(**)	.410(**)	.610(**)	1

**. Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed)

Table 5- 3. Item-to-Item Correlations – Relationship between IIS and SN Performance

	SIS1	SIS2	SIS3	SIS4	SIS5	SIS6	SIS7	SIS8	OIS1	OIS2	OIS3	OIS4	SISF	OISF
SIS1	1													
SIS2	.563(**)	1												
SIS3	.650(**)	.530(**)	1											
SIS4	.640(**)	.479(**)	.677(**)	1										
SIS5	.466(**)	.409(**)	.510(**)	.443(**)	1									
SIS6	.392(**)	.349(**)	.409(**)	.306(**)	.570(**)	1								
SIS7	.417(**)	.411(**)	.447(**)	.336(**)	.492(**)	.739(**)	1							
SIS8	.533(**)	.603(**)	.489(**)	.465(**)	.457(**)	.432(**)	.548(**)	1						
OIS1	.158(**)	.338(**)	.274(**)	0.095	.272(**)	.364(**)	.320(**)	.237(**)	1					
OIS2	.118(*)	.213(**)	.253(**)	.131(*)	.199(**)	.254(**)	.206(**)	.183(**)	.532(**)	1				
OIS3	.155(**)	.253(**)	.258(**)	.219(**)	.202(**)	.218(**)	.180(**)	.166(**)	.441(**)	.618(**)	1			
OIS4	.217(**)	.252(**)	.336(**)	.220(**)	.275(**)	.397(**)	.346(**)	.254(**)	.449(**)	.399(**)	.504(**)	1		
SISF	.375(**)	.280(**)	.396(**)	.324(**)	.264(**)	.358(**)	.401(**)	.380(**)	.246(**)	.158(**)	.146(**)	.191(**)	1	
OISF	.217(**)	.248(**)	.287(**)	.173(**)	.241(**)	.340(**)	.336(**)	.269(**)	.379(**)	.334(**)	.342(**)	.398(**)	.559(**)	1
PII1	.183(**)	.176(**)	.149(**)	0.065	0.043	.199(**)	.233(**)	.122(*)	.275(**)	.202(**)	.262(**)	.206(**)	.152(**)	.108(*)
PII2	.228(**)	.203(**)	.209(**)	.108(*)	.106(*)	.268(**)	.235(**)	.133(*)	.294(**)	.222(**)	.290(**)	.226(**)	.204(**)	.154(**)
PII3	.278(**)	.207(**)	.221(**)	.133(*)	.121(*)	.338(**)	.320(**)	.141(**)	.362(**)	.269(**)	.353(**)	.286(**)	.199(**)	.212(**)
SVPC1	0.013	.142(**)	0.057	0.033	-0.005	.142(**)	0.093	0.029	.229(**)	.116(*)	.193(**)	.146(**)	0.088	0.057
SVPC2	.114(*)	.154(**)	.155(**)	.123(*)	0.067	.144(**)	.130(*)	0.092	.172(**)	.109(*)	.210(**)	.231(**)	0.029	0.007
SVPC3	0.030	.125(*)	.119(*)	0.073	-0.057	.111(*)	.126(*)	0.072	.133(*)	0.079	.137(*)	.181(**)	.108(*)	0.043
SVPC4	0.084	.132(*)	.153(**)	0.078	0.027	.137(*)	.178(**)	0.099	.171(**)	.106(*)	0.106	.217(**)	.113(*)	0.048
SVPC5	.115(*)	.196(**)	.189(**)	.156(**)	0.058	.145(**)	.168(**)	.121(*)	.235(**)	.110(*)	.228(**)	.206(**)	.115(*)	0.053
SVPC6	.124(*)	.212(**)	.179(**)	.126(*)	0.059	.147(**)	.179(**)	.145(**)	.163(**)	0.097	.176(**)	.256(**)	0.058	0.072
PROCU1	-0.036	-0.035	-0.085	-0.033	-0.081	-0.077	-0.056	-0.072	-0.007	0.080	.159(**)	0.032	-0.045	0.007
PROCU2	0.017	-0.062	-0.039	-0.048	-0.020	0.031	-0.006	-.117(*)	0.059	.125(*)	.147(**)	-0.022	0.088	0.051
SDREL1	0.070	0.105	.123(*)	0.078	0.038	0.095	0.079	0.016	.187(**)	.132(*)	.231(**)	.149(**)	0.082	0.077
SDREL2	.111(*)	0.105	.175(**)	.120(*)	0.104	.218(**)	.179(**)	0.062	.185(**)	.207(**)	.197(**)	.224(**)	.121(*)	.123(*)
SDREL3	.123(*)	.182(**)	.157(**)	.112(*)	0.071	.184(**)	.177(**)	.106(*)	.174(**)	.179(**)	.204(**)	.144(**)	0.025	0.011
SDRESP	.133(*)	.177(**)	.243(**)	.163(**)	0.066	.170(**)	.225(**)	.178(**)	.182(**)	.169(**)	.246(**)	.228(**)	.141(**)	.122(*)
SFLEX	.132(*)	.128(*)	.138(*)	.174(**)	0.039	.154(**)	.192(**)	.171(**)	.169(**)	.140(**)	.236(**)	.159(**)	0.105	0.080
FDREL1	-0.001	-0.002	0.089	0.064	0.024	0.003	0.002	-0.065	0.065	.115(*)	.198(**)	.120(*)	-0.036	0.013
FDREL2	0.049	0.077	.111(*)	0.077	0.056	0.029	0.044	0.009	0.068	.146(**)	.221(**)	.130(*)	-0.002	0.043
FDREL3	0.009	0.017	0.025	0.059	0.063	0.004	-0.008	-0.040	0.036	.110(*)	.205(**)	.125(*)	-0.063	0.016
FDRESP	0.074	0.051	0.058	0.046	.137(*)	0.03	0.015	0.068	0.098	.121(*)	.172(**)	.110(*)	-0.007	0.026
FFLEX	-0.011	0.075	0.029	-0.015	-0.042	-0.041	-0.004	0.036	.142(**)	.160(**)	.173(**)	.135(*)	.132(*)	.136(*)
FCR1	-0.055	-0.050	-0.079	-0.010	0.012	0.021	0.007	-0.051	0.024	0	0.049	0.021	0.050	0.084
FCR2	0.014	-0.036	-0.054	0.051	0.045	0.025	0.031	0.058	0.039	0.041	.111(*)	0.063	-0.006	.119(*)
FCR3	0.082	0.017	0.083	.136(*)	0.066	0.024	.108(*)	.121(*)	0.031	0.099	0.070	0.031	0.096	0.099
FAMF1	0	0.044	-0.042	0.026	0.015	-0.035	0.030	0.096	0.029	-0.014	.129(*)	-0.016	0.037	0.011
FAMF2	.134(*)	0.013	0.065	0.100	.112(*)	0.081	.114(*)	0.100	0.004	0.065	.169(**)	0.091	0.066	0.074
FAMF3	0.013	-0.046	0.011	0.077	0.065	0.028	0.040	0.044	0.090	.142(**)	.182(**)	0.044	0.011	0.052

**. Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed)

Table 5-3. Item-to-Item Correlations: Relationship between IIS and SN Performance (contd)

	PII1	PII2	PII3	SVPC1	SVPC2	SVPC3	SVPC4	SVPC5	SVPC6	PROCU1	PROCU2	SDREL1	SDREL2
SIS1													
SIS2													
SIS3													
SIS4													
SIS5													
SIS6													
SIS7													
SIS8													
OIS1													
OIS2													
OIS3													
OIS4													
SISF													
OISF													
PII1	1												
PII2	.746(**)	1											
PII3	.734(**)	.757(**)	1										
SVPC1	.368(**)	.341(**)	.379(**)	1									
SVPC2	.429(**)	.376(**)	.459(**)	.655(**)	1								
SVPC3	.349(**)	.341(**)	.366(**)	.749(**)	.639(**)	1							
SVPC4	.351(**)	.337(**)	.401(**)	.538(**)	.698(**)	.627(**)	1						
SVPC5	.297(**)	.331(**)	.359(**)	.649(**)	.535(**)	.641(**)	.597(**)	1					
SVPC6	.361(**)	.336(**)	.365(**)	.556(**)	.691(**)	.572(**)	.690(**)	.719(**)	1				
PROCU1	.213(**)	.176(**)	.189(**)	.107(*)	.204(**)	0.068	0.103	0.079	.133(*)	1			
PROCU2	.261(**)	.231(**)	.254(**)	.161(**)	.205(**)	.162(**)	0.096	.129(*)	.133(*)	.462(**)	1		
SDREL1	.437(**)	.427(**)	.389(**)	.537(**)	.466(**)	.474(**)	.467(**)	.472(**)	.412(**)	.146(**)	.288(**)	1	
SDREL2	.400(**)	.389(**)	.441(**)	.482(**)	.525(**)	.428(**)	.491(**)	.356(**)	.403(**)	0.031	.186(**)	.722(**)	1
SDREL3	.409(**)	.371(**)	.386(**)	.462(**)	.498(**)	.432(**)	.469(**)	.401(**)	.417(**)	.107(*)	.211(**)	.659(**)	.711(**)
SDRESP	.373(**)	.401(**)	.395(**)	.514(**)	.533(**)	.512(**)	.541(**)	.529(**)	.571(**)	0.095	.179(**)	.622(**)	.620(**)
SFLEX	.269(**)	.339(**)	.285(**)	.467(**)	.366(**)	.397(**)	.416(**)	.457(**)	.386(**)	0.070	.155(**)	.559(**)	.496(**)
FDREL1	.226(**)	.211(**)	.241(**)	.218(**)	.273(**)	.256(**)	.224(**)	.138(*)	0.086	0.024	.163(**)	.310(**)	.339(**)
FDREL2	.260(**)	.231(**)	.258(**)	.283(**)	.327(**)	.261(**)	.259(**)	.217(**)	.189(**)	0.087	.170(**)	.324(**)	.363(**)
FDREL3	.171(**)	.183(**)	.166(**)	.160(**)	.215(**)	.165(**)	.132(*)	0.087	0.073	-0.016	.127(*)	.262(**)	.238(**)
FDRESP	.201(**)	.170(**)	.169(**)	.234(**)	.188(**)	.157(**)	.115(*)	.146(**)	0.063	-0.003	.179(**)	.271(**)	.262(**)
FFLEX	.161(**)	.118(*)	.152(**)	.206(**)	.168(**)	.229(**)	.214(**)	.237(**)	.184(**)	0.010	.179(**)	.190(**)	.209(**)
FCR1	.115(*)	0.057	0.104	.196(**)	.190(**)	.219(**)	.107(*)	0.040	0.054	0.064	.211(**)	.117(*)	.184(**)
FCR2	0.004	0.067	0.005	0.042	0.048	0.090	0.081	0.044	0.022	0.038	-0.013	0.081	0.078
FCR3	0.050	.126(*)	0.050	0.001	0.061	0.082	.123(*)	0.071	.145(**)	-0.078	-0.007	.150(**)	.139(*)
FAMF1	0.041	0.039	0.012	0.079	0.046	.138(*)	0.022	0.063	0.002	-0.010	0.075	.131(*)	.124(*)
FAMF2	0.054	0.070	0.059	0.032	.112(*)	0.055	0.084	0.050	0.015	0.028	0.094	.137(*)	.113(*)
FAMF3	0.105	.154(**)	.127(*)	.157(**)	.201(**)	.145(**)	.130(*)	.204(**)	0.054	.152(**)	.156(**)	.305(**)	.254(**)

**. Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed)

Table 5-3. Item-to-Item Correlations:Relationship between IIS and SN Performance (contd)

	SDREL3	SDRESP	SFLEX	FDREL1	FDREL2	FDREL3	FDRESP	FFLEX	FCR1	FCR2	FCR3	FAMF1	FAMF2	FAMF3
SIS1														
SIS2														
SIS3														
SIS4														
SIS5														
SIS6														
SIS7														
SIS8														
OIS1														
OIS2														
OIS3														
OIS4														
SISF														
OISF														
PII1														
PII2														
PII3														
SVPC1														
SVPC2														
SVPC3														
SVPC4														
SVPC5														
SVPC6														
PROCU1														
PROCU2														
SDREL1														
SDREL2														
SDREL3	1													
SDRESP	.663(**)	1												
SFLEX	.531(**)	.666(**)	1											
FDREL1	.249(**)	.334(**)	.242(**)	1										
FDREL2	.316(**)	.353(**)	.313(**)	.860(**)	1									
FDREL3	.232(**)	.248(**)	.225(**)	.775(**)	.777(**)	1								
FDRESP	.196(**)	.202(**)	.207(**)	.641(**)	.663(**)	.611(**)	1							
FFLEX	.140(**)	.235(**)	.255(**)	.418(**)	.418(**)	.420(**)	.413(**)	1						
FCR1	0.091	.152(**)	.156(**)	.406(**)	.396(**)	.421(**)	.377(**)	.351(**)	1					
FCR2	0.101	.154(**)	.177(**)	.221(**)	.263(**)	.312(**)	.221(**)	.212(**)	.552(**)	1				
FCR3	0.078	.258(**)	.228(**)	.256(**)	.233(**)	.213(**)	.272(**)	.225(**)	.406(**)	.524(**)	1			
FAMF1	.241(**)	.170(**)	0.096	.236(**)	.252(**)	.236(**)	.271(**)	.230(**)	.415(**)	.478(**)	.446(**)	1		
FAMF2	.119(*)	.188(**)	.175(**)	.354(**)	.347(**)	.299(**)	.314(**)	.232(**)	.355(**)	.432(**)	.425(**)	.508(**)	1	
FAMF3	.266(**)	.286(**)	.215(**)	.350(**)	.302(**)	.327(**)	.266(**)	.237(**)	.379(**)	.450(**)	.400(**)	.595(**)	.635(**)	1

**. Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed)

5.2 Examination of Data

Summated scales were created for all of the multi-item measures. Additionally scales were created to represent the different IIS typologies associated with operational IIS, strategic IIS and frequency of IIS. Box plots identified only a few points that were outliers but most of these were within tolerable limits since their removal did not make a noticeable impact on the results. Two outliers that were isolated from the other points in box plots showed up as extreme points (>3 std. deviations) in a regression analysis report. Following further investigation it was decided to also retain these cases since the slope coefficients did not change significantly when they were removed, as would have occurred if they were influential cases.

A series of tables and plots are presented to get a better understanding of our data. A breakdown of the types and frequency of IIS is presented in Tables 5-4 to 5-7. Information on the supply network pattern is presented in Tables 5-8 to 5-10. Finally a cross-tabulation of the type of IIS by firm location is presented in Tables 5-11 and 5-12.

Table 5-4. Types of Operational IIS

Type of IIS	Frequency
Production schedules	234
Advanced shipping notices	271
Order Status	289
Inventory Levels	232

Results from Table 5-4 indicate that advanced shipping notices and order status were the most frequent types of operational IIS while information on inventory levels and production

schedules were the least although the difference between the most and least frequent was less than 60.

Table 5-5. Types of Strategic IIS

Type of IIS	Frequency
Target Markets	141
Product Development	217
Distribution Strategies	163
Promotional Strategies	153
Facility Layout	153
Capacity Planning	185
Sourcing Plans	160
Research	149

Table 5-5 shows that for strategic IIS, product development followed by capacity planning were the most frequent types of IIS. Here the difference between the most and the least frequent IIS was less than 80.

Next we examine the cross-tabulations of strategic and operational IIS in Table 5-6.

Table 5-6. Cross-tabulations for Operational and Strategic IIS

		Strategic IIS		Total
		No	Yes	
Operational IIS	No	14	10	24
	Yes	43	279	322
Total		57	289	346

From Table 5-6 we note that most of the firms are engaged in operational and strategic IIS with only fourteen firms pursuing purely market transactions entailing no IIS. On the contrary 10 respondents were classified as only strategic IIS while for 43 it was only operational IIS.

Table 5-7. Frequency of IIS

	Operational	Strategic
Not Applicable	0	7
Never	1	49
Rarely	60	69
Most months w/in year	58	100
1-3times/month	52	53
Weekly	91	34
Most days	70	20

From Table 5-7 we note that the frequency distribution for operational IIS is different from that for strategic IIS. The majority of the firms engage in operational IIS on a weekly basis while for strategic IIS this happens at a less frequent interval of most months within the year.

The network patterns are presented in Table 5-8.

Table 5-8. Network Pattern Summary

	Network Pattern	
	Frequency Count	Percent %
Dyadic	46	13.5
Multiple Dyadic	300	86.5

Indications from Table 5-8 are that the vast majority of the respondents transact with multiple firms. A more detailed view is presented in Table 5-9 where the network patterns are broken down by the Type of IIS between the focal firm and the transacting parties. Again, each Type of IIS represents a combination of the information, (operational or strategic) and the frequency with which this information is shared. Thus Type 1 IIS is low frequency operational IIS while Type 2 is high frequency operational.

Table 5-9. Cross-tabulation for Network Pattern and Type of IIS

		Types of IIS			
		Type 1 Operational Low freq.	Type 2 Operational High freq.	Type 3 Strategic Low freq.	Type 4 Strategic High freq.
Network Pattern	Dyadic	14	19	22	16
	Multiple Dyadic	151	128	167	84
	Total	165	147	189	100

The cells in the above table reflect a count of the different types of IIS within our sample based on the network pattern. The cell counts, as it relates to type of IIS, are not mutually exclusive as a firm that shares Type 1 IIS could also share Type 3 IIS for example. Unique (mutually exclusive) instances are presented later in Table 5-10.

A visual display of Table 5-9 is presented in figure 7.

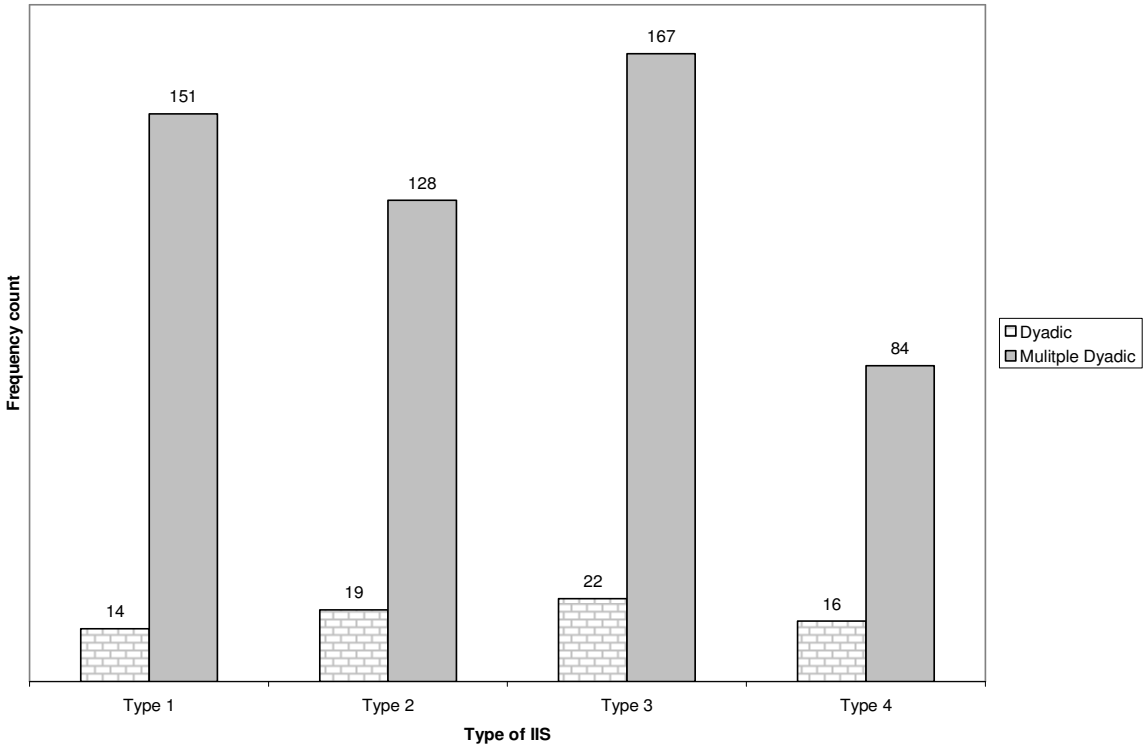


Figure7. Bar chart for Type of IIS by Network Pattern

Table 5-10. Summary of Unique Instances of Types of IIS by Network Pattern

		Type 1	Type 2	Type 3.	Type 4.	Total
Network Pattern	Dyadic	3	2	0	0	5
	Multiple Dyadic	26	12	6	4	48
	Total	29	14	6	4	53

For the mutually exclusive types of IIS in our data, the dyadic pattern shows very few instances with only operational IIS (Type 1 and Type 2) and none for only strategic IIS (Type 3 and Type 4). In the case of the multiple dyadic pattern, instances of only strategic IIS occur less frequently than those for only operational IIS. For both network patterns, operational IIS occurs most frequently.

In Tables 5-11 and 5-12 we look at the distribution of the type of IIS based on firm location. Data in these two tables exclude the two endpoints, that is, the initial raw material source and the consumer since our focus is on the locations that are close to these two endpoints.

Table 5-11. Summary of Unique Instances of Types of IIS by Firm Location

		Types of IIS			
		Type 1 Operational Low freq.	Type 2 Operational High freq.	Type 3 Strategic Low freq.	Type 4 Strategic High freq.
Firm Location	Near Initial Raw Material Source	9	4	1	0
	Near Consumer	20	8	4	2
	Total	29	12	5	2

In the above table, the largest frequency counts are for Type 1 IIS and the smallest for Type 4 IIS. Note that the cell counts shown reflect unique instances for each type of IIS.

Table 5-12. Crosstabulation for Type of IIS by Firm Location

		Type of IIS			
		Type 1 Operational Low freq.	Type 2 Operational High freq.	Type 3 Strategic Low freq.	Type 4 Strategic High freq.
Firm Location	Near Initial Raw Material Supplier	53	49	68	22
	Near Consumer	101	94	112	61

In Table 5-12, Type 3 IIS has the highest frequently while the smallest frequency count is for Type 4 IIS. A visual display of this table is presented in Figure 8.

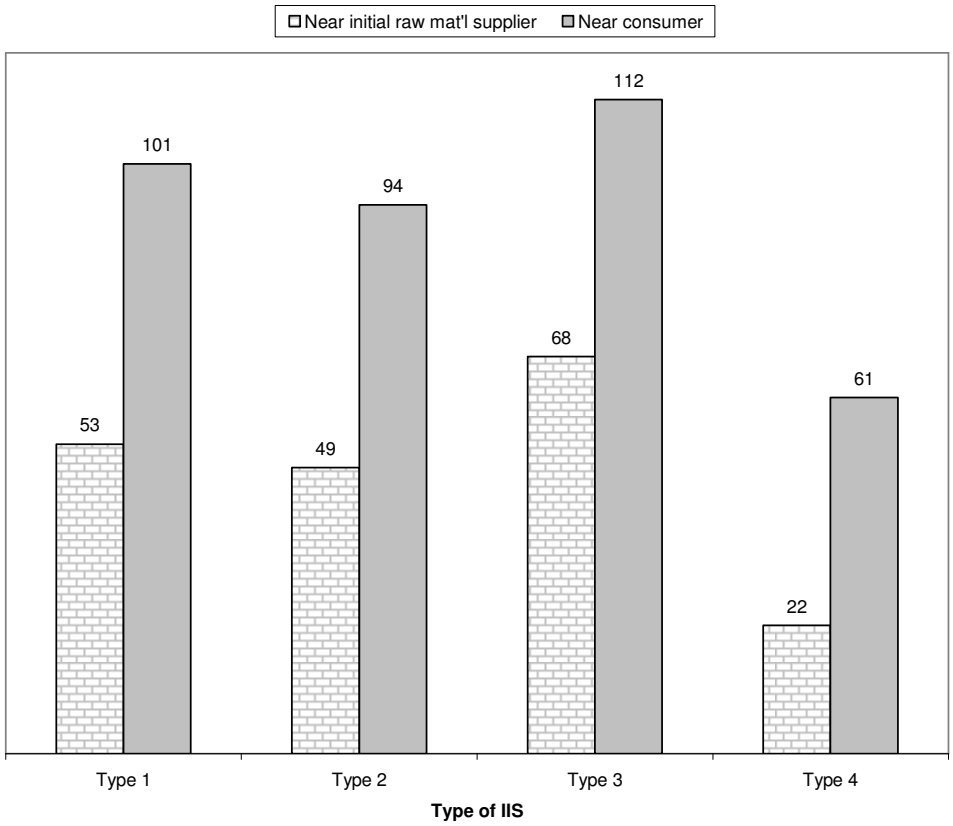


Figure 8. Bar chart for Type of IIS by Firm Location

5.3 Test of Hypotheses

For our analysis we examine the following:

- the relationship between supply network configuration and IIS (H1a, H1b, H3a, H3b),
- the role of the coordination structure as it relates to the SN pattern and IIS (H4a, H4b),
- the direct effect of partner information visibility (H5a), variability in supplier capability (H6a) and process uncertainty on supply network performance (H7a)
- the moderating effect of these uncertainty variables on the relationship between IIS and supply network performance (H5b, H5c, H6b, H7b).

5.3.1 Tests of the Relationship between the Supply Network Configuration and IIS

Two elements of the supply network configuration are tested: the network pattern and the location of the firm in the supply network.

Hypothesis 1a and 1b

Hypotheses 1a and 1b investigate the relationship between the network pattern and IIS. According to hypothesis 1a, we posit that a single stage dyadic SN will engage in Type 4 IIS. We posit that for a multiple dyadic SN it will be Type 1 IIS. To statistically test our null hypothesis that the relationship between network pattern and type of IIS are independent, we use the chi-square test of independence. Data was adjusted prior to conducting our analysis to exclude instances of double counts arising from the sharing of both Type 1 and Type 4 IIS. Table 5-13 presents the observed and the expected cell frequencies for each cell. Divergence from the observed values in each cell is indicated by these expected frequencies.

Table 5-13. Type of IIS by Network Pattern

		Type of IIS		
		Operational Low freq Type 1	Strategic High freq Type 4	Total
Netwk Pattern	Dyadic	12(16.7)	14(9.3)	26
	%Netwk Pattern	46.2%	53.8%	100%
	Multiple Dyadic	134(129.3)	67(71.7)	201
	%Netwk Pattern	66.7%	33.3%	100%
Total		146	81	227
		64.3%	35.7%	100%

χ^2=4.221, p-value =.05. Numbers in parenthesis are the expected frequency counts

An examination of Table 5-13 indicates that Type 4 IIS is more frequently associated with the dyadic pattern than Type 1 IIS and the observed frequencies are also noticeably different than the expected frequencies. These observations suggest that firms in a dyadic pattern are more likely to engage in Type 4 IIS than in Type1 IIS.

In the case of the multiple dyadic pattern, we observe Type1 IIS is more frequently associated with this pattern than is Type 4 IIS. Here too, the observed frequencies are different than the expected frequencies. These results imply that there is an association between the multiple dyadic pattern and Type1 IIS.

These findings are further reinforced by the differences observed in the row percentages for both columns. For instance, in the Type 4 IIS column, we observe that the percentage of the sample engaging in Type 4 IIS is much larger for the dyadic network pattern (53.8%) than for either the multiple dyadic pattern (33.3%) or overall (35.7%).

In general, the differences between the expected and actual frequency counts and between the row percentages suggest that these associations are not due to chance. Our findings which are statistically significant (χ^2 =4.221, p =.04) imply that dyadic patterns are associated with Type 4 IIS and multiple dyadic patterns are associated with Type 1 IIS. Based on these results we conclude that there is support for hypotheses 1a and 1b.

Hypothesis 3a and 3b

We now analyze and present our findings for hypothesis 3a and 3b which examines the relationship between firm location and type of IIS.

Our data set excluded respondents at either endpoint of the location continuum. In addition, firms sharing both Type 1 (operational low frequency) IIS and Type 4 (strategic high frequency IIS) are excluded from the analysis since our inquiry concerns the differences between these two groups. Thus the frequency counts in Table 5-14 are slightly lower than those in Table 5-12.

Hypothesis 3a postulated that firms located close to the initial raw material source, in the SN, would be associated with Type 1 IIS. Hypothesis 3b postulated that firms located close to the consumer would be associated with Type 4 IIS. Table 5-14 presents the results.

Table 5-14. Cross-tabulation of Firm Location and IIS

		Type of IIS		
		Operational Low freq Type 1	Strategic High freq Type 4	Total
Firm location	Near to Initial Raw Mat'l supplier	48(43.5)	17(21.5)	65
	% Within Firm Location	73.8%	26.2%	100%
	Near to consumer	92(96.5)	52(47.5)	144
	% Within Firm Location	63.9%	36.1%	100%
Total		140	69	209
		67%	33%	100%

$\chi^2 = 2.005$, p-value=0.156. Numbers in parenthesis are the expected frequency counts

For firms located near to the initial raw material supplier there are noticeable differences between the expected and observed frequencies with an observed count less than expected for Type 4 IIS and more than expected for Type 1 IIS. These findings suggest that firms near to the initial raw material supplier would be more prone to Type 1 IIS.

In the case of firms located near to the consumer the expected and observed frequencies differ with the counts being higher than expected for Type 4 IIS and less than expected for Type 1 IIS.

The row percentages associated with the first column show that overall 67% of the firms in the sample engage in Type 1 IIS. Of those firms located near to the initial raw material supplier, 73.8% engage in Type 1 IIS while it is 63.9% for those located near to the consumer. The row percentages associated with the right column are much smaller with 33% of the firms overall engaged in Type 4 IIS, 26.2% for those firms near to the initial raw material supplier and 36.2% for firms that are near to the consumer.

Differences in the row percentages and between the expected and observed cell frequencies suggest that there is a relationship between the Type of IIS and firm location however the results of the chi-square test of independence indicate that these differences are not statistically significant ($\chi^2 = 2.008$, p=0.156). Consequently we cannot reject the null hypothesis that there is no association between the types of IIS and firm location and conclude that there is no support for hypotheses 3a and 3b.

Hypothesis 4a and 4b

For these hypotheses we employ the Student's t-test to compare means in a centralized coordination structure and a decentralized coordination structure as it relates to

a) Strategic IIS – hypothesis 4a
b) Frequency of operational IIS – hypothesis 4b.

Hypothesis 4a postulated that for a single-stage dyadic SN, strategic IIS is stronger with a centralized coordination structure than with a decentralized coordination structure. The sub-sample dataset used to test this hypothesis contains only firms in a single stage dyadic SN that engage in strategic IIS. We create two groups (one for firms with a centralized coordination structure and the other for firms with a decentralized coordination structure) from this dataset. Tests are performed for skewness and kurtosis, since the size of both samples are less than 30, to determine if the distributions are fairly normal. The skewness and kurtosis values for the centralized coordination structure are -0.56 and 0.53 respectively. In the case of the decentralized coordination structure the values are -0.22 and -0.517 which are well within the desired range of -1 to +1. A two sample Student's t-test assuming unequal variance was performed to test the hypothesis that the decentralized coordination structure has a mean strategic IIS that is greater than or equal to that of the centralized coordination structure for firms in single stage dyadic

SNs. Results indicate that the mean strategic IIS for SNs with a centralized coordination structure was significantly greater than that for SNs with a decentralized coordination structure, t (36) =2.35, p=0.012. These findings provide support for hypothesis 4a.

Hypothesis 4b proposed that for a single stage multiple dyadic SN, the frequency with which firms shared operational IIS is stronger with a centralized coordination structure than with a decentralized coordination structure. To test this hypothesis we create a sub-sample dataset comprised of only the multiple dyadic network pattern. The frequency of operational IIS in this dataset is then separated into two groups (centralized and decentralized coordination structure). Results from the two sample Student's t-test performed, assuming unequal variances, are statistically significant, t (263) =1.77, p=0.039. Our results confirm that the mean frequency with which operational information is shared is significantly higher in a centralized coordination structure than in a decentralized coordination structure for the multiple dyadic SN. This indicates support for hypothesis 4b.

5.3.2 Test of the Direct Effects of Uncertainty on Performance

In hypotheses 5a, 6a, 7a we investigate the impact of partner information visibility, variability in supply capability and process uncertainty on SN performance. The low and high categories for each of these uncertainty variables were determined by a median split (Cheema et al. 2008; Ghosh et al. 1997; Wiesenfeld et al. 2007).

Hypothesis 5a posited that the performance of a SN with high partner information visibility would be higher than the performance of a SN with low partner information visibility. A two sample Student's t-test is performed to test the null hypothesis that the mean performance for low partner information visibility is the same or less than that for low partner information visibility, assuming unequal variance. Results indicate a p-value <.05, t= -6.17 for the one-tailed test, consequently we reject the null hypothesis and conclude that there is statistical evidence in support of our hypothesis.

Hypothesis 6a proposed that the performance of a SN with high variability in supplier capability would be lower than the performance of a SN with low variability in supplier capability. In this case the Fischer's test indicates that the variances were equal. As a result, a two sample Student's

t-test, using the pooled estimate of the variance is performed to test the null hypothesis that the mean performance for high variability in supplier capability is the same or greater than that for low variability in supplier capability. The mean performance for high variability in supplier capability is significantly lower than that for low variability in supplier capability, t=7.10, p<.001. These results provide evidence in support of our hypothesis on the relationship between SN performance and variability in supplier capability.

Hypothesis 7a posited that the performance of a SN with high process uncertainty would be lower than the performance of a SN with low process uncertainty. The Student's t-test is performed assuming unequal variance to test the null hypothesis that the performance of a SN with high process uncertainty is equal to or higher than the performance with low process uncertainty. The results are statistically significant thus providing support for this hypothesis.

Table 5-15. Summary of the Results for the Direct Effects of Model Variables on SN Performance

	Hypothesis	N	Mean	Std Dev	F-test	t-test
Low (High) Partner information visibility	H5a	199(141)	79.50(87.26)	11.56(11.20)	1.06(0.351)	6.17, p<.0001
Low (High) Variability in supplier capability	H6a	162(180)	87.29(78.68)	10.23(12.01)	1.37(0.018)	7.10, p<.0001
Low (High) Process Uncertainty	H7a	173(171)	84.46(81.06)	11.66(12.04)	0.937(0.337)	2.66, p<0.004

5.3.3 Test of the Quasi-Moderating Role of Various Uncertainty Parameters on the Relationship between IIS and SN Performance

Our research model hypothesized that partner information visibility, variability in supplier capability, and process uncertainty all moderated the relationship between IIS and performance. To test these hypotheses we investigate the interaction effects using regression analysis which is more appropriate when the moderator is measured on a quantitative scale, producing superior statistical power (Cohen et al. 2003; Frazier et al. 2004). The moderating variables were mean-centered prior to calculating the product terms to reduce the potential for

the effects of multicollinearity (Aiken et al. 1991; Jaccard et al. 1990). We then utilize the moderated regression approach which involves three regression equations as follows:

1. Model 1: a baseline model with only the predictor variables and control variables
2. Model 2: a main effects model with the moderator variable added
3. Model 3: a model which builds on model 2 by introducing an interaction term

To test for the presence of a moderating variable we compare the models to determine if:

1. Adjusted R^2 increased on addition of the interaction term to the model
2. The standardized coefficients for the interaction term is significant
3. The main effect between the criterion and predictor variable is significant.

An interaction plot is presented in any situation where all of these three criteria are met. In all of the subsequent regression analyses performed, the control variables are insignificant and all the variance inflation factors are below 2.0 indicating that multicollinearity is not a problem.

Hypothesis 5b posited that there would be a stronger positive association between operational IIS in the SN with low partner information visibility than with high partner information visibility. Table 5-16 presents the results.

Table 5-16. Results of Regression Analysis: Effects of Operational IIS and Partner Information Visibility on Supply Network Performance (standardized beta coefficients)

Variables	Model 1 β (T-value) Controls	Model 2 β (T-value) w/Independent variables	Model 3 β (T-value) w/Interactions
Control variables			
Industry	0.035 (0.642)	0.035 (0.677)	0.033 (0.634)
Years with partner	0.081 (1.401)	0.076 (1.380)	0.077 (1.389)
Firm size	-0.016 (-0.275)	-0.029 (-0.522)	-0.030 (-0.536)
Independent variables			
Operational IIS	0.215 (3.872)***	0.126 (2.275)*	0.131 (2.329)*
Partner Information Visibility		0.303 (5.509)***	0.307 (5.538)***
Interaction			
Partner Information Visibility*Operational IIS			0.030 (.553)
Adj. R^2	0.046	0.128	0.126
R^2 change	0.058	0.142	0.142
F change	4.874***	10.358***	8.664***

Dependent variable: SN Performance

*p<.05, **p<.01, *** p<.001.

An examination of our results indicates that the variance (adjusted R^2) in SN performance explained by operational IIS increases from 4.6% to 12.8% with the addition of partner information visibility variable but decreases slightly to 12.6% when the interaction term of partner information visibility and operational IIS is introduced in Model 3. The beta coefficient for the interaction term is not statistically significant. Based on these results, we conclude that there is no support for hypothesis 5b.

Hypothesis 5c posited that there would be a stronger positive association between strategic IIS in the SN with low partner information visibility than with high partner information visibility. The results of the regression analysis show that the interaction between partner information visibility and strategic IIS is not statistically significant. Table 5-17 presents the results of our analysis.

Table 5-17. Results of Regression Analysis: Effects of Strategic IIS and Partner Information Visibility on Supply Network Performance (standardized beta coefficients)

Variables	Model 1	Model 2	Model 3
	β (T-value)	β (T-value)	β (T-value)
	Controls	w/Independent variables	w/Interactions
Control variables			
Industry	0.011 (0.189)	0.011 (0.202)	0.010 (0.179)
Years with partner	0.106 (1.775)	0.099 (1.731)	0.100 (1.765)
Firm Size	-0.032 (-0.527)	-0.057 (-0.998)	-0.048 (-0.836)
Independent variables			
Strategic IIS	0.247 (4.268)***	0.150 (2.601)**	0.128 (2.154)*
Partner Information Visibility		0.323 (5.606)***	0.341 (5.813)***
Interaction			
Partner Information Visibility*Strategic IIS			0.088 (1.545)
Adj. R^2	0.057	0.149	0.153
R^2 change	0.07	0.161	0.171
F change	5.301***	13.480***	9.595***

Dependent Variable: SN Performance

*p<.05, **p<.01, *** p<.001

Although the variance explained by the model increases slightly from 14.9% to 15.3% when the interaction term is added to the regression model, the beta coefficient for the interaction term is not statistically significant. Thus the results do not support our hypothesis concerning the moderating role of the partner information visibility variable.

For hypothesis 6b we postulated that there would be a stronger positive association between strategic IIS and the performance of a SN with high variability (i.e. uncertainty) in supplier capability than with low variability in supplier capability. Table 5-18 presents the results.

Table 5-18. Results of Regression Analysis: Effects of Strategic IIS and Variability in Supplier Capability on Supply Network Performance (standardized beta coefficients)

Variables	Model 1 β (T-value) Controls	Model 2 β (T-value) w/Independent variables	Model 3 β (T-value) w/Interactions
Control variables			
Industry	0.011 (0.189)	-0.028 (-0.543)	-0.020 (-0.388)
Years with partner	0.106 (1.775)	0.059 (1.110)	0.060 (1.1125)
Firm size	-0.032 (-0.527)	-0.070 (-1.300)	-0.059 (-1.091)
Independent variables			
Strategic IIS	0.247 (4.268)***	0.153 (2.907)**	0.125 (2.306)*
Variability in Supplier Capability		-0.464 (-8.751)***	-0.474 (-8.937)***
Interaction			
Variability in Supplier Capability x Strategic IIS			-0.100 (-1.885)
Adj. R^2	0.057	0.256	0.263
R^2 change	0.07	0.269	0.278
F change	5.301***	20.694***	17.994***

*p<.05, **p<.01, *** p<.001.

With the introduction of the variability in supplier capability term, the variance in SN performance explained by the independent variables increases from 5.7% to 25.6%. As expected when the variability in supplier capability is high, SN performance is low and vice versa. In model 3, the interaction term explains only an additional 0.7% (over the variance in model 2) of the variance in SN performance and is not statistically significant. Consequently we reject hypothesis 6b.

Hypothesis 7b proposed that the positive relationship between operational IIS and the performance of the supply network is stronger in a SN with high process uncertainty than one with low process uncertainty. The results of our regression analysis are presented in Table 5-19 in which the standardized coefficients and t-values, shown in parenthesis, are reported.

Table 5-19. Results of Regression Analysis: Effects of Operational IIS and Process Uncertainty on Supply Network Performance (standardized beta coefficients)

Variables	Model 1 β (T-value) Base Model	Model 2 β (T-value) w/moderator variable	Model 3 β (T-value) w/Interaction
Control variables			
Industry	0.035 (0.642)	0.028 (0.519)	0.033 (0.619)
Years with partner	0.081 (1.401)	0.088 (1.531)	0.076 (1.320)
Firm Size	-0.016 (-0.275)	-0.022 (-0.392)	-0.022 (-.384)
Independent variables			
Operational IIS	0.215 (3.872)***	0.215 (3.896)***	0.228 (4.142)***
Process Uncertainty		-0.127 (-2.339)*	-0.123 (2.271)*
Interaction			
Process Uncertainty x Operational IIS			0.128(2.348)*
Adj. R^2	0.046	0.060	0.073
R^2 change	0.058	0.074	0.090
F change	4.874***	5.049***	5.186***

Dependent Variable: SN Performance

*p<.05, **p<.01, *** p<.005.

The results show a significant change in the adjusted R^2 values, first when the process uncertainty variable is added and then again when the interaction term is added. There is a positive and statistically significant relationship between operational IIS and SN Performance and also when process uncertainty is added in model 2. Additionally, we note that process uncertainty positively moderates the relationship between operational IIS and SN performance and is statistically significant (β=0.128, p=0.019).

To assist in further explaining the nature of the interaction effect we examine the interaction plot shown in figure 9. In this plot, values of one standard deviation below (low process uncertainty) and one standard deviation above (high process uncertainty) the mean are assigned to the interaction of process uncertainty and operational IIS.

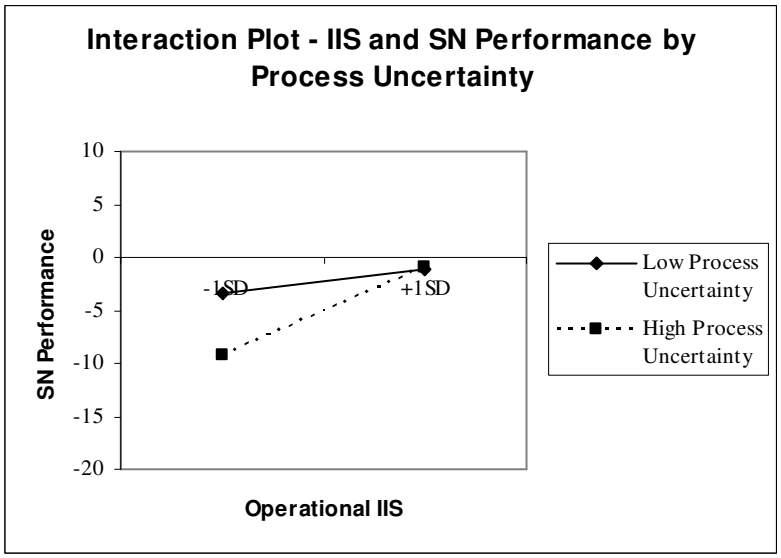


Figure 9. Interaction Plot

The lack of parallelism in the interaction plots is consistent with the results from the regression analysis where the interaction term is significant. The slope, when there is high process uncertainty, is much greater than the slope when there is low process uncertainty. Thus more performance benefits are gained from operational IIS when there is high process uncertainty than when process uncertainty is low. These results provide evidence to support hypothesis 7b.

Hypothesis 7c proposed that the positive relationship between strategic IIS and the performance of the supply network is stronger in a SN with high process uncertainty than one with low process uncertainty. The results of our regression analysis are presented in Table 5-20 in which the standardized coefficients and t-values, shown in parenthesis, are reported.

Table 5-20. Results of Regression Analysis: Effects of Strategic IIS and Process Uncertainty on Supply Network Performance (standardized beta coefficients)

Variables	Model 1	Model 2	Model 3
	β (T-value)	β (T-value)	β (T-value)
	Base Model	w/moderator variable	w/Interaction
Control variables			
Industry	0.011 (1.891)	0.006 (0.113)	0.010 (0.169)
Years with partner	0.106 (1.775)	0116 (1.935)	0.104 (1.736)
Firm Size	-0.032 (-0.527)	-0.043 (-0.709)	-0.037 (-0.610)
Independent variables			
Strategic IIS	0.247 (4.268)***	0.255 (4.420)***	0.262 (4.551)***
Process Uncertainty		-0.122 (-2.124)*	-0.128 (-2.225)*
Interaction			
Process Uncertainty x Strategic IIS			0.098 (1.700)
Adj. R^2	0.057	0.068	0.075
R^2 change	0.070	0.085	0.094
F change	5.301***	5.196***	4.840***

Dependent Variable: SN Performance

*p<.05, **p<.01, *** p<.005.

Here the change in adjusted R^2 is very small and the interaction is not statistically significant, p=.090, so hypothesis 7c is rejected.

Hypotheses were not developed for the relationship between IIS and SN performance but since the interaction test associated with this relationship was statistically significant it is incumbent on us to check these results. We state these hypotheses as follows:

Hypothesis 8a: The higher the strategic IIS, the higher the SN Performance.

Hypothesis 8b: The higher the operational IIS, the higher the SN Performance.

Hypothesis 8c: The higher the IIS (both strategic and operational IIS, the higher the SN Performance.

A summary of the results associated with hypotheses 8a, 8b and 8c is presented in Table 5-21.

Table 5-21. Results of Regression Analysis for IIS on Performance

Variable	β	t	**Adj R^2**
Both Operational and Strategic IIS	.176	3.288***	.030
Strategic IIS	.123	2.271*	.014
Operational IIS	.214	4.112***	.046

Dependent variable: SN Performance *p<.05, **p<.01, *** p<.005

A summary of the results of all the hypotheses is presented in Table 5-22.

Table 5- 22. Summary of the Results

Relationship	Hypothesis	Findings
Dyadic SN <---> Type 4 IIS	H1a	Supported
Multiple Dyadic <---> Type 1 IIS	H1b	Supported
Stages <---> Frequency Operational IIS	H2	Not Tested
Location <---> Types 1 & 4 IIS	H3a, H3b	Not Supported
Coordination Structure <---> Strategic IIS (Dyadic SN)	H4a	Supported
Coordination Structure <---> Freq. Operational IIS (Multi. Dyadic SN)	H4b	Supported
Partner Information Visibility ---> Performance	H5a	Supported
Variability Supplier Capability ---> Performance	H6a	Supported
Process Uncertainty ---> Performance	H7a	Supported
Moderation		
StagesxCoordination Structure ---> Frequency Operational IIS	H4c	Not Tested
Partner Information Visibility x Operational IIS ---> SN Performance	H5b	Not Supported
Partner Information Visibility x Strategic IIS ---> SN Performance	H5c	Not Supported
Variability in Supplier Capability x Strategic IIS ---> SN Performance	H6b	Not Supported
Process Uncertainty x Operational IIS ---> SN Performance	H7b	Supported
Process Uncertainty x Strategic IIS ---> SN Performance	H7c	Not Supported
Additional Hypotheses (not developed but form part of the interaction analysis)		
Operational IIS ----> Performance	H8a	Supported
Strategic IIS ---> Performance	H8b	Supported
IIS (Operational and Strategic) ---> Performance	H8c	Supported

6. DISCUSSION

In this manuscript we explored the relationship between supply network configuration and IIS, classified as a two-dimensional construct in terms of the type of IIS and the frequency with which information is shared, and how it is impacted by different coordination structures. Our motivation was largely driven by Storey's (2002) appeal for pragmatic approaches that focus on some of the challenges faced in managing supply networks. In keeping with his suggestion for further study on topics such as the structure, and processes associated with supply chain management we sought to:

- Add some clarity to the ambiguous findings in the literature on the effect that IIS has on the performance of supply networks,
- Investigate how critical factors such as process and partner uncertainty affect the relationship between IIS and performance and
- Examine the role of the coordination structure as it relates to the SN pattern and IIS.

Drawing on the marketing, operations, strategy and information management literature, a theoretical model was developed utilizing transaction cost economics and social network theories. Such an integrative approach offered the potential for a richer understanding of the factors in our model. The proposed model was empirically validated in a cross-sectional setting, using a sampling frame randomly selected and comprised of supply management executives from various industries within the United States.

Our findings and their implication for academicians and practitioners are discussed in the following sections.

6.1 Findings

6.1.1 Performance and Information Sharing

Extant literature on information sharing and performance has been ambiguous. As discussed earlier, information sharing has been shown to lead to higher performance (Carr et al. 1999; Dyer 1996; Jap 2001), or incremental performance gains (Cachon et al. 2000) or no gains at all (Graves 1999).

It has been suggested, that the greatest benefits from inter-organizational information sharing are obtained when firms work collaboratively rather than by merely engaging in information transfer between parties (Kulp et al. 2004).

Our observations corroborate findings that report a positive relationship between IIS and performance. We go a step further in this study by identifying the nature of the IIS associated with SN performance. The results indicate that operational IIS and strategic IIS are positively related to SN performance individually and collectively. Operational IIS can help with scheduling and inventory planning so as to gain efficiencies in the supply network for both the buyer and the supplier, thus allowing firms to have a leaner and more agile operation. Strategic IIS is also important to the transacting parties particularly for firms that are involved in collaborative relationships.

From our analysis we observe that the variance in SN performance explained by operational IIS and strategic IIS, when considered either separately or jointly, is less than 10%. A possible reason could be that performance increases normally attributed to information sharing may stem from causes other than those included in our model. For example, Carr and Kaynak (2007) attribute some of the financial performance gains for the buying firm to an indirect link

from information sharing through other supply chain initiatives such as product quality improvements.

To help us better understand the IIS-to-performance link, we discuss in section 6.1.4 the moderating effect of uncertainty on the relationship between IIS and SN Performance.

6.1.2 Performance and Partner Uncertainty

The Transaction Cost Economics literature and agency theory provide some guidance on how to interpret the direct relationship found between performance and two characteristics of partner uncertainty: partner information visibility and variability in supplier capability.

There is often a lack of goal congruence in buyer/supplier relationships involving firms with low partner information visibility. While the goal of the buyer is typically to find suppliers who can provide cost effective products, the suppliers in those relationships are more interested in deals that return high profit margins (Jap 2001). In the absence of common goals firms are more likely to act in their own self interest (Jensen et al. 1976), resulting in information asymmetry which can then lead to opportunistic behavior. There is high transaction costs associated with opportunistic behavior as it is more difficult to coordinate activities without having the requisite information, which ultimately leads to sub-optimal performance (Jap 2001).

On the contrary, firms that have high partner information visibility are more likely to have common goals and this will motivate them to share information among their members. With high partner information visibility, transaction costs are lowered, transaction value enhanced (Dyer 1997) and relational rents generated (Anderson et al. 1990). Accordingly the observed direct and positive relationship between partner information visibility and SN performance is supported by extant literature.

With respect to variability in supplier capability, a buying firm relies on the supplier to a large extent to maintain a competitive position (Monczka et al. 1993) so it is important that the suppliers have the capability to satisfy the needs of the buying firm. According to Handfield et al

"*One of the most important activities in the new development process is understanding the focal suppliers' capabilities and design expertise, conducting a technology risk assessment, and weighing the risks against the probability of success*." (Handfield et al. 1999b)

One can then assume that a firm that is unable to assess the capability of a supplier partner would likely be reluctant to involve that supplier in a new product development project that may require specialized skills to cope with new technology, for instance. While quality initiatives, supplier development programs and collaborative relationships are instrumental to improving the supplier capability (Monczka et al. 1993), the buying firm may instead decide to work with an alternative partner that has the necessary skills (Handfield et al. 2007). High switching costs will result from using an alternative supplier in cases where idiosyncratic assets are already in place.

Conversely, with low variability in supplier capability, a buying firm is fully cognizant of the supplier's skills and resources and can put the requisite plans in place to address any inadequacies of the supplier. The firm will therefore be more willing to integrate the supplier in the design phase for new products. Potential benefits from early supplier involvement normally include reduced costs, reduced time to market, and higher quality products (Handfield et al. 1999b) which lead to performance gains and ultimately, more satisfied customers. Thus, the positive relationship between variability in supplier capability and SN performance is not surprising.

6.1.3 SN Performance and Process Uncertainty

According to (Hopp et al. 2004), process uncertainty can be reduced by introducing flexibility into processes and internal control systems. The manner in which this flexibility is introduced will then become very important. Miller and Dröge (1986) suggests that firms can respond more readily to uncertainty when lower levels of a firm's hierarchy are allowed to make decisions.

One problem with using lower level staff, however, is that that the firm's ability to handle some issues may be diluted owing to the wide range and often conflicting responses received from these lower level staff (Iyer et al. 2004) who may not be as experienced or have all the expertise to handle a more centralized problem. Such inefficiencies will drive up transaction costs and result in lower performance returns. Based on these arguments there is merit in the findings that there is a direct but negative relationship between process uncertainty and SN performance.

6.1.4 SN Performance, IIS and the Quasi-Moderators

Of the three moderators (process uncertainty, partner information-visibility, and variability in supplier capability) only process uncertainty showed a significant moderation effect for the relationship between IIS and SN performance in the case of operational IIS.

Given the finding that process uncertainty has no impact on the relationship between strategic IIS and SN performance but has influence when the IIS is operational, we conjecture that since process uncertainty is focused primarily on current issues such as machine breakdowns and delivery delays the greatest influence will be on operational IIS. To effectively manage process uncertainty will require more operational IIS to garner SN performance gains.

Turning to variability in partner capability, the literature suggests that when variability in supplier capability is high, suboptimal decisions result and these can be costly to the firms in the network. Since the variability in supplier capability is looking at future expectations it would not have much influence on the relationship between operational IIS and Performance. Although not reported in our results, our analysis confirmed that belief. However the lack of influence that the variability in supplier capability has on the relationship between strategic IIS and performance was unexpected. One plausible explanation for this is that firms after assessing the risk of continuing a relationship with a supplier that has low supplier capability opts instead to outsource to alternative suppliers. This may be attributable to the inability of firms to properly assess supplier capabilities (Handfield et al. 2007) or their unwillingness to institute supplier development programs and other initiatives to upgrade the skills and resources of the supplier.

Finally partner information visibility also did not have any significant influence on the relationship between IIS and SN performance as expected. With high partner information visibility, the literature on agency theory suggests that firms would tend to withhold information and behave opportunistically. While firms may not be willing to share the information that they possess, the trading partner may have found alternative sources to get that information or be working with similar firms so that their reliance on the firm that is withholding information is substantially diminished.

6.1.5 IIS, Supply Network Configuration and Coordination Structure

Several studies on supply network structure (Beamon 1998; Choi et al. 2002; Fisher 1997; Harland et al. 2001) have been conducted, but how it relates to IIS has not, to my knowledge, been empirically established in the literature. Some researchers (Lee et al. 2000b)

have noted the lack of empirical research on information sharing in supply networks with most of the work examined from a theoretical perspective.

Our empirical analysis provides some significant insights into how the configuration of the supply network is related to IIS. Our findings that dyadic supply networks are associated with Type 4 (strategic, high frequency) IIS while multiple dyadic networks are associated with Type 1 (operational, low frequency) IIS are consistent with the tenets of social network and TCE theories. The interdependence and the strong ties existing in a dyadic network foster Type 4 IIS. In the multiple dyadic networks where tie strength is much weaker and relationships are primarily governed by market transactions, Type 1 IIS is the more likely outcome. Since both operational and strategic IIS increase performance and the appropriate type of IIS changes depending on the SN configuration, it is likely that the SN configuration also affects the SN performance. Such conjectures await future research however.

One of the other dimensions of the supply network configuration is the location of the firm in the network. The literature on the "bull whip" effect (Lee et al. 1997b) and on "clockspeed" (Fine 1998) illuminated our discourse and postulates as it relates to firm location. Contrary to our hypotheses that firms located close to the consumer would engage in Type 4 IIS and those close to the initial source of material would engage in Type 1 IIS, our finding of Type 1 IIS irrespective of the firm location was initially a bit surprising. However, in retrospect there is a plausible explanation for this discrepancy.

The complexity of a network can be partially attributed to how the firms are linked (Choi et al., 2001). As the complexity of such networks increase from dyadic to multiple dyadic they will require more interaction with others in the network in order to coordinate the various activities that are involved in accomplishing day-to-day tasks efficiently. In such an environment

firms will share operational IIS. Complex networks can exist anywhere along the continuum from the initial raw material supplier to the consumer. Thus while the location of the firm can be an important consideration in determining the type of IIS, the complexity of the network is a more compelling determinant and so takes precedence.

In terms of the coordination structure, results show that firms in a single stage dyadic network that have a centralized coordination structure are more likely to share strategic IIS than those in a decentralized coordination structure. This corroborates with our hypotheses where we expect that there will be more strategic IIS in the centralized coordination structure since in that case the decisions made have significant impact on both the buyer and the supplier. This is quite different from a decentralized coordination structure were control is more localized. With respect to the multiple dyadic networks, as expected, frequent operational IIS is required to successfully manage the many rules and procedures. These are used to control and maintain orderliness in the day-to-day activities of multiple firms in a centralized coordination structure more so than with a decentralized coordination structure where the focus is on responsiveness to local changes (Choi et al. 2002).

6.2 Theoretical Contributions

This dissertation makes several contributions to academic inquiry. Our study increases the understanding of how structural factors can affect IIS by developing a framework that integrates the design of the supply network with IIS. Research has been conducted separately on supply network design and on IIS but how these two are related has not been established. To advance the study of IIS, a theoretical framework is developed in which links between key characteristics of supply network configuration and IIS are investigated.

Enhancements to understanding the influence of the supply network design on IIS are provided by associating different types of IIS with the appropriate supply network design. The finding of a significant association between the network pattern and the type of IIS constitutes a significant contribution to, and extension of the current literature in supply chain management. Thus Type 4 IIS is expected to dominate in dyadic networks and Type 1 IIS in multiple dyadic networks. In much of the prior literature, IIS is narrowly construed in terms of either the scale (Gavirneni et al. 1999) or scope (Seidmann et al. 1998) of information shared, neither of which are adequate.

Our model also extends the parameters under inquiry to include an investigation of how performance is impacted when the information shared is constrained by uncertainty and how coordination structure can influence the Type of IIS in the SN.

Finally, this study adds to the scant body of empirical research on networks. Traditionally IIS in supply networks has been studied primarily with respect to the supplier or the buyer and less frequently the buyer-supplier dyad. The problem with taking these perspectives is that findings cannot always be assumed to inductively apply to supply networks, thus compromising the efficacy of many studies. However, due to the complex and oftentimes dynamic nature of supply networks there are only a few researchers that have ventured into empirical studies of networks. We add to the limited research by utilizing a sampling frame that includes data on product supply networks comprised of focal firms, and a downstream and an upstream partner for each of those firms.

6.3 Practical Implications

The findings from our research provide several managerial insights for practitioners on information sharing in dyadic and multiple dyadic networks. Essential to the effective management of the supply network is an understanding of the relationship between the types of IIS and the design of the supply network. Prior to sharing information, firms need to decide not only what to share but also how to share, decisions that can be more appropriately determined by considering IIS in terms of two-dimensions comprised of the type of information shared and the frequency with which information is shared (Samaddar et al. 2004).

Managers who are able to understand that the type of IIS that occurs will depend on how the transacting parties are connected in the supply network, and are sensitive to the effect that uncertainty has on performance can be more effective in developing and deploying their strategic plans. Firms that can institute procedures aimed at reducing the uncertainties in their processes and with their suppliers will be more likely to reap optimal benefits from their IIS endeavors. These include reconfiguring the SN, improving the communication channels, instituting supplier development plans, supply councils and guest engineer programs where applicable to increase the capability of their suppliers and develop trust within their networks.

6.4 Limitations and Future Research

We acknowledge some limitations of our study that can be useful in guiding future research activities.

Our sample population comprised only those in a manufacturing network so there may be limited generalizability to other types of industries. Additionally we used only a single informant

to gather the information on the buyer and the supplier which gives a one sided view that could lead to inherent biases even though several steps were taken to mitigate this effect.

Another limitation is the cross-sectional nature of our study. A longitudinal study would be helpful to determine if, over time, the type of IIS changes for a particular SN configuration or if there is a different type of IIS when the SN configuration changes.

Future research should expand the data collection to include the buyer's and supplier's perspective so that we can get a more balanced view and be able to fully examine the nature of the relationship. A study that examines our model across other sectors such as the public sector or different countries may also be instructive given today's global environment.

Additionally, future research should look at the different types of IIS to answer questions such as 'does the sharing of promotional strategies provide greater performance improvements than other types of strategic IIS?' Another area for future research is to explore if there are differences in the IIS dynamics between the upstream and downstream portions of the product supply network. These two areas will provide some finer grained information that can help us get a better understanding of some of the intricacies associated with IIS.

Finally future research can investigate the performance of the buyer and the firm separately and compare that to the performance of the supply network.

Notwithstanding the aforementioned limitations we believe that this manuscript makes a compelling case for the structure/process/outcome model linking the supply network configuration to IIS and in turn, to Performance.

6.5 Conclusion

Despite burgeoning literature on IIS, the guiding principles that are essential to an understanding of this process are still evolving. Several researchers have expounded the benefits of IIS to the overall supply network. Yet the "emergent, dynamic and unpredictable" nature of supply networks (Choi et al. 2001) presents challenges for organizations and oftentimes the purported benefits do not materialize.

Many managers are unsure on how best to leverage their resources so that they can capitalize on the information sharing opportunities that are available. Our research study, in addition to its theoretical contributions, moved towards filling this gap by suggesting that structural factors, such as the design of the supply network, play a significant role in facilitating IIS. Additionally the role of the coordination structure and its influence on the type of IIS in a SN were investigated. We also added some clarity on how IIS can impact performance by identifying some uncertainty conditions that can determine whether or not performance benefits accrue to the supply network. From our exploration emerged a clearer picture of some of the dynamics associated with a supply network. An understanding of these issues can help propel organizations and guide managers on how best to navigate the complex and fast moving environment within which they operate.

Transaction cost economics and social network theories provided the theoretical lens for our study. Cross-sectional data collected from manufacturing industries validated our assertions that the structure of the supply network plays a part in the type of information shared and corroborated other research findings, that IIS can improve performance.

APPENDIX A –Typology of IIS (Samaddar et al. 2004)

New Typology of IIS

To reduce uncertainty or the ill effects of uncertainty, firms need to interact frequently, which requires sharing of information. While the degree of interaction, which can be interpreted as frequency of sharing, is important, the quality or richness of information shared is also important (Daft et al. 1986). Even though the scope of the information does not mean richness of the information, most of operational information is less rich than strategic information as mentioned. Therefore, by knowing the scope of information, it is possible to guess the richness of information. Scale-based IIS types focus only on quantity of information shared, not quality of information shared. In contrast, scope-based IIS types focus only on quality of information, which misses the frequency of interaction. Clearly, the uni-dimensional IIS typology is not an effective way of classifying various forms of IIS. As a result, we propose a new typology of IIS by using two dimensions: frequency and scope. We represent the decision of 'what to share' by the scope of the information (operational vs. strategic), and the decision of 'how to share' by the frequency of information sharing (low vs. high). Both dimensions are needed to gain a more comprehensive understanding of IIS strategies than what is afforded by the literature. This two-dimensional framework is presented in the table below.

Type Frequency	Operational	Strategic
Low	*Type I* Lower information cost Low concern about security and proprietary information	*Type 3* Low information cost High concern about security and proprietary information
High	*Type 2* High information cost Low concern about security and proprietary information	*Type 4* Higher information cost High concern about security and proprietary information

Table A -1. Typology of IIS

In this framework, Type 1 (Type 2) IIS has a capability of sharing operational information with low (high) frequency. Similarly, Type 3 (Type 4) has a capability of sharing strategic information with low (high) frequency. Note that operational (Type 1 and 2) IIS deals with mostly quantitative and simple data and information. On the contrary, strategic (Type 3 and 4) IIS deals with mostly qualitative information and knowledge. In this typology strategic information include operational information, and high frequency sharing also includes low

frequency sharing. That is, for example, it is possible to do Type 1 IIS using Type 2 IIS. However, having Type 2 IIS in the place of Type 1 IIS will create higher cost (for example, information cost) than the case of having appropriate type of IIS (i.e., Type 1). In this paper, we define information costs as the combined costs associated with acquiring information, processing the acquired information, and building and maintaining system(s) that facilitate information sharing. To facilitate information flow, supply network can implement various information system such as direct connect, outsourcing or third party provider of information system (Premkumar 2000); Each of these options has pros and cons. As cost-effective information system is one of the key drivers of supply network management (Lee et al. 2000b), identifying appropriate types of IIS is important task when the organization design and manage the supply network. By knowing what type of information sharing is required, the organizations can build appropriate information system.

Low frequency/operational IIS (Type 1)

Type 1 IIS involves the occasional sharing of information. Tasks that impact transacting parties are normally well-structured with standardized procedures for handling activities so that information only needs to be shared when there are exceptions, which occurs seldom. Under these circumstances, coordination costs, which are associated with managing interdependent activities, are low as there is very little need for operational information to be shared regularly to facilitate task completion. Decision rights are often decentralized for the well-structured task or process, and frequent information sharing is not required in those situations (Anand et al. 1997). There are also few exceptions in the process or task, and therefore entities can rely primarily on local knowledge and information to make decisions. As a result, Type 1 IIS is often employed in decentralized decision structures, where information costs are low (Anand et al. 1997).

With Type 1 IIS there is often no need for advanced IT to transmit information owing to the low frequency of information sharing and the nature of information. As a consequence there is more flexibility with the communication media that can be utilized. In situations where simple technology, such as FAX and e-mail can be used, implementation costs are expected to be low.

Owing to the short-term nature of operational decisions and the ease with which actions taken can be reversed (Hitt et al. 1999), firms are not that concerned with information leakage to potential competitors. Therefore security and proprietary concerns with respect to the information shared tend to be low.

High frequency/operational IIS (Type 2)

In Type 2 IIS, information is shared on a recurrent basis to facilitate activities such as production planning, or delivery scheduling. Although these tasks are well-structured and are not complex, they are sensitive to many disturbances (or uncertainties) both those internal and external to the supply network. The use of automated systems is prevalent in these situations in order to handle the flow of information in a timely manner and with a high degree of accuracy. For instance, at Chrysler where frequent and accurate communication was required between the assembly plants and suppliers, the implementation of EDI allowed suppliers to obtain real time information on the precise requirements of the assembly plants and, in turn, to provide the plants with advance shipping notices (Mukhopadhyay et al. 1995).

Even with frequent information sharing in this type of IIS, much of the information sharing can be handled using automated systems, because the information shared tends to be well-structured and quantitative. Therefore, human intervention can often be avoided. This allows transacting agents to switch their focus from regulating operational exchanges to concentrating on other cooperative activities with their partners (Bensaou 1997).

The information costs associated with Type 2 IIS will be higher than for Type 1 owing to the potential need for automated systems in the former. In the absence of an automated system more human resources have to be used for Type 2 to regulate high frequency exchanges, which increases the information costs due to high processing cost. In addition, unlike Type 1 IIS, high frequency information sharing is often found where decision rights are centralized and this also leads to high information cost (Anand et al. 1997). Security and proprietary concern are also low owing to the nature of the information shared.

Low frequency/strategic IIS (Type 3)

Type 3 IIS is used to assist various strategic decisions in cases where information sharing is needed infrequently, which often means that information shared requires less interaction. However, due to its nature, which is often qualitative and non-standardized, strategic information is not as suitable for automation as operational information. Also, common language between transacting parties about the information shared is required to interpret such information and use it uniformly towards decision making [reference]. Such language is needed to share and integrate aspects of knowledge [and information] that is not common between individuals (Grant 1996). Without common knowledge, parties have no choice but to share information frequently in order to alleviate misunderstanding. Thus, a necessary condition for Type 3 IIS is a common language between source and recipient. Note, however, that it is possible to have frequent information sharing (i.e., Type 4 IIS) even with the presence of common knowledge between firms. For example, if high interaction is required for a certain task (such as innovative new product development), then even with the presence of common language parties will share information more frequently. Where parties are in the same industry and have a long history of relationship they are more prone to have this common language.

Similar to Type 1, Type 3 IIS is more suitable where decision rights are decentralized because the frequency of information sharing is low (Anand et al. 1997). Thus information costs are low. In general, sharing strategic information is more difficult than operational information because it requires a richer communication media (Daft et al. 1986). Therefore information costs are higher for Type 3 than for Type 1 and Type 2.

Strategic decisions usually make a significant contribution to the overall success of the organization and can have far reaching implications. Owing to the long-term nature of such decisions and the difficulty to reverse any action taken, firms need to institute protective measures to safeguard their information from potential competitors. As a result, these types of information have a higher concern about security and proprietary issues compared to operational information. Even with commonalities, fear of information leakage will make parties share strategic information infrequently(Seidmann et al. 1998).

High frequency/strategic IIS (Type 4)

Type 4 IIS involves recurrent information flow between parties. This occurs in collaborative endeavors where timely information is critical to the completion of the activity. In addition, frequent information exchange is often required in order to obtain accurate interpretation (due to the lack of common language or to the novel technologies used) of strategic information and to ensure effective coordination with all the relevant parties.

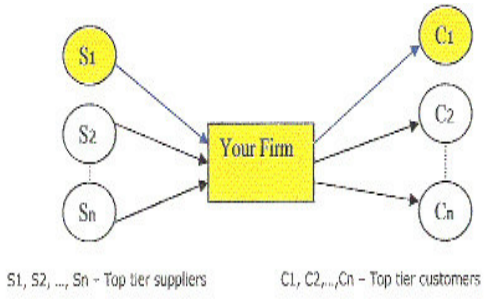
For example, consumer demand is often forecasted jointly by manufacturers and retailers such as Wal-mart and Target using collaborative planning, forecasting and replenishment (CPFAR) initiatives (Kiely 1998). The key characteristics of CPFAR are the sharing of real-time inventory data by retailers with manufacturers allowing forecasts to be developed in a timely manner and continuous replenishment of retailer inventory by manufacturers. Even though forecasting customer demand can be considered simple, each firm may have different formulas, safety stock requirement, etc. (i.e., lack of common languages) This forces the firms to have more interaction, thus frequent recurrent information exchange, to ensure correct understanding of strategic information (e.g., forecasting formulas or safety stock requirement) provided.

In many of these collaborative ventures, IT often plays a critical role (Premkumar 2000), since the information in Type 4, unlike Types 1 and 2, is often complex and requires rich communication media such as face-to-face meeting or video conferencing (Roberts 2000). Potential drawbacks could exist at many levels, such as high security and proprietary concern and poor standard of communication. Of all four types of IIS, Type 4 IIS has the highest information costs due to the combination of high frequency and the nature of the information, which requires common language for interpretation (Choudhury et al. 1997)

APPENDIX B – SURVEY

B1. Introduction to Survey

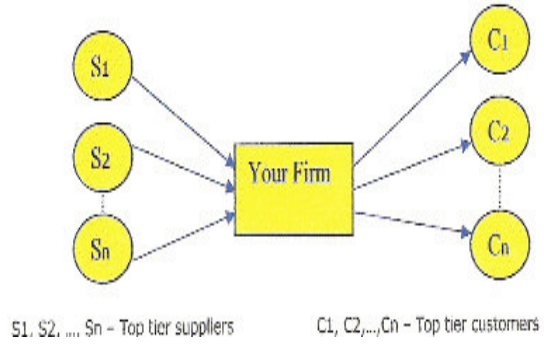
You are invited to participate in our survey on Information Sharing between firms in supply networks. In this survey, you will be asked to pick one top tier supplier (e.g. S1) and one top tier customer (e.g. C1), as shown below, who are external to your firm and with whom your firm transacts directly.



The supplier and customer selected must be part of the same supply network. Thus an item (e.g. product/part/subassembly) bought from supplier S1 must be used to produce an item sold to customer C1.

Section 1 of this questionnaire focuses on the relationship between your firm and one supplier (the link between S1 and your firm). Section 2 focuses on the relationship between your firm and one customer (the link between your firm and C1).

In section 3 we focus on the supply network as shown below:



Here we are interested in all the immediate suppliers and customers that your firm transacts with for the item referenced in sections 1 and 2.

It will take approximately 15-20 minutes to complete the questionnaire.

Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. Please answer all questions as completely as possible in order to facilitate a comprehensive analysis of the data. Feel free to consult with the relevant persons in your firm if you do not have all the information necessary to answer a question. Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential.

If you have questions at any time about the survey or the procedures, you may contact Marcia Daley at 404 217-2889 or by email at mdawnja@aol.com.

Thank you very much for your time and support. Please start with the survey now by clicking on the Continue button below.

B.2. Qualifying question (Qualify)

On average, how much of your time do you spend on activities and decision-making issues related to your firm's supply networks (suppliers, customers)?
1) 0-10% 2) 11-20% 3) 21-30% 4) 31-40% 5)41-50% 6) 51-60% 7) 61-70% 8) 71-80% 9) >80%

B3. MEASUREMENT ITEMS

SECTION 1 - YOUR SUPPLIER
Consider a supplier that provides your firm with an item (e.g. material/part/ subassembly) used to generate a significant portion of your firms revenue. Please respond to the following questions and statements in reference to this supplier.

Years Working with Supplier – (YRSWS)

How long has your firm been doing business with this supplier? (Check one)
1. Not Applicable
2. Less than 1 year
3. 1-3 years
4. 4-5 years
5. 6-10 years
6. More than 10 years

Operational Information Sharing
(Seven-point Likert scale: Strongly Disagree / Strongly Agree)

Your firm shares the following operational information with this supplier:
1. Production schedules. (SOIS1)
2. Advanced shipping notices. (SOIS2)
3. Order status. (SOIS3)
4. Inventory levels. (SOIS4)

Frequency of Operational Information Sharing – (SOISF)
In general, how frequently does your firm share operational information with this supplier?
1. Not Applicable
2. Never
3. Rarely
4. Most months within a year
5. 1-3 times/month
6. Weekly
7. Most days

Strategic Information Sharing
(Seven-point Likert scale: Strongly Disagree / Strongly Agree)

Your firm shares the following strategic information with this supplier:
1. Target markets. (SSIS1)
2. Product development. (SSIS2)
3. Distribution strategies. (SSIS3)
4. Promotional strategies. (SSIS4)

5. Facility layout. (SSIS5)
6. Capacity planning. (SSIS6)
7. Sourcing plans. (SSIS7)
8. Research. (SSIS8)

Frequency of Strategic Information Sharing (SSISF)
In general, how frequently does your firm share strategic information with this supplier?

1. Not Applicable
2. Never
3. Rarely
4. Most months within a year
5. 1-3 times/month
6. Weekly
7. Most days

Supplier Partner Information Visibility
(Seven-point Likert scale: Strongly Disagree / Strongly Agree)

We are interested in determining if the information that this supplier shares with you is useful for assessing its operations. Please select the response that best describes the extent to which you disagree or agree with the following statements.

1. The information received from this supplier is generally accurate. (SPII1)
2. The information received from this supplier is generally timely. (SPII2)
3. Based on our past experience, the information received from this supplier is normally adequate to assess its operations. (SPII3)

Variability in Supplier Capability*
We are interested in determining this supplier's ability to deliver on time and with acceptable quality. Please select the response that best describes the extent to which you agree or disagree with the following statements
(Seven-point Likert scale: Strongly Disagree / Strongly Agree)

1. This supplier has the resources (e.g. skill level of workforce, plant capacity, manpower) to deliver in a timely manner even if there are significant product/component changes. (SVPC1)
2. The quality of work received from this supplier will not deteriorate, even if there is significant product, or component changes. (SVPC2)
3. This supplier has the resources to deliver in a timely manner despite significant process changes. (SVPC3)
4. The quality of work received from this supplier will not deteriorate with significant process changes. (SVPC4)
5. This supplier has the resources to deliver in a timely manner despite significant technology interface changes. (SVPC5)
6. The quality of work received from this supplier will not deteriorate despite significant technology interface changes. (SVPC6)

*Reverse coded - High values indicate low variability (low uncertainty)

Supplier Performance
(Seven-point Likert scale: Greatly Below Average / Greatly Above Average)

Please rate your supplier's performance with respect to the following:

1. Delivery performance to commit date. (SDREL1)
2. Fill rate. (SDREL2)
3. Customer satisfaction with orders. (SDREL3)
4. Order fulfillment lead times. (SDRESP)
5. Responsiveness to changes in customer demand (SFLEX)

SECTION 2 - YOUR CUSTOMER
Consider now a top-tier customer who purchases a significant amount of an item (e.g. product/part/subassembly) from your firm. Note: This customer must be one for whom the item referenced in section 1 is required in order to fulfill its orders.

Please respond to the following questions and statements in reference to this customer.

How long has your firm been doing business with this customer? (Check one) (YRSWC)
1. Less than 1 year
2. 1-3 years
3. 4-5 years
4. 6-10 years
5. More than 10 years

Location of the Customer in the Supply Network (CLOC)
Please select one of the following to describe the position of this customer in the supply network
1. Raw material Distributor
2. Intermediate product/part/subassembly Manufacturer
3. Intermediate product/part/subassembly Distributor
4. Final product Manufacturer
5. Wholesaler/Distributor
6. Retailer/Distributor to the public
7. Consumer
8. Other

Operational Information Sharing
(Seven-point Likert scale: Strongly Disagree / Strongly Agree)

Your firm shares the following operational information with this customer:
1. Production schedules. (COIS1)
2. Advanced shipping notices. (COIS2)
3. Order status. (COIS3)
4. Inventory levels. (COIS4)

Frequency of Operational Information Sharing (COISF)
In general, how frequently does your firm share operational information with this customer?
1. Not Applicable
2. Never
3. Rarely
4. Most months within a year
5. 1-3 times/month
6. Weekly
7. Most days

Strategic Information Sharing
(Seven-point Likert scale: Strongly Disagree / Strongly Agree)

Your firm shares the following strategic information with this supplier:
1. Target markets. (CSIS1)
2. Product development. (CSIS2)
3. Distribution strategies. (CSIS3)
4. Promotional strategies. (CSIS4)
5. Facility layout. (CSIS5)
6. Capacity planning. (CSIS6)
7. Sourcing plans. (CSIS7)
8. Research. (CSIS8)

Frequency of Strategic Information Sharing (CSISF)
In general, how frequently does your firm share strategic information with this customer?

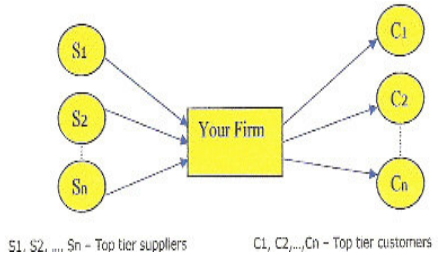
1. Not Applicable
2. Never
3. Rarely
4. Most months within a year
5. 1-3 times/month
6. Weekly
7. Most days

Partner Information Visibility
(Seven-point Likert scale: Strongly Disagree / Strongly Agree)

We are interested in determining if the information that this customer shares with you is useful in assessing its operations. Please select the response that best describes the extent to which you agree or disagree with the following statements.

1. The information received from this supplier is generally accurate. (CPII1)
2. The information received from this supplier is generally timely. (CPII2)
3. Based on our past experience, the information received from this supplier is normally adequate to assess its operations. (CPII3)

SECTION 3 - PRODUCT SUPPLY NETWORK
Focusing on the product supply network (see below) which includes all top tier suppliers and customers for the item (e.g. material/part/subassembly) referenced in sections 1 and 2 of this questionnaire, please provide the following information:



Please specify the number of top-tier suppliers that your firm transacts with for this item _____ (NumTTS)

Please specify the number of top-tier customers that your firm transacts with (those for whom this item is required in order for your firm to fulfill their orders) _____ (Num TTC)

Please identify from the following, the position of your firm in the supply network for this item check one: (FLOC)

1. Raw material Manufacturer
2. Raw material Distributor
3. Intermediate product/part/subassembly Manufacturer
4. Intermediate product/part/subassembly Distributor
5. Final product Manufacturer
6. Wholesaler/Distributor
7. Retailer/Distributor to the public
8. Consumer

Coordination Structure
(Seven-point Likert scale: Strongly Disagree / Strongly Agree)
Please select the response that best describes the extent to which you agree or disagree with the following statements.

1. Supplier selection decisions are made by our firm without active involvement from any of our partners. (CS1)
2. There is very little active involvement with our partners on product design matters. (CS2)
3. Our firm is free to make local adaptations to meet the needs of our clients. (CS3)
4. Our firm has the authority to make strategic decisions related to our activities in the supply network without getting permission from our partners.(CS4)
5. Suggestions and recommendations made by our partners have to be considered when making strategic decisions.(CS5)
6. Decision-making in this network is centralized.

The authority for making strategic decisions (check one): (CS7)

1. Resides in our firm
2. Is shared but our firm has more authority than our partner
3. Is shared equally between our firm and our partner
4. Is shared but our firm has less authority
5. Resides in our partners firm

SECTION 4 - YOUR FIRM
Focusing only on your firm, please respond to the following statements by selecting the most appropriate response as it relates to the production time.

Process Uncertainty
With respect to production time, the duration of planned shutdown in our firm is typically: (PROCU1)

1. More than 10%
2. 6-10%
3. 1-5%
4. Less than 1%

With respect to production time, the duration of unplanned stoppages in our firm that significantly affect operations is typically: (PROCU2)

1. More than 10%
2. 6-10%
3. 1-5%
4. less than 1%

Firm Performance
(Seven-point Likert scale: Greatly Below Average / Greatly Above Average)

Please rate your firm's performance in the supply network relative to other firms in the same industry based on the following:

1. Delivery performance to commit date. (FDREL1)
2. Fill rate. (FDREL2)
3. Customer satisfaction with orders. (FDREL3)
4. Delivery responsiveness (FDRESP)
5. Responsiveness to changes in customer requirements (FFLEX)
6. Value added per employee. (FCR1)
7. Cost of goods sold. (FCR2)
8. Warranties/returns processing costs (FCR3)
9. Cash-to-cash cycle time. (FAMF1)
10. Inventory days of supply. (FAMF2)
11. Net asset turns. (FAMF3)

SECTION 5 - DEMOGRAPHIC INFORMATION
The following information is needed for classification and comparison purposes only.

What is your position within this firm? (TITLE)
1. Partner/Owner
2. President/CEO
3. Chief Procurement Officer
4. COO
5. EVP/SVP
6. VP/Assistant VP/Principal
7. General Manager
8. Director/Assistant Director
9. Department Head
10. Purchasing Manager/ Senior Manager/ Senior Buyer
11. Assistant Manager/Buyer
12. Other _____

How many years have you been working with this firm? (Check One) (YRSEXP)
1. Less than 5 years
2. 6-10 years
3. 11-15 years
4. 16-20 years
5. More than 20 years

Which of the following best describes the primary industry of your firm? (INDUS)
1. Textile
2. Automotive
3. Chemicals/Pharmaceuticals
4. Computer &Peripherals
5. Electronics
6. Food and Beverage
7. Telecommunications
8. Transportation
9. Semiconductor
10. Other _____

Please answer the following questions with your best estimate if exact data are not available.
Approximately how many people are employed in your firm? (NumEMP)
1. Less than 5 employees
2. 6-10 employees
3. 11-50 employees
4. 51-100 employees
5. 101-500 employees
6. 501-1000 employees
7. 1001-5000 employees
8. 5001-10000 employees
9. 10,000+ employees

What was the total dollar value of **ALL** items purchased in the last fiscal year? (PURCH)
1. Less than $10 million
2. $10 million to $49.9 million
3. $50 million to $99.9 million
4. $100 million to $499.9 million
5. $500 million to $999.9 million
6. $1 billion to $5 billion
7. Over $5 billion

What was the total annual gross sales (dollars) for ALL items sold in the last fiscal year? (SALES)

1. Less than $10 million
2. $10 million to $49.9 million
3. $50 million to $99.9 million
4. $100 million to $499.9 million
5. $500 million to $999.9 million
6. $1 billion to $5 billion
7. Over $5 billion

Please note that all individual responses to this study will be kept strictly confidential. However if you would like to receive the aggregate results, please complete the contact information below:
Email Address:

REFERENCES

Aiken, L.S., and West, S.G. *Multiple Regression: Testing and Interpreting Interactions* Sage, Newbury Park, CA, 1991.

Alavi, M., and Leidner, D.E. "Review: Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues," *MIS Quarterly* (25:1) 2001, pp 107-136.

Anand, K.S., and Mendelson, H. "Information and Organization for Horizontal Multimarket Coordination," *Management Science* (43:12) 1997, pp 1609-1627.

Anderson, E., and Narus, J.A. "A Model of Distributor Firm and Manufacturer Firm Working Partnerships," *Journal of Marketing* (54:1) 1990, pp 42-58.

Anderson, J.C., Hakansson, H., and Johanson, J. "Dyadic Business Relationships Within a Business Network Context," *Journal of Marketing* (58:4) 1994, pp 1-15.

Aoki, M. "Horizontal vs. Vertical Information Structure of the Firm," *The American Economic Review* (76:5) 1986, pp 971-983.

Armstrong, J.S., and Overton, T.S. "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research* (14:3) 1977, pp 396-402.

Aviv, Y. "Gaining Benefits from Joint Forecasting and Replenishment Processes: The Case of Auto-Correlated Demand," *Manufacturing & Service Operations Management* (4:1) 2002, pp 55-74.

Axelrod, R.M. *The Evolution of Cooperation* Basic Books, New York, 1984.

Babbie, E.R. *The Practice of Social Research*, (8th ed.) Wadsworth Publishing Co., Belmont, CA, 1998.

Bagozzi, R.P., and Yi, Y. "Assessing Method Variance in Multitrait-Multimethod Matrices: The Case of Self-Reported Affect and Perceptions at Work," *Journal of Applied Psychology* (75:5) 1990, pp 547-560.

Bagozzi, R.P., Yi, Y., and Phillips, L.W. "Assessing Construct Validity in Organizational Research," *Administrative Science Quarterly* (36:3) 1991, pp 421-458.

Balakrishnam, S., and Koza, M.P. "Information Asymmetry, Adverse Selection and Joint-Ventures: Theory and Evidence," *Journal of Economic Behavior and Organization* (20:1) 1993, pp 99-117.

Baron, R.M., and Kenny, D.A. "The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic and Statistical Considerations," *Journal of Personality and Social Psychology* (51:6) 1986, pp 1173-1182.

Bartol, K., and Srivastava, A. "Encouraging Knowledge Sharing: The Role of Organizational Reward Systems," *Journal of Leadership and Organizational Studies* (9:1) 2002, pp 64-76.

Beamon, B.M. "Supply Chain Design and Analysis: Models and Methods," *International Journal of Production Economics* (55:3) 1998, pp 281-294.

Beamon, B.M. "Measuring Supply Chain Performance," *International Journal of Operations & Production Management* (19:3/4) 1999, pp 275-292.

Becerra, M., and Gupta, A.K. "Perceived Trustworthiness within the Organization: The Moderating Impact of Communication Frequency on Trustor and Trustee Effects," *Organization Science* (14:1) 2003, pp 32-44.

Bello, D.C., Dant, S.P., and Lohtia, R. "Hybrid Governance: The Role of Transaction Costs, Production Costs and Strategic Considerations," *Journal of Business and Industrial Marketing* (12:2) 1997, pp 118-133.

Bensaou, M. "Interorganizational Cooperation: The Role of Information Technology: An Empirical Comparison of US and Japanese Supplier Relations," *Information Systems Research* (8:2) 1997, pp 107-124.

Bhatnagar, R., and Sohal, A.S. "Supply Chain Competitiveness: Measuring the Impact of Location Factors, Uncertainty and Manufacturing Practices," *Technovation* (25:5), Available on line 11/18/03 2005, pp 443-456.

Bolton, P., and Farrell, J. "Decentralization, Duplication, and Delay," *The Journal of Political Economy* (98:4) 1990, pp 803-826.

Bourland, K.E., Powell, S.G., and Pyke, D.F. "Exploring Timely Demand Information to Reduce Inventories," *European Journal of Operational Research* (92:2) 1996, pp 239-253.

Bullinger, H.-J., Kuhner, M., and Hoof, A.V. "Analyzing Supply Chain Performance using a Balanced Measurement Method," *International Journal of Production Research* (40:15) 2002, pp 3533-3543.

Burt, R.S. *Toward a Structural Theory of Action: Network Models of Social Structure, Perception, and Action* Academic Press, New York, 1982, p. 381.

Burt, R.S. *Structural Holes: The Social Structure of Competition* Harvard University Press, Cambridge. MA, 1992.

Burt, R.S. "The Contingent Value of Social Capital," *Administrative Science Quarterly* (42:2) 1997, pp 339-365.

Cachon, G.P., and Fisher, M. "Supply Chain Inventory Management and the Value of Shared Information," *Management Science* (46:8) 2000, pp 1032-1048.
Campbell, D.T. "The Informant in Quantitative Research," *American Journal of Sociology* (60:4) 1955, pp 339-342.
Carmines, E.G., and Zeller, R.A. *Reliability and Validity Assessment* Sage, Beverley Hills, CA, 1979.
Carr, A.S., and Kaynak, H. "Communication Methods, Information Sharing, Supplier Development and Performance: An Empirical Study of their Relationships," *International Journal of Operations & Production Management* (27:4) 2007, pp 346-370.
Carr, A.S., and Pearson, J.N. "Strategically Managed Buyer-Supplier Relationships and Performance Outcomes," *Journal of Operations Management* (17:5) 1999, pp 497-519.
Chao, C., Scheuing, E.E., and Ruch, W.A. "Purchasing Performance Evaluation," *International Journal of Purchasing and Materials Management* (29:3) 1993, pp 33-39.
Cheema, A., and Patrick, V.M. "Anytime Versus Only: Mind-Sets Moderate the Effect of Expansive vs. Restrictive Frames on Promotion Evaluation," *Journal of Marketing Research* (45:4) 2008, pp 462-472.
Chen, F. "Echelon Reorder Points, Installation Reorder Points, and the Value of Centralized Demand Information," *Management Science* (44:12) 1998, pp S221-S234.
Chen, F. "Decentralized Supply Chains Subject to Information Delays," *Management Science* (45:8) 1999, pp 1076-1090.
Chen, F., Drezner, Z., Ryan, J.K., and Simchi-Levi, D. "Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact Of Forecasting, Lead Times and Information.," *Management Science* (46:3) 2000, pp 436-443.
Chen, I.J., and Paulraj, A. "Towards a Theory of Supply Chain Management: The Constructs and Measurements," *Journal of Operations Management* (22:2) 2004, pp 119-150.
Childerhouse, P., Hermiz, R., Mason-Jones, R., Popp, A., and Towill, D.R. "Information Flow in Automotive Supply Chains - Identifying and Learning to Overcome Barriers to Change," *Industrial Management + Data Systems* (103:7) 2003, pp 491-502.
Choi, T.Y., Dooley, K.J., and Rungtusanatham, M. "Supply Networks and Complex Adaptive Systems: Control Versus Emergence," *Journal of Operations Management* (19:3) 2001, pp 351-366.
Choi, T.Y., and Hong, Y. "Unveiling the Structure of Supply Networks: Case Studies in Honda, Acura, and DaimlerChrysler," *Journal of Operations Management* (20:5) 2002, pp 469-493.
Choudhury, V., and Sampler, J.L. "Information Specificity and Environmental Scanning: An Economic Perspective," *MIS Quarterly* (21:1) 1997, pp 25-53.
Churchill, G.A., Jr. "A Paradigm for Developing Better Measures of Marketing Constructs," *Journal of Marketing Research* (16:1) 1979, pp 64-73.
Clarke, R.N. "Collusion and the Incentives for Information Sharing," *Bell Journal of Economics* (14:2), 1983, pp 383-394.
Clemons, E.K., and Row, M.C. "Limits to Interfirm Coordination Through Information Technology: Results of a Field Study in Consumer Packaged Goods Distribution," *Journal of Management Information Systems* (10:1) 1993, pp 73-95.
Coase, R.H. "The Nature of the Firm," *Economica* (16:4) 1937, pp 386-405.
Cohen, J. "A Power Primer," *Psychological Bulletin* (112:1) 1992, pp 155-159.
Cohen, J., Cohen, P., West, S.G., and L.S.Aiken *Applied Multiple Regression/Correlational Analysis for the Behavioral Sciences* Erlbaum, Mahwah, N.J., 2003.
Corbett, C.J. "Stochastic Inventory Systems in a Supply Chain with Asymmetric Information: Cycle Stocks, Safety Stocks and Consignment Stock," *Operations Research* (49:4) 2001, pp 487-500.
Corbett, C.J., Blackburn, J.D., and Wassenhove, L.N.v. "Partnerships to Improve Supply Chains," *Sloan Management Review* (40:4) 1999, pp 71-82.
Cousins, P.D., Handfield, R.B., Lawson, B., and Petersen, K.J. "Creating Supply Chain Relational Capital: The Impact of Formal and Informal Socialization Processes," *Journal of Operations Management* (24:6) 2006, pp 851-863.
Cronbach, L.J. *Essentials of Psychological Testing*, (5th ed.) HarperCollins, New York, 1990.
Daft, R.L., and Lengel, R.H. "Organizational Information Requirements, Media Richness and Structural Design," *Management Science* (32:5) 1986, pp 554-571.
Davenport, T.H., and Prusak, L. *Working Knowledge: How Organizations Manage What They Know* Harvard Business School Press, Boston, Mass, 1998, p. 199.
Davis, T. "Effective Supply Chain Management," *Sloan Management Review* (34:4) 1993, pp 35-46.
Dillman, D.A. *Mail and Telephone Surveys: The Total Design Method* Wiley, New York, 1978.

Dreyer, D.E. "Performance Measurement: A Practitioner's Perspective," *Supply Chain Management Review* (4:4) 2000, pp 62-68.
Drucker, P.F. "Management's New Paradigms," *Forbes* (162:7) 1998, pp 152-179.
Dutta, S., and John, G. "Combining Lab Experiments and Industry Data in Transaction Cost Analysis: The Case of Competition as a Safeguard," *Journal of Law, Economics & Organization* (11:1) 1995, pp 87-111.
Dwyer, F.R., and Oh, S. "Output Sector Munificence Effects on the Internal Political Economy of Marketing Channels," *Journal of Marketing Research* (24:4) 1987a, pp 347-358.
Dwyer, F.R., Schurr, P.H., and Oh, D. "Developing Buyer-Seller Relationships," *Journal of Marketing* (51:2) 1987b, pp 11-27.
Dwyer, F.R., and Welsh, M.A. "Environmental Relationships of the Internal Political Economy of Marketing Channels," *Journal of Marketing Research* (22:4) 1985, pp 397-414.
Dyer, J.H. "Specialized Supplier Networks as a Source of Competitive Advantage: Evidence from the Automotive Industry," *Strategic Management Journal* (17:4) 1996, pp 271-291.
Dyer, J.H. "Effective Interfirm Collaboration: How Transactors Minimize Transaction Costs and Maximize Transaction Value," *Strategic Management Journal* (18:7) 1997, pp 535-556.
Dyer, J.H., and Chu, W. "The Role of Trustworthiness in Reducing Transaction Costs and Improving Performance: Empirical Evidence from the United States, Japan and Korea," *Organization Science* (14:1), 2003, pp 57-68.
Dyer, J.H., and Nobeoka, K. "Creating and Managing a High Performance Knowledge-sharing Network: The Toyota Case," *Strategic Management Journal* (21:3) 2000, pp 345-367.
Dyer, J.H., and Singh, H. "The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage," *Academy of Management Review* (23:4) 1998, pp 660-679.
Earl, M. "Knowledge Management Strategies: Toward a Taxonomy," *Journal of Management Information Systems* (18:1) 2001, pp 215-233.
Ellram, L.M., and Hendrick, T.E. "Partnering Characteristics: A Dyadic Perspective," *Journal of Business Logistics* (16:1) 1995, pp 41-64.
Etgar, M. "Effects of Administrative Control on Efficiency of Vertical Marketing Systems," *Journal of Marketing Research* (13:1) 1976, pp 12-24.
Evans, J.R., and Mathur, A. "Value of Online Surveys," *Internet Research* (15:2) 2005, pp 195-219.
Farmer, A. "Information Sharing with Capacity Uncertainty: The Case of Coffee," *Canadian Journal of Economics* (27:2) 1994, pp 415-432.
Fine, C.H. *Clockspeed: Winning Industry Control in the Age of Temporary Advantage* Perseus Books, Reading, Mass, 1998, p. 96.
Fine, C.H. "Clockspeed-based strategies for Supply Chain design," *Production and Operations Management* (9:3) 2000, pp 213-221.
Fisher, M.L. "What is the Right Supply Chain for your Product," *Harvard Business Review* (75:2) 1997, pp 105-116.
Flynn, M.S., Alkire, K.F., and Graham, D. "OEM Parts Purchasing: Shifting Strategies," UMTRI 00-48, University of Michigan Transportation Research Institute, Ann Arbor, Michigan, 2001, p. 60.
Forrester, J.W. "Industrial Dynamics," *Harvard Business Review* (36:4) 1958, pp 37-66.
Frazier, P.A., Tix, A.P., and Barron, K.E. "Testing Moderator and Mediator Effects in Counseling Psychology Research," *Journal of Counseling Psychology* (51:1) 2004, pp 115-134.
Fu, Y., and Piplani, R. "Supply-side Collaboration and Its Value in the Supply Chains," *European Journal of Operational Research*) 2003.
Gal-Or, E. "Information Sharing in Oligopoly," *Econometrica* (53:2) 1985, pp 329-343.
Gal-Or, E. "Information Transmission-Cournot and Bertrand Equilibria," *The Review of Economic Studies* (53:1) 1986, pp 85-92.
Gal-Or, E. "Vertical Restraints with Incomplete Information," *The Journal of Industrial Economics* (39:5) 1991, pp 503-516.
Galbraith, J.R. *Designing Complex Organizations* Addison-Wesley, Reading, Mass., 1973, p. 150.
Ganesan, S. "Deteminants of Long-Term Orientation in Buyer-Seller Relationships," *Journal of Marketing* (58:2) 1994, pp 1-19.
Gavirneni, S., Kapuscinski, R., and Tayur, S. "Value of Information in Capacitated Supply Chains," *Management Science* (45:1) 1999, pp 16-24.
Geary, S., Childerhouse, P., and Towill, D. "Uncertainty and the Seamless Supply Chain," *Supply Chain Management Review* (6:4) 2002, pp 52-59.

Ghosh, D., and Ray, M.R. "Risk, Ambiguity and Decision Choice: Some Additional Evidence," *Decision Sciences* (28:1) 1997, pp 81-104.
Ghoshal, S., and Moran, P. "Bad for Practice: A Critique of theTransaction Cost Theory," *Academy of Management Review* (21:1) 1996, pp 13-47.
Gosain, S., Malhotra, A., and El Sawy, O.A. "Coordinating for Flexibility e-Business Supply Chains," *Journal of Management Information Systems* (21:3) 2004/2005, pp 7-45.
Granovetter, M. "The Strength of Weak Ties," *The American Journal of Sociology* (78:6), May 1973, pp 1360-1380.
Granovetter, M. "Economic Action and Social Structure: The Problem of Embeddedness," *American Journal of Sociology* (91:3) 1985, pp 481-510.
Granovetter, M. "Problems of Explanation in Economic Sociology," in: *Networks and Organizations: Structure, Form and Action,* N. Nohria and R. Eccles (eds.), Harvard Business School Press, Boston, MA, 1992, pp. 25-56.
Grant, R.M. "Toward a knowledge-based theory of the firm," *Strategic Management Journal* (17:Special), Winter 1996, pp 109-122.
Graves, S.C. "A Single-Item Inventory Model for a Nonstationary Demand Process," *Manufacturing & Service Operations Management* (1:1) 1999, pp 50-61.
Grossman, S.J., and Hart, O.D. "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy* (94:4) 1986, pp 691-719.
Guimaraes, T., Cook, D., and Natarajan, N. "Exploring the Importance of Business Clockspeed as a Moderator for Determinants of Supplier Network Performance," *Decision Sciences* (33:4) 2002, pp 629-644.
Gulati, R. "Social Structure and Alliance Formation Patterns: A longitudinal analysis," *Administrative Science Quarterly* (40:4) 1995, pp 619-652.
Gulati, R. "Alliances and Networks," *Strategic Management Journal* (19:4) 1998, pp 293-317.
Gulati, R., and Singh, H. "The Architecture of Cooperation: Managing Coordination Costs and Appropriation Concerns In Strategic Alliances," *Administrative Science Quarterly* (43:4) 1998, pp 781-814.
Gunsekaran, A., Patel, C., and McGaughey, R.E. "A Framework for Supply Chain Performance Measurement," *International Journal of Production Economics* (87:3) 2004, pp 333-347.
Gurbaxani, V., and Whang, S. "The Impact of Information Systems on Organizations and Markets," *Communications of the ACM* (34:1) 1991, pp 59-73.
Hage, J., and Aiken, M. "Relationship of Centralization to other Structural Properties," *Administrative Science Quarterly* (12:1) 1967, pp 72-92.
Hair, J.F., Anderson, R.E., Tatham, R.L., and Black, W.C. *Multivariate Data Analysis*, (5th ed.) Prentice Hall, Upper Saddle River, New Jersey, 1998.
Handfield, R.B., and Ernest L. Nichols, J. *Introduction to Supply Chain Management* Prentice-Hall, Upper Saddle River, NJ, 1999a.
Handfield, R.B., and Ernest L. Nichols, J. *Supply Chain Redesign: Transforming Supply Chains Into Integrated Value Systems* Prentice Hall, Upper Saddle River, NJ, 2002, p. 371.
Handfield, R.B., Krause, D.R., Scannell, T.V., and Monczka, R.M. "Avoid the Pitfalls in Supplier Development," *Sloan Management Review* (41:2) 2000, pp 37-49.
Handfield, R.B., and Lawson, B. "Integrating Suppliers into New Product Development," *Research Technology Management* (50:5) 2007, pp 44-51.
Handfield, R.B., Ragatz, G.L., Petersen, K.J., and Monckza, R.M. "Involving Suppliers in New Product Development," *California Management Review* (42:1) 1999b, pp 59-82.
Harland, C., Zheng, J., Johnsen, T., and Lamming, R. "A Conceptual Model for Researching the Creation and Operation of Supply Networks," *British Journal of Management* (15:1) 2004, pp 1-21.
Harland, C.M. "Supply Chain Management: Relationships, Chains and Networks," *British Journal of Management* (7:1) 1996, pp S63-S80.
Harland, C.M., Lamming, R.C., Zheng, J., and Johnsen, T.E. "A Taxonomy of Supply Networks," *The Journal of Supply Chain Management* (37:4) 2001, pp 21-27.
Harrigan, K.R. "Matching Vertical Integration Strategies to Competitive Condition," *Strategic Management Journal* (7:6) 1986, pp 535-555.
Haythornwaite, C. "Social Network Analysis: An Approach and Technique for the Study of Information Exchange," *Library & Information Science Research* (18:4) 1996, pp 323-342.
Heide, J.B., and John, G. "Alliances in Industrial Purchasing: The Determinants of Joint Action in Buyer-Supplier Relationships," *Journal of Marketing Research* (27:1) 1990, pp 24-36.

Heide, J.B., and Stump, R.L. "Performance Implications of Buyer-Supplier Relationships in Industrial Markets: A Transaction Cost Explanation," *Journal of Business Research* (32:1) 1995, pp 57-66.
Herer, Y.T., Tzur, M., and Yucesan, E. "Transhipments: An emerging inventory recourse to achieve supply chain leagility," *International Journal of Production Economics* (80:3) 2002, pp 201-212.
Hitt, M.A., Ireland, D.R., and Hoskisson, R.E. *Strategic Management* Southwestern College Publishing, Cincinnati, Ohio, 1999.
Hopp, W.J., and Spearman, M.L. "To Pull or Not to Pull: What Is the Question?," *Manufacturing & Service Operations Management* (6:2) 2004, pp 133-148.
Hoyt, J., and Huq, F. "From Arms-Length to Collaborative Relationships in the Supply Chain: An Evolutionary Process," *International Journal of Physical Distribution & Logistics Management* (30:9) 2000, pp 750-764.
Huber, G.P., and Power, D.J. "Retrospective Reports of Strategic-level Managers: Guidelines for Increasing their Accuracy," *Strategic Management Journal* (6:2) 1985, pp 171-180.
Hulland, J. "Review of Partial Least Squares (PLS) in Strategic Management Research: A Review of Four Recent Studies," *Strategic Management Journal* (20:2) 1999, pp 195-204.
Hwang, H.-S. "Heterogeneity and the Incentive to Share Information in Cournot Oligopoly," *International Economic Review* (35:2) 1994, pp 329-345.
Iyer, K.N.S., Germain, R., and Frankwich, G.L. "Supply Chain B2B e-Commerce Time-based Delivery Performance," *International Journal of Physical Distribution & Logistics Management* (34:8) 2004, pp 645-661.
Jaccard, J., Turrisi, R., and Wan, C.K. *Interaction Effects in Multiple Regression* Sage Publications, Newbury Park, CA, 1990.
Jap, S.D. "Perspectives on Joint Competitive Advantages in Buyer-Supplier Relationships," *International Journal of Research in Marketing* (18:1-2) 2001, pp 19-35.
Jensen, M.C., and Meckling, W.N. "Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure," *Journal of Financial Economics* (3:4) 1976, pp 305-360.
John, G. "An Empirical Investigation of Some Antecedents of Opportunism in a Marketing Channel," *Journal of Marketing Research* (21:3) 1984, pp 278-289.
John, G., and Martin, J. "Effects of Organizational Structure of Marketing Planning on Credibility and Utilization of Plan Output," *Journal of Marketing Research* (21:2) 1984, pp 170-183.
Jones, C., Hesterly, W.S., and Borgatti, S.P. "A General Theory of Network Governance: Exchange Conditions and Social Mechanisms," *Academy of Management Review* (22:4) 1997, pp 911-945.
Kiely, D.A. "Synchronizing Supply Chain Operations With Consumer Demand Using Customer Data," *Journal of Business Forecasting Methods & Systems* (17:4) 1998, pp 3-9.
Klassen, R.D., and Jacobs, J. "Experimental comparison of Web, electronic and mail survey technologies in operations management," *Journal of Operations Management* (19:6) 2001, pp 713-725.
Knight, F.H. *Risk, Uncertainty, and Profit* Augustus M. Kelley (reprints of economic classics), New York, 1964, p. 381.
Koh, S.C.L., Saad, S.M., and Jones, M.H. "Uncertainty Under MRP Planned Manufacture:Review and Categorisation," *International Journal of Production Research* (40:10) 2002, pp 2399-2421.
Kopczak, L.R., and Johnson, M.E. "The Supply-Chain Management Effect," *MIT Sloan Management Review* (44:3) 2003, pp 27-34.
Kotabe, M., Martin, X., and Domoto, H. "Gaining from Vertical Partnerships: Knowledge Transfer, Relationship Duration and Supplier Performance Improvement in the U.S. and Japanese Automotive industries," *Strategic Management Journal* (24:4) 2003, pp 293-316.
Krause, D.R., and Ellram, L.M. "Success Factors in Supplier Development," *International Journal of Physical Distribution & Logistics Management* (27:1) 1997, pp 39-52.
Kulp, S.C., Lee, H.L., and Ofek, E. "Manufacturer Benefits from Information Integration with Retail Customers," *Management Science* (50:4) 2004, pp 431-444.
Kumar, N., Stern, L.W., and Anderson, J.C. "Conducting interorganizational Research Using Key Informants," *Academy of Management* (36:6) 1993, pp 1633-1651.
Lambe, C.J., Spekman, R.E., and Hunt, S.D. "Alliance Competence, Resources and Alliance Success: Conceptualization, Measurement, and Initial Test," *Journal of the Academy of Marketing Science* (30:2) 2002, pp 141-158.
Lambert, D., Cooper, M.C., and Pagh, J.D. "Supply Chain Management: Implementation Issues and Research Opportunities," *The International Journal of Logistics Management* (9:2) 1998, pp 1-19.

Lambert, D.M., and Cooper, M.C. "Issues in Supply Chain Management," *Industrial Marketing Management* (29:1) 2000, pp 65-83.
Lamming, R., Johnsen, T., Zheng, J., and Harland, C. "An Initial Classification of Supply Networks," *International Journal of Operations & Production Management* (20:5/6) 2000, pp 675-691.
Lancioni, R.A., Smith, M.F., and Oliva, T.A. "The Role of the Internet in Supply Chain Management," *Industrial Marketing Management* (29:1) 2000, pp 45-56.
Larson, A. "Network Dyads in Entrepreneural Settings: A Study of the Governance of Exchange Relationships," *Administrative Science Quarterly* (37:1) 1992, pp 76-104.
Lawler, E., and Yoon, J. "Power and the Emergence of Commitment Behavior in Negotiated Exchange," *American Sociological Review* (58:4) 1993, pp 465-481.
Lee, H.L., and Billington, C. "Managing Supply Chain Inventory: Ptifalls and Opportunities," *Sloan Management Review* (33:3) 1992, pp 65-73.
Lee, H.L., Padmanabhan, V., and Whang, S. "The Bullwhip Effect in Supply Chains," *Sloan Management Review* (38:3) 1997a, pp 93-102.
Lee, H.L., Padmanabhan, V., and Whang, S. "Information Distortion in a Supply Chain: The Bullwhip Effect," *Management Science* (43:4) 1997b, pp 546-558.
Lee, H.L., So, K.C., and Tang, C.S. "The Value of Information Sharing in a Two-Level Supply Chain," *Management Science* (46:5) 2000a, pp 626-643.
Lee, H.L., and Whang, S. "Information Sharing in a Supply Chain," *International Journal of Technology Management* (20:3/4) 2000b, pp 373-387.
Li, L. "Cournot Oligopoly with Information Sharing," *Rand Journal of Economics* (16:4) 1985, pp 521-536.
Li, L. "Information Sharing in a Supply Chain with Horizontal Competition," *Management Science* (48:2) 2002, pp 1196-1212.
Lin, F.-r., Huang, S.-h., and Lin, S.-c. "Effects of Information Sharing on Supply Chain Performance in Electronic Commerce," *IEEE Transactions on Engineering Management* (49:3) 2002, pp 258-268.
Lindell, M.K., and Whitney, D.J. "Accounting for Common Method Variance in Cross-Sectional Designs," *Journal of Applied Psychology* (86:1), 2001, pp 114-121.
Lonsdale, C. "Locked-in to Supplier Dominance: On the Dangers of Asset Specificity for the Outsourcing Decision," *Journal of Supply Chain Management* (37:2) 2001, pp 22-27.
Malhotra, A., Gosain, S., and El Sawy, O.A. "Absorptive Capacity Configurations in Supply Chains: Gearing for Partner-Enabled Market Knowledge Creation," *MIS Quarterly* (29:1) 2005, pp 145-187.
Malone, T.W. "Modeling Coordination in Organizations and Markets," *Management Science* (33:10) 1987, pp 1317-1332.
Mann, L., Saxena, A., and Knapp, G.M. "Statistical-based or Condition-based Preventative Maintenance," *Journal of Quality in Maintenance Engineering* (1:1) 1995, pp 46-59.
March, J.G., and Simon, H.A. *Organizations* Wiley, New York, 1958.
Marsden, P.V., and Campbell, K.E. "Measuring Tie Strength," *Social Forces* (63:2) 1984, pp 482-501.
Maskell, B.H. *Performance Measurement for World Class Manufacturing: A Model for American Companies* Productivity Press, Cambridge, Mass, 1991a.
Maskell, B.H. *Performance Measurement for World Class Manufacturing: A Model for American companies* Productivity Press, Cambridge, Mass., 1991b, p. 408.
McAllister, D.J. "Affect- and Cognition-based Trust as Foundations for Interpersonal Cooperation in Organizations " *Academy of Management* (38:1) 1995, pp 24-59.
McDougall, P. Collaborative Business, 2001. Retrieved August 15, 2005 from http://www.informationweek.com/836/collaborate.htm, 2001.
McEvily, B., Perrone, V., and Zaheer, A. "Trust as an Organizing Principle," (14:1), Jan/Feb 2003, pp 91-103.
Mentzer, J.T., Min, S., and Zacharia, Z.G. "The Nature of Interfirm Partnering in Supply Chain Management," *Journal of Retailing* (76:4) 2000, pp 549-568.
Miller, D., and Droge, C. "Psychological and Traditional Determinants of Structure," *Administrative Science Quarterly* (314:539-560) 1986.
Moberg, C.R., Cutler, B.D., Gross, A., and Speh, T.W. "Identifying Antecedents of Information Exchange within Supply Chains," *International Journal of Physical Distribution & Logistics Management* (32:9) 2002, pp 755-770.
Mohr, J.J., Fisher, R.J., and Nevin, J.R. "Collaborative Communication in Interfirm Relationships: Moderating Effects of Integration and Control," *Journal of Marketing* (60:3) 1996, pp 103-115.

Monczka, R., and Trent, R. "Global Sourcing: A Development Approach," *International Journal of Purchasing and Materials Management* (27:2) 1991, pp 2-8.
Monczka, R.M., Trent, R.J., and Callahan, T.J. "Supply Base Strategies to Maximize Supplier Performance," *International Journal of Physical Distribution & Logistics Management* (23:4) 1993, pp 42-54.
Mukhopadhyay, T., Kekre, S., and Kalathur, S. "Business Value of Information Technology: A Study of Electronic Data Interchange," *MIS Quarterly* (19:2) 1995, pp 137-156.
Murphy, K. "Using Power Analysis to Evaluate and Improve Research," in: *Handbook of Research Methods in Industrial and Organizational Psychology,* S. Rogelberg (ed.), Blackwell Publishers Ltd, Oxford, UK 2002.
Nahapiet, J., and Ghoshal, S. "Social Capital, Intellectual Capital, and the organizational Advantage," *Academy of Management Review* (23:2) 1998, pp 242-266.
Nassimbeni, G. "Network Structures and Co-ordination Mechanisms," *International Journal of Operations & Production Management* (18:5/6) 1998, pp 538-554.
Nelson, R.E. "The Strength of Strong Ties: Social Networks and Intergroup Conflict in Organizations," *Academy of Management* (32:2) 1998, pp 377-401.
Nelson, R.E., and Mathews, K.M. "Network Characteristics of High-Performing Organizations," *Journal of Business Communication* (28:4) 1991, pp 367-386.
New, S., and Payne, P. "Research Frameworks in Logistics," *International Journal of Physical Distribution & Logistics Management* (25:10) 1995, pp 60-77.
Nooteboom, B. "A Postmodern Philosophy of Markets," *International Studies of Management & Organizations* (22:2) 1992, pp 53-76.
Novshek, W., and Sonnenschein, H. "Fulfilled Expectations Cournot Duopoly with Information Acquisition and Release," *The Bell Journal of Economics* (13:1) 1982, pp 214-218.
Nunally, J.C. *Psychometric Theory* McGraw-Hill, New York, 1978.
Oliver, C. "The Institutional Embeddedness of Economic Activity," in: *Advances in Strategic Management,* J.A.C. Baum and J.E. Dutton (eds.), JAI Press, Greenwich, CT, 1996, pp. 163-186.
Ouchi, W.G. "Markets, Bureaucracies, and Clans," *Administrative Science Quarterly* (25:1) 1980, pp 129-141.
Paulraj, A., and Chen, I.J. "Strategic Supply Management and Dyadic Quality Performance: A Path Analytical Model," *Journal of Supply Chain Management* (41:3) 2005, pp 4-18.
Persson, G. "Logistics Process Redesign: Some Useful Insights," *International Journal of Logistics Management* (6:1) 1995, pp 13-25.
Pfeffer, J., and Salancik, G.R. *The External Control of Organizations: A Resource Dependence Perspective* Harper & Row, New York, 1978, p. 300.
Pisano, G.P. "The R&D Boundaries of the Firm: An Empirical Analysis," *Administrative Science Quarterly* (35:1) 1990, pp 153-176.
Podolny, J.M. "Market Uncertainty and the Social Character of Economic Exchange," *Administrative Science Quarterly* (39:3) 1994, pp 458-483.
Podsakoff, P.M., Mackenzie, S.B., Lee, J.-Y., and Podsakoff, N.P. "Common Method Biases in Behavioral Research: A Critical Literature Review of the Literature and Recommended Remedies," *Journal of Applied Psychology* (88:5) 2003, pp 879-903.
Podsakoff, P.M., and Organ, D.W. "Self Reports in Organizational Research: Problems and Prospects," *Journal of Management* (12:4) 1986, pp 531-544.
Powell, W.W. "Neither Market Nor Hierarchy: Network Forms of Organization," *Research in Organizational Behavior* (12) 1990, pp 295-336.
Powell, W.W., Koput, K.W., and Smith-Doerr, L. "Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology," *Administrative Science Quarterly* (41:1) 1996, pp 116-145.
Prahinski, C., and Benton, W.C. "Supplier Evaluations: Communication Strategies to Improve Supplier Performance," *Journal of Operations Management* (22:1) 2004, pp 39-62.
Premkumar, G.P. "Interorganization Systems and Supply Chain Management: An Information Processing Perspective," *Information Systems Management* (17:3) 2000, pp 56-69.
Raghunathan, S. "Information Sharing in a Supply Chain: A Note on its Value when Demand is Nonstationary," *Management Science* (47:4) 2001, pp 605-610.
Randall, T., and Ulrich, K. "Product Variety, Supply Chain Structure, and Firm Performance:Analysis of the U. S. Bicycle Industry," *Management Science* (47:12) 2001, pp 1588- 1604.
Reed, R., and DeFillippi, R.J. "Causal Ambiguity, Barriers to Imitation and Sustainable Competitive Advantage," *Academy of Management Review* (15:1) 1990, pp 88-102.

Rindfleisch, A., and Heidi, J.B. "Transaction Cost Analysis: Past, Present, and Future Applications," *Journal of Marketing* (61:4) 1997, pp 30-54.
Ring, P.S., and Van de Ven, A.H. "Structuring Cooperative Relationships between Organizations," *Strategic Management Journal* (13:6) 1992, pp 483-498.
Robbins, S.P. *Organization Theory: Structure, Design, and Application*, (3 ed.) Prentice-Hall, Inc., Englewood Cliffs, New Jersey 1990, p. 552.
Roberts, J. "From Know-how to Show-how? Questioning the Role of Information and Communication Technologies in Knowledge Transfer," *Technology Analysis & Strategic Management* (12:4) 2000, pp 429-443.
Rogers, E.M., and Kincaid, D.L. *Communication Networks: Toward a New Paradigm for Research* Free Press, New York, 1981, p. 386.
Rowntree, D. *Statistics without Tears* Penguin, New York, 1981.
Russell, C.J., and Russell, R.D. "An Examination of the Effects of Organizational Norms, Organizational Structure, and Environmental Uncertainty on Entrepreneurial Strategy," *Journal of Management* (18:4) 1992, pp 639-656.
Sadler, I., and Hines, P. "Strategic Operations Planning for Manufacturers with a Supply Chain Focus: Concepts and a Meat Processing Application," *Supply Chain Management* (7:4) 2002, pp 225-241.
Sahin, F., and Robinson, E.P. "Flow Coordination and Information Sharing in Supply Chains: Review, Implications, and Directions for Future Research," *Decision Sciences* (33:4) 2002, pp 505-536.
Samaddar, S., Hill, C.A., Kim, D., and Daley, M. "Inter-organizational Information Sharing As A Mechanism of Supply Network Coordination," *Working Paper, Georgia State University*) 2004.
Samaddar, S., Nargundkar, S., and Daley, M. "Inter-organizational Information Sharing: The Role of Supply Network Configuration and Partner Goal Congruence," *European Journal of Operational Research* 174(2) 2006, pp 744-765.
Seidler, J. "On Using Informants: A Technique for Collecting Quantitative Data and Controlling Measurement Error in Organization Analysis," *American Sociological Review* (39:6) 1974, pp 816-831.
Seidmann, A., and Sundarajan, A. *Sharing Logistics Information Across Organizations: Technology, Competition and Contracting* Kluwer, Boston, MA, 1998.
Shapiro, C. "Exchange of Cost Information in Oligopoly," *The Review of Economic Studies* (53:174) 1986, pp 433-446.
Simon, H.A. *Administrative Behavior*, (4th ed.) MacMillan Co., New York, 1997, p. 259.
Spekman, R.E., Kamauff, J.W., Jr., and Myhr, N. "An Empirical Investigation into Supply Chain Management: A Perspective on Partnerships," *Supply Chain Management* (3:2) 1998, pp 53-67.
Spens, K.M., and Bask, A.H. "Developing a Framework for Supply Chain Management," *International Journal of Logistics Management* (13:1) 2002, pp 73-88.
Spulber, D.F. "Bertrand Competition When Rivals' Costs Are Unknown," *Journal of Industrial Economics* (43:1) 1995, pp 1-11.
Stephens, S. Supply Chain Council & Supply Chain Operations Reference (SCOR) Model Overview, 2001. Retrieved August 8, 2005 from http://www.athabascau.ca/scm/pdf10-02/SCOR_ReferenceModel.pdf
Stevens, G. "Integrating the Supply Chain," *International Journal of Physical Distribution & Materials Management* (19:8) 1989, pp 3-8.
Stevenson, M. "The Store to End All Stores," *Canadian Business Review* (67:5) 1994, pp 20-26.
Stock, G.N., Greis, N.P., and Kasarda, J.D. "Enterprise Logistics and Supply Chain Structure: The Role of Fit," *Journal of Operations Management* (18:5) 2000, pp 531-547.
Stone, E. *Research Methods in Organizational Behavior* Goodyear Pub. Co., Santa Monica, 1978.
Storey, J. "What are the Key General Manager Issues in 'Supply Chain Management'?," *Journal of General Management* (27:4) 2002, pp 15-28.
Straub, D., Rai, A., and Klein, R. "Measuring Firm Performance at the Network Level: A Nomology of the Business Impact of Digital Supply Networks," *Journal of Management Information Systems* (21:1) 2004, pp 83-114.
Stump, R.L., and Heidi, J.B. "Controlling Supplier Opportunism in Industrial Relationships," *Journal of Marketing Research* (33:4) 1996, pp 431-441.
Trochim, W.M. The Research Methods Knowledge Base. Retrieved November 10th, 2005 from http://www.socialresearchmethods.net/kb.
Tsai, W. "Social Structure of "Coopetition" Within a Multiunit Organization. Coordination, Competition and Intraorganizational Knowledge Sharing," *Organization Science* (13:2) 2002, pp 179-190.
Uzzi, B. "The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect," *American Sociological Review* (61:4) 1996, pp 674-698.

Uzzi, B. "Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness," *Administrative Science Quarterly* (42:1) 1997, pp 35-67.
Uzzi, B. "Embeddedness in the Making of Financial Capital: How Social Relations and Networks Benefit Firms Seeking Financing," *American Sociological Review* (64:4) August 1999, pp 481-505.
Van de Ven, A.H. "Central Problems in the Management of Innovations," *Management Science* (32:5) 1986, pp 590-607.
Van de Ven, A.H., and Ferry, D.L. *Measuring and Assessing Organizations* Wiley, New York, 1980, p. 552
Van der Vorst, J., Beulens, A.J.M., De Wit, W., and Van Beek, P. "Supply Chain Management in Food Chains: Improving Performance by Reducing Uncertainty," *International Transactions in Operational Research* (5:6) 1998, pp 487-499.
Vijayasarathy, L.R., and Robey, D. "The Effect of EDI on Market Channel Relationships in Retailing," *Information and Management* (33:2) 1997, pp 73-86.
Walker, G., Kogut, B., and Shan, W. "Social Capital, Structural Holes and the Formation of an Industry Network," *Organization Science* (8:2) 1997, pp 109-125.
Walker, G., and Weber, D. "Supplier Competition, Uncertainty, and Make-or-Buy Decisions," *Academy of Management Journal* (30:3) 1987, pp 589-596.
Walton, M. "When Your Partner Fails You," *Fortune* (135:10) 1997, pp 151-153.
Wathne, K.H., and Heide, J.B. "Opportunism in Interfirm Relationships: Forms, Outcomes, and Solutions," *Journal of Marketing* (64:4) 2000, pp 36-51.
Wathne, K.H., and Heide, J.B. "Relationship Governance in a Supply Chain Network," *Journal of Marketing* (68:1) 2004, pp 73-89.
Whang, S. "Coordination in Operations: A Taxonomy," *Journal of Operations Management* (12:3-4) 1995, pp 413-422.
Wiesenfeld, B.M., William B. Swann, J., Brockner, J., and Bartel, C.A. "Is More Fairness Always Preferred? Self-esteem Moderates Reactions to Procedural Justice.," *Academy of Management Journal* (50:5) 2007, pp 1235-1253.
Williamson, O.E. *Markets and Hierarchies: Analysis and Antitrust Implications* Free Press, New York, 1975.
Williamson, O.E. "Transaction Cost Economics: The Governance of Contractual Relations," *Journal of Law and Economics* (22:2) 1979, pp 233-261.
Williamson, O.E. *The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting* Free Press, New York, 1985, p. 450.
Williamson, O.E. *Handbook of Industrial Organization*, (xxvi ed.) Elsevier Science Pub. Co., Amsterdam: North Holland, 1989, p. 1555.
Williamson, O.E. "Comparative Economic Organization: The Analysis of Discrete Structural Alternatives," *Administrative Science Quarterly* (36:2) 1991, pp 269-296.
Williamson, O.E. "Transaction Cost Economics and Organization Theory," in: *The Handbook of Economic Sociology,* N.J. Smelser and R. Swedberg (eds.), Princeton University Press, Princeton, NJ, 1994, pp. 77-107.
Williamson, O.E. *The Mechanisms of Governance* Oxford University Press, New York, 1996, p. 429.
Wood, M. "Mind the Gap? A Processual Reconsideration of Organizational Knowledge," *Organization* (9:1) 2002, pp 151-171.
Wu, W.-P., and Choi, W.L. "Transaction Cost, Social Capital and Firms' Synergy Creation in Chinese Business Networks: An Integrative Approach," *Asia Pacific Journal of Management* (21:3) 2004, pp 325-343.
Yu, Z., Yan, H., and Cheng, T.C.E. "Benefits of Information Sharing with Supply Chain Partnerships," *Industrial Management + Data Systems* (101:3/4) 2001, pp 114-119.
Yuchtman, E., and Seashore, S.E. "A System Resource Approach to Organizational Effectiveness," *American Sociological Review* (32:5) 1967, pp 891-903.
Zhao, X., and Xie, J. "Forecasting Errors and the Value of Information Sharing in a Supply Chain," *International Journal of Production Research* (40:2) 2002a, pp 311-335.
Zhao, X., Xie, J., and Zhang, W.J. "The Impact of Information Sharing and Ordering Co-Ordination on Supply Chain Performance," *Supply Chain Management: An International Journal* (7:1) 2002b, pp 24-40.
Zikmund, W.G. *Business Research Methods*, (7th ed.) South-Western, 2003.
Ziv, A. "Information Sharing in Oligopoly: The Truth-Telling Problem," *The Rand Journal of Economics* (24:3) 1993, pp 455-465.