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The Effect of Information Quality on Supply Chain Performance: An Interorganizational Information System Perspective

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Kenneth J. Petersen

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THE EFFECT OF INFORMATION QUALITY ON SUPPLY CHAIN PERFORMANCE: AN INTERORGANIZATIONAL INFORMATION SYSTEM PERSPECTIVE

By

Kenneth James Petersen

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Submitted to
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ABSTRACT

THE EFFECT OF INFORMATION QUALITY ON PERFORMANCE: AN INTERORGANIZATIONAL INFORMATION SYSTEM PERSPECTIVE

By

Kenneth James Petersen

This research is conducted within the broad theme of how interorganizational information systems may help firms to make better decisions and how these improved decisions may lead to improved firm performance.

The theoretical model developed in this research reflects the notion that when higher quality information is exchanged between supply chain partners, outcomes of joint planning and decision-making processes will be improved, which will lead to improved firm performance. Within this framework, one of the fundamental propositions is that an effective interorganizational information system will increase the quality of the information exchanged between supply chain partners. The increased quality of information associated with interorganizational information systems is expected to be associated with better outcomes from joint planning and decision making processes, which are in turn expected to be associated with greater levels of performance.

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The theoretical model was tested using a sample of 169 purchasing and supply chain managers and executives primarily located in the United States. Structural equation modeling (SEM) was employed in this research to estimate the parameters associated with the relationships of interest.

Key results from this research include the finding that information quality has a significant impact on the outcomes of eight different joint planning and decision making processes and that these processes are associated with certain firm-level performance outcomes. Further, within several of these processes, the effect of information quality on joint planning and decision making outcomes is significantly larger for interorganizational information system enabled information quality than for non-interorganizational information system enabled information quality.

Theoretical and practical insight is developed within each of the eight joint planning and decision making contexts.

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John

This research is dedicated to Sigrid, Erin, Andrew and John. Without your friendship, this work would never have been completed. Sigrid - - your understanding and support through this difficult process has been nothing short of phenomenal. Erin, Andrew and John – each of you helped your dad along in your own special way.

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I would like to thank Dr. Robert Monczka for his patience, time and willingness to support this research. I would also like to thank The Global Procurement and Supply Chain Benchmarking Initiative at Michigan State University for graciously providing financial support and access to the world's most leading-edge companies. I would like to thank the dissertation committee, Dr. Gary Ragatz, Dr. Robert Handfield and Dr. David Closs for their insightful contributions to this work.

Finally, I would like to thank my father, Dr. Russell J. Petersen, for his support, help and guidance.

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BBNNFI.........

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XML...............

List of Abbreviations

BBNFI.. Bentler-Bonett Normed Fit Index

BBNNFI...................................... Bentler-Bonett Non-Normed Fit Index

CFA... Confirmatory Factory Analysis

CFI.. Comparative Fit Index

EDI.. Electronic Data Interchange

ERP.. Enterprise Resource Planning

FCS... Feedback Control System

IOS.. Interorganizational Information System

LM... Lagrange Multiplier

IS.. Information System

IT.. Information Technology

PEU.. Perceived Environmental Uncertainty

RFQ... Request for Quotation

TCA.. Transaction Cost Analysis

TCE.. Transaction Cost Economics

VAN.. Value Added Network

VMI.. Vendor Managed Inventory

VP... Vice President

XML.. Extensible Markup Language

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Chapter 1

> The solution of today's major social problems will come from more and better technology - not from less technology. For technology is just another name for human knowledge. We need to deepen our scientific knowledge, broaden our repository of alternatives, and strengthen our technology of decision procedures. Above all, we need a more profound understanding of man himself, for all human problems have their roots in our own nature. (Simon, 1973)

Introduction

Research Question

This research attempts to answer three primary questions: (1) Does information quality affect interorganizational integration?; (2) Does interorganizational integration affect performance outcomes?; (3) Is there a difference between the effect of interorganizational information system and non-interorganizational information system enabled information quality on interorganizational integration and performance outcomes. Furthermore, this examination is done in the context of eight different manufacturing, procurement and supply chain joint planning and decision making processes. Answering these three research questions will fill a critical void in the academic literature as well as provide practical insight that is usable by practitioners today.

Importance of the Research

In order to achieve preeminence in today's competitive marketplace firms must not only manage their own operations, but they must also manage the supply chains in which they participate. The role of each supply chain member in managing the supply chain may vary

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chain may vary depending on the function of that supply chain member in the supply chain. However, in order for the supply chain to function optimally, all members must contribute in some way to the management of the supply chain. Jeff Trimmer of Chrysler emphasized this point when he noted that "if any one of the links breaks or fails, the customer is not going to be satisfied. And one thing that has become apparent to us is that the leanest chain wins" (Sheridan, 1998).

A ***supply chain*** is defined in this research as an "organization of networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute the finished products to customers" (Lee & Billington, 1992). This definition includes the suppliers from whom the raw materials and components, subsystems and systems are purchased. There is evidence in support of the observation that (1) there are indeed better performing supply chains and that (2) these better performing supply chains are more competitive than their poorer performing counterparts. A recent study conducted by PRTM revealed that top performing supply chains have achieved significant reductions in supply chain costs (Anonymous, 1997a) including 40% to 65% reductions in cash-to-cash cycle times (Sheridan, 1998) and 50% to 80% reductions in inventory compared to competitors (Sheridan, 1998).

How well information is shared between firms in a given supply chain can have a significant effect on the performance of the supply chain as well as the performance of each of the firms that belong to the supply chain. Lee, Padmanabhan and Whang (1997) noted a particular supply chain problem they termed the "bullwhip effect." The bullwhip effect relates to how "distorted information from one end of a supply chain to the other can lead to treme

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can lead to tremendous inefficiencies: excessive inventory investment, poor customer service, lost revenues, misguided capacity plans, ineffective transportation, and missed production schedules" (Lee et al., 1997). Andreas Rulke (PRTM) believes that the need to have efficient information flow within a supply chain is critical. Rulke wrote that "the supply-chain management team must have full visibility of the product pipeline and online-inquiry access to end-user demand, vendor supply actions, and current material availability aggregated across the entire supply chain of its company" (Anonymous, 1997b).

Interorganizational information systems provide a mechanism by which firms may share this information. Porter and Millar (1985) described the importance of interorganizational information systems to supply chain management when they wrote:

> Information technology is permeating the value chain at every point, transforming the way value activities are performed and the nature of the linkages among them. It also is affecting competitive scope and reshaping the way products meet buyer needs. These basic effects explain why information technology has acquired strategic significance and is different from the many other technologies businesses use.

Balsmeier and Voisin (1996) argue that the ultimate level of supply chain integration is marked by members of the supply chain continuously exchanging all necessary information. The authors believe that this level of information flow is not possible without the use of information technology as a medium for interorganizational information exchange. Evans and Wurster (1997), adopting a more iconoclastic view, wrote:

> Over the past decade, managers have focused on adapting their operating processes to new information technologies. Dramatic as those operating changes have been, a more

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> profound transformation of the business landscape lies ahead. Executives - and not just those in high-tech or information companies - will be forced to rethink the strategic fundamentals of their businesses. Over the next decade, the new economics of information will precipitate changes in the structure of entire industries and in the ways companies compete.

Roger Sterling, Vice President of Global Supply Management at Honeywell, was quoted as saying, "I subscribe to the definition of supply chain management developed through the Michigan State University Global Procurement and Supply Chain Benchmarking Initiative. That is, 'efforts to link customer requirements, new product, process, and service development, and order fulfillment activities (from customer order entry through purchasing, manufacturing and operations, and distribution) so as to gain competitive advantage in terms of cost, quality, time, or technology.' I believe that companies that do this well will have a sustainable competitive advantage. I believe also that the key enabler is an integrated information system" (Porter, 1997). Writing about the changes that have occurred recently in supply chain management, Lawrence Gould noted:

> What is different today are the technologies that make those fundamentals [supply chain management] more efficient and productive, and that give enterprises the ability to respond to a customer's request quickly. Another difference is that the concept of "supply chain" goes well beyond the enterprise and includes both customers and suppliers (Gould, 1998).

The role of information technology within organizations has undergone a key transformation that has led us to expand our view of how information technology can and should be employed. We once viewed information technology as a tool used to provide improvements in efficiency through the automation of tasks. We now view information technology as a key enabler to creating and maintaining a flexible business network of interorganizatio

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interorganizational arrangements (Venkatraman, 1994). Cash and Konsynski provided support for this notion when they wrote:

> These systems, defined as automated information systems shared by two or more companies, will significantly contribute to the enhanced productivity, flexibility, and competitiveness of many companies. However, current examples illustrate that some interorganizational systems will radically change the balance of power in buyer-supplier relationships, provide entry and exit barriers in industry segments, and in most instances, shift the competitive position of intra-industry competitors (Cash & Konsynski, 1985).

Cash and Konsynski's writings underscore the critically important role that interorganizational information systems will play in enabling the sharing of information across company boundaries.

In practice, it is evident that many companies are attempting to adopt the spirit of interorganizational information system enabled interorganizational integration. The push for interorganizational information system enabled interorganizational integration may be seen in the development of such software as *CrossRoute Alliance (Software, 1998c)*, *ActiveWeb Integration System (Software, 1998a)*, *Crossroads Customer Interaction (Software, 1998b)*, *NEONet (Networks, 1998)*, *Prospero (Software, 1998d)*, *TIB/Active Enterprise (Software, 1998e)* and *Vitria Business Agility (Technology, 1998)* which are all designed to allow disparate enterprise resource planning (ERP) implementations to interconnect on a cross-enterprise basis. It is hoped that this interorganizational "bridging" software will further enable companies to more seamlessly integrate different types of interorganizational information flows, contributing to increased interorganizational integration. Further, it is estimated that the integration software market will grow from $650M in 1997 to $4B by 2002. This underscores the fact that companies are p

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companies are placing a very high value on the ability to create and maintain interorganizational information systems.

As another example, the XML Working Group (1998) (formerly the SGML Editorial Board) chaired by John Bosak of Sun Microsystems has developed a new Internet standard designated the "Extensible Markup Language" or "XML." This standard is being developed as a reincarnation of EDI that is designed for use across the World Wide Web, as opposed to the more traditional VAN frequently employed by EDI. XML is an open standard that will very likely take the place of traditional EDI (Adams, 1997). ***The important take away from these two examples is that companies are pushing hard for solutions that will allow effective electronic integration across key business processes on an interorganizational basis.***

While much has been written about interorganizational information systems and supply chain integration in the popular press, little substantive research has been done to determine whether interorganizational information systems help to create more integrated, better performing supply chains. Two notable exceptions include Bensaou (1992; 1997) and Zaheer and Venkatraman (1994) who each theorized that interorganizational information systems act as an antecedent to successful interorganizational integration.

Interorganizational Integration Defined

The notion of *interorganizational integration* is central to the theoretical framework adopted in this research. McGee noted that interorganizational integration is marked by the extent to which interdependent activities which link interacting organizational units are viewed, operated and managed as a single system (McGee, 1991). McGee

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1991). McGee also noted that interorganizational integration is often reflected in (1) a specialized language system for interaction, (2) jointly developed procedures for interacting, (3) subordination of individual performance measures to system performance, and (4) common conceptual maps of the environment (McGee, 1991). This treatment of interorganizational integration forms the foundation for the definition of interorganizational integration that is adopted in this research. Specifically, *interorganizational integration is defined as the extent to which interacting members of a supply chain are viewed, operated and managed as a single system.* This definition also encompasses Clemons' notion of 'explicit coordination,' which has been defined as "...the extent to which decisions reflect and are tailored to a specific relationship, and is distinguished from the implicit coordination of the invisible hand of market competition" (Clemons, Reddi, & Row, 1993; Clemons & Row, 1992).

Interorganizational Information Systems Defined

Cash and Konsynski (1985) developed the definition of an interorganizational information system that will be adopted by this research. Many researchers studying interorganizational information systems have employed this definition. While the definition is simple, it captures the essential elements of an interorganizational information system which include (1) the use of information technology (both computer and communications technologies) to (2) enable different organizations to create, manage and share information with other organizations. Specifically, Cash and Konsynski (1985) define an interorganizational information system as:

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> ... [a] system which ...[is]... built around information technology, i.e., around the computer and communications technology that facilitates the creation, storage, transformation, and transmission of information. An interorganizational system differs from an internal, distributed information system by allowing information to be sent across organizational boundaries. Access to stored data and applications programs is shared, sometimes to varying degrees, by the participants in an interorganizational system.

Research Question

This research attempts to answer three primary questions: (1) Does information quality affect interorganizational integration?; (2) Does interorganizational integration affect performance?; (3) Is there a difference between the effect of interorganizational information system and non-interorganizational information system enabled information quality on interorganizational integration and performance.

Firms on a worldwide basis are in the process of purchasing and installing information systems to enable the management of not just their own firms, but the supply chains in which their firms participate. The popular press has heralded the marked trend toward interorganizational technology adoption often as both a solution and a stumbling block to creating better performing supply chains. The relationship between information quality, interorganizational integration and performance has yet to be empirically tested. Answering these three research questions will fill a critical void in the academic literature as well as provide practical insight that is usable by practitioners today.

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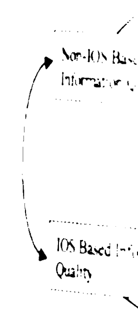

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Overview of the Research

The theoretical model to be tested in this research (see Figure 1) reflects the notion that when higher quality information is exchanged between supply chain

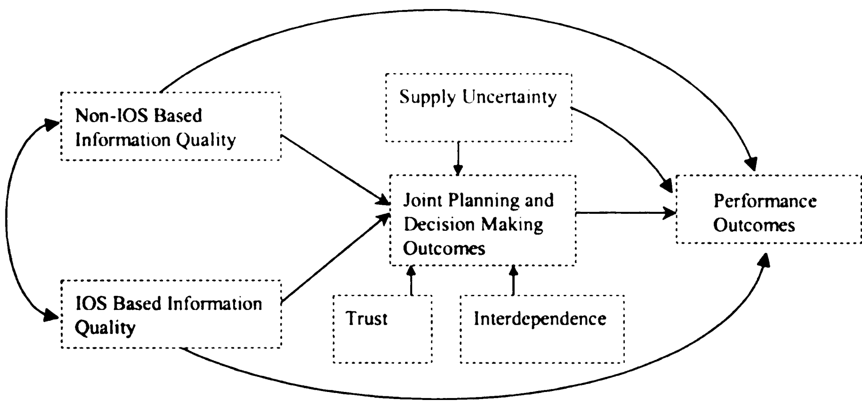

Figure 1: Explanatory Model Overview

partners, joint planning and decision-making outcomes will be improved, leading to higher levels of performance. Within this framework, the fundamental proposition is that the use of an interorganizational information system will increase the quality of the information shared between supply chain partners. The increased quality of information associated with interorganizational information systems is expected to be associated with better joint planning and decision making process outcomes, which are in turn expected to be associated with higher levels of performance. The joint planning and decision making construct is developed as a proxy for the integration of supply chain partners on key business processes. This conceptualization is consistent with previous conceptions of interorganizatio

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Uncertainty in supply is theorized to affect both the joint planning and decision making processes outcomes, as well as overall performance. When greater supply uncertainty exists, firms will be forced to improve their joint planning and decision-making processes in order to make the best decisions. This improvement in joint planning and decision making processes will be evidenced by better joint planning and decision making process outcomes. Consistent with the same argument, supply uncertainty will have a negative effect on overall performance. While these firms will attempt to work together to reduce supply uncertainty, they will only be partially effective in doing so. Through joint efforts, firms may be able to mitigate the risk associated with supply uncertainty, but they will not be able to overcome the entire effect of supply uncertainty on performance.

The trust and interdependence exhibited between supply chain partners is also expected to affect the joint planning and decision-making processes of these supply chain partners. The greater the degree of trust and interdependence between supply chain partners, the more likely those partners are to participate in joint planning and decision making processes. The interdependence between the supply chain partners has the effect of aligning each of the supply chain partner's individual goals with overall system goals.

Scope of Research

This research will examine the interaction between organizations within a supply chain for a specific part, assembly, service or commodity. Figure 2 is a depiction of the processes that are included in an integrated approach to creating and managing an integrated supp

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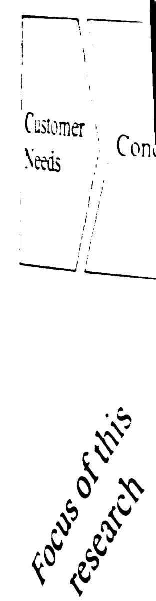

Figure 2: Supplier

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integrated supply chain. The focus of this research will be the ***customer order fulfillment cycle***. While the new product/process/service development cycle is a critical part of an overall interorganizational integration strategy, it is outside of the scope of this research. Participating firms must have an established interorganizational information system that is used in the customer order fulfillment process with a focal supplier.

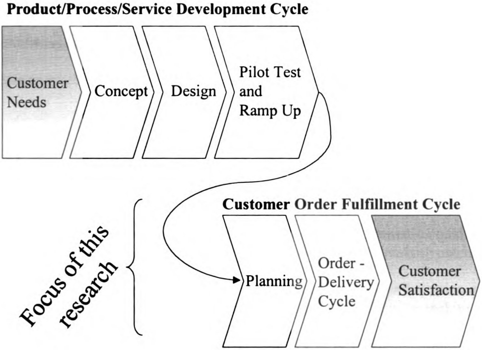

Figure 2: Supplier Integration Processes (GEBN, 1996)

<u>Hypothesized Relationships</u>

As previous discussed, Figure 1 provides a simplified overview of the explanatory model to be evaluated in this research. For clarity, definitions of the constructs used in this explanatory model are summarized in Appendix A. Figure 3 is the same explanatory model found in Figure 1 with the addition of the specific research hypotheses. Each of the research hypotheses labeled in Figure 3 will be described in turn.

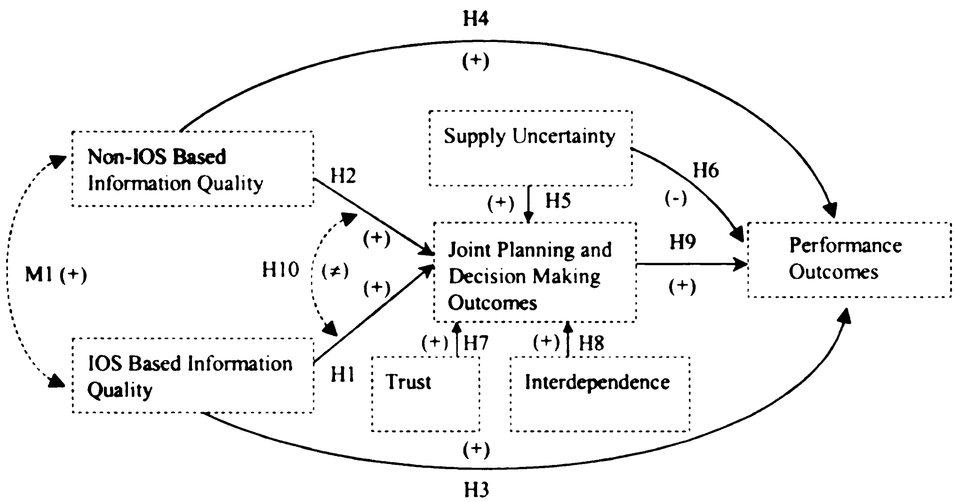

Figure 3: Model Description (with Hypotheses)

H1: Interorganizational information system (IOS) information quality has a direct and positive effect on joint planning and decision-making outcomes

H2: Non-interorganizational information system (IOS) information quality has a direct and positive effect on joint planning and decision-making outcomes

Information quality is defined as the degree to which the information exchanged between organizations meets the needs of the organizations. Information quality is a construct that has been employed in a variety of contexts (Bailey & Pearson, 1983; Jones & McLeod, 1986; King & Epstein, 1983; Miller & Doyle, 1987; Rivard & Hugg, 1984; Srinivasan, 1985). Several important dimensions of information quality (Goodhue, 1995) frequently employed in the literature include information currency (Bailey & Pearson, 1983; Raymond, 1985), information completeness (Bailey & Pearson, 1983; Baroudi, 1988; Raymond, 1985), information validity and information reliability (Bailey & Pearson, 1983; Baroudi, 1988; Raymond, 1985). Furthermore, information reliability has been partitioned

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been partitioned into three dimensions that include information accuracy reliability, information relevancy reliability and information precision reliability (Bailey & Pearson, 1983; Baroudi, 1988; Raymond, 1985). Zmud (1978) noted that the perception of information has four dimensions, that include (1) the significance, usefulness, or helpfulness of the information; (2) the accuracy, factualness, and timeliness of the information; (2) the quality of format or physical presentation and readability of the information; and (4) the meaningfulness or reasonableness of the information. Other important dimensions of information quality include information compatibility (Goodhue, 1995), locatability (Goodhue, 1995), authorization (Bailey & Pearson, 1983; Goodhue, 1995), convenience of access (Bailey & Pearson, 1983; Raymond, 1985), and timeliness (Bailey & Pearson, 1983; Raymond, 1985). Performance results are defined as the set of tangible benefits that accrue to the organization as a result of closer interorganizational integration with a supply chain partner. Examples of these tangible benefits include reductions in inventory, cycle-time and cost.

A higher degree of information quality with respect to the information that is being exchanged by supply chain partners is hypothesized to lead to better joint planning and decision making outcomes between these supply chain partners. Information quality has been partitioned into interorganizational information system enabled information quality (H1) and non-interorganizational information system enabled information system quality (H2). The reason for examining the information quality of both IOS and non-IOS information flows is that IOS enabled information flows are hypothesized to be of greater quality than non-IOS enabled information flows (see H10).

The eight joint planning and decision making processes that provide the context for this research were selected because of their inherent need for the mutual exchange of information. These joint planning and decision making processes have been summarized in Figure 4. Each of these processes has been identified as being critical to effective supply chain integration (Monczka & Morgan, 1998).

Joint Planning and Decision Making Processes

- Forecasting and Inventory Positioning
- Inventory Visibility
- Capacity Planning
- Post Supplier Selection Performance Evaluation/Feedback and Conformance
- Sourcing and Supply Proposal Evaluation
- Part/Material Standardization
- Supplier Scheduling
- Joint Goal/Target Setting

Figure 4: Information Elements

H3: IOS information quality has a direct and positive effect on performance

H4: Non-IOS information quality has a direct and positive effect on performance

The better the quality of information exchanged between supply chain partners, the better performance will be. Information quality has been partitioned into interorganizational information system enabled information quality (H3) and non-interorganizational information system enabled information quality (H4). The notion that better information will lead to better decisions is well supported in the literature. The range of possib

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range of possible decisions that are likely to benefit from better information is quite large. However, the joint planning and decision making construct (which mediates the relationship between information quality and performance) was developed to be a reflection of only a small subset of the decisions which might occur within the customer order fulfillment process. As a result, it is intuitive that there will be a direct relationship, although likely attenuated by missing mediating decision processes, between information quality and performance. H3 and H4 capture the effect of information quality on performance through these missing mediating joint planning and decision making processes.

H5: Supply uncertainty has a direct and positive effect on joint planning and decision making process outcomes

H6: Supply uncertainty has a direct and negative effect on performance

Supply uncertainty is defined as the degree of unpredictability in future material supply states (Pfeffer & Salancik, 1978). The focus of supply uncertainty is on the supply of material from the upstream supply chain partner that is used in the firm's manufacturing process. Supply uncertainty is more broadly defined in the transaction cost economics literature as "unanticipated changes in circumstances surrounding an exchange" (Noordewier, John, & Nevin, 1990).

Uncertainty in supply is theorized to affect both joint planning and decision making processes, as well as overall performance. When greater supply uncertainty exists, firms will be forced to improve their joint planning and decision-making processes in order to make better decisions. This improvement in joint planning and decision making processes will be evidenced by better joint planning and decision making process outcomes (H5). For the same reason, supply uncertainty will have a negative effect on overall perform

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overall performance. Through joint efforts, firms may be able to mitigate the risk associated with supply uncertainty, but they will not be able to overcome the entire effect of supply uncertainty on performance (H6).

H7: Trust between firms within a supply chain has a direct and positive effect on the results of joint planning and decision-making processes

H8: Interdependence of firms within a supply chain has a direct and positive effect on the results of joint planning and decision-making processes

Trust is defined as a willingness to rely on an exchange partner in whom one has confidence" (Moorman, Zaltman, & Deshpande, 1992). Trust is frequently conceptualized as either a determinant of relationship quality (Anderson & Narus, 1990; Moorman et al., 1992), or as a feature of relationship quality (Dwyer, Schurr, & Oh, 1987). This research conceptualizes trust as a determinant of relationship quality. Trust has been identified as being of three generic types: (1) knowledge-based, (2) identification-based and (3) calculus based (Bechtel, 1998):

> ***Knowledge-based trust*** – Trust is grounded in predictability – knowing the other party sufficiently well so that the other's behavior is anticipatable. Knowledge-based trust relies on information rather than deterrence as a motivator.
>
> ***Identification-based trust*** – Trust is based on identification with the other party's desires and intentions. Trust exists because the parties effectively understand and appreciate the other's wants. A mutual understanding develops as each side clearly understands the motivations and problems of the other side.
>
> ***Calculus-based trust*** – Trust based on control or assuring that the other party will do what they say. Trust is sustained through a clear deterrent (punishment). The threat of punishment is likely to be a more significant motivator than promise of a reward. Calculus-based trust often involves a high degree of monitoring to assess whether a party is being opportunistic.

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This study specifically includes knowledge-based, identification-based, and calculus-based conceptualizations of trust.

Interdependence is defined as the lack of ability on the part of supply chain partners to individually control all of the conditions necessary to achieve an action or desired outcome. The central thesis of resource dependency theory (Emerson, 1962; Pfeffer & Salancik, 1978) is that interorganizational behaviors can be explained by the degree to which uncertainty within the relationship is reduced (Handfield, 1993). Handfield (1993) wrote that:

> ...Organizations are believed to react in one of three manners in the face of uncertainty: (1) they work towards acquiring control over resources to minimize dependence on other organizations ("absorbing the environment"); (2) they attempt to control interdependence through legal means ("creating the environment"); or (3) they establish collective structures of interorganizational action ("negotiating the environment").

Interdependence in the context of this research deals directly with the collective structures (interorganizational information systems/joint planning and decision making processes) that are developed in the face of uncertainty.

The trust (H7) and interdependence (H8) exhibited between supply chain partners are each expected to affect the joint planning and decision-making outcomes of these supply chain partners. The greater the degree of trust and interdependence between supply chain partners, the more likely those partners are to share sensitive information. The interdependence between the supply chain partners has the effect of aligning each of the supply chain partner's individual goals with overall system goals.

H9: Joint planning and decision making outcomes have a direct and positive effect on performance

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Joint planning and decision making processes are defined as those decision making processes that require bilateral information flow between supply chain partners. For instance, there is a joint planning and decision making process for manufacturing capacity planning. A supplying firm must inform its customers of its manufacturing capacity constraints, just as a buying firm must inform its suppliers of its purchase requirements. Only when this information is jointly shared may a better decision be reached. The eight specific joint planning and decision making processes that provide the context for this research include (1) forecasting and inventory positioning, (2) inventory visibility, (3) capacity planning, (4) post supplier selection performance evaluation/feedback and conformance, (5) sourcing and supply proposal evaluation, (6) part/material standardization, (7) supplier scheduling and (8) joint goal/target setting.

Joint planning and decision-making activities between supply chain partners are expected to lead to better performing supply chains. The notion that better joint planning and decision making processes have a positive effect on joint business outcomes has been previously studied in relation to supplier alliances (Mohr & Spekman, 1994; Monczka, Petersen, Handfield, & Ragatz, 1998), supplier integration into new product development (Ragatz, Handfield, & Scannell, 1997), supplier development (Krause, 1995; Krause, 1997), and a host of other supply chain related areas.

H10: The degree of association between interorganizational information system enabled information quality and joint planning and decision making will be of a significantly greater magnitude than the degree of association between non-interorganizational information system enabled information quality and joint planning and decision making.

It is expected that any given element of information required in the joint planning and decision making process will be drawn through either an IOS-enabled information communicatior

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communication channel or through a non IOS-enabled information communication channel, but not through both. IOS based information communication is expected to be of a higher quality than that of non-IOS based information communication. There are many reasons why we might expect this to be the case. Several dimensions of information quality depend directly on the underlying quality of the data on which the information is based. Data quality has been defined as "the measure of the agreement between the data views presented by an information system and that same data in the real world" (Orr, 1998). Feedback control system (FCS) theory supports the notion that interorganizational information system enabled information flows will be of higher quality when the data that they contain is used more frequently. To provide an illustration of how data quality can affect information quality, several rules offered by FCS theory are described (Orr, 1998). These rules include:

Rule 1. Unused data cannot remain correct for very long;
Rule 2. Data quality in an information system is a function of its use, not its collection;
Rule 3. Data quality will, ultimately, be no better than its most stringent use;
Rule 4. Data quality problems tend to become worse as the system ages;
Rule 5. The less likely some data attribute (element) is to change, the more traumatic it will be when it finally does change;
Rule 6. Laws of data quality apply equally to data and metadata (the data about the data)

From FCS theory, we may understand that the use of an interorganizational information system to share information necessarily increases the use of the supporting data, leading to increased data quality and then to increased information quality.

As another example, information compatibility (Goodhue, 1995), locatability (Goodhue, 1995), authorization (Bailey & Pearson, 1983; Goodhue, 1995), convenience of access (Bailey & Pearson, 1983; Raymond, 1985), and timeliness (Bailey & Pearson, 1983; Raymond, 1985) are likely to improve with the use of an interorganizational information system when compared to more traditional information communication channels.

> **M1:** The association between the measurement errors for each like attribute of information quality across the IOS-enabled information flows and the non-IOS enabled information flows may be positive.

Because the same measures of the attributes of information quality are applied to both IOS enabled information flows and non-IOS enabled information flows, the measurement errors for each of the like attributes of information quality are likely to be positively associated. This association is a product of the design of the research, and does not represent any substantive finding. Chapter 4 will present a more detailed analysis of these associated measurement errors.

Overview of Subsequent Chapters

Chapter 2 examines the literature surrounding supply chain integration and interorganizational information systems. Chapter 3 presents the research design that will be used in Chapter 4 to test the theoretical model under examination in this research. Chapter 5 provides a discussion of the research results with special emphasis drawn to key academic and practically relevant findings.

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Chapter 2

Review and Summary of the Literature

The theoretical foundations for this research are derived from the body of knowledge surrounding supply chain integration and interorganizational information systems. Each of these bodies of literature will be explored with a focus on the applicability of each of these broad bodies of research to the theories proposed by this research.

Supply Chain Integration

The topic of integrated supply chains has received considerable attention in the popular press. However, little academic research has been done to address much of the uncertainty surrounding integrating supply chains.

Monczka and Morgan (1997) wrote, "after almost a decade of existence, supply chain management continues to be a poorly understood, badly explained, and wretchedly implemented concept." Monczka and Morgan (1997) believe that the set of supply chain management related issues that must be addressed include:

- Fragmentation in the way supply chain management is understood and applied.
- Failure of companies to develop true integration of the processes used to achieve supply chain management.
- Organizational resistance to the concept.
- Lack of buy-in by many top corporate managers.
- Lack of and/or slow development of needed measurement systems.

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- Lack of good and sufficient information, including integrated information systems and electronic commerce linking firms in the supply chain.
- Failure of supply management thinking to push beyond the bounds of individual companies.

Troyer and Cooper (1995) supported the ideas of Monczka and Morgan (1997) when they wrote that:

> Manufacturers, distributors, and retailers all are scrambling under the guise of various industry initiatives such as efficient consumer response, quick response, and just-in-time manufacturing to gain advantage - whether it is in the form of lower costs, better service, or a combination of both. These programs all share a common essence: integrating the supply chain. Never before have companies undertaken such intensive efforts to coordinate their operations with their customers.

Further support for the notion that supply chain integration is critical to firms may be found in the writings of Sengupta and Turnbill (1996):

> The efficient solution to supply chain management problems is now recognized as an integral part of the day-to-day function of an organization. People have realized that growing market share is not an infinite possibility since the market itself is finite. This has turned corporate attentions toward streamlining operations in order to generate savings from a slimmer and more reactive supply chain.

Radding (1998) wrote that "the supply-chain movement is forcing companies and their trading partners to shorten product cycles and cut out unnecessary steps. Supply-chain integration will be accomplished largely through linking key business systems."

Lee and Billington (1992) addressed problems related to inventory positioning throughout the supply chain that occur (in part) as a result of the lack of information flow between supply chain members. Lee, Padmanabhan and Whang (1997) addressed a problem dubbed the "bullwhip effect" which is related to the lack of proper information flow between :

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flow between members of a supply chain. Vendor Managed Inventory (VMI) programs have recently begun to receive considerable treatment in the popular press (Cottrill, 1997). In a VMI program "the supplier assumes responsibility for managing inventories at customer locations through the use of highly automated electronic messaging systems. Detailed sales and demand information are exchanged between vendors and customers, and the information is used to plan and implement product replenishment and sales strategies" (Cottrill, 1997). Cottrill notes that "...the supply chain will itself become a trading entity... supply chains will compete against other integrated supply chains, looking to create economic value (the key objective of all participants in the chain) across the whole chain and measuring performance using overall chain metrics" (Cottrill, 1997).

Interorganizational Information Systems Theory

Interorganizational Information System Typologies

Barrett and Konsynski (1982) studied a number of firms using interorganizational information systems. The product of this research was a classification scheme that grouped interorganizational information systems into five different levels of interorganizational system participation including (1) remote I/O node, (2) application processing node, (3) multi-participant exchange node, (4) network control node, and (5) integrating network node.

- **Level 1:** Remote I/O Node participants have the simplest and least costly method of interorganizational system participation. An example might include the electronic exchange of orders, shipping status, etc. between a buyer and supplier.
- **Level 2:** Application Processing Node participants "develop and share a specific application such as an inventory query or order processing system." The cost incurred in the development of this application is partially offset by the efficiencies created by the application. An example might include a second-tier automotive supplier providing shipping status to a first-tier automotive supplier through the first-tier automotive supplier's proprietary application.

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- **Level 3:** Multi-Participant Exchange Node participants provide the capability for other lower-level participants and applications to be connected. An example might include an automotive manufacturer who has developed and maintains a network and portfolio of applications (inventory processing, exception handling, etc) for its second-tier suppliers.
- **Level 4:** Network Control Node participants develop and share a network with a diverse set of applications and participants. An example is an automated clearinghouse.
- **Level 5:** Integrating Network Node participants link all of the lower-level participants and provide simultaneous processing capabilities. An example might be an interorganizational credit facility such as TRW.

The classification scheme developed by Barrett and Konsynski is interesting in that it helps to describe the relationship between the level of participation in an interorganizational information system and potential costs and benefits associated with that participation. Further, the authors argue that there are four factors that will be affected by the level of participation in the interorganizational system which include (1) the participation strategy, (2) the organization structure, (3) the user department, and (4) the internal IS department. Cash and Konsynski (1985) refine the work done by Barrett and Konsynski (1982) and in so doing reduce the five levels of interorganizational system participation to three. These three levels include (1) information entry and receipt, (2) software development and maintenance, and (3) network processing management. Both Barrett and Konsynski (Barrett & Konsynski, 1982) and Cash and Konsynski (1985) attempt to create a classification system for interorganizational information systems that is based on degree of interorganizational information system participation. Johnston and Vitale (1988) develop a three-tiered framework for classifying interorganizational information systems. The authors argue that an interorganizational system might be classified "on the business purpose of the system, on the relationship between the sponsoring organization and the other participants, and on the information function in the system." Mal

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system." Malone, Yates and Benjamin (1987), relying on transaction cost economics, classified interorganizational information systems based on whether or not they facilitated electronic markets or electronic hierarchies.

Venkatraman (1994) developed a framework that classified IT-enabled business transformation into five categories which included (1) Localized exploitation, (2) Internal integration, (3) Business process redesign, (4) Network redesign, and (5) Business scope redefinition. Venkatraman developed these five levels of IT-enabled business transformation using an action research methodology.

Information Quality

Information quality represents the degree to which the information exchanged between organizations meets the needs of the organizations.

McGowan (1998) noted that the "output of an information system is perceived to be useful only if it is of high quality, readily accessible, and provides accurate and relevant information. Information quality has been employed in academic research in a variety of capacities. DeLone and McLean (1992) and Seddon (1997) employed information quality as an exogenous latent variable in a model of IS success. In their research, the authors noted that "information quality is concerned with such issues as the relevance, timeliness, and accuracy of information generated by an information system. Not all applications of IT involve the production of information for decision-making (e.g., word processor does not actually produce information) so information quality is not a measure that can be applied to all systems" (Seddon, 1997). McGowan (1998) employed information quality as an exogenous latent variable that was hypothesized to impact the usefulness of an activity based costing management system. Studying computer-mec

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computer-mediated communication, Kettinger and Grover (1997) hypothesized that information quality was an exogenous latent variable that impacted the use of interorganizational email. Speaking about Qualcomm, Inc.'s decision to implement the PeopleSoft ERP package, Norm Fjieldheim (VP of IS at Qualcomm) noted:

> At first, we were looking at PeopleSoft and Red Pepper individually, but when PeopleSoft acquired Red Pepper, that secured our decision. A bolt-on product is ok, but we wanted to do a lot better than that. Now everything happens within the same system. You don't have to manually extract data generated in the planning engine and then squeeze it back into the ERP system" (Stein, 1998).

Furthermore, one ERP user was quoted as saying "we want to be able to log on to each other's systems and extract key information. From a technology standpoint, data sharing is not completely there yet. But we expect the ERP vendors to carry the load" (Stein, 1998).

These comments highlight the importance of the ability to electronically transport information across organizational boundaries in a manner that allows that information to be compatible with both the sender and the recipient of that information.

Environmental Uncertainty

Environmental uncertainty has been found to play an important role in the ability of organizations to integrate successfully (Bensaou, 1996; Bensaou & Anderson, 1997; Bensaou & Venkatraman, 1996a; Bensaou, 1992; Bensaou, 1997; Bensaou & Venkatraman, 1995a; Bensaou & Venkatraman, 1995b; Bensaou & Venkatraman, 1996b; Clemons & Row, 1992; Clemons & Row, 1993). Transaction cost economic theory supports the notion that "uncertainty about the environment creates adaptation and information processing problems for a firm. (Bensaou, 1997). Furthermore, Bensaou notes that one

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notes that one major type of environmental uncertainty is that of technological unpredictability. Bensaou writes that:

> In particular, the inability to forecast accurately new technological or design requirements for the parts and components exchanged within the relationship may be managed more efficiently through no or loose coupling (i.e., source selection can be done by competitive bidding based only on price between a large number of suppliers provided with detailed design specifications) and therefore less investment in joint efforts, such as joint planning and development" (Bensaou, 1997).

In other research, Bensaou partitions environmental uncertainty into three dimensions including capacity, complexity, and dynamism (Bensaou & Venkatraman, 1995a). Capacity is defined as "the extent to which the environment can or does support growth" and is similar in nature to Starbuck's (1976) environmental munificence and Aldrich's (1979) environmental capacity constructs (Bensaou & Venkatraman, 1995a). Complexity is defined as "the heterogeneity and range of an organization's activities" (Bensaou & Venkatraman, 1995a). Dynamism is defined as the degree to which contingencies remain basically the same over time or are in a continual process of change" (Bensaou, 1992). Clemons and Row noted that under conditions of high uncertainty it might be difficult to contract for all contingencies (Clemons & Row, 1992). In fact, in the limiting case of high uncertainty, it may make more sense to vertically integrate as opposed to contract with another organization (Clemons & Row, 1992).

Environmental uncertainty has received much attention in the academic literature (Milliken, 1987; Rindfleisch & Heide, 1997). A large number of environmental uncertainty measures have been employed. Particular focus has been directed toward the perceived environmental uncertainty (PEU) scales developed by Miles and Snow (1978). Support for the PEU scales have been established (Milliken, 1987) and the PEU scales have been val

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have been validated (Ireland, Hitt, Bettis, & De Porras, 1987; Milliken, 1987). Buchko (1994) conducted research to determine the measurement properties of the PEU scales and found the scales to be reliable (Cronbach, 1951). However, Rindfleisch and Heide (1997) noted that "among all of the TCA constructs, environmental uncertainty seems to be the most problematic from a measurement standpoint."

Trust

Williamson (1996) wrote that social scientists often view trust as a subclass of risk. Williamson noted that "according to this formulation, trust is warranted when the expected gain from placing oneself at risk to another is positive, but not otherwise. Indeed, the decision to accept such a risk is taken to imply trust" (Williamson, 1996). Barua, Ravindran and Whinston (1997) noted that "even in a world of permanence, cooperation in information sharing cannot emerge in the absence of trust." Trust has been defined as "the extent to which negotiations are fair and commitments are upheld" (Zaheer & Venkatraman, 1994) and has been found to be of critical importance in the relationship between organizations attempting to integrate. Zaheer and Venkatraman (1994) found that trust played a significant role in predicting the success of interorganizational information system integration in the insurance industry and observed that "...trust should be recognized as an important construct in future research efforts." Barua, Ravindran and Whinston noted that "even in a world of permanence, cooperation in information sharing cannot emerge in the absence of trust" (Barua et al., 1997). Sheridan wrote that

> Leading edge firms including Microsoft Corp. have looked further into the future and are painting visions of a new world where supply-chain-management platforms converge

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> However, from the standpoint of the user--the manufacturing executive--there is a serious problem that the software companies tend to gloss over: No amount of expensive software can compensate for flawed human thinking or for corporate cultures that create antagonistic relationships within a supply chain. It is becoming increasingly clear to many that information technology is only part of the solution to the supply-chain puzzle. Without good internal and external relationships, based on such intangibles as trust and open sharing of information, today's increasingly complex supply-chain structures will continue to pose monstrously difficult management challenges (Sheridan, 1998).

Interdependence

Resource dependence theory (Emerson, 1962; Pfeffer & Salancik, 1978) specifies the conditions under which one social unit is able to obtain compliance with its demands when interdependence is present. These relationships have been explored in empirical studies, which investigate the relationship between dependence and control in buyer-supplier relationships (Handfield, 1993). For instance, Provan and Skinner (1989) found that dealers of agricultural equipment were less opportunistic when they depended on a primary supplier, whereas suppliers with greater control over dealers' decisions exhibited greater opportunism. Resource dependence can also influence other outcomes, including supplier JIT delivery performance (Handfield, 1993).

Business Results Attributed to Interorganizational Information Systems

Business results represent the set of tangible and intangible benefits that accrue to the organization as a result of closer interorganizational integration with a supply chain partner. Chatfield and Bjorn-Anderson (1997) used a resource-based view of the firm to study how the implementation of an interorganizational system (focused on Electronic

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Data Interchange and a Customer Reservation System) helped Japanese Airlines (JAL) to achieve improved business results. The authors found that the implementation of an interorganizational system lead JAL to experience (1) increased business growth, (2) increased competitiveness, (3) accelerated response time, and (4) accelerated cycle time.

Interorganizational Integration

Carter and Narasimhan (1996), in a study of future purchasing and supply chain management directions, noted that:

> Beyond the traditional "cost focus," purchasing and supply management increasingly will emphasize...a process focus through interorganizational integration necessitated by electronic interchange of product and manufacturing process data.

Carter, Carter, Monczka and Slaight (1998) conducted focus group studies, an environmental scan and conducted field interviews in attempt to make a five and ten year forecast of the future of purchasing and supply. Their research findings clearly point to the fact that supply chains will become increasingly integrated over the next 5-10 years. Further, information system technology will play a key role in the integration of these supply chains.

Bensaou (1992) studied the use of interorganizational information systems within the context of interorganizational buyer-supplier relationships. With the hope of establishing a common framework between three different theoretical bodies of literature (organization theory, transaction cost economics, and political economy), Bensaou examined three types of uncertainty (task uncertainty, partnership uncertainty, and environment uncertainty) and three types of coordination mechanisms (structural coordination, process coordination, and technological coordination). The resulting analysis supported the notion that there are nine different naturally occurring configurations

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configurations of these six factors that may be taken together to explain the use of a particular type of interorganizational system. In later research, Bensaou and Venkatraman (1995a) narrowed the list of significant configurations to five which included (1) Remote Relationship, (2) Electronic Control, (3) Electronic Interdependence, (4) Structural Relationships, and (5) Mutual Adjustment.

Bensaou (1997) later tested an explanatory model that included the scope of information technology use as one of the antecedents to the degree of interorganizational cooperation experienced in a focal buyer-supplier relationship. Bensaou also hypothesized several other antecedents to the degree of interorganizational cooperation including (1) environmental uncertainty, (2) partnership uncertainty, (3) the governance structure of the relationship, and (4) the climate of the relationship. Bensaou's research was conducted on a sample of 447 independent buyer-supplier relationships in both the Japanese and U.S. automobile industry. Table 1 summarizes the findings of Bensaou's research.

Table 1: Bensaou (1997) Empirical Findings

	Effect on Interorganizational Integration	
Factor	**U.S.**	**Japan**
Environmental Uncertainty	Yes	No
Governance Structure	Yes	Yes
Climate of the Relationship	Yes	Yes
Information Technology	Marginal	Yes

In a similar study, Zaheer and Venkatraman (1994) conducted research aimed at discovering the antecedents to electronic integration in the insurance industry. Zaheer and Venkatraman, using transaction cost economic theory (Williamson, 1975), defined electronic int

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electronic integration as "a specific form of vertical quasi-integration achieved through the deployment of dedicated information systems between relevant actors in adjacent stages of the value-chain." The authors found support (see Table 2) for each of the constructs that was hypothesized to impact the degree of electronic integration.

Table 2: Zaheer and Venkatraman (1994) Empirical Findings

Factor	**Hypothesized Relationship with Integration**	**Significant Findings**
Business Process Asset Specificity	Positive	Yes
Trust	Positive	Yes
Reciprocal Investments	Negative	Marginal
Size	Negative	Yes

Konsynski and McFarlan (1990) noted that information partnerships can create new channels of distribution, operational efficiencies, revenue enhancements, increased scale, better customer service, and a new basis for differentiation. The authors also noted that there were several factors that were important to the development of a successful information partnership. These factors included (1) shared vision at the top, (2) reciprocal skills in information technology, (3) concrete plans for an early success, and (4) coordination on business policy.

Nidumolu (1995) studied the association of specialized interorganizational system investments with the structure and climate of buyer-supplier relationships. Nidumolu conducted this study in the insurance industry (with a distribution channel focus), and found support for the notion that investments in specialized buyer-supplier interorganizational information systems were associated with greater buyer-supplier vertical interactions and a more favorable buyer-supplier transaction climate.

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Grover (1993) investigated the factors affecting customer-based interorganizational system (CIOS) adoption. Grover hypothesized that the factors that influenced the adoption of a CIOS included (1) organizational factors, (2) support factors, (3) policy factors, (4) environmental factors, (5) and interorganizational information system factors. The interorganizational information system factors included (1) compatibility, (2) relative advantage, and (3) complexity. One of the findings of this research was that the IOS factors were strong predictors of CIOS adoption.

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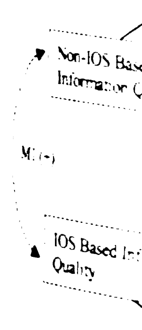

Figure 5: Model ...

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Chapter 3

Research Methodology

This chapter will (1) review the constructs included in the explanatory model, (2) describe the measures for these constructs and (3) examine the research methodology that was used in the testing of the explanatory model.

Model Description

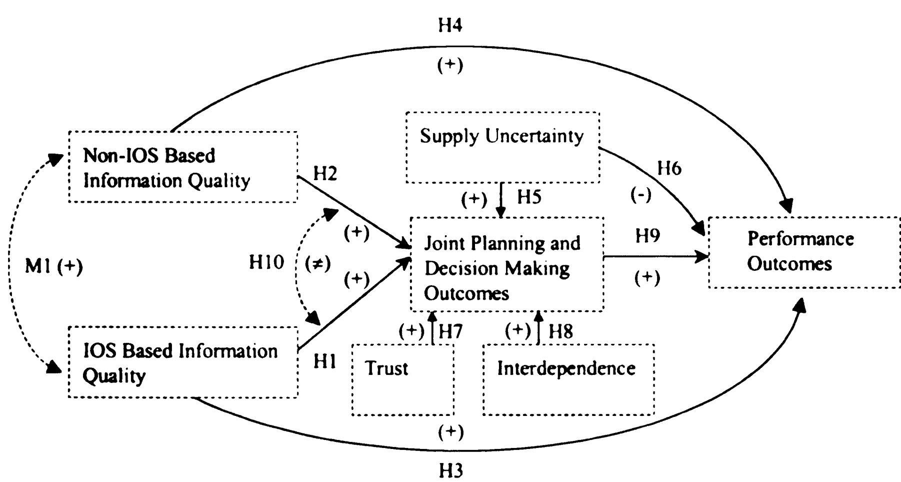

Figure 5: Model Description (with Hypotheses)

Figure 5 provides a graphical depiction of the explanatory model that is the focus of this research. Overlaid on this model are the hypotheses that have been tested in this research. This theoretical model reflects the notion that when higher quality information is exchanged between supply chain partners, joint planning and decision-making outcomes wi

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outcomes will be improved, which will lead to higher levels of performance. Within this framework, the fundamental proposition is that the use of interorganizational information systems will increase the quality of the information flows between the supply chain partners. The increased quality of information associated with interorganizational information systems is expected to be associated with better joint planning and decision making outcomes, which are in turn expected to be associated with greater levels of performance. The 'joint planning and decision making' construct is developed as a proxy for the integration of supply chain partners on key business processes. This conceptualization is consistent with previous conceptions of interorganizational integration (Clemons et al., 1993; Clemons & Row, 1992; McGee, 1991).

Uncertainty in supply is theorized to affect both the joint planning and decision making processes outcomes, as well as overall performance. When greater supply uncertainty exists, firms will be forced to increase their joint planning and decision-making processes in order to make the best decisions. Consistent with the same argument, supply uncertainty will have a negative effect on overall performance. While these firms will attempt to work together to reduce supply uncertainty, they will only be partially effective in doing so.

The trust and interdependence exhibited between supply chain partners is expected to affect the joint planning and decision-making processes of these supply chain partners. The greater the degree of trust and interdependence between supply chain partners, the more likely those partners are to participate in joint planning and decision making processes. The interdependence between the supply chain partners has the effect of aligning each of the supply chain partner's individual goals with overall system goals.

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Construct Definitions

This section will establish a set of constructs with specific definitions to provide both an understanding of the constructs and insight into their measurement.

Information Quality

Definition: Information quality is defined as the degree to which the information exchanged between organizations meets the needs of the organizations.

There are a number of attributes of information quality that have been used in previous research. This study employs the set of attributes of information quality found in Table 3.

Table 3: Attributes of Information Quality

Information Quality	
1. Information currency	(Bailey & Pearson, 1983; Raymond, 1985)
2. Information completeness	(Bailey & Pearson, 1983; Baroudi, 1988; Raymond, 1985)
3. Information accuracy	(Bailey & Pearson, 1983; Baroudi, 1988; Raymond, 1985)
4. Information compatibility	(Goodhue, 1995)
5. Convenience of access to information	(Bailey & Pearson, 1983; Raymond, 1985)

The measures of information quality (see Table 3) were applied to both IOS enabled information flows (see IOS Enabled Communication) as well as non-IOS enabled information flows (see Non-IOS Enabled Communication). Designing the research in this way allowed for (1) an examination of the quality of the information available for use in the joint planning and decision making processes of the focal firm, (2) an examination of the outcomes of the joint planning and decision making processes, (3) and an examination of how these joint planning and decision making processes affect performance. It is then possible to inspect the total effects (Bollen, 1989) of both IOS enabl

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IOS Enabled Communication

Definition: All forms of interorganizational communication that are conducted within an interorganizational information system.

The key joint planning and decision making processes that are employed in this research are depicted in Figure 6. While the decisions made in these process areas are likely to require both IOS enabled information and non-IOS enabled information, this construct only includes the information that is enabled by an interorganizational information system. Examples of communication methods included in this construct include the sharing of information through EDI, the World Wide Web (WWW), linked Enterprise Resource Planning Systems (ERP), etc (see Table 4).

Table 4: IOS Enabled Information Communication

IOS Enabled Information Communication - Examples
1. ERP (Enterprise Resource Planning) System
2. WWW (World Wide Web) Shared Resources
3. DRP (Distribution Requirements Planning) System
4. EDI (Electronic Data Interchange)

Non-IOS Enabled Communication

Definition: All forms of interorganizational communication that are outside of the communication conducted within the interorganizational information system.

The joint planning and decision making processes that are employed in this research are depicted in Figure 6. While the decisions made in these process areas are likely to require both IOS enabled information and non-IOS enabled information, this construct only includes the information that is not enabled by an interorganizational information system. Examples of communication methods included in this construct are postal mail,

meetings, vi

Table 5: No

Non-IOS E
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postal mail, telephone communications, facsimile copies, voice mail, face-to-face meetings, video conferencing, etc. (see Table 5).

Table 5: Non-IOS Enabled Information Communication

Non-IOS Enabled Information Communication – Examples
1. Email
2. Telephone
3. Facsimile
4. Voice Mail
5. Postal Mail
5. Face-to-face Meetings
6. Video Conferencing

<u>Joint Planning and Decision-Making</u>

Definition: The critical planning and decision-making processes that require bilateral information flow between supply chain partners.

The focus of these joint planning and decision making processes is of a more strategic nature and includes the broad categories found in Figure 6. The quality of the information shared between supply chain partners within the context of each of these joint planning and decision making processes was assessed.

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- Inventory
- Capacity P
- Post Supp
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- Sourcing a
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Figure 6: Key Business I

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Joint Planning and Decision Making Processes

- Forecasting and Inventory Positioning
- Inventory Visibility
- Capacity Planning
- Post Supplier Selection Performance Evaluation/Feedback and Conformance
- Sourcing and Supply Proposal Evaluation
- Part/Material Standardization
- Supplier Scheduling
- Joint Goal/Target Setting

Figure 6: Key Business Processes

Context 1: Forecasting and Inventory Positioning

Forecasting and inventory positioning is used to ensure that required items are available at the proper location and in the proper form when needed in the supply chain. An example of information sharing in support of inventory positioning is the joint sharing of forecasted inventory levels by location and quantity, safety stock levels, replenishment cycle information, etc.

Context 2: Inventory Visibility

Inventory visibility provides the ability to track where any given item is physically located (transit, customs, supplier, etc.) or where it was used. An example of information sharing in support of inventory visibility includes the joint sharing of current inventory information by location and quantity.

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Context 3: Capacity Planning

Capacity planning is conducted to ensure that the supplier will have the ability to produce or make available the required items/services in the required lead-time. An example of information sharing in support of capacity planning would include (1) the supplier sharing plant capacity utilization information with the buying company or (2) the buying company sharing future demand forecasts and plans with the supplier.

Context 4: Post Supplier Selection Performance Evaluation/Feedback and Conformance

Post supplier selection performance evaluation/feedback and conformance (based on objective measures) is used to ensure that there is joint understanding and agreement about both the buying firm's and the supplier's performance. Examples of information sharing in support of post selection performance evaluation/feedback and conformance include (1) the buying company sharing supplier performance information related to quality, delivery, responsiveness using agreed to metrics with the supplier or (2) the supplier sharing similar performance information with the buying company.

Context 5: Sourcing and Supply Proposal Evaluation

Sourcing and supply proposal evaluation is the process of setting the terms and conditions of the purchase. These terms and conditions frequently include price, quantity, quantity discount, quality, technology, etc. Examples of information sharing in support of sourcing and supply proposal evaluation include (1) the buying company sending the supplier a request for quotation (RFQ) or (2) the supplier sending the buying company a quote in response to an RFQ.

Context 6: Part/Material Standardization

Part/material standardization is used to reduce the number of unique parts/materials maintained in the inventory system by using more standard and fewer unique parts/materials. Examples of information sharing in support of part/material standardization would include (1) a buying company sharing materials lists with a supplier and (2) a supplier evaluating these lists and making recommendations to the buying company about any possible standard part substitutions.

Context 7: Supplier Scheduling

The supplier scheduling process controls the releases of orders through MRP (or other) and ensures communications of priorities, needs, and quantities between the buying organization's production or operations management system and suppliers. Examples of information sharing in support of supplier scheduling include the sharing of information related to order date, quantity ordered, required due date, ship-to-location, item identification, key contact person and so forth.

Context 8: Joint Goal/Target Setting

Joint goal/target setting ensures that there are mutually acceptable performance targets that are rooted in common/aligned metrics. An example of information sharing in support of joint goal/target setting includes the sharing of information by supply chain partners related to establishing acceptable purchased-product quality levels (Cpk, ppm, etc.), responsiveness, on-time delivery, cost improvements, etc.

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Supply Uncertainty

Definition: Supply uncertainty (from the buying company's perspective) is defined as the degree of unpredictability in future material supply states (Pfeffer & Salancik, 1978).

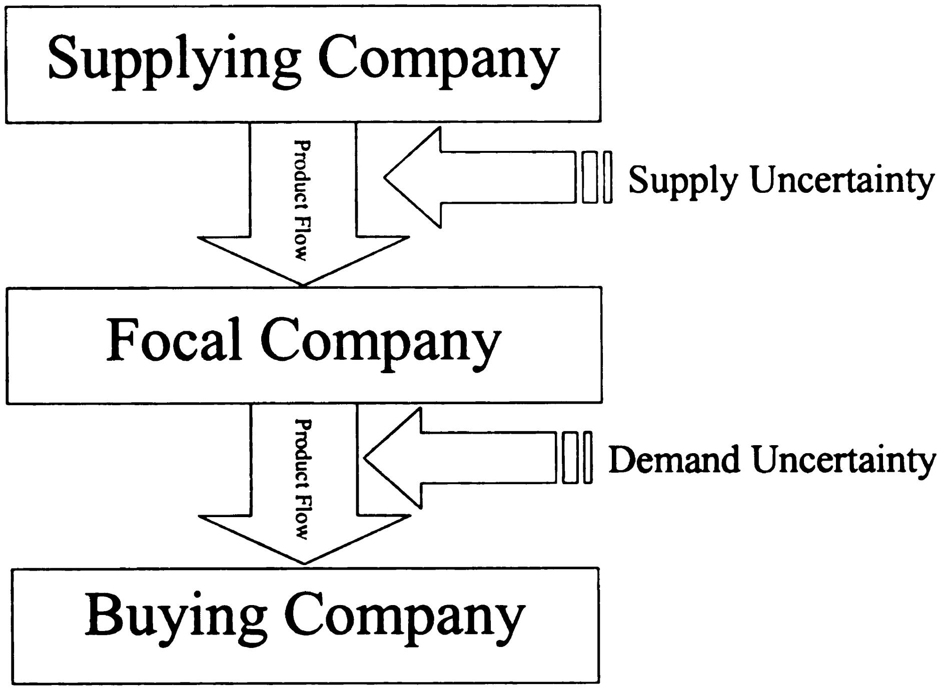

Figure 7: Supply & Demand Uncertainty

Supply uncertainty is designed to capture the degree to which the supply of material to the focal firm's manufacturing processes is stable (see Figure 7). Supply uncertainty embodies a host of issues that might affect the stability of material supply including the availability of qualified suppliers, achieved/expected prices, current/predicted technology and timing (see Table 6).

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Table 6: Supply Uncertainty

Supply Uncertainty
1. Supply availability
2. Pricing
3. Technology
4. Timing

Trust

Definition: Trust is defined as a willingness to rely on an exchange partner in whom one has confidence" (Moorman et al., 1992).

This study will adopt a modified form of the measures of trust used by Cummings and Bromily (1996) (see Table 7) and Zaheer and Venkatraman (1994) (see Table 8).

Table 7: Trust (Cummings and Bromily)

Trust (Cummings and Bromily)
1. I think the people in our partner firm tell the truth in negotiations
2. I think that our partner meets its negotiated obligations to our department
3. In my opinion this partner is reliable
4. I think that the people in our partner firm succeed by stepping on other people
5. I feel that our partner firm tries to get the upper hand
6. I think that our partner takes advantage of our problems
7. I feel that our partner negotiates honestly
8. I feel that our partner will keep their word
9. I think that our partner does not mislead us
10. I feel that our partner does not try to get out of commitments
11. I feel that our partner negotiates joint expectations fairly
12. I feel that our partner takes advantage of people who are vulnerable

Table 8: Trust (Zaheer & Venkatraman, 1994)

Trust (Zaheer & Venkatraman, 1994)
1. The degree to which there is mutual trust between the organizations
2. The degree to which the organizations work together as partners
3. The likelihood that inter-organizational agreements will be continued

Interdependence

Definition: Interdependence is defined as the lack of ability on the part of supply chain partners to individually control all of the conditions necessary to achieve an action or desired outcome.

Several studies have addressed the notion of interdependence (bilateral dependence) including Ganesan (1996) and Lusch and Brown (1994).

This study will adopt a modified form of the measures of interdependence developed by Lusch and Brown (1994) (see Table 9):

Table 9: Interdependence (Lusch and Brown, 1994)

Buyer-Supplier Dependence
1. We are dependent on this key supplier
2. Our major supplier would be difficult to replace
3. Our major supplier would be costly to loose
Supplier-Buyer Dependence
4. Our key supplier is dependent on us
5. Our major supplier would find it difficult to replace us
6. Our major supplier would find it costly to loose us

Performance Outcomes

Definition: Performance outcomes are defined as the set of tangible benefits that accrue to the organization as a result of closer interorganizational integration with a supply chain partner.

The interorganizational information system literature supports the notion that the effective use of an interorganizational information system will lead to improvements in certain business-level performance outcomes which include cycle time, cost, quality, delivery, and customer service. The measures for performance outcomes may be found in Table 10.

Table 10: Firm Performance

Please indicate the degree to which you feel that your OVERALL BUSINESS UNIT'S PERFORMANCE has changed over the past two years:
1. Return on investment (ROI)
2. Return on equity (ROE)
3. Profit margin
4. Cash-to-cash cycle time
5. External customer service levels
6. Total inventory turnover rate
7. Supplier on-time delivery
8. Purchase price reduction
9. Purchase price reduction compared to market
10. Total cost reduction
11. Supplier quality performance
12. Supplier responsiveness

Research Design

Much of the research that has been done in the area of interorganizational information systems has employed a case study methodology (Vijayasarathy, 1994). To extend the body of knowledge that exists within this area of academic endeavor, the few empirical studies that exist will be synthesized and extended to form a higher-level explanatory model (see Figure 5). The methodology adopted by this research is survey-based in nature and was selected because it allows for the rigorous testing of the explanatory model that is the focus of this research. This methodology is also a logical extension of the field research-based methodologies that have thus far been prominent.

Unit of Analysis

The unit of analysis in this study is the interorganizational relationship that exists between two members of a given supply chain. The only information flows examined between the supply chain partners were those within the context of the customer order fulfillment process (see Figure 2).

Data Collection

Data Collection Procedure

The procedure that was used to collect the data for this study is shown in Table 11.

Table 11: Data Collection Procedure

Step	Procedure
1.	***Commitment Letter and Survey Mailing*** A commitment letter (see Appendix C) and survey instrument (see Appendix F and F) were mailed to a Chief Executive Officer or Senior Purchasing Executive at a focal firm. The purpose of the commitment letter was to gain top-level support for this research and to provide access to the firm's employees who are most qualified to participate in this research. A fax-back response form (see Appendix WASD) was also included in this mailing. The purpose of the fax-back response form was to gain an understanding of the likely response rate and to aid in the tracking of informants who had committed to returning the questionnaire.
2.	***Re-send Commitment Letter (45 Days)*** The commitment letter (see Appendix C), survey instrument (see Appendix F and F) and fax-back response form (see Appendix WASD) were mailed a second time to director-level contacts who did not respond to the mailing within the first 45 days. Director level contacts were chosen for the second mailing based on the fact that they were likely to be more able to respond to the questionnaire directly, where a CEO would have to route the questionnaire to the appropriate personnel.

Survey Instrument Review/Pretest

To ensure face validity (Cook & Campbell, 1979), the survey instrument was reviewed by a panel of faculty drawn from the Department of Marketing and Supply Chain Management at Michigan State University. Upon completion of this review, the survey instrument was then reviewed in detail by ten purchasing/sourcing directors from a cro

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a cross-section of the organizations in the primary sample. The purpose of this review was to ensure that the survey instrument was unambiguous and had a high degree of face validity. Each of the ten purchasing/sourcing directors also completed the survey instrument.

Primary Sample

The primary sample was drawn from purchasing/sourcing managers and executives (see Figure 12). Each informant responded to the survey specifically about an interorganizational relationship that existed between their own company and a supplier of their choice (see Figure 8). However, the informant was directed to choose a supplier that also provided critical material to the informant's company. The purpose of selecting a supplier of critical material was to increase the likelihood that the two firms (informant's firm and supplier) were engaged in the joint planning and decision making processes that are the focus of this research.

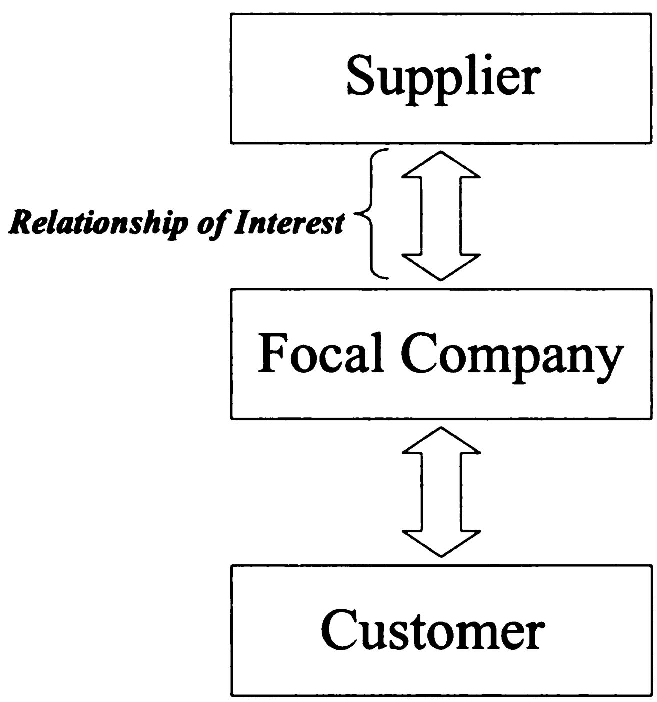

Figure 8: Unit of Analysis

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Non-Response Bias

Non-response bias was estimated in this study using a procedure outlined by Armstrong and Overton (1977). An underlying primary assumption of this technique is that "subjects who respond less readily are more like non-respondents" (Armstrong & Overton, 1977). The non-response estimation method employed in this study is termed "wave" analysis. The parameter estimates for each "wave" of survey receipts are compared using regression analysis. If the regression estimates between the different "waves" are within the same confidence interval, the data are assumed to not be affected by non-response bias.

Measurement Development

The use of covariance structure analysis generally requires that the data to be analyzed is free from any missing values (Bollen, 1989). In order to ensure that the data used in this study were amenable to covariance structure analysis, cases/questions contributing too heavily to the overall degree of missing data were discarded. This procedure produced a data set that contained no missing data among the measures of the independent constructs and a small rate of missing data rate among the measures of the dependent constructs. The missing data values among the dependent measures were replaced with a simple mean imputation (Anderson & Gerbing, 1982) calculated across all remaining responses to a given question.

Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) was used in this research to validate the measurement model (Anderson & Gerbing, 1982). Generally, the measurement model specifies the causal relations between the observed variables or indicators and the u

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underlying latent variables or theoretical constructs, which are presumed to determine responses to the observed measures. This measurement model was tested using EQS 5.7 with a maximum likelihood (Bentler, 1995) method.

All of the latent variables and their reflective manifest variables were placed into a CFA which allowed for the variances and covariances between the latent variables (ϕ), the loadings of the manifest variables onto their respective latent variables (Λ) and measurement errors (Θ_δ) to be estimated. No structural relationships were allowed to exist between the latent variables (η & ξ). An examination of the data to assess the degree of correlated measurement error was conducted using Lagrange Multiplier (LM) (Bentler, 1995) tests.

The overall fit of the measurement model was provided by the chi square statistic. Furthermore, the Bentler-Bonett non-normed fit index (BBNNFI), Bentler-Bonett normed fit index (BBNFI) and Comparative Fit Index (CFI) were used to provide evidence of model fit. These fit statistics enabled conclusions regarding the overall fit of the measurement model to be drawn (Bagozzi & Yi, 1988).

In addition to examining the overall fit of the measurement model, a careful examination of convergent, discriminate and nomological validity was also undertaken.

<u>Convergent Validity</u>

Convergent validity was assessed by examining both the magnitude of the factor loadings of the manifest variables on their respective latent variables (Λ) as well as whether or not those factor loadings were statistically different from zero.

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Discriminant Validity

Discriminant validity was assessed by examining the cross-factor loadings of one manifest variable onto all latent constructs on which high loadings were not expected. This analysis was conducted by examining the matrix of factor loadings (Λ) as well as by employing Lagrange Multiplier tests (Bentler, 1995).

Nomological Validity

Nomological validity was assessed by examining the matrix of variances/covariances (ϕ) between the latent constructs to determine whether the magnitude, statistical significance and direction of each of the relationships between the latent constructs was consistent with the theory under evaluation.

Structural Model

The measurement model assessed in the previous section using CFA was modified in such a way as to allow for the inclusion of structural relationships between the independent (ξ) and dependent (η) constructs.

The structural equations (see Table 14) were estimated using the EQS 5.7 software package (Bentler, 1995).

Table 12: Structural Equations

Variable	Structural Equation
JPDM	$= IQ1 + IQ2 + SU + T + I + D_{JPDM}$
SCP	$= IQ1 + IQ2 + SU + JPDM + D_{SCP}$
Variable	Definition
JPDM	Joint Planning and Decision Making
SCP	Performance
IQ1	IOS Based Information Quality
IQ2	Non-IOS Based Information Quality
SU	Supply Uncertainty
T	Trust
I	Interdependence
D_{JPDM}	Disturbance Term
D_{SCP}	Disturbance Term

Chapter 4

Research Findings & Hypothesis Testing

This chapter presents the research results. The first section of this chapter presents the characteristics of the sample. The next section provides a review and discussion of the explanatory model (see Figure 9) which was evaluated within the context of each of the eight joint planning and decision-making processes (see Figure 6). The last section of this chapter will provide a summary of the results.

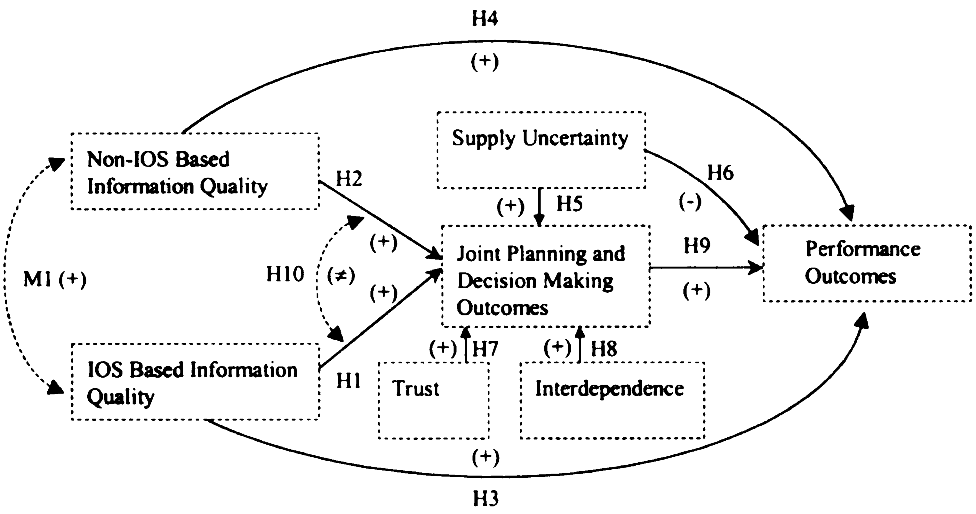

Figure 9: Model Description (with Hypotheses)

Preliminary Analysis

This section describes the characteristics of the sample. Specific characteristics evaluated included the informant's position/title within the firm as well as the geographic location of the firm.

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Characteristics of the sample

The sample was largely composed of purchasing/sourcing Vice Presidents (17.8%), Directors (46.2%) and Managers (28.4%), composing 92.4% of the total sample (Table 12). The remaining identifiable responses were made by Chief Executive Officers (2.4%). Several responses did not include any demographic information (5.2%).

Table 13: Informant's Job Title

Informant Position	Number of Informants	Percentage of Informants
CEO	4	2.4%
Vice President	30	17.8%
Director	78	46.2%
Manager	48	28.4%
Other	9	5.2%
Total Responses	169	100%

The informants were primarily from companies located in the United States (88.2%) (see Figure 13). Several firms were located in Western Europe (6.5%) while the remaining firms were from Canada (1.8%), Japan (1.2%), Australia (.6%) and Asia Pacific/Other (.6%). Two informants (1.2%) did not provide the location of their firms.

Table 14: Sample Demographic Information

Geography	Number of Informants	Percentage of Informants
United States	149	88.2%
Western Europe	11	6.5%
Canada	3	1.8%
Japan	2	1.2%
Australia	1	.6%
Asia Pacific/Other	1	.6%
Missing Response	2	1.2%
Total Responses	169	100%

Approximated 3531 surveys were initially mailed. Of these, 386 were non-deliverable. This provided an overall response rate to the survey of approximately 5.38%. Additionally, of the 394 fax-back response forms (see Appendix D) returned, 60 fax-back forms indicated that they would not respond and also indicated a reason for not responding (see Tables 15 and 16). A closer examination of Table 16 reveals that many firms (41.67%) did not respond because they were not using linked information systems. Further, it is apparent that many firms did not feel that they had sufficient time (18.33%) or the contact had retired or died (16.67%).

This analysis lends support to the notion that the data may be relatively free from non-response bias. In order to gain additional support for this notion, a non-response bias test was conducted. The results of this test are presented in the next section.

Table 15: Effective Response Rate Calculation

	NAPM	CM-US	GEBN	
Mailed	1907	1574	50	3531
Undeliverable	197	189		386
Net Mailed	1710	1385	50	3145
Provided Explanation For Not Responding				-60
Effective Mailed				3085
Received				166
Response Rate				**5.38%**

Table 16: Fax-Back Response Form Results

Fax Yes	85	19	24	**128**
Fax No	180	80	6	**266**
				394

Explanations:	Count	Percentage
No Linked Information Systems	25	41.67%
Cannot Comlete Survey In Time To Meet Deadline	11	18.33%
Respondent Died/Retired	10	16.67%
Not Appropriate Company	6	10.00%
Our Firm Has Already Responded	2	3.33%
Respondent Lacks Sufficient Knowledge	2	3.33%
Too Many NAPM Studies	2	3.33%
Wrong Contact	1	1.67%
Company Does Not Participate In Survey Research	1	1.67%
	60	100.00%

Non-Response Bias

A general approach to assessing non-response bias was undertaken for each set of manifest variables that corresponded to a given joint planning and decision making context (Armstrong & Overton, 1977).

The data set was reorganized into two separate groups. The first group contained the manifest variables of the first 20 questionnaires returned. The second group contained the manifest variables of the last 20 questionnaires returned. Non-response bias testing was conducted individually within each joint planning and decision making context. A simple paired-sample t-test (equal variances) was computed. The tables found in Appendix F (Tables 25 - 32) describe the probabilities of rejecting the null i

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hypothesis that the means of each manifest variable are the same across the two groups (first and last 20 questionnaires received).

These T-test comparisons revealed no significant difference between the first group and the last group. This finding, taken in conjunction with the sample characteristics (see Tables 14 & 15) and the explanations provided by contacts for not responding (see Table 16), lends support to the notion that the data are relatively free from non-response bias.

Overall Construct Development

Three of the constructs (trust, interdependence and supply uncertainty) included in the overall research model (see Figure 9) failed to demonstrate adequate degrees of convergent and discriminant validity to allow for their inclusion in the testing of the exploratory model. These constructs were omitted from the explanatory model and their associated hypotheses were not tested. These hypotheses included:

H5: Supply uncertainty has a direct and positive effect on joint planning and decision making process outcomes

H6: Supply uncertainty has a direct and negative effect on performance

H7: Trust between firms within a supply chain has a direct and positive effect on the results of joint planning and decision-making processes

H8: Interdependence of firms within a supply chain has a direct and positive effect on the results of joint planning and decision-making processes

Figure 10 represents the revised explanatory model that will be tested in the following sections.

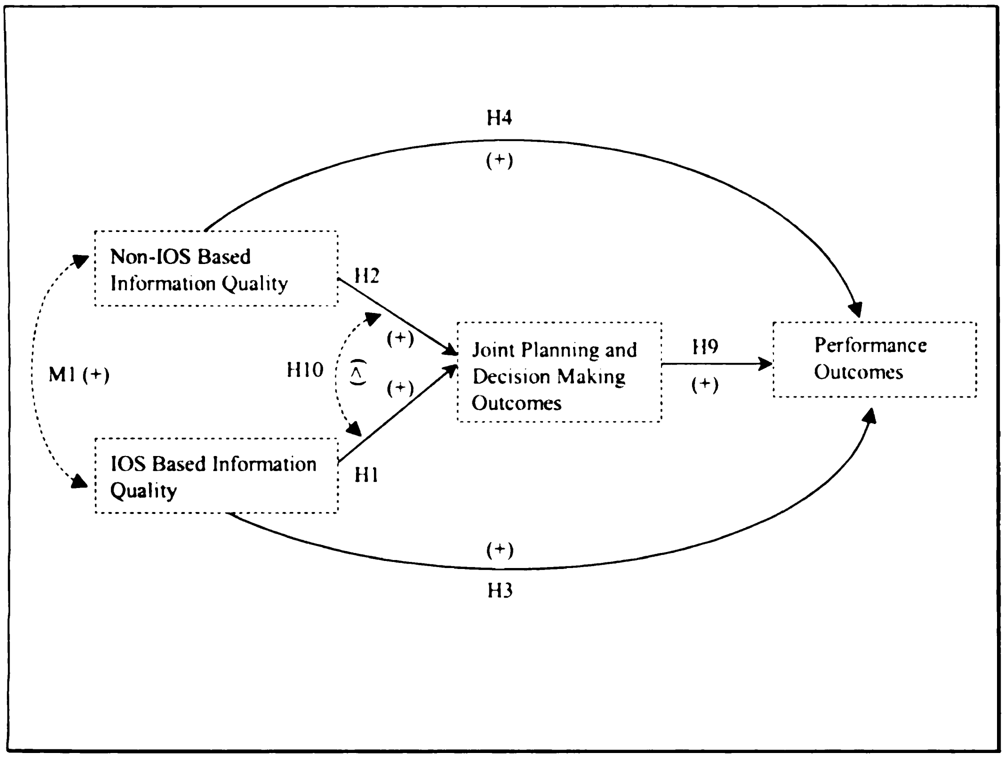

Figure 10: Revised Explanatory Model

Measurement Validation

It is imperative that the measurement model be closely examined prior to the testing of a theoretical model and subsequent hypothesis testing. Important steps in the validation of the measurement model include (1) an examination of univariate distributions for excessive skewness or kurtosis, (2) an assessment of measurement reliability and (3) and assessment of construct validity. Each of these topics will be addressed in turn.

Descriptive Statistics

An examination of the univariate distributions within each joint planning and decision making context was a critical first step in the analysis of this data. The data were examined for excessive skewness and kurtosis. Also, the standard deviation of each manifest variable was assessed to ensure that it was sufficiently large.

Appendix I (Tables 65-72) contains the descriptive statistics associated with the manifest variables from each joint planning and decision making context. An examination of the descriptive statistics reveals that the univariate distributions are relatively normal.

While normality of the univariate distributions is necessary condition for multivariate normality (an assumption required by the maximum likelihood (ML) fit function), it is not sufficient to establish multivariate normality (Bollen, 1989). Mardia's coefficient (Mardia, 1970) was calculated for the data within each of the eight joint planning and decision making contexts. The assumption of multivariate normality was not met in any of the eight joint planning and decision making contexts. As a result, the ML fit function was not employed in the calculation of the parameter estimates for the explanatory model. Instead, the generalized least squares (GLS) fit function was employed. The GLS method does not assume multivariate normality and has been successfully employed in previous studies where lack of multivariate normality precluded using the ML fit function (Bollen, 1989).

Measurement Reliability

Table 17: Reliability Estimates (Cronbach's Alpha)

Parameter	Latent Variable	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation and Feedback	Supply Proposal Evaluation	Part Material Standardize	Supplier Scheduling	Joint Goal/Target Setting
Current Accurate Complete	N-IOS	.924	.932	.960	.966	.962	.959	.964	.960
Current Accurate Complete	IOS	.946	.965	.981	.981	.983	.968	.960	.985
Effective Decisions Positive Results	JPDM	.921	.951	.952	.944	.885	.968	.944	.942
Performance Outcomes	Perf.	.635	.433	.655	.736	.760	.861	.509	.600

Construct Validity

Eight measurement models were developed and tested using a confirmatory factor analysis (CFA) technique. Each of the eight measurement models was used as a method of establishing acceptable degrees of convergent and discriminant validity, enabling the subsequent testing of the correspondent structural equation models (SEM). Tables 18 and 23 provide a summary of some of the more important parameters and their associated test statistics. Measures of overall model fit are provided in Table 19. A complete set of statistics related to the testing of each of the measurement models may be found in Appendix G.

Most λ's demonstrated significant associations between correspondent latent variables and their reflective manifest variables. The λ's associated with the measures of non-IOS enabled information quality in the context of supplier scheduling did not demonstrate a sufficient degree of statistical significance. A review of the Cronbach's alpha reliability calculations presented in Table 17 provides for an alpha of .964 in this joint planning and decision making context, indicating that these manifest variables are reliable measures of non-IOS enabled information quality.

The overall fit of each measurement model was acceptable as evidenced by non-significant chi-square tests (see Table 19). Further, the Bentler-Bonnett Non-Normed Fit Indices and the Comparative Fit Indices demonstrated acceptable levels of overall measurement model fit in each of the eight joint planning and decision making contexts (see Table 19).

No measurement errors were allowed to correlate with the exception of the three measures of information quality (currency, accuracy and completeness). Associations between these measurement errors were allowed to exist because they were consistent with theoretical underpinnings of this research. The same three measures of information quality were applied to both the IOS enabled information flows as well as the non-IOS enabled information flows. Developing the measurement model in this way provided for the expectation that each of the three measures of the IOS enabled information flows would necessarily be associated to some degree with its corresponding measure of the non-IOS enabled information flows. Appendix G details the associations between these error terms within each of the eight CFAs.

Reliability

An assessment of measurement reliability was conducted using a split-half method developed by Cronbach (1951). The results of the reliability calculations may be found in Table 17. The measures of non IOS-enabled information quality, IOS enabled information quality and joint planning and decision making outcomes appear to be very reliable. Reliability estimates (α) between .9 and .98. The measures of performance outcomes did not exhibit the same degree of degree of reliability. Reliability estimates (α) for these measures range from .43 to .86.

The manifest variables exhibited sufficient reliability to be included in the subsequent analysis. Further, an examination of the λ coefficients that relate each manifest variable to a latent variable also provided an indication of measurement reliability. This analysis is described in the next section.

Table 18: Key Parameter Estimates (CFA)

Parameter	Latent Variable	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation and Feedback	Supply Proposal Evaluation	Part Material Standardize	Supplier Scheduling	Joint Goal/Target Setting
Current	N-IOS	0.834 (3.417)	0.872 (3.267)	0.892 (5.397)	0.926 (2.525)	0.907 (2.571)	0.913 (4.209)	0.922 (1.920)	0.926 (6.824)
Accurate	N-IOS	0.961 (3.452)	0.959 (3.275)	0.995 (5.259)	0.971 (2.532)	0.963 (2.541)	0.975 (4.189)	0.979 (1.933)	0.964 (6.769)
Complete	N-IOS	0.888 (3.413)	0.896 (3.222)	0.959 (5.434)	0.975 (2.526)	0.959 (2.565)	0.955 (4.177)	0.957 (1.911)	0.944 (6.679)
Current	IOS	0.870 (6.644)	0.933 (5.783)	0.956 (6.366)	0.951 (2.482)	0.969 (2.970)	0.956 (4.326)	0.911 (3.214)	0.985 (4.539)
Accurate	IOS	0.958 (6.933)	0.960 (5.779)	0.974 (6.401)	0.985 (2.488)	0.985 (2.957)	0.977 (4.366)	0.968 (3.237)	0.993 (4.549)
Complete	IOS	0.945 (6.953)	0.964 (5.886)	0.987 (6.422)	0.980 (2.475)	0.966 (2.959)	0.950 (4.328)	0.961 (3.257)	0.961 (4.521)
Effective Decisions	JPDM	0.921 (7.083)	0.952 (7.714)	0.959 (8.364)	0.945 (3.450)	0.828 (3.808)	0.956 (6.153)	0.943 (3.933)	0.978 (8.448)
Positive Results	JPDM	0.947 (7.349)	0.965 (7.834)	0.958 (8.495)	0.970 (3.544)	0.960 (4.340)	0.982 (6.221)	0.955 (3.972)	0.937 (8.012)

*   Standardized lambda (z-score)

** Shading indicates significant (p<.05) z-value

Table 18: Key Parameter Estimates (CFA), Cont'd

Parameter	Latent Variable	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation and Feedback	Supply Proposal Evaluation	Part Material Standardize	Supplier Scheduling	Joint Goal/Target Setting
Inventory Turnover	Perf.	0.470 (3.321)					0.665 (1.426)		
On-Time Delivery	Perf.	0.817 (4.510)	0.798 (4.157)		0.683 (2.184)		0.726 (1.427)	0.442 (2.065)	
Responsive	Perf.	0.589 (3.666)	0.605 (3.135)						
ROI	Perf.			0.977 (2.416)					
ROE	Perf.			0.944 (2.405)					
Profit Margin	Perf.			0.796 (2.371				0.711 (2.269)	
Quality	Perf.				0.719 (2.246)				
Total Cost Reduction	Perf.				0.586 (2.090)	0.833 (3.014)			0.785 (3.056)
Purchase Price Reduction	Perf.					0.870 (3.127)	0.378 (1.349)		0.807 (3.225)
Purchase Price Reduction (CTM)	Perf.					0.836 (3.049)			
Cash-Cash Cycle Time								0.796 (2.357)	

* Standardized lambda (z-score)

** Shading indicates significant (p<.05) z-value

Statistic Forecasting and Inventory Capacity

Table 19: Goodness of Fit Statistics (CFA)

Fit Statistic	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation and Feedback	Supply Proposal Evaluation	Part Material Standardize	Supplier Scheduling	Joint Goal/Target Setting
χ^2 (df) p	35.01 (37) p=0.56263	24.696 (28) p=0.64435	27.445 (37) p=0.8738	42.622 (37) p=0.24072	35.832 (37) p=0.52369	34.738 (37) p=0.57556	36.387 (37) p=0.49757	31.439 (28) p=0.29793
BBNFI	0.843	0.885	0.895	0.816	0.839	0.850	0.835	0.864
BBNNFI	1.018	1.031	1.069	0.952	1.010	1.019	1.005	0.970
CFI	1.000	1.000	1.000	0.968	1.000	1.000	1.000	0.981

Structural Equation Model

This section will develop and test each of the hypotheses (see Appendix H) within the context of each of the eight joint planning and decision making processes.

Tables 20 and 21 provide a summary of some of the more important parameters and their associated test statistics. A complete set of statistics related to the testing of each of the structural equation models may be found in Appendix H.

The overall fit of each of the eight structural equation models was acceptable as evidenced by non-significant chi-square tests (Table 21). Further, the Bentler-Bonnett Non-Normed Fit Indices, Bentler-Bonnet Normed Fit Indices and the Comparative Fit Indices demonstrated acceptable levels of overall measurement model fit (see Table 21) in each of the eight joint planning and decision making contexts.

A test of difference between the β's that relate both IOS enabled information quality and non-IOS enabled information quality to joint planning and decision making outcomes was performed in each of the eight joint planning and decision making contexts. This difference test compared the chi-square obtained from the fit of the base model with the chi-square obtained from the fit of a model where the two β's were constrained to be equal. As the difference between two chi-squares is also distributed as chi-square, calculating the statistical significance of the difference is straightforward. The results of these chi-square difference test calculations may be found in Table 20. For completeness, another set of difference tests were performed that tested the difference between the β's that relate both IOS enabled information quality and non-IOS enabled information quality to joint planning and decision making outcomes was performed in each of the eight joint planning and decision making contexts. This set of difference tests was done using a multiple regression methodology. Each factor was reformed as a linear average of each of the three manifest variables (information currency, quality and completeness). Each β was estimated using an ordinary least squares (OLS) multiple regression method. Once the β parameter estimates were obtained, 95% confidence intervals were constructed around them. It follows that the test of difference between these β parameter estimates ($p=.05$) is simply the comparison of their confidence intervals to determine whether or not they overlap. If the confidence intervals overlap, then the null hypothesis (the β parameter estimates are not different) may not be rejected. The results of this analysis (see Appendix L, Tables 89 - 96) compared exactly to the results of the analysis conducted above which employed a change in chi-squares technique.

Table 20: Key Parameter Estimates (SEM)

Parameter	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation and Feedback	Supply Proposal Evaluation	Part Material Standardize	Supplier Scheduling	Joint Goal/Target Setting
$\beta_{N\text{-}IOS,JPDM}$	0.072 (0.834)	0.204 (2.660)	0.343 (4.520)	0.359 (3.983)	0.276 (2.174)	0.404 (4.980)	0.209 (2.590)	0.281 (7.643)
$\beta_{IOS,JPDM}$	0.570 (5.970)	0.565 (7.195)	0.501 (6.480)	0.353 (3.887)	0.327 (3.131)	0.445 (5.370)	0.556 (6.337)	0.580 (3.839)
$\beta_{N\text{-}IOS,PERF}$	0.017 (0.159)	0.120 (1.151)	0.037 (0.348)	0.078 (0.635)	0.098 (0.826)	-0.028 (-0.205)	0.028 (0.259)	0.310 (2.095)
$\beta_{IOS,PERF}$	0.128 (0.942)	-0.029 (-0.231)	0.099 (0.816)	-0.051 (0.418)	0.055 (0.516)	0.064 (0.448)	-0.012 (-0.092)	0.062 (0.546)
$\gamma_{JPDM,PERF}$	0.392 (2.472)	0.461 (3.443)	0.144 (1.038)	0.315 (2.277)	0.313 (2.696)	0.159 (0.959)	0.359 (2.502)	0.097 (0.666)
χ^2 Difference Test $\beta_{N\text{-}IOS,JPDM}$ $\beta_{IOS,JPDM}$	8.29 1 d.f.	7.473 1 d.f.	2.816 1 d.f.	1.311 1 d.f.	0.00 1 d.f.	.028 1 d.f.	9.608 1 d.f.	8.315 1 d.f.

* Standardized lambda (z-score)

Table 21: Goodness of Fit Statistics (SEM)

Fit Statistic	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation and Feedback	Supply Proposal Evaluation	Part Material Standardize	Supplier Scheduling	Joint Goal/Target Setting
χ^2 (df) P	35.518 (35) p=0.540	23.457 (26) p=0.607	27.000 (35) p=0.831	40.701 (35) p=0.234	34.900 (35) p=0.473	34.402 (35) p=0.497	34.945 (35) p=0.471	27.442 (26) p=0.387
BBNFI	0.850	0.890	0.896	0.824	0.843	0.851	0.842	0.881
BBNNFI	1.014	1.026	1.061	0.949	1.001	1.005	1.001	0.987
CFI	1.000	1.000	1.000	0.968	1.000	1.000	1.000	0.992

Hypothesis Testing

This section will evaluate each of the hypotheses across the eight joint planning and decision making contexts. Table 22 provides a summary of each of the hypothesis tests and the magnitude of the parameter associated with the hypothesis test. A description of key parameter values and test statistics for each of the joint planning and decision making contexts may be found in Table 20. Appendix H contains a complete set of all parameter values and test statistics for each of the eight joint planning and decision making contexts.

H1: Interorganizational information system (IOS) information quality has a direct and positive effect on joint planning and decision-making outcomes

H1 was supported in each of the eight joint planning and decision making processes (see Table 22).

H2: Non-interorganizational information system (IOS) information quality has a direct and positive effect on joint planning and decision-making outcomes

H2 was supported in 7 of the 8 joint planning and decision making contexts (see Table 22). H2 was not supported in the joint planning and decision making context of forecasting and inventory positioning.

H3: IOS information quality has a direct and positive effect on performance

H3 was not supported within any of the joint planning and decision making contexts (see Table 22).

H4: Non-IOS information quality has a direct and positive effect on performance

H4 was only supported in the joint planning and decision making context of joint goal/target setting (see Table 22). H4 was not supported in the remaining 7 joint planning and decision making contexts.

H9: Joint planning and decision making outcomes have a direct and positive effect on performance.

H9 was supported for 5 of the 8 joint planning and decision making contexts including (1) forecasting and inventory positioning, (2) inventory visibility, (3) performance evaluation and feedback, (4) supply proposal evaluation and (5) supplier scheduling (see Table 22). H9 was not supported in the remaining 3 joint planning and decision making contexts.

H10: The degree of association between interorganizational information system enabled information quality and joint planning and decision making will be of a significantly greater magnitude than the degree of association between non-interorganizational information system enabled information quality and joint planning and decision making.

H10 was supported in 5 of the 8 joint planning and decision making contexts including (1) forecasting and inventory positioning, (2) inventory visibility, (3) capacity planning (marginal support), (4) supplier scheduling and (5) joint goal/target setting (see Table 22). H10 was not supported in any of the remaining 3 joint planning and decision making contexts.

M1: The association between the measurement errors for each like attribute of information quality across the IOS-enabled information flows and the non-IOS enabled information flows may be positive.

Support for M1 was varied across the 8 joint planning and decision making contexts. In any given joint planning and decision making context, there was support for none, one two or three of the individual correlated measures of information quality (currency, accuracy and completeness). Appendix G contains the parameters and test statistics associated with M1 within each of the 8 joint planning and decision making contexts. Also, the term "partially supported" (as referred to in Table 22) indicates that some number of the three correspondent measurement errors for the manifest variables reflecting information quality had a significant association.

Table 22: Hypothesis Testing Summary

Hypothesis	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation	Supply Proposal Evaluation	Part/Material Standardization	Supplier Scheduling	Goal/Target Setting
H1 (IOS IQ->JPDM)	S (.570)	S (.565)	S (.501)	S (.353)	S (.320)	S (.445)	S (.556)	S (.580)
H2 (NON-IOS IQ->JPDM)	S (.072)	S (.204)	S (.343)	S (.359)	S (.276)	S (.404)	S (.209)	S (.281)
H3 (IOS IQ->PERF)	N	N	N	N	N	N	N	N
H4 (NON-IOS IQ->PERF)	N	N	N	N	N	N	N	N
H9 (JPDM->PERF)	S (.392)	S (.461)	S (.144)	S (.315)	S (.313)	N	S (.359)	N
H10 (IOS IQ > NON IOS IQ)	S	S	S	N	N	N	S	S
M1 (IQ COMMON METHOD)	P	P	P	P	S	P	P	N

S (Parameter Estimate)= Supported N = Not Supported
P = Partially Supported

Chapter 5

Discussion of Research Findings

Bill Gates, Chairman and CEO of Microsoft, wrote:

> If the 1980s were about quality and the 1990s were about reengineering, then the 2000s will be about velocity. About how quickly the nature of business will change. About how quickly business itself will be transacted. About how information access will alter the lifestyle of consumers and their expectations of business. Quality improvements and business process improvements will occur far faster. When the increase in velocity of business is great enough, the very nature of business changes. A manufacturer or retailer that responds to changes in sales in hours instead of weeks is no longer at heart a product company, but a service company that has a product offering (Gates, 1999).

Empirical research in the area of interorganizational information systems is in its infancy. Academics and practitioners alike are starved for meaningful research in this arena. Within the context of manufacturing, purchasing and supply chain management, even less empirically based research exists related to the use of interorganizational information systems. The analysis conducted in Chapter 4 revealed a set of joint planning and decision making processes whose outcomes are affected by the quality of IOS enabled and non-IOS enabled information flows. This chapter presents an in-depth discussion centered on each of the eight joint planning and decision making contexts with special attention paid to key academic and practical findings.

Discussion of Critical Research Findings

The following section will develop a discussion of the critical research findings in each of the eight joint planning and decision making contexts. However, before this discussion is undertaken, it is important to draw several broad observations across the set of contexts.

A review of each of the joint planning and decision making processes areas will reveal that each of these decision making process areas may be characterized by a number of different attributes. The difference in these characteristics is important to understand, as the discussion surrounding each of the eight joint planning and decision making areas must be understood within this context.

Table 23 describes 5 key dimensions of each of the joint planning and decision making processes areas. A closer examination of Table 23 reveals that the joint planning and decision making contexts may be divided into two separate groups based on their "structuredness," "definateness," regularity, frequency and "objectiveness." For clarification, each of these terms will be defined. "Structuredness" refers to the degree to which the information required as an input to this joint planning and decision making context is standardized and well defined. "Definateness" describes the degree to which information shared in support of this joint planning and decision making context is required for the successful completion of this process. Regularity describes whether or not the information required in support of this joint planning and decision making process is exchanged on consistent time intervals. Frequency describes whether or not the information shared in support of this joint planning and decision making process is shared on shorter or longer intervals. "Objectiveness" describes whether the information shared is based on ‘hard’ information or rather whether it is of a more subjective nature (‘soft’).

Forecasting and inventory positioning, inventory visibility, capacity planning and supplier scheduling are all relatively structured, definite, regular and objective. These characteristics may make these 4 joint planning and decision making areas particularly conducive to the use of an interorganizational information system. However, performance evaluation, supply proposal evaluation, part/material standardization and joint goal/target setting are much less structured, definite, regular and objective. This characterization helps to frame the notion that the latter joint planning and decision making contexts may not be (currently) as well suited to the use of an interorganizational information system. An alternative interpretation may have to do with the fact that the latter joint planning and decision making processes are less developed than the former, leading to the natural situation that they have yet to achieve the same degree of structure, “dininiteness”, regularity and “objectivenss.” This interpretation leads to the observation that these latter joint planning and decision making contexts may well be where the rewards for using interorganizational information systems currently exist!

Table 23: Characteristics of Joint Planning and Decision Making Processes

	Context							
Hypothesis	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation	Supply Proposal Evaluation	Part/Material Standardization	Supplier Scheduling	Goal/Target Setting
"Structuredness" (H,M,L)	H	H	H	L/M	H	L	H	L
"Definateness" (H,M,L)	H	H	H	L/M	H	L	H	L
Regularity (H,M,L)	H	L/M	H	L/M	M	L	H	L/M
Frequency (H,M,L)	M/H	M	M	L/M	NG	L	H	L/M
"Objectiveness" (H,M,L)	H	H	H	L	M	H	H	M

H = High
M = Medium
L = Low
NG = No Generalization Possible

Forecasting and Inventory Positioning

> **Forecasting and inventory positioning is used to ensure that required items are available at the proper location and in the proper form when needed in the supply chain. Another way to express this is that the right items are at the right place at the right time.**

Information that is exchanged between supply chain partners in this context is typically very standardized and well defined. This information is typically also exchanged on a pre-determined/standard schedule. This joint planning and decision making context provides a natural/intuitive setting for an interorganizational information system.

This research supports the notion that improved information quality is associated with better joint forecasting and inventory positioning process outcomes. Further, within the context of joint forecasting and inventory positioning, the resulting information quality stemming from the use of an interorganizational information system appears to be critical to making effective decisions. This may be seen when one compares the large magnitude (.570) of the β that relates the quality of IOS-enabled information flows with joint planning and decision making outcomes to the very small magnitude (.072) of the β that relates the quality of non-IOS enabled information flows with joint planning and decision making outcomes. A statistical test of difference confirmed that these parameter estimates are indeed different ($p<.01$).

The results also show that each element of information quality (currency, accuracy, completeness, compatibility and convenience to access) had a significantly higher mean score for the quality of IOS enabled information than for the quality of non-IOS enabled information (see Table 81).

It is also apparent that information quality is associated with certain firm-level performance results including responsiveness, on-time delivery and inventory turnover. Specifically, the indirect effect (mediated by joint planning and decision making outcomes) of IOS enabled information flows on performance outcomes (responsiveness, on-time delivery and inventory turnover) is 0.35144. It is interesting to note that the indirect effect (mediated by joint planning and decision making outcomes) of non-IOS enabled information flows on performance outcomes (responsiveness, on-time delivery and inventory turnover) is .045224. This is a very strong argument in favor of employing interorganizational information systems in the context of joint forecasting and inventory positioning processes.

The use of an interorganizational information system is a key contributor to the success of a firm's joint forecasting and decision making processes, which in turn positively affect the firm's ability to respond to perturbations in production/delivery schedules and ability to maintain reduced system-wide inventory levels. Managers with responsibilities for forecasting and inventory positioning should examine these results in the context of their specific business situation. However, the startling difference between the quality of IOS enabled and non-IOS enabled information flows taken with the large indirect effect of the quality of IOS enabled information flows on firm performance promises that use of interorganizational information systems in the arena of forecasting and inventory positioning may well provide positive performance results.

While not a direct finding of this research, it is recognized that supply chains do **NOT** have effective interorganizational information systems in place that link the majority of the firms composing in the chain. Performance results discovered in this research are very likely being achieved from the use of an interorganizational information system spanning only two organizations. It seems clear that as supply chains become more integrated through the use of interorganizational information systems, better forecasting and inventory positioning outcomes and subsequent firm performance results will be achieved.

To further examine what types of firm-level results might be expected from an improved joint forecasting and inventory positioning process, a post-hoc analysis of the association between forecasting and inventory positioning joint planning and decision making outcomes and firm-level performance results was performed (see Table 73). The results of this post-hoc analysis revealed that successful joint forecasting and decision making processes were associated with:

1. improved supplier on-time delivery ($r=.35$, $p=0.00$)
2. improved supplier responsiveness ($r=.26$, $p=0.00$)
3. an increased rate of inventory turnover ($r=.22$, $p=0.01$)
4. improved cash-to-cash cycle time ($r=.19$, $p=0.03$)
5. reduction of purchase price compared to market ($r=.15$, $p=0.08$)

These findings lend credence to Kalakota and Whinston's (1997) notion that "to support 'pull'-based models, planning systems need to support three goals: to gather information about consumer demand effectively; to accommodate fluctuations in demand; and to use demand information for inventory investment, including safety stock, inventory turns, and replenishment frequency. This involves integrating into one seamless solution the process of (1) order generation and planning, which helps anticipate customer demand through market forecasting; and (2) order taking and entry, which feeds replenishment planning; this incorporates distribution requirements planning (DRP), vendor managed inventory (VMI) and continuous replenishment (CRP). "

This research points to the fact that firms are putting increased emphasis on their forecasting and inventory positioning processes. Informants were asked to rate the degree to which they felt that their joint forecasting and inventory positioning processes had improved over the past two years (see Figure 11). It is clear that over the past two years firms believe that they have improved their joint forecasting and inventory positioning processes.

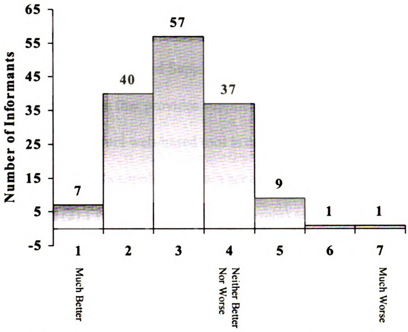

Figure 11: Forecasting & Inventory Positioning Process Improvements

Given the findings relating to IOS information quality to forecasting and inventory positioning outcomes, the forward-thinking manager should make an assessment of the status of their firm/industry/supply chain with respect to the use of these interorganizational information system technologies. Issues should be addressed not from the perspective of "how does my firm share information with firm X." Rather, the appropriate question is "how does my supply chain share information across all supply chain members in a fashion to better achieve our common and individual goals?" Industry leaders (OEMs, large suppliers, etc.) have the opportunity to play a key role in shaping the technology standards that will be used for the next 20 years. If we invest the time and resources into developing these interorganizational communication standards correctly today, we will avoid creating another set of standards and technologies that are not well deployed.

An interesting application of a joint forecasting and inventory positioning planning and decision making tool can be found at Intel. Intel uses a number of web based applications to provide electronic linkages to suppliers (Intel, 1999b). One of these tools is called the "Automated Supplier Response to Forecast Tool" or ASRF. The ASRF is a secure application that provides suppliers the ability to respond to Intel generated forecasts. Another Intel web-based tool is called "Supplier Activated Materials" or SAM. SAM allows materials suppliers to gain access to (1) Intel's weekly demand requirements, (2) 13 week historical (and current) and present inventory demands, (3) the last five receipts for materials and (4) the ability to download these reports in MS Excel 97 format. These tools provide a mechanism by which Intel's suppliers may (on an as-needed basis) gain access to critical planning information that they might not otherwise have easy access to.

Inventory Visibility

> **Inventory visibility provides the ability to track where any given item is physically located (transit, customs, supplier, etc.) or where it was used. An example of information sharing in support of inventory visibility includes the joint sharing of current inventory information by location and quantity.**

Information that is exchanged between supply chain partners in this context is typically very standardized and well defined (i.e. location and quantity). Locating inventory in the system may frequently be done on an ad-hoc basis in order to meet changes in demand, changes in production schedules, etc. This joint planning and decision making context provides a natural/intuitive setting for an interorganizational information system.

This research supports the notion that better information quality leads to better joint inventory visibility planning and decision making outcomes. Further, improvements in the quality of both IOS enabled and non-IOS enabled information flows are associated with better joint inventory visibility outcomes. The β that associates IOS enabled information flows with joint inventory visibility outcomes (0.565, $p<.01$) was of a very large magnitude. The β that associates non-IOS enabled information flows with joint inventory visibility outcomes (0.204, $p<.01$) was of a smaller, but still reasonably large magnitude. A statistical test of difference revealed that these parameter estimates are indeed different ($p<.01$). In a similar fashion to the forecasting and inventory positioning joint planning and decision making context, each individual element of information quality (currency, accuracy, completeness, compatibility and convenience to access) had a significantly higher mean score for the quality of IOS enabled information than for the quality of non-IOS enabled information (see Table 82).

Information quality is also associated with certain firm-level performance results including on-time delivery and responsiveness. Specifically, the total effect (mediated by joint planning and decision making outcomes) of IOS enabled information flows on performance outcomes (responsiveness and on-time delivery) is 0.232. The total effect (mediated by joint planning and decision making outcomes) of non-IOS enabled information flows on performance outcomes (responsiveness and on-time delivery) is .214. These total effects indicate that perhaps the quality of information exchanged by supply chain partners has a more equal impact on performance outcomes, than on joint planning and decision making outcomes. For instance, the quality of information passed through an interorganizational information system is much greater than information exchanged through traditional communication mechanisms. However, since the total effects of information quality on performance outcomes are very similar, there must be another mechanism afoot which accounts for the leveling of the total effects compared to the direct effects within this joint planning and decision making context. One explanation is that interorganizational information systems are employed for the more routine/standard set of information transactions, while traditional communication methods are employed for the non-standard or 'out of the ordinary' information transactions. One might expect that a transaction that has attained the level of "standard" may not (at the margin) make the same contribution to bottom line firm performance as the more ad-hoc "firefighting" information transaction that is frequently needed to quickly adapt to the changing competitive environment. It is this "firefighting" that may well be the source of the larger magnitude β which associates non-IOS information quality directly with firm performance, and in so doing accounts for the leveling of the effects of information quality on firm performance outcomes.

This finding is particularly interesting in that it clearly describes a situation in which interorganizational information system technologies are not employed to their fullest extent. It is also somewhat inconsistent with the finding that inventory visibility joint planning and decision making processes had significantly improved over the past two years (see Figure 12).

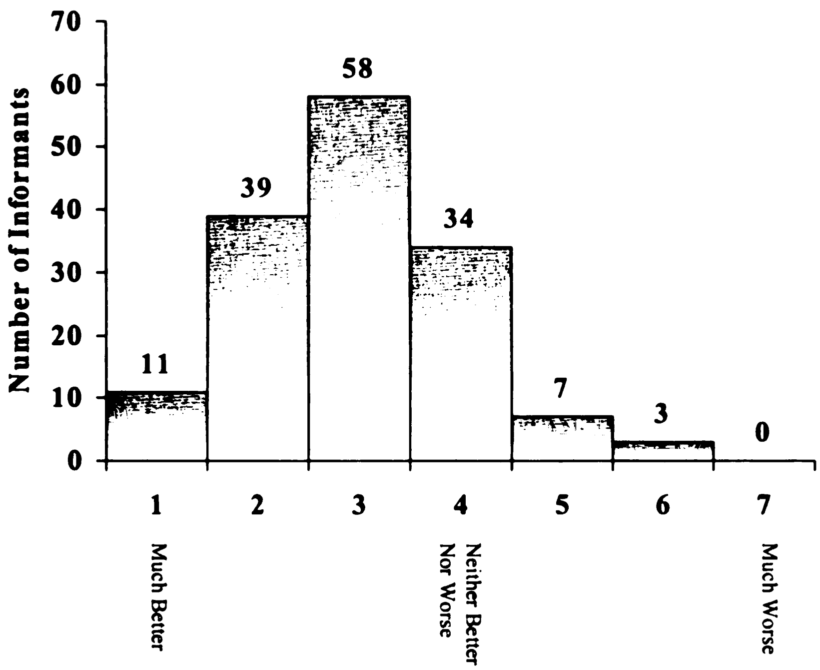

Figure 12: Inventory Visibility Process Improvements

Because the quality of information is significantly better when received through an interorganizational information system (as compared to traditional communication method), firms should capitalize on this by leveraging interorganizational information systems to handle more ad-hoc/non-standard information transactions. The benefits of leveraging interorganizational information system technologies in this fashion may come from a variety of areas including (1) better results from joint planning and decision making processes, (2) better use of human resources by freeing up time to focus on longer-range issues and (3) better supply chain inventory management.

Capacity Planning

Capacity planning is conducted to ensure that the supplier will have the ability to produce or make available the required items/services in the required lead-time. An example of information sharing in support of capacity planning would include the sharing of plant capacity utilization information between supply chain partners.

Information that is exchanged between supply chain partners in this context is typically very standardized and well defined (i.e. capacity utilization by time period). Information is typically exchanged on a pre-determined/standard schedule. This joint planning and decision making context provides a natural/intuitive setting for an interorganizational information system.

This research supports the notion that better information quality is associated with better joint capacity planning and decision making outcomes. Both the quality of IOS enabled and non-IOS enabled information flows are associated with improvements in joint capacity planning outcomes. The β that associates IOS enabled information flows with joint capacity planning (0.501, $p<.01$) was of a very large magnitude. The β that associates non-IOS enabled information flows with joint capacity planning outcomes (0.304, $p<.01$) was also of a large magnitude. A statistical test of difference revealed that these parameters are different ($p<.1$). Consistent with the previous two joint planning and decision making contexts, each individual element of information quality (currency, accuracy, completeness, compatibility and convenience to access) had a significantly higher mean score for the quality of IOS enabled information than for the quality of non-IOS enabled information (see Table 83).

While the firm-level performance outcome construct included in the SEM (reflected by ROI, ROE and profit margin) did not appear to be significantly affected by the quality of information exchanged between supply chain partners (either through an IOS or traditional communication method), an examination of Table 75 clearly indicated that certain firm-level performance outcomes are likely to be associated with improved joint capacity planning and decision making outcomes. Specifically, these firm-level performance outcomes included:

(1) total inventory turnover rate ($r=.25$, $p<.01$)
(2) purchase price reduction compared to market ($r=.25$, $p<.01$)
(3) supplier on-time delivery ($r=.23$, $p<.05$)
(4) supplier responsiveness ($r=.22$, $p<.05$)
(5) total cost reduction ($r=.22$, $p<.05$)
(6) return on investment ($r=.20$, $p<.05$)
(7) profit margin ($r=.19$, $p<.05$)
(8) return on equity ($r=.19$, $p<.05$)
(9) purchase price reduction ($r=.18$, $p=.05$)

These findings are of particular interest in that it appears that improvements in joint capacity planning and decision making processes may very well lead to improvements in a wide range of firm-level performance outcomes. Further, it is important to note that the magnitude of the β that associates IOS enabled information quality with joint capacity planning and decision making outcomes ($\beta=.501$) is relatively larger than the magnitude of the β that associates non-IOS enabled information quality with joint capacity planning and decision making outcomes ($\beta=.343$). It would appear that the increased quality of information exchanged through an interorganizational information system might have a greater direct affect on joint planning and decision making outcomes and a greater indirect effect on firm-level performance.

The joint capacity planning and decision making context was described typically requiring the sharing of information by supply chain partners and a regular/scheduled basis. It is likely that the established schedule for sharing capacity planning information is in many cases inadequate to meet the needs of the supply chain partners. In effect, this may build a lag in information flow into the planning system. The use of a properly implemented interorganizational information system may remove this lag in information flow, providing higher quality information on an as-needed basis by the relevant supply chain partners.

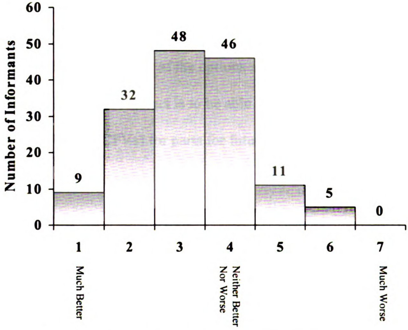

Figure 13: Capacity Planning Process Improvements

While firms reported that their capacity planning processes had improved over the past two years (see Figure 13), they typically do not have well implemented interorganizational information systems that extend across their supply chains. Hence, capacity planning is likely done in pairs of firms, who at the time of the planning activity, are not able to incorporate the capacity plans for other members of the supply chain. The need for a supply-chain wide interorganizational information system seems clear. The firms who are able to establish an effective supply chain–wide interorganizational information system are likely to gain significant competitive advantage. It is very likely that the increase in firm-level performance outcomes will be so great as to make it difficult for competing firms/supply chains to catch up.

However, it is also the case that some firms are well on the way to establishing interorganizational information systems that appear to be quite well implemented, although typically not throughout the entire supply chain. For instance, DaimlerChrysler has implemented an extended-enterprise system called "The Extended Enterprise™." One of the features of The Extended Enterprise™ is called SPIN for "Supply Part Information Network." One of the options available to a DaimlerChrysler supplier with an active part/material contract is to be able to view financial and capacity planning volumes (FPVs and CPVs) for parts for future model years.

Post Supplier Selection Performance Evaluation/Feedback and Conformance

> **Post supplier selection performance evaluation/feedback and conformance (based on objective measures) is used to ensure that there is joint understanding and agreement about both the buying firm's and the supplier's performance. Examples of information sharing in support of post selection performance evaluation/feedback and conformance include mutual sharing of performance information related to quality, delivery and responsiveness using agreed to metrics.**

Information that is exchanged between supply chain partners in this joint planning and decision making context is typically (although not always) very standardized and well defined. Information is usually exchanged on a well-defined schedule. The exception occurs when the performance measurement process returns a finding that performance has worsened. It may be the case that during the period of corrective action following this finding, the types of information and the frequency that this information is being exchanged deviates from the schedule.

This research supports the notion that better information quality is associated with improved results from the joint performance evaluation/feedback and conformance planning and decision making process. Within this context, the quality of both IOS enabled and non-IOS enabled information flows are associated with improved outcomes from this joint process. Both β's that associated IOS and non-IOS enabled information flows with joint performance evaluation/feedback and conformance planning and decision making outcomes ($\beta_{non\text{-}IOS}$=0.353, p<.01; β_{IOS}=0.359, p<.01) were of a large magnitude. Further, a statistical test of difference revealed that these parameter estimates were not statistically different (p=.252).

Analysis of the information quality data revealed (see Table 84) that there was no statistical difference between the accuracy, completeness or compatibility of information shared through traditional or IOS methods. Interestingly though, IOS enabled information flows were more current and more convenient to access than their non-IOS counterparts.

A closer examination may reveal that firms are only now at the beginning stages of using interorganizational information systems in the context of joint performance evaluation/feedback and conformance planning and decision making. We may well recognize that where these interorganizational information systems are implemented, they have a similar impact on joint planning and decision making outcomes as their non-IOS enabled systems. However, as the deployment of these interorganizational information systems continues, the increased levels of information currency and convenience of access to information may well serve to increase the effect of IOS enabled information systems over their non-IOS enabled counterparts. ***Managers should take specific note of these findings since this appears to be an area where IOS may be employed to their firm's direct benefit.***

This research suggests that there are also certain firm-level performance outcomes that may be obtained through the increased information quality associated with better joint performance evaluation/feedback and conformance planning and decision making. The γ that relates joint performance evaluation/feedback and conformance planning and decision making outcomes with firm performance was relatively large (γ=.313, p<.01). In this SEM, performance outcomes where characterized by quality and total cost reduction (see Table 20). It is also true that there were other firm-level performance outcomes associated with planning and decision making in this context (see Table 76), including:

(1) supplier Responsiveness ($r=.29$, $p<.01$),
(2) supplier on-time delivery ($r=.28$, $p<.01$),
(3) purchase price reduction compared to market ($r=.23$, $p<.01$),
(4) supplier quality performance ($r=.21$, $p<.05$),
(5) return on investment (ROI) ($r=.18$, $p<.05$),
(6) return on equity (ROE) ($r=.17$, $p<.1$),
(7) total cost reduction ($r=.17$, $p<.1$) and
(8) external customer service levels ($r=.17$, $p<.1$).

Managers currently recognize the importance of post supplier selection performance evaluation/feedback and conformance. In fact, this context appears to have been a focus for improvement over the past two years for most informants in this study (see Figure 14). However, managers must recognize that post supplier selection performance evaluation/feedback and conformance is a planning and decision making context into which interorganizational information systems must play a key role in order to obtain better firm-level performance. It is simply not practical, nor is it an effective use of an employee's time to use traditional communication mechanisms to monitor supplier performance (and own firm's conformance) in most cases.

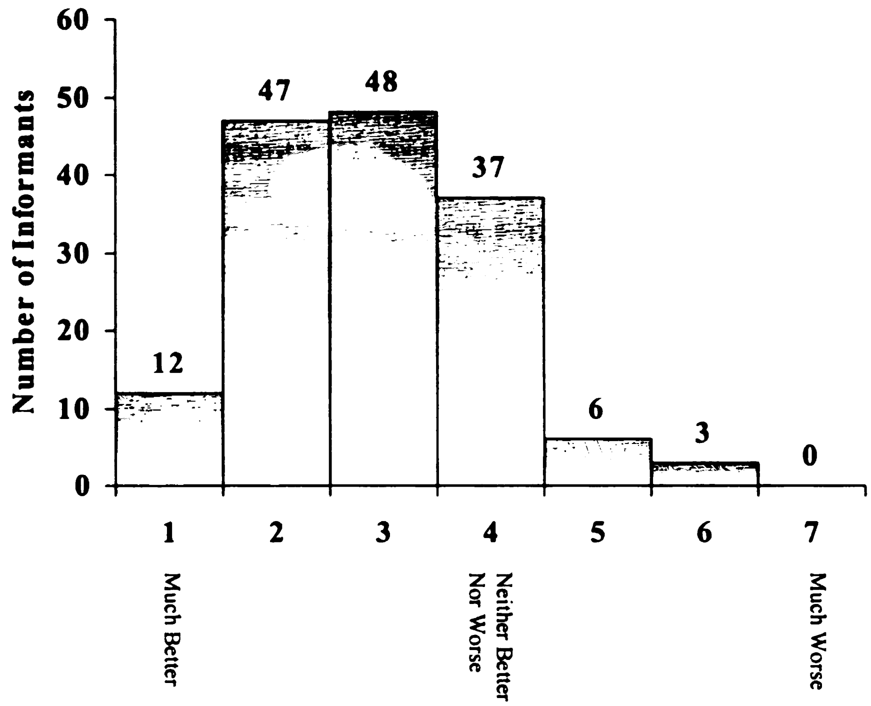

Figure 14: Post supplier selection performance evaluation/feedback and conformance process improvements

It is interesting to note that firms are doing some very interesting things related to post supplier selection performance evaluation/feedback and conformance. Returning to the DaimlerChrysler Extended Enterprise System™ example, "The Non-Conformance System (a function of SPIN) measures suppliers at the plant, division and top-parent levels; by individual Chrysler plants; and by Procurement and Supply directors, purchasing agents, buyers, quality managers, quality specialists and commodity codes. The Non-Conformance System improves communication and reduces time, waste and redundancy. The process allows any user at a participating Chrysler location to create a potential alert, which is a notification of a part problem. Users may attach illustrations of the nonconforming parts to the tickets. The system also can fax tickets and illustrations to Chrysler suppliers. (DaimlerChrysler, 1997)"

Sourcing and Supply Proposal Evaluation

Sourcing and supply proposal evaluation is the process of setting the terms and conditions of a purchase. These terms and conditions frequently include price, quantity, quantity discount, quality, technology, etc. Examples of information sharing in support of sourcing and supply proposal evaluation include (1) the buying company sending the supplier a request for quotation (RFQ) or (2) the supplier sending the buying company a quote in response to an RFQ.

Information that is exchanged between supply chain partners in this joint planning and decision making context is frequently standardized and well defined over finite time periods. Information is typically also exchanged on standardized schedules for finite periods of time. When a source is selected and a contract is established for the supply of certain materials in certain time periods, this defines a specific standard for the ensuing information transactions. Outside of this contract window, the information and periodicity of information exchange will typically be much more variable.

This research supports the notion that better information quality is associated with improved outcomes from sourcing and supply proposal evaluation planning and decision making processes. Within this context, the quality of both IOS enabled and non-IOS enabled information flows were associated with improvements in this joint process. Both β's that associated IOS and non-IOS enabled information flows with sourcing and supply proposal evaluation planning and decision making outcomes ($\beta_{non\text{-}IOS}$=0.276, $p<.01$; β_{IOS}=0.327, $p<.01$) were of a large magnitude. Further, a statistical test of difference revealed that these parameter estimates were not statistically different ($p=.988$). In addition, the analysis revealed (see Table 85) that there were no statistical differences between the currency, accuracy, completeness or compatibility of information shared through traditional or IOS methods. Similar to the post selection supplier performance evaluation/feedback and conformance joint planning process, there was a statistical difference on the convenience of information access between IOS and traditional methods. IOS enabled information flows were more convenient to access than their non-IOS counterparts. In a fashion very similar to that of post supplier selection performance evaluation/feedback and conformance, the effects of both IOS and non-IOS enabled information quality on joint performance evaluation/feedback and conformance planning and decision making outcomes were essentially equal. Again, an explanation is needed for the fact that while IOS enabled information flows provide a more convenient mechanism for information access, the effect of IOS quality on joint planning and decision making outcomes is not statistically different between the IOS and non-IOS enabled information communication mechanisms.

One possible explanation might be that this joint planning and decision making context is one in which interorganizational information systems are frequently employed between firms who have been doing business together for a significant length of time. In the past, the most common IOS enabled method for sharing information related to this joint planning and decision making context was that of EDI. However, because of the high cost of establishing and operating an EDI system, most suppliers (certainly the smaller ones) would not have had the resources necessary to implement such a system. It is for this reason that it is very likely that the findings within this joint planning and decision making context are skewed towards a few larger firms and larger suppliers. However, it is absolutely critical to recognize that there are now many other mechanisms by which firms may share information related to supply proposal evaluation. In fact, in recent months, firms have begun to utilize the World Wide Web (WWW) for this purpose. Further, a more general version of EDI based on the XML standard is being developed that will employ the WWW in place of a VAN as well as provide a more robust set of transaction elements.

The purchasing/sourcing community has placed great emphasis on this joint planning and decision making process over the past two years (see Figure 15).

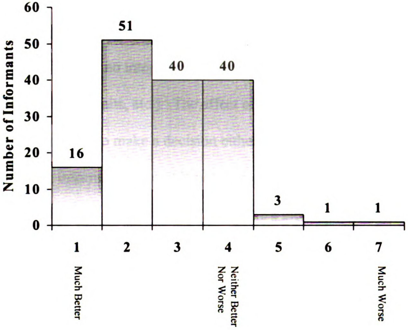

Figure 15: Supply proposal evaluation process improvement

Purchasing managers are spending time and money to create more efficient/effective supply proposal evaluation processes. Certain improvements have come in the area of supplier qualification/certification. By pre-qualifying/certifying suppliers, the buying company no longer has to spend time evaluating every reasonable source for a given purchase requirement. With the use of a well-implemented interorganizational information system, the speed/flexibility of these information transactions may occur with qualified/certified suppliers may be greatly enhanced.

Purchasing professionals frequently have difficulty including/selecting the appropriate potential sources of supply in a sourcing/supply proposal evaluation decision. It is this arena that the use of an interorganizational information system may have significant advantages for the purchasing organization in the not-so-distant future. It is a well-understood fact that human beings are not very good at documenting, storing and disseminating knowledge over time. Information frequently exists randomly over a system, with little or no integration between system elements (people, departments, divisions, business units, etc.). The effect of this situation is that the people who need critical information to make a decision either don't have access to the information or can't find the information (i.e. it is not convenient to access the information). A well-implemented information system may provide a mechanism by which critical information/knowledge (performance reporting, procedural issues, contact information, etc.) may be captured and retained by one firm, but in so doing, made available to all firms participating in that interorganizational system. Hence, a geometric expansion of information is available on each potential source of supply.

There are also certain firm-level performance outcomes that might be expected from improved joint sourcing/supply proposal evaluation processes. The SEM included (1) total cost reduction, (2) purchase price reduction and (3) purchase price reduction compared to market as measures of firm-level performance outcomes. The γ that related joint source/supply proposal evaluation with performance outcomes was of a relative large magnitude (γ=.313, p<.01). While these cost/price performance outcomes are clearly expected to result from improved joint source/supply proposal evaluation processes, it is clear that there may well be other elements of firm-level performance that may be affected by improvements in this process. Table 77 describes several other firm-level performance outcomes that may well be expected from improvements in this joint planning and decision making process area. Some of these potential firm-level performance improvements include:

(1) total cost reduction ($r=.30$, $p<.01$)
(2) purchase price reduction ($r=.29$, $p<.01$)
(3) supplier on-time delivery ($r=.23$, $p<.01$)
(4) purchase price reduction compared to market ($r=.19$, $p<.05$)
(5) return on equity (ROE) ($r=.18$, $p<.05$)
(6) supplier responsiveness ($r=.16$, $p<.1$)
(7) return on investment ($r=.16$, $p<.1$)

It is clear that the joint planning and decision making context of sourcing and supply proposal evaluation is one that is critically important to the success of the firm. It is also clear that the role interorganizational information systems currently play within this context is relatively limited. Managers must review these findings in the context of their business situation to determine how best to employ an interorganizational information system in a more effective way within this context.

Part/Material Standardization

Part/material standardization is used to reduce the number of unique parts/materials maintained in the inventory system by using more standard and fewer unique parts/materials. Examples of information sharing in support of part/material standardization would include (1) a buying company sharing materials lists with a supplier and (2) a supplier evaluating these lists and making recommendations to the buying company about any possible standard part substitutions.

Information that is exchanged between supply chain partners within this joint planning and decision making context is frequently both of a non-standardized nature and done on an ad-hoc basis. Many firms are attempting to develop better ways to employ interorganizational information systems to enable more effective part/material standardization processes, but much work remains to be done. While interorganizational information systems appear to offer the long-term solution to many of the problems associated with the part/material standardization process, these solutions do not yet exist in a widely useable form.

This research supports the notion that information quality plays a critical role in the outcome of the joint part/material standardization planning and decision making process. Within this context, improved information quality within both IOS enabled and non-IOS enabled information flows are associated with improved joint planning and decision making outcomes. Both β's that associated IOS and non-IOS enabled information flows with sourcing and supply proposal evaluation planning and decision making outcomes ($\beta_{non\text{-}IOS}$=0.404, $p<.01$; β_{IOS}=0.445, $p<.01$) were of a large magnitude. Further, a statistical test of difference revealed that these parameter estimates were not statistically different ($p=.868$). In addition, the analysis revealed (see Table 86) that there were no statistical differences between the accuracy, completeness or compatibility of information shared through traditional or IOS methods. There was a statistical difference on information currency and the convenience of information access between IOS and traditional methods. IOS enabled information flows were more current and more convenient to access than their non-IOS counterparts. Given these differences in the elements of information quality and the fact that the effects of both IOS and non-IOS enabled information quality on joint part/material standardization planning and decision making outcomes were essentially equal, an explanation is required to reconcile these inconsistencies.

It is very likely that the number of interorganizational information system applications related to the joint part/material standardization processes are very few in number. These applications are also likely to be implemented on a very narrow basis. These results suggest that the overall impact that information quality has on joint part/material standardization processes is essentially equal between IOS and non-IOS enabled mechanisms. ***However, these findings do point to the fact that joint part/material standardization processes are likely to be an area of large upside process improvement potential.*** Specifically, the findings of this research demonstrate that information used in the part/material standardization process is much more current and much easier to access than the same information accessed through traditional communication mechanisms. For obvious reasons, within the context of joint part/material standardization, information currency is an absolutely essential. Further, if the information available through an IOS enabled mechanism is more convenient to access, it is more likely to be used, providing a greater likelihood that the purchasing team will actually be successful in standardizing parts and materials.

There are a number of firm-level performance outcomes that might be expected from better joint part/material standardization processes. The SEM included (1) inventory turnover, (2) on-time delivery and (3) purchase price reduction as measures of firm-level performance outcomes. While the γ that related joint part/material standardization with performance outcomes was not statistically significant, it is clear that there are a number of expected firm-level performance outcomes that are associated with improved joint part/material standardization processes (see Table 78). Several of these firm-level performance areas include:

(1) cash-to-cash cycle time ($r=.29$, $p<.01$)
(2) supplier on-time delivery ($r=.25$, $p<.01$)
(3) supplier quality performance ($r=.19$, $p<.05$)
(4) total inventory turnover rate ($r=.18$, $p<.05$)
(5) profit margin ($r=.17$, $p<.1$)

It is clear that the joint planning and decision making context of part/material standardization is one that is important to the success of the firm. It is also clear that the role interorganizational information systems currently play within this context may be limited. The part/material standardization process is one of the joint planning and decision making processes that will likely never be completely implemented until a supply chain-wide interorganizational information system is established. The shear numbers of parts/materials that exist any given supply chain makes the problem of part/material standardization (performed without and interorganizational information system) an incredibly labor intensive process that is destined to bear sub-optimal results. Unfortunately, to implement an interorganizational information system to improve the joint part/material standardization process, a huge amount of labor must be used in order to provide the framework for the standardized system (part specification comparison, common coding, etc). An examination of Figure 16 supports this conclusion. Firms have not achieved improvements in their joint part/material standardization processes to the same degree as many of the other joint planning and decision making processes that have been addressed in this research. This is very likely due to the fact that the problems associated with joint part/material standardization are much more difficult to address than many of the problems associated with other joint planning and decision making process areas.

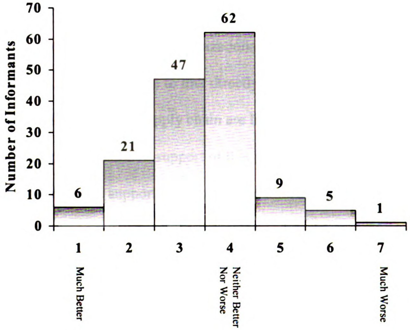

Figure 16: Joint part/material standardization process improvements

Supplier Scheduling

> **The supplier scheduling process controls the releases of orders through MRP systems (or other systems) and ensures communications of priorities, needs, and quantities between the buying organization's production or operations management system and suppliers. Examples of information sharing in support of supplier scheduling include the sharing of information related to order date, quantity ordered, required due date, ship-to-location, item identification, key contact person and so forth.**

Information that is exchanged between supply chain partners in this context is typically very standardized and well defined. This information is frequently exchanged on a relatively standard schedule. This joint planning and decision making context provides a natural/intuitive setting for an interorganizational information system. In fact, for pairs of firms, this is one of the joint planning and decision making processes that has the most robust history of interorganizational information system use. While these systems typically are not able to link directly through a supply chain (though a common element), many firms in a supply chain are likely to be interconnected through pairs of firms sharing information in support of this joint planning and decision making process.

This research supports the notion that information improved quality is associated with better joint inventory visibility planning and decision making outcomes. Both the quality of IOS enabled and non-IOS enabled information flows are associated with improved joint inventory visibility planning and decision making outcomes. The β that associates IOS enabled information flows with joint inventory visibility outcomes (0.556, $p<.01$) was of a very large magnitude. The β that associates non-IOS enabled information flows with joint inventory visibility outcomes (0.209, $p<.01$) was of a smaller, but still reasonably large magnitude. A statistical test of difference revealed that these parameter estimates were indeed different (p<.01). In a similar fashion to both forecasting and inventory positioning and inventory visibility, each individual element of information quality (currency, accuracy, completeness, compatibility and convenience to access) had a significantly higher mean score for the quality of IOS enabled information than for the quality of non-IOS enabled information (see Table 87).

Information quality is also associated with certain firm-level performance results including on-time delivery, profit margin and cash-to-cash cycle time. Specifically, the total effect (mediated by joint planning and decision making outcomes) of IOS enabled information flows on performance outcomes (responsiveness and on-time delivery) is 0.188. The total effect (mediated by joint planning and decision making outcomes) of non-IOS enabled information flows on performance outcomes (responsiveness and on-time delivery) is .103. These total effects indicate that while there is a fairly stark contrast in the effects of information quality on joint planning and decision making outcomes between IOS and non-IOS enabled information mechanisms, this difference is attenuated when the total effect on firm-level performance is examined. While it may appear that this smaller difference between the total effects of IOS and non-IOS enabled information quality firm-level performance outcomes (when compared to joint planning and decision making outcomes) reduces the significance of these findings, this is not the case. Firm-level performance outcomes are affected by a host of other variables (both internal and external to the firm). When viewed in this light, it is clear that the supplier scheduling joint planning and decision making context may very well be one of the success stories for interorganizational information systems in the manufacturing arena today. Clearly all five elements of information quality are significantly better than the same elements for non-IOS enabled information quality. It is this increased quality of information that allows better joint planning and decision making outcomes to occur. These improved joint planning and decision making outcomes have a significant positive affect on firm performance. In addition to the measures of firm-level performance described above, this research supports the notion that there are several other firm-level performance results that may be expected from improved joint supplier scheduling planning and decision making outcomes (see Table 79). Several of these firm-level performance measures include:

(1) total cost reduction ($r=.18$, $p<.01$)
(2) inventory turnover ($r=.23$, $p<.01$)
(3) purchase price reduction compared to market ($r=.22$, $p<.01$)
(4) purchase price reduction ($r=.22$, $p<.01$)
(5) ROI ($r=.20$, $p<.05$)
(6) ROE ($r=.20$, $p<.05$)
(7) profit margin ($r=.19$, $p<.05$)
(8) on-time delivery ($r=.18$, $p<.05$)
(9) cash-to-cash cycle time ($r=.16$, $p<.1$)

However, it is critical to note that the joint supplier scheduling planning and decision making context is not devoid of potential for improvement. In fact, quite the opposite is actually the case as firms reported that they have made substantial improvements in their supplier scheduling planning and decision making processes over the past two years (see Figure 17).

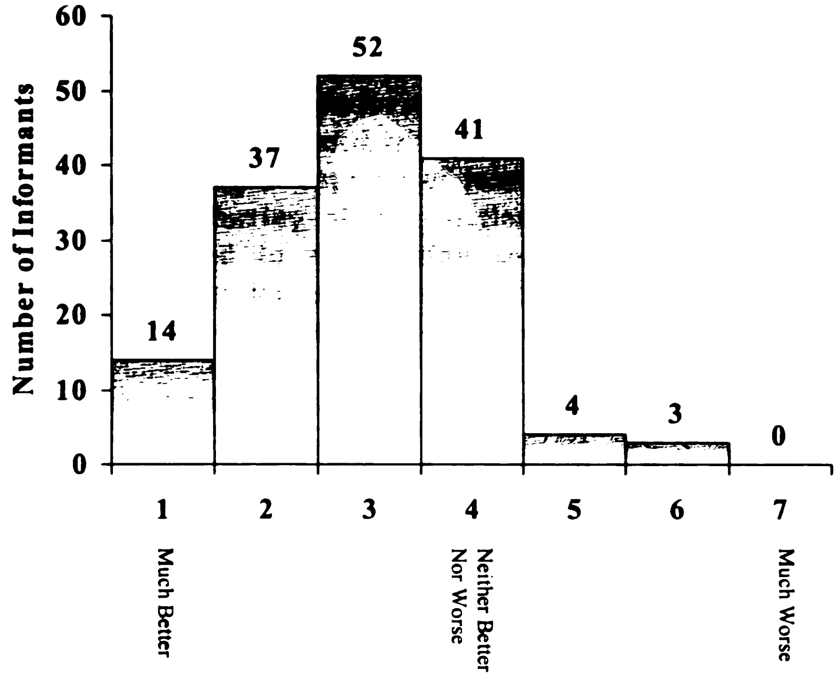

Figure 17: Supplier Scheduling Process Improvements

Joint Goal/Target Setting

Joint goal/target setting ensures that there are mutually acceptable performance targets that are rooted in common/aligned metrics. An example of information sharing in support of joint goal/target setting includes the sharing of information by supply chain partners related to establishing acceptable purchased-product quality levels (Cpk, ppm, etc.), responsiveness, on-time delivery, cost improvements, etc.

Information that is exchanged between supply chain partners in this joint planning and decision making context is frequently non-standardized and not well defined. Information is typically not shared on a standard or defined schedule. The joint goal/target setting process is frequently done in the spirit of continuous improvement and generally involves quite a bit of direct contact between key members in each of the organizations. Typically this direct contact is undertaken through traditional communication methods.

This research supports the notion that improved information quality is associated with better outcomes from the joint goal/target setting planning and decision making process. Within this context, the quality of both IOS enabled and non-IOS enabled information flows are associated with improved outcomes of this joint process. Both β's that associated IOS and non-IOS enabled information flows within the joint goal/target setting planning and decision making outcomes ($\beta_{non\text{-}IOS}$=0.209, p<.01; β_{IOS}=0.556, p<.01) were of a large magnitude. Further, a statistical test of difference revealed that these parameter estimates were statistically different (p=.004). In addition, the analysis revealed (see Table 85) that there were no statistical differences between the currency, accuracy, completeness or compatibility or convenience of access of information shared through traditional or IOS methods. This raises an interesting question. How is it possible that while none of the individual measures of information quality were statistically different (between IOS enabled and non-IOS enabled information flows), there is a significant difference between the parameters that relate the higher order information quality constructs to the join planning and decision making outcomes? The answer to this question may be found by examining the β that relates non-IOS enabled information quality directly to firm-level performance. This parameter is of a large magnitude (β=.310,p<.01). Further, the parameter that relates joint goal/target setting planning and decision making outcomes with firm-level performance was not of a large magnitude (γ=.062, p=.666). Hence, it is clear that there is some other mechanism at work in this context. It is important to note that the SEM included only total cost reduction and purchase price reduction as measures of firm-level performance. A brief discussion will follow that will explain this apparent inconsistency in these findings.

Figure 19 depicts a very simple performance measurement process. The process begins by establishing a set of joint goals/targets between firms. During this phase of the process, it would be expected that information quality would have a direct and positive effect on the joint planning and decision making outcomes. Indeed, these research findings support this contention. However, it would not necessarily follow that at this stage in the joint planning and decision making process, there would be a cost/price firm-level performance result. These results may have to do with the fact that better quality information is enabling better performance measurement which is itself leading to better firm-level cost/price performance outcomes. As this study was cross-sectional in nature, this effect may be attributed to the fact that the process we are examining is longitudinal in nature, and the results of the process actually occur in a subsequent process stage.

Overall, firms reported that their joint goal/target setting processes had improved over the past two years (see Figure 18).

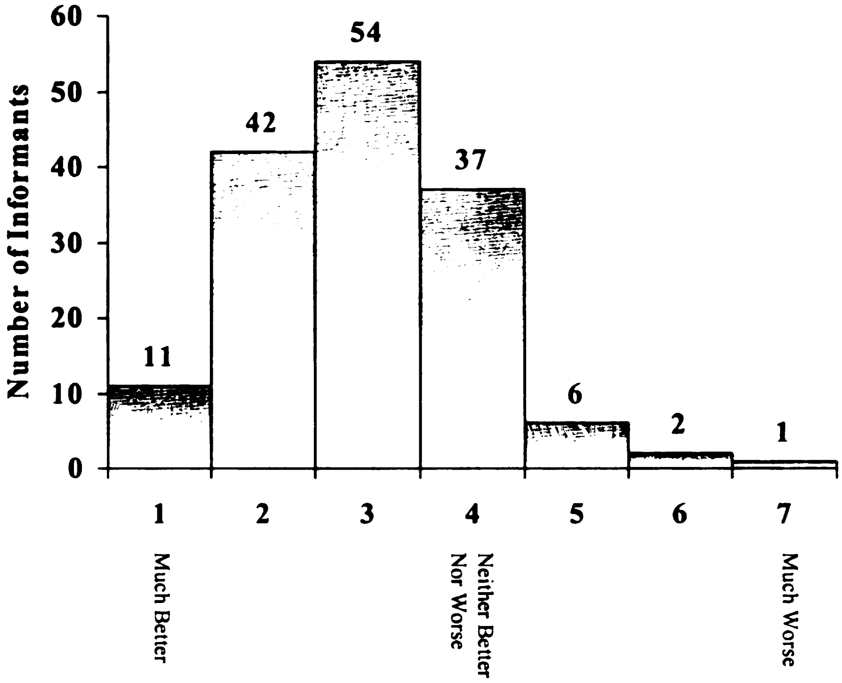

Figure 18: Joint Goal/Target Setting Process Improvements

It is important to note that there were several other firm-level performance outcomes which may also result from improved joint goal/target setting planning and decision making (see Table 80). Several of these include:

(1) purchase price reduction compared to market (r=.3, p<.01)
(2) purchase price reduction (r=.28, p<.01)
(3) total cost reduction (r=.25, p<.01)
(4) supplier responsiveness (r=.22, p<.01)
(5) supplier on-time delivery (r=.21, p<.05)
(6) total inventory turnover rate (r=.20, p<.05)
(7) return on equity (r=.19, p<.05)
(8) return on investment (r=.17, p<.1)

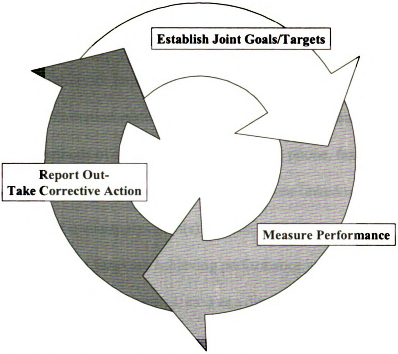

Figure 19: Joint Goal/Target Setting Process

Managerial Implications

This research established that the quality of the information exchanged between firms has a significant impact on a firm's ability to make better decisions. It also shows that linked information systems typically provide better quality information than more traditional methods of communication (meetings, phone, fax, etc.). These findings should reinforce the need for firms to develop their linked information systems within the context of their own supply chain(s) specific needs.

Frequently, firms are achieving performance improvements (total cost, price, quality, delivery, responsiveness, etc.) as a direct result of using linked information systems with only a very few key suppliers. However, the development of these systems is frequently done largely in a vacuum, without the context of the broader supply chain. This development strategy is short-term in nature and at best will provide an unnecessary period of "stumbling around" while the firms within a supply chain each create a variety of one-off linked information systems. At worst, the lack of a supply chain focus in the development of linked information systems will make it very difficult if not impossible to fully realize the potential that these technologies are able to offer.

Consideration needs to be paid not only to the needs of each supply chain member in the creation of the linked information system, but to the resources and capabilities of each supply chain member as well. There are lessons to be learned from our last global effort at creating a linked information system. EDI, while brilliant in its conception, was not cost-effective to operate and required significant up-front expense to implement. This necessarily excluded most firms (certainly smaller/less sophisticated ones) from participating. We must not make these same mistakes again.

We now have the technologies and network infrastructure available to allow for the creation of a set of standards and technology-enabled mechanisms that will lay the groundwork for a fully interchangeable/universally connectable system. Development of linked-information systems should be done with this in mind.

Managers today should be working hard to discover where there is a logical place to remove traditional cross-organizational processes and supplement (or replace) them with linked information system enabled processes. The following is a brief review of each of the eight joint planning and decision making process areas. Key applicability to linked information systems is established and linkages to performance outcomes are drawn.

The following sections review the eight joint planning and decision making areas with particular attention paid to managerial implications. Further, Table 24 provides a summary of the effects of improved joint planning and decision making processes on firm level performance within each of the eight joint planning and decision making contexts. Figure 20 provides a 2 X 2 matrix designed to aid in establishing the priority for interorganizational information system development. Each of the eight areas is discussed in light of its potential marginal contribution to overall firm performance. This discussion should be taken in the context of the "average firm." Firms who have particularly strong or weak interorganizational information systems in each of these areas should view these results within that context.

Table 24: Bivariate Correlation's Between JPDM Outcomes and Key Firm Performance Indicators

Parameter	Forecasting and Inventory Positioning	Inventory Visibility	Capacity Planning	Performance Evaluation and Feedback	Supply Proposal Evaluation	Part Material Standardize	Supplier Scheduling	Joint Goal/Target Setting
Inventory Turnover	.22	.22	.25			.18	.23	.20
On-Time Delivery	.35	.37	.23	.28	.23	.25	.18	.21
Responsive	.26	.29	.22	.29	.16		.16	.22
ROI			.20	.18	.16		.20	.17
ROE		.19	.19	.17	.18		.20	.19
Profit Margin			.19			.17	.19	
Quality				.21		.19		
Total Cost Reduction			.22	.17	.30		.28	.25
Purchase Price Reduction			.18		.29		.22	.28
Purchase Price Reduction (CTM)	.15	.22	.25	.23	.19		.22	.30
Cash-Cash Cycle Time	.19					.29		
External Customer Service				.17				

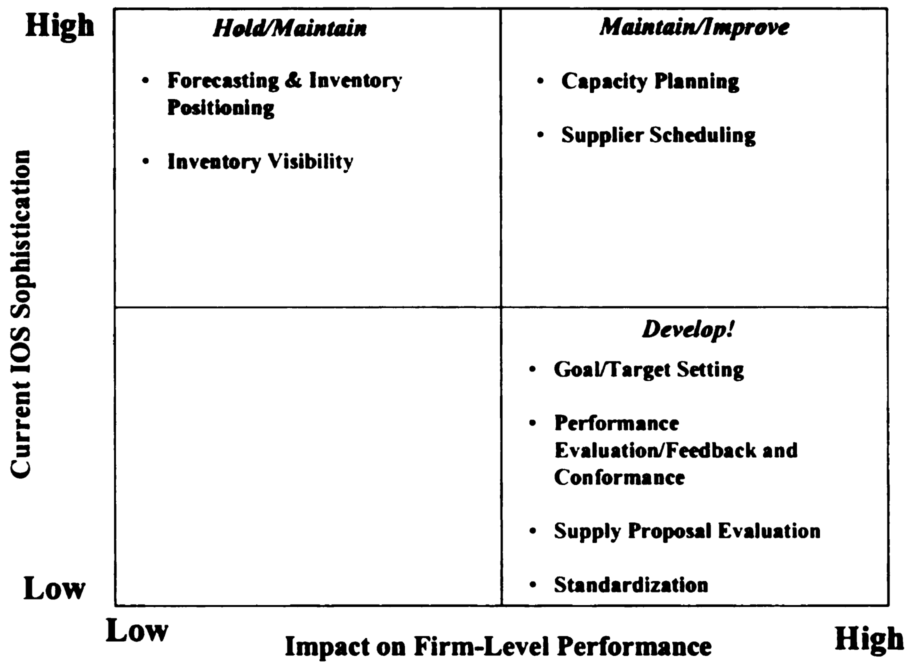

Figure 20: IOS Development Priority Matrix

<u>Priority 1: Joint Goal/Target Setting</u>

Firms reported that their joint goal/target setting processes had improved significantly over the past two years and that linked information system applications in support of joint goal/target setting do provide a significantly higher degree of information quality than their traditional counterparts. However, the many firms have not developed joint goal/target setting IOS enabled interorganizational information systems to an extent take full advantage of the wide range of firm level performance outcomes that are found within this context. Specifically, Firms reported performance improvements in the areas of purchase price reduction compared to market, purchase price reduction, total cost reduction, supplier responsiveness, delivery, inventory turnover, return on equity and return on investment.

Priority 1: Post Supplier Selection Performance Evaluation/Feedback and Conformance

This area provides quite a bit of potential for improvement. While this joint planning and decision making context has received quite a bit of focus over the past several years it is much less developed than many of the processes examined in this research. It would appear that some firms are using linked information systems to support performance measurement, but likely only in a very limited way. The focus of these improvements must be undertaken within the spirit of a supply chain linked information system. This area was selected as a "priority 1" area because of the fact that interorganizational systems are not yet well developed and the finding that improvements in this process area lead to a wide range of performance benefits including supplier responsiveness, delivery, purchase price reduction compared to market, supplier quality performance, return on investment, return on equity, total cost reduction and external customer service levels.

An example of a firm who has implemented a linked information system includes DaimlerChrysler. When material defects are discovered, users at DaimlerChrysler can create alerts that may be sent online to suppliers. These alerts may contain illustrations or scanned in images of the material defect problems. While this is much more simple system than might be warranted, it is a vital initial step in the development of a more inclusive performance measurement system.

Priority 1: Part/Material Standardization

Part/material standardization was selected as a "priority 1" area for interorganizational information system development for a number of reasons. First, the process by which standardization is achieved is very well-suited to an information system enabled solution. Second this is the one area where firms did not report that significant improvements had been made in the process over the past two years. While this may, in part, be a function of the difficulty in solving some of the problems related to making improvements in this area, it does leave room for a significant amount of both process and technology development. Finally, firms reported that improvements in their joint part/material standardization processes were associated with a wide range of firm-level performance outcomes including cash-to-cash cycle time, delivery, quality, inventory turnover and profit margin.

Priority 1: Sourcing and Supply Proposal Evaluation

Sourcing and supply proposal evaluation was selected as a "priority 1" area for interorganizational information system development for a number of reasons. First, there is a large amount of organizational knowledge that must be considered in a sourcing/supply proposal decision. There is no effective way to share this organizational knowledge without the use of an interorganizational information system. It is only through the use of a properly deployed knowledge management system that the best source of supply may be selected. Further, interorganizational information systems implemented in this areas leave room for substantial improvements. Finally, firms reported that improvements in this joint planning and decision making area were associated with a wide range of firm-level performance outcomes including on-time delivery, supplier responsiveness, return on investment, return on equity, total cost reduction, purchase price reduction and purchase price reduction compared to market. Also, firms reported that the use of a linked information system was typically more convenient than the use of traditional methods to support decision making. Given the new technologies that are available, this process area provides an extremely high opportunity for linked information system use.

Priority 2: Capacity Planning

Capacity planning was selected as a "priority 2" area for development because significant sophistication currently exists in joint capacity planning and decision making systems. This is not to say that systems development should not be undertaken in this area. However, systems development should be done with the knowledge that development budgets are limited, and improvements in other areas may make a larger contribution to the bottom line. The wide range of performance improvements reported by firms in this study lend credence to the fact that this joint planning and decision making context is one in which firms are currently having quite a bit of success. Specifically, performance improvements were reported in the areas of inventory turnover, purchase price reduction compared to market, delivery, supplier responsiveness, total cost reduction, return on investment, profit margin, return on equity and purchase price reduction.

It is also true that there are firms who have, to some degree, implemented basic supply chain-wide capacity planning systems. For instance, DaimlerChrysler has implemented a World Wide Web based system that allows any DaimlerChrysler supplier with an active contract to view DaimlerChrysler capacity planning information.

Priority 2: Supplier Scheduling

Supplier scheduling was selected as a "priority 2" area because it has both received the benefit of considerable process improvement and has been one of the mainstay areas for the few linked information systems that exist today. Interestingly, firms have reported making substantial improvements in their supplier scheduling systems over the past two years and also reported performance improvements in the areas of cash-to-cash cycle time, delivery, quality, inventory turnover and profit margin.

Priority 3: Forecasting and Inventory Positioning

Firms are working diligently to develop linked information systems designed to enable improved forecasting and inventory positioning processes. The use of linked information systems to facilitate this joint planning and decision making process is natural and many of these systems exist today. However, work needs to be done to transform these systems expanding the linkages to firms on a supply chain-wide basis.

Firms are achieving significant performance results in the areas of delivery, supplier responsiveness, inventory turnover, cash-to-cash cycle time and reduction of purchase price compared to market.

Priority 3: Inventory Visibility

Firms are putting an emphasis on creating linked information systems to facilitate better joint inventory visibility planning and decision making processes. However, these systems may be more often employed for the more routine inventory location functions. It would appear that firms might improve performance by implementing linked information systems designed to facilitate ad-hoc inventory location purposes. In order to achieve this goal, a focus on the supply chain-wide linked information system is necessary. Additional development may need to be done in the area of "ad-hoc" inventory visibility tools.

Firms reported performance results from this joint planning and decision making context that included delivery, supplier responsiveness, purchase price reduction compared to market, inventory turnover rate and return on equity.

Summary and Conclusion

> "Doing business over the internet has got to be the wave of the future. If you look around the world today there's perhaps 8 or 9 billion dollars worth of business done over the internet.
>
> Forecasts are by the end of this decade there'll be hundreds of billions of dollars in business done each year over the internet. The reasons for this are very simple: it's fast, efficient, gives you access to information anytime, anyplace, anywhere. It is the wave of the future.
>
> That's the direction that Intel's going. That's [where] we need your [suppliers] help. We're putting our tools up on the internet, [and] our information... That's how we want to conduct business in the future. It's going to be the only way that we conduct business in the future. We're looking forward to working with you [suppliers], doing business that way. Thanks. (Intel, 1999a)"
>
> —Craig R. Barrett,
> President and Chief Operating Officer, Intel Corporation
> March 23, 1998

Craig Barrett, in the above speech to Intel's suppliers sums this research up nicely. Interorganizational information systems are not a luxury, rather they are well on their way to becoming the predominant way in which firms will conduct business. This research examined eight joint planning and decision making contexts and the quality of information shared between organizations within each. It was clear that information quality plays an absolutely critical role in joint planning and decision making processes. Further, in many of these contexts, it was clear that the information quality afforded by the use of an interorganizational information system was significantly greater than the information quality inherent in traditional communication methods.

The message seems clear. Firms **must** recognize that they will necessarily be using interorganizational information systems for more and more processes that were traditionally performed using traditional communication methods. It is absolutely vital that these new interorganizational systems and the standards that surround them are implemented in a well thought through manner. If these systems are implemented individually by firms without respect to other firms in the their supply chains, industries, etc. the result will be an ineffective system that will fall substantially short of meeting their potential. In ten years we will need to rebuild these systems as opposed to using them as a foundation for greater achievements.

Research Extensions

This research employed a technique whereby the responding company selected a supplier and responded to the questionnaire exclusively about the quality of the information that is exchanged between the focal firm and the chosen supplier. A valuable extension to this study would be to use a set of paired buying and supplying companies. Each set of paired firms would respond regarding the quality of the information flowing between the firms. This would provide for a more robust assessment of the quality of information passing between the firms.

This research might also be extended by studying the effect of information quality on joint decisions made in another part of the supply chain. For instance, there are many firms today who are using the internet to facilitate the sale of their wares (Dell, Gateway, Amazon.com, etc.). An interesting extension to this research would be to apply this research framework to an OEM-end consumer integrated information system.

Research Limitations

This research examined the effect of the quality of information flowing between supply chain partners on joint planning and decision making outcomes and firm-level performance. An improved assessment could be made if this research also measured the quantity (or volume) of information flowing between supply chain partners. It would bolster the findings of this research if the issue of information volume could be separated from information quality.

The use of a single firm to respond regarding the quality of the information passed between to supply chain partners is likely to create a bias in the estimates of information quality. The responding company must guess as to the perceived quality of the information from the perspective of the supplying company.

The sample used in the research was drawn primarily from firms located in the United States of America. Firms from abroad must recognize this fact and employ an extra measure of caution when applying the findings of this study to their own business situations.

APPENDICES

Appendix A: Key Definitions

KEY DEFINITIONS

Key Term	Definition
Data Quality	"The measure of the agreement between the data views presented by an information system and that same data in the real world" (Orr, 1998).
Information Quality	The degree to which the information exchanged between organizations meets the needs of the organizations.
Interdependence	The lack of ability on the part of supply chain partners to individually control all of the conditions necessary to achieve an action or desired outcome.
Interorganizational Information Systems (IOS)	A system which is built around information technology, i.e., around the computer and communications technology that facilitates the creation, storage, transformation, and transmission of information. An interorganizational system differs from an internal, distributed information system by allowing information to be sent across organizational boundaries. Access to stored data and applications programs is shared, sometimes by varying degrees, by the participants in an interorganizational system (Cash & Konsynski, 1985).
Interorganizational Integration	The extent to which interdependent activities which link interacting organizational units are viewed, operated and managed as a single system (McGee, 1991).
IOS enabled communication	All forms of interorganizational communication that are conducted within the interorganizational information system.
Joint Planning and Decision Making	The critical planning and decision-making processes that require bilateral information flow between supply chain partners. The focus of these joint planning and decision making processes is of a more strategic nature and includes the broad categories of supply planning, demand planning, inventory management and goals and performance measurement.
Non-IOS enabled communication	All forms of interorganizational communication that are outside of the communication conducted within the interorganizational information system.
Supply Chain	An organization of networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute the finished products to customers (Lee & Billington, 1992). In addition, this definition includes the suppliers from whom the raw materials and components, subsystems and systems are purchased.
Performance Results	The set of tangible benefits that accrue to the organization as a

Key Term	Definition
	result of closer interorganizational integration with a supply chain partner.
Supply Planning Business Processes	Supply planning business processes are those processes that enable the supply of acceptable materials/services from your supplier to your firm in a timely fashion. Some examples of the supply planning business processes include (1) supplier development, (2) lead-time/responsiveness planning, (3) supplier product schedule visibility, (4) shared supplier cost information, etc.
Supply Uncertainty	The degree of unpredictability in future material supply states (Pfeffer & Salancik, 1978). Similarly defined in the TCE literature as "unanticipated changes in circumstances surrounding an exchange" (Noordewier, John, & Nevin, 1990).
Trust	A willingness to rely on an exchange partner in whom one has confidence" (Moorman et al., 1992).

Appendix B: Structural Equation Methodology Symbols/Definitions

STRUCTURAL EQUATION METHODOLOGY SYMBOLS/DEFINITIONS

Symbol	Definition (Bollen, 1989)
Θδ (Theta Delta)	Covariance matrix of δ
Θε (Theta Epsilon)	Covariance matrix of ε
x	Observed indicators of η
y	Observed indicators of ξ
δ	Measurement errors for y
ε	Measurement errors for x
φ (Phi)	Covariance matrix of ξ
η (Eta)	Latent endogenous variables
ψ (Psi)	Covariance matrix of ζ
ξ (Ksi)	Latent exogenous variables
ζ (Zeta)	Latent errors in equation
Λ_x (Lambda x)	Coefficient relating y to η
Λ_Y (Lambda y)	Coefficient relating x to ξ
B (Beta)	Coefficient matrix for latent endogenous variables
Γ (Gamma)	Coefficient matrix for latent exogenous variables

Appendix C: Survey Cover Letter

MICHIGAN STATE
UNIVERSITY

Mr. First_Name Last_Name
Title_1
Title_2
Company_Name
Address
City, State Zip

November 11, 1998

Dear First_Name:

The Global Procurement and Supply Chain Benchmarking Initiative in The Eli Broad Graduate School of Management at Michigan State University is conducting a worldwide study to learn how the use of inter-company integrated information systems may help to create better performing supply chains. We request your firm's participation in this critical research. This project is in addition to both our current and scheduled 1999-2000 work.

Establishing inter-company integrated information systems with appropriate suppliers may have a significant impact on a firm's competitiveness through improvements in product development and other cycle times, quality, cost, technology, delivery and product/service value. We will determine what this impact is, as well as relationships to key methods of integration.

In return for your participation, you will receive an Executive Summary of the findings from this research that we will complete during the first quarter of 1999. This Executive Summary will provide your firm with valuable strategic and tactical information for achieving competitive advantage through the use of integrated information systems. Some key outputs in the Executive Summary will include:

- ❑ An analysis/prioritization of which joint planning and decision making activities are better suited for use with an integrated information system and which activities are better left to more traditional ways of sharing information.
- ❑ A prioritization of which joint planning and decision making activities have greater impact on bottom-line supply chain performance.
- ❑ Insight into where firms are having the greatest success and the greatest difficulty in managing the exchange of information with supply chain partners.
- ❑ Recommendations to help improve these communication and joint planning and decision making processes.

Please complete and fax the enclosed ***Fax Participation Response Form*** indicating when we should expect to receive your response (please return your completed survey not later than **December 15, 1998**). If you have any questions regarding items in the questionnaire, please call Ken Petersen, project manager, at (517) 432-2086 ext. 273, or send email to peterl31@pilot msu edu

We strongly encourage your firm's participation in this important research and believe the resulting Executive Summary will be valuable in enhancing your firm's competitiveness. We look forward to your participation

Sincerely,

Robert M Monczka

BROAD

THE ELI BROAD GRADUATE SCHOOL OF MANAGEMENT

The Global Procurement and Supply Chain Benchmarking Initiative

Robert M. Monczka, Ph.D.

Director and Professor of Strategic Sourcing Management and The National Association of Purchasing Management Professor

Michigan State University
N505 North Business Complex
East Lansing Michigan
48824-1122

517 / 432 2086
FAX 517 / 432-2094
E-mail [illegible]
WWW [illegible]

Appendix D: Survey Fax-Back Response Form

The Global Procurement and Supply Chain Benchmarking Initiative
Eli Broad Graduate School of Management • Michigan State University
N505 North Business Complex • East Lansing, MI 48824-1122
Phone: 517/432-2086 ext. 273 • Fax: 517/432-2094 • Internet: peter131@pilot.msu.edu
• WWW: http://gebn.bus.msu.edu

DATE: November 11, 1998

Fax Participation Response Form

FROM: Salutation First_Name Last_Name
Company

RE: **The Impact of Information Systems on Achieving Supply Chain Integration**

1. Please fill out the following form and fax it to The Global Procurement and Supply Chain Benchmarking Initiative at 517-432-2094.

☐ ***Yes*** - I will participate in *The Impact of Information Systems on Achieving Supply Chain Integration.*

You will receive my response by:

☐ November 30, 1998

☐ December 15, 1998 - *If you are responding, we must have your completed questionnaire by this date.*

My fax number is: ____________________________

☐ ***No*** - I will not participate in this study.

PLEASE FAX THIS FORM TO 517-432-2094

(REFERENCE: #)

Appendix E: Survey Instrument

THE GLOBAL PROCUREMENT AND SUPPLY CHAIN BENCHMARKING INITIATIVE

"A Leader in Procurement and Supply Chain Research"

The Eli Broad Graduate School of Management
Michigan State University

Director: Robert M. Monczka, Ph.D.
Principal Investigator: Kenneth J. Petersen

THE IMPACT OF INFORMATION SYSTEMS ON ACHIEVING SUPPLY CHAIN INTEGRATION

SECTION I: BUSINESS UNIT BACKGROUND

Please fill in your contact information in the space provided:

Company Name:			
Your Name:			
Your Title:			
Your Address:			
Telephone Number:	Country Code:	Area/City Code:	Number:
Fax Number	Country Code:	Area/City Code:	Number:
E-Mail Address			

1. **Which description best characterizes your business unit? Please check ONE response only.**

   - ☐ Company
   - ☐ Group
   - ☐ Division
   - ☐ Plant/Site
   - ☐ Other (Specify) ______________________

2. **Where is your business unit located? Please check ONE response only.**

   - ☐ U.S.A.
   - ☐ Canada
   - ☐ Mexico or South America
   - ☐ Australia
   - ☐ Japan
   - ☐ Korea
   - ☐ Hong Kong
   - ☐ Asia Pacific - Other
   - ☐ Western Europe
   - ☐ Eastern Europe
   - ☐ Middle East

3. **Check the box that best describes the manufacturing/operations/service process in the business unit for which you are responding. Please check ONE response only.**

   Manufacturing
   - ☐ Batch fabrication
   - ☐ Batch process
   - ☐ Repetitive manufacturing/assembly
   - ☐ Continuous process

   - ☐ **Service** (Please describe below) ______________________
   - ☐ Other (Please describe below) ______________________

4. **Please check the box that approximately represents the total annual sales revenue for the business unit for which you are responding (U.S. Dollars). Please check ONE response only.**

   - ☐ \$0 - \$250 million
   - ☐ >\$250 million - \$500 million
   - ☐ >\$500 million - \$1 billion
   - ☐ > \$1 billion - \$5 billion
   - ☐ Greater than \$5 billion

5. **Please check the box that best represents your business unit's IMMEDIATE customer for your primary output. Please check ONE response only.**

   - ☐ Another business unit of the same company
   - ☐ Manufacturer
   - ☐ Wholesaler
   - ☐ Retailer
   - ☐ End user (consumer)

SECTION II: INFORMATION QUALITY AND PROCESS OUTCOMES

The following questions ask you about the *Processes In Use* between your business unit and the selected supplier.

6. **FORECASTING AND INVENTORY POSITIONING** - Forecasting and inventory positioning is used to ensure that required items are available at the proper location and in the proper form when needed in the supply chain. An example of information sharing in support of inventory positioning is the joint sharing of forecasted inventory levels by location and quantity, safety stock levels, replenishment cycle information, etc. **The information shared between my BUSINESS UNIT and this SUPPLIER (in support of FORECASTING AND INVENTORY POSITIONING):**

When using Traditional Methods (phone, fax, meetings, postal mail, etc.) is:

	Strongly Agree 1	2	3	Indifferent 4	5	6	Strongly Disagree 7
a. Current	1	2	3	4	5	6	7
b. Accurate	1	2	3	4	5	6	7
c. Complete	1	2	3	4	5	6	7
d. Compatible	1	2	3	4	5	6	7
e. Convenient to access	1	2	3	4	5	6	7

When using Linked Information Systems (EDI, MRP, ERP, WWW, etc.) is:

	Strongly Agree 1	2	3	Indifferent 4	5	6	Strongly Disagree 7
f. Current	1	2	3	4	5	6	7
g. Accurate	1	2	3	4	5	6	7
h. Complete	1	2	3	4	5	6	7
i. Compatible	1	2	3	4	5	6	7
j. Convenient to access	1	2	3	4	5	6	7

	Strongly Agree 1	2	3	Indifferent 4	5	6	Strongly Disagree 7
k. The ***forecasting and inventory positioning*** process in place with this supplier has helped **MY BUSINESS UNIT** to make effective decisions	1	2	3	4	5	6	7
l. The ***forecasting and inventory positioning*** process in place with this supplier has helped this **SUPPLIER** to make effective decisions	1	2	3	4	5	6	7
m. The ***forecasting and inventory positioning*** process in place with this supplier has provided positive results for **MY BUSINESS UNIT**	1	2	3	4	5	6	7
n. The ***forecasting and inventory positioning*** process in place with this supplier has provided positive results for this **SUPPLIER**	1	2	3	4	5	6	7

7. **INVENTORY VISIBILITY** - Inventory visibility provides the ability to track where any given item is physically located (transit, customs, supplier, etc.) or where it was used. An example of information sharing in support of inventory visibility includes the joint sharing of current inventory information by location and quantity. **The information shared between my BUSINESS UNIT and this SUPPLIER (in support of INVENTORY VISIBILITY):**

When using Traditional Methods (phone, fax, meetings, postal mail, etc.) is:

	Strongly Agree 1	2	3	Indifferent 4	5	6	Strongly Disagree 7
a. Current	1	2	3	4	5	6	7
b. Accurate	1	2	3	4	5	6	7
c. Complete	1	2	3	4	5	6	7
d. Compatible	1	2	3	4	5	6	7
e. Convenient to access	1	2	3	4	5	6	7

When using Linked Information Systems (EDI, MRP, ERP, WWW, etc.) is:

	Strongly Agree 1	2	3	Indifferent 4	5	6	Strongly Disagree 7
f. Current	1	2	3	4	5	6	7
g. Accurate	1	2	3	4	5	6	7
h. Complete	1	2	3	4	5	6	7
i. Compatible	1	2	3	4	5	6	7
j. Convenient to access	1	2	3	4	5	6	7

	Strongly Agree 1	2	3	Indifferent 4	5	6	Strongly Disagree 7
k. The ***inventory visibility*** process in place with this supplier has helped **MY BUSINESS UNIT** to make effective decisions	1	2	3	4	5	6	7
l. The ***inventory visibility*** process in place with this supplier has helped this **SUPPLIER** to make effective decisions	1	2	3	4	5	6	7
m. The ***inventory visibility*** process in place with this supplier has provided positive results for **MY BUSINESS UNIT**	1	2	3	4	5	6	7
n. The ***inventory visibility*** process in place with this supplier has provided positive results for this **SUPPLIER**	1	2	3	4	5	6	7

8. **CAPACITY PLANNING - Capacity planning is conducted to ensure that the supplier will have the ability to produce or make available the required items/services in the required lead-time. An example of information sharing in support of capacity planning would include (1) the supplier sharing plant capacity utilization information with your business unit or (2) your business unit sharing future demand forecasts and plans with the supplier. The information shared between my BUSINESS UNIT and this SUPPLIER (in support of CAPACITY PLANNING):**

When using Traditional Methods (phone, fax, meetings, postal mail, etc.) is:

	Strongly Agree		Indifferent				Strongly Disagree
a. Current	1	2	3	4	5	6	7
b. Accurate	1	2	3	4	5	6	7
c. Complete	1	2	3	4	5	6	7
d. Compatible	1	2	3	4	5	6	7
e. Convenient to access	1	2	3	4	5	6	7

When using Linked Information Systems (EDI, MRP, ERP, WWW, etc.) is:

	Strongly Agree		Indifferent				Strongly Disagree
f. Current	1	2	3	4	5	6	7
g. Accurate	1	2	3	4	5	6	7
h. Complete	1	2	3	4	5	6	7
i. Compatible	1	2	3	4	5	6	7
j. Convenient to access	1	2	3	4	5	6	7

	Strongly Agree			Indifferent			Strongly Disagree
k. The ***capacity planning*** process in place with this supplier has helped MY BUSINESS UNIT to make effective decisions	1	2	3	4	5	6	7
l. The ***capacity planning*** process in place with this supplier has helped this SUPPLIER to make effective decisions	1	2	3	4	5	6	7
m. The ***capacity planning*** process in place with this supplier has provided positive results for MY BUSINESS UNIT	1	2	3	4	5	6	7
n. The ***capacity planning*** process in place with this supplier has provided positive results for this SUPPLIER	1	2	3	4	5	6	7

9. **POST SUPPLIER SELECTION PERFORMANCE EVALUATION/FEEDBACK AND CONFORMANCE** - Post supplier selection performance evaluation/feedback and conformance (based on objective measures) is used to ensure that there is joint understanding and agreement about both your firm's and the supplier's performance. Examples of information sharing in support of post selection performance evaluation/feedback and conformance include (1) your business unit sharing supplier performance information about quality, delivery, responsiveness, using agreed to metrics with the supplier or (2) the supplier sharing similar performance information with your business unit. **The information shared between my BUSINESS UNIT and this SUPPLIER (in support of POST SUPPLIER SELECTION PERFORMANCE EVALUATION/FEEDBACK AND CONFORMANCE):**

When using Traditional Methods (phone, fax, meetings, postal mail, etc.) is:

	Strongly Agree		Indifferent				Strongly Disagree
a. Current	1	2	3	4	5	6	7
b. Accurate	1	2	3	4	5	6	7
c. Complete	1	2	3	4	5	6	7
d. Compatible	1	2	3	4	5	6	7
e. Convenient to access	1	2	3	4	5	6	7

When using Linked Information Systems (EDI, MRP, ERP, WWW, etc.) is:

	Strongly Agree		Indifferent				Strongly Disagree
f. Current	1	2	3	4	5	6	7
g. Accurate	1	2	3	4	5	6	7
h. Complete	1	2	3	4	5	6	7
i. Compatible	1	2	3	4	5	6	7
j. Convenient to access	1	2	3	4	5	6	7

	Strongly Agree			Indifferent			Strongly Disagree
k. The ***post selection supplier performance evaluation/feedback and conformance*** process in place with this supplier has helped MY BUSINESS UNIT to make effective decisions	1	2	3	4	5	6	7
l. The ***post selection supplier performance evaluation/feedback and conformance*** process in place with this supplier has helped this SUPPLIER to make effective decisions	1	2	3	4	5	6	7
m. The ***post selection supplier performance evaluation/feedback and conformance*** process in place with this supplier has provided positive results for MY BUSINESS UNIT	1	2	3	4	5	6	7
n. The ***post selection supplier performance evaluation/feedback and conformance*** process in place with this supplier has provided positive results for this SUPPLIER	1	2	3	4	5	6	7

10. **SOURCING AND SUPPLY PROPOSAL EVALUATION** - Sourcing and supply proposal evaluation is the process of setting the terms and conditions of the purchase. These terms and conditions frequently include price, quantity, quantity discount, quality, technology, etc. Examples of information sharing in support of sourcing and supply proposal evaluation include (1) your firm sending the supplier a request for quotation (RFQ) or (2) the supplier sending your firm a quote in response to your firm's RFQ. **The information shared between my BUSINESS UNIT and this SUPPLIER (in support of SOURCING AND SUPPLY PROPOSAL EVALUATION):**

When using Traditional Methods (phone, fax, meetings, postal mail, etc.) is:

	Strongly Agree		Indifferent				Strongly Disagree
a. Current	1	2	3	4	5	6	7
b. Accurate	1	2	3	4	5	6	7
c. Complete	1	2	3	4	5	6	7
d. Compatible	1	2	3	4	5	6	7
e. Convenient to access	1	2	3	4	5	6	7

When using Linked Information Systems (EDI, MRP, ERP, WWW, etc.) is:

	Strongly Agree		Indifferent				Strongly Disagree
f. Current	1	2	3	4	5	6	7
g. Accurate	1	2	3	4	5	6	7
h. Complete	1	2	3	4	5	6	7
i. Compatible	1	2	3	4	5	6	7
j. Convenient to access	1	2	3	4	5	6	7

	Strongly Agree			Indifferent			Strongly Disagree
k. The ***sourcing and supply proposal evaluation*** process in place with this supplier has helped **MY BUSINESS UNIT** to make effective decisions	1	2	3	4	5	6	7
l. The ***sourcing and supply proposal evaluation*** process in place with this supplier has helped this **SUPPLIER** to make effective decisions	1	2	3	4	5	6	7
m. The ***sourcing and supply proposal evaluation*** process in place with this supplier has provided positive results for **MY BUSINESS UNIT**	1	2	3	4	5	6	7
n. The ***sourcing and supply proposal evaluation*** process in place with this supplier has provided positive results for this **SUPPLIER**	1	2	3	4	5	6	7

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11. **PART/MATERIAL STANDARDIZATION** - Part/material standardization is used to reduce the number of unique parts/materials maintained in the inventory system by using more standard and fewer unique parts/materials. Examples of information sharing in support of part/material standardization would include (1) your business unit sharing materials lists with the supplier and (2) the supplier evaluating these lists and making recommendations to your business unit about any possible standard part substitutions. **The information shared between my BUSINESS UNIT and this SUPPLIER (in support of PART/MATERIAL STANDARDIZATION):**

When using Traditional Methods (phone, fax, meetings, postal mail, etc.) is:

	Strongly Agree		Indifferent				Strongly Disagree
a. Current	1	2	3	4	5	6	7
b. Accurate	1	2	3	4	5	6	7
c. Complete	1	2	3	4	5	6	7
d. Compatible	1	2	3	4	5	6	7
e. Convenient to access	1	2	3	4	5	6	7

When using Linked Information Systems (EDI, MRP, ERP, WWW, etc.) is:

	Strongly Agree		Indifferent				Strongly Disagree
f. Current	1	2	3	4	5	6	7
g. Accurate	1	2	3	4	5	6	7
h. Complete	1	2	3	4	5	6	7
i. Compatible	1	2	3	4	5	6	7
j. Convenient to access	1	2	3	4	5	6	7

	Strongly Agree			Indifferent			Strongly Disagree
k. The ***part/material standardization*** process in place with this supplier has helped **MY BUSINESS UNIT** to make effective decisions	1	2	3	4	5	6	7
l. The ***part/material standardization*** process in place with this supplier has helped this **SUPPLIER** to make effective decisions	1	2	3	4	5	6	7
m. The ***part/material standardization*** process in place with this supplier has provided positive results for **MY BUSINESS UNIT**	1	2	3	4	5	6	7
n. The ***part/material standardization*** process in place with this supplier has provided positive results for this **SUPPLIER**	1	2	3	4	5	6	7

12. **SUPPLIER SCHEDULING** – The supplier scheduling process controls the releases of orders through MRP (or other) and ensures communications of priorities, needs, and quantities between the buying organization's production or operations management system and suppliers. Examples of information sharing in support of supplier scheduling include the sharing of information related to order date, quantity ordered, required due date, ship-to-location, item identification, key contact person and so forth. **The information shared between my BUSINESS UNIT and this SUPPLIER (in support of SUPPLIER SCHEDULING):**

When using Traditional Methods (phone, fax, meetings, postal mail, etc.) is:

	Strongly Agree			Indifferent			Strongly Disagree
a. Current	1	2	3	4	5	6	7
b. Accurate	1	2	3	4	5	6	7
c. Complete	1	2	3	4	5	6	7
d. Compatible	1	2	3	4	5	6	7
e. Convenient to access	1	2	3	4	5	6	7

When using Linked Information Systems (EDI, MRP, ERP, WWW, etc.) is:

	Strongly Agree			Indifferent			Strongly Disagree
f. Current	1	2	3	4	5	6	7
g. Accurate	1	2	3	4	5	6	7
h. Complete	1	2	3	4	5	6	7
i. Compatible	1	2	3	4	5	6	7
j. Convenient to access	1	2	3	4	5	6	7

	Strongly Agree			Indifferent			Strongly Disagree
k. The ***supplier scheduling process*** in place with this supplier has helped **MY BUSINESS UNIT** to make effective decisions	1	2	3	4	5	6	7
l. The ***supplier scheduling process*** in place with this supplier has helped this **SUPPLIER** to make effective decisions	1	2	3	4	5	6	7
m. The ***supplier scheduling process*** in place with this supplier has provided positive results for **MY BUSINESS UNIT**	1	2	3	4	5	6	7
n. The ***supplier scheduling process*** in place with this supplier has provided positive results for this **SUPPLIER**	1	2	3	4	5	6	7

13. **JOINT GOAL/TARGET SETTING** - Joint goal/target setting ensures that there are mutually acceptable performance targets that are rooted in common/aligned metrics. An example of information sharing in support of joint goal/target setting includes when your business unit and a supplier share information when establishing acceptable purchased-product quality levels (Cpk, ppm, etc.), responsiveness, on-time delivery, cost improvements, etc. **The information shared between my BUSINESS UNIT and this SUPPLIER (in support of JOINT GOAL/TARGET SETTING):**

When using Traditional Methods (phone, fax, meetings, postal mail, etc.) is:

	Strongly Agree			Indifferent			Strongly Disagree
a. Current	1	2	3	4	5	6	7
b. Accurate	1	2	3	4	5	6	7
c. Complete	1	2	3	4	5	6	7
d. Compatible	1	2	3	4	5	6	7
e. Convenient to access	1	2	3	4	5	6	7

When using Linked Information Systems (EDI, MRP, ERP, WWW, etc.) is:

	Strongly Agree			Indifferent			Strongly Disagree
f. Current	1	2	3	4	5	6	7
g. Accurate	1	2	3	4	5	6	7
h. Complete	1	2	3	4	5	6	7
i. Compatible	1	2	3	4	5	6	7
j. Convenient to access	1	2	3	4	5	6	7

	Strongly Agree			Indifferent			Strongly Disagree
k. The ***joint goal/target setting*** process in place with this supplier has helped **MY BUSINESS UNIT to make effective decisions**	1	2	3	4	5	6	7
l. The ***joint goal/target setting*** process in place with this supplier has helped this **SUPPLIER** to make effective decisions	1	2	3	4	5	6	7
m. The ***joint goal/target setting*** process in place with this supplier has provided positive results for **MY BUSINESS UNIT**	1	2	3	4	5	6	7
n. The ***joint goal/target setting*** process in place with this supplier has provided positive results for this **SUPPLIER**	1	2	3	4	5	6	7

SECTION III: RELATIONSHIP CHARACTERISTICS

The following questions ask you about the *RELATIONSHIP* between your BUSINESS UNIT and the selected supplier.

		Strongly Agree			Neither Agree Nor Disagree			Strongly Disagree
14.	I think the people at this supplier firm tell the truth in negotiations	1	2	3	4	5	6	7
15.	I think that this supplier meets its obligations to our department	1	2	3	4	5	6	7
16.	In my opinion this supplier is reliable	1	2	3	4	5	6	7
17.	I think that the people in this supplier firm succeed by stepping on other people	1	2	3	4	5	6	7
18.	I feel that this supplier tries to get the upper hand	1	2	3	4	5	6	7
19.	I think that this supplier takes advantage of our problems	1	2	3	4	5	6	7
20.	I feel that this supplier negotiates honestly	1	2	3	4	5	6	7
21.	I feel that the people at this supplier will keep their word	1	2	3	4	5	6	7
22.	I think that this supplier does not mislead us	1	2	3	4	5	6	7
23.	I feel that this supplier does not try to get out of commitments	1	2	3	4	5	6	7
24.	I feel that this supplier negotiates joint expectations fairly	1	2	3	4	5	6	7
25.	I feel that this supplier takes advantage of people who are vulnerable	1	2	3	4	5	6	7
26.	We are dependent on this supplier	1	2	3	4	5	6	7
27.	This supplier would be difficult to replace	1	2	3	4	5	6	7
28.	This supplier would be costly to loose	1	2	3	4	5	6	7
29.	This supplier is dependent on us	1	2	3	4	5	6	7
30.	This supplier would find it difficult to replace us	1	2	3	4	5	6	7
31.	This supplier would find it costly to lose us	1	2	3	4	5	6	7

SECTION IV: UNCERTAINTY IN YOUR SUPPLY ENVIRONMENT

The following questions ask you about the *UNCERTAINTY* in your SUPPLY ENVIRONMENT.

		Strongly Agree			Neither Agree Nor Disagree			Strongly Disagree
32.	The supply of material to my firm has been stable	1	2	3	4	5	6	7
33.	The supply of material to my firm has been predictable	1	2	3	4	5	6	7
34.	The price of material to my firm has been stable	1	2	3	4	5	6	7
35.	The price of material to my firm has been predictable	1	2	3	4	5	6	7
36.	There are many qualified suppliers from which to choose	1	2	3	4	5	6	7
37.	Technology is relatively stable in my industry	1	2	3	4	5	6	7
38.	Customer demand is relatively stable in my industry	1	2	3	4	5	6	7
39.	My firm's product mix generally stays about the same	1	2	3	4	5	6	7
40.	Our customers don't demand changes in technology very frequently	1	2	3	4	5	6	7
41.	My industry is characterized by fierce and changing competition	1	2	3	4	5	6	7

SECTION V: PERFORMANCE

Please indicate the ***degree*** to which you feel that your **OVERALL BUSINESS UNIT'S PERFORMANCE** has changed over the past two years:

	Much Better			Neither Better Nor Worse			Much Worse
42. Return on investment (ROI)	1	2	3	4	5	6	7
43. Return on equity (ROE)	1	2	3	4	5	6	7
44. Profit margin	1	2	3	4	5	6	7
45. Cash-to-cash cycle time	1	2	3	4	5	6	7
46. External customer service levels	1	2	3	4	5	6	7
47. Total inventory turnover rate	1	2	3	4	5	6	7
48. Supplier on-time delivery	1	2	3	4	5	6	7
49. Purchase price reduction	1	2	3	4	5	6	7
50. Purchase price reduction compared to market	1	2	3	4	5	6	7
51. Total cost reduction	1	2	3	4	5	6	7
52. Supplier quality performance	1	2	3	4	5	6	7
53. Supplier responsiveness	1	2	3	4	5	6	7

	Much Better			No Change			Much Worse
54. How much have your ***OVERALL*** supply chain processes improved/worsened over the past two years? (check one)	1	2	3	4	5	6	7

Please indicate the ***degree*** to which you feel that each of the processes listed below has improved over the past two years:

	Much Better			Neither Better Nor Worse			Much Worse
55. Forecasting and Inventory Positioning	1	2	3	4	5	6	7
56. Inventory Visibility	1	2	3	4	5	6	7
57. Capacity Planning	1	2	3	4	5	6	7
58. Post Supplier Selection Performance Evaluation/Feedback and Conformance	1	2	3	4	5	6	7
59. Sourcing and Supply Proposal Evaluation	1	2	3	4	5	6	7
60. Part/Material Standardization	1	2	3	4	5	6	7
61. Supplier Scheduling	1	2	3	4	5	6	7
62. Joint Goal/Target Setting	1	2	3	4	5	6	7

	Much Better			Neither Better Nor Worse			Much Worse
63. How much have your business unit's ***OVERALL*** joint planning and decision making processes changed over the past two years? (check one)	1	2	3	4	5	6	7
64. How much have your supplier's ***OVERALL*** joint planning and decision making processes changed over the past two years? (check one)	1	2	3	4	5	6	7
65. To what extent have your business unit's and your supplier's joint planning and decision making processes jointly improved over the past two years? (check one)	1	2	3	4	5	6	7

66. By what degree have your supply chain processes improved your business unit's profitability over the past two years (as a % of profits)? (check one)

☐ < 0%	☐ 11% - 15%	☐ 26% - 30%
☐ 1% - 5%	☐ 16% - 20%	☐ 31% - 35%
☐ 6% - 10%	☐ 21% - 25%	☐ > 35%

Thank you!
We expect that the results of this research will be available to you in Spring, 1999

Appendix F: Non-Response Bias

Tables in this appendix contain the probability values associated with the null hypothesis that there is no difference (on each given parameter) between the first twenty cases received and the last twenty cases received. Probability values less than .05 indicate that the null hypothesis should be rejected (95% confidence).

Table 25: Forecasting and Inventory Positioning - Non-Response Bias

	Currency	Accuracy	Completeness
Non-IOS Enabled	0.74	0.78	0.39
IOS Enabled	0.59	0.77	0.56
Effective Decisions	0.44		
Positive Results	0.44		
Inventory Turnover	1.00		
On-Time Delivery	0.77		
Responsiveness	0.66		

Table 26: Inventory Visibility - Non-Response Bias

	Currency	Accuracy	Completeness
Non-IOS Enabled	0.80	0.75	0.78
IOS Enabled	0.54	0.45	0.45
Effective Decisions	0.33		
Positive Results	0.62		
On-Time Delivery	0.85		
Responsiveness	0.50		

Table 27: Capacity Planning – Non-Response Bias

	Currency	Accuracy	Completeness
Non-IOS Enabled	0.86	0.92	0.67
IOS Enabled	0.72	0.69	0.85
Effective Decisions	0.85		
Positive Results	0.84		
ROI	0.83		
ROE	0.91		
Profit Margin	0.61		

Table 28: Post Supplier Selection Performance Evaluation/Feedback and Conformance – Non-Response Bias

	Currency	Accuracy	Completeness
Non-IOS Enabled	1.00	0.67	0.50
IOS Enabled	0.09	0.16	0.13
Effective Decisions	0.07		
Positive Results	0.24		
On-Time Delivery	1.00		
Total Cost Reduction	0.88		
Supplier Quality Performance	0.73		

Table 29: Sourcing and Supply Proposal Evaluation – Non-Response Bias

	Currency	Accuracy	Completeness
Non-IOS Enabled	0.24	0.91	0.68
IOS Enabled	0.03	0.02	0.03
Effective Decisions	0.50		
Positive Results	0.72		
Purchase Price Reduction	0.91		
Purchase Price Reduction Compared to Market	0.04		
Total Cost Reduction	0.76		

Table 30: Part/Material Standardization – Non-Response Bias

	Currency	Accuracy	Completeness
Non-IOS Enabled	0.05	0.32	0.45
IOS Enabled	0.36	0.17	0.38
Effective Decisions	0.00		
Positive Results	0.02		
Total Inventory Turnover	0.74		
Supplier On-Time Delivery	0.88		
Purchase Price Reduction	0.23		

Table 31: Supplier Scheduling – Non-Response Bias

	Currency	Accuracy	Completeness
Non-IOS Enabled	0.79	0.66	0.61
IOS Enabled	0.29	0.38	0.78
Effective Decisions	0.11		
Positive Results	0.19		
Profit Margin	0.41		
Cash to Cash Cycle Time	0.46		
Supplier On-Time Delivery	0.87		

Table 32: Joint Goal/Target Setting – Non-Response Bias

	Currency	Accuracy	Completeness
Non-IOS Enabled	0.70	0.38	0.75
IOS Enabled	0.02	0.02	0.01
Effective Decisions	0.04		
Positive Results	0.44		
Purchase Price Reduction	0.62		
Total Cost Reduction	0.89		

Appendix G: Confirmatory Factor Analysis

Forecasting and Inventory Positioning

Table 33: CFA - Forecasting & Inventory Positioning

Manifest Variable	Latent Variable	Standardized λ	Z-Value	Statistical Significance
Current	N-IOS	0.834	3.417	P<.01
Accurate	N-IOS	0.961	3.452	P<.01
Complete	N-IOS	0.888	3.413	P<.01
Current	IOS	0.870	6.644	P<.01
Accurate	IOS	0.958	6.933	P<.01
Complete	IOS	0.945	6.953	P<.01
Effective Decisions	JPDM	0.921	7.083	P<.01
Positive Results	JPDM	0.947	7.349	P<.01
Inventory Turnover	Performance	0.470	3.321	P<.01
On-Time Delivery	Performance	0.817	4.510	P<.01
Responsiveness	Performance	0.589	3.666	P<.01

Table 34: CFA - Forecasting & Inventory Positioning - Fit Statistics

Chi-Square =	35.01
Degrees of Freedom =	37
P =	0.56263
BENTLER-BONETT NORMED FIT INDEX =	0.843
BENTLER-BONETT NONNORMED FIT INDEX =	1.018
COMPARATIVE FIT INDEX =	1.000

Table 35: CFA - Forecasting & Inventory Positioning – Measurement Error Correlations

	IOS – Enabled			
		Current	Accurate	Complete
Non-IOS Enabled	Current	0.190 (p<0.1)		
	Accurate		0.036 (p=n.s.)	
	Complete			0.430 (p<.01)

Inventory Visibility

Table 36: CFA - Inventory Visibility

Manifest Variable	Latent Variable	Standardized λ	Z-Value	Statistical Significance
Current	N-IOS	0.872	3.267	P<.01
Accurate	N-IOS	0.959	3.275	P<.01
Complete	N-IOS	0.896	3.222	P<.01
Current	IOS	0.933	5.783	P<.01
Accurate	IOS	0.960	5.779	P<.01
Complete	IOS	0.964	5.886	P<.01
Effective Decisions	JPDM Buying Co.	0.952	7.714	P<.01
Positive Results	JPDM Buying Co.	0.965	7.834	P<.01
On-Time Delivery	Performance	0.798	4.157	P<.01
Responsiveness	Performance	0.605	3.135	P<.01

Table 37: CFA - Inventory Visibility - Fit Statistics

Chi-Square =	24.696
Degrees of Freedom =	28
P =	0.64435
BENTLER-BONETT NORMED FIT INDEX =	0.885
BENTLER-BONETT NONNORMED FIT INDEX =	1.031
COMPARATIVE FIT INDEX =	1.000

Table 38: CFA - Inventory Visibility – Measurement Error Correlations

	IOS – Enabled			
		Current	Accurate	Complete
Non-IOS Enabled	Current	0.068 (p=n.s.)		
	Accurate		0.201 (p=n.s.)	
	Complete			0.199 (p=n.s.)

Capacity Planning

Table 39: CFA – Capacity Planning

Manifest Variable	Latent Variable	Standardized λ	Z-Value	Statistical Significance
Current	N-IOS	0.892	5.397	P<.01
Accurate	N-IOS	0.995	5.529	P<.01
Complete	N-IOS	0.959	5.434	P<.01
Current	IOS	0.956	6.366	P<.01
Accurate	IOS	0.974	6.401	P<.01
Complete	IOS	0.987	6.422	P<.01
Effective Decisions	JPDM Buying Co.	0.959	8.364	P<.01
Positive Results	JPDM Buying Co.	0.958	8.495	P<.01
ROI	Performance	0.977	2.416	P<.01
ROE	Performance	0.944	2.405	
Profit Margin	Performance	0.796	2.371	P<.01

Table 40: CFA – Capacity Planning - Fit Statistics

Chi-Square = Degrees of Freedom = P =	27.445 37 0.87380
BENTLER-BONETT NORMED FIT INDEX =	0.895
BENTLER-BONETT NONNORMED FIT INDEX =	1.069
COMPARATIVE FIT INDEX =	1.000

Table 41: CFA – Capacity Planning – Measurement Error Correlations

	IOS – Enabled			
		Current	Accurate	Complete
Non-IOS Enabled	Current	0.317 (p<.01)		
	Accurate		-0.127 (p=n.s.)	
	Complete			0.518 (p<.01)

Post Supplier Selection Performance Evaluation/Feedback and Conformance

Table 42: CFA – Post Supplier Selection Performance Evaluation/Feedback and Conformance

Manifest Variable	Latent Variable	Standardized λ	Z-Value	Statistical Significance
Current	N-IOS	0.926	2.525	P<.01
Accurate	N-IOS	0.971	2.532	P<.01
Complete	N-IOS	0.975	2.526	P<.01
Current	IOS	0.951	2.482	P<.01
Accurate	IOS	0.985	2.488	P<.01
Complete	IOS	0.980	2.475	P<.01
Effective Decisions	JPDM Buying Co.	0.945	3.450	P<.01
Positive Results	JPDM Buying Co.	0.970	3.544	P<.01
On-Time Delivery	Performance	0.683	2.184	P<.05
Total Cost Reduction	Performance	0.586	2.090	P<.05
Supplier Quality Performance	Performance	0.719	2.246	P<.05

Table 43: CFA – Post Supplier Selection Performance Evaluation/Feedback and Conformance - Fit Statistics

Chi-Square =	42.622
Degrees of Freedom =	37
P =	0.24072
BENTLER-BONETT NORMED FIT INDEX =	0.816
BENTLER-BONETT NONNORMED FIT INDEX =	0.952
COMPARATIVE FIT INDEX =	0.968

Table 44: CFA – Post Supplier Selection Performance Evaluation/Feedback and Conformance – Measurement Error Correlations

	IOS – Enabled			
		Current	Accurate	Complete
Non-IOS Enabled	Current	0.405 (p<.01)		
	Accurate		-0.531 (p<.01)	
	Complete			0.422 (p<.1)

Sourcing and Supply Proposal Evaluation

Table 45: CFA – Sourcing and Supply Proposal Evaluation

Manifest Variable	Latent Variable	Standardized λ	Z-Value	Statistical Significance
Current	N-IOS	0.907	2.571	P<.01
Accurate	N-IOS	0.963	2.541	P<.01
Complete	N-IOS	0.959	2.565	P<.01
Current	IOS	0.969	2.970	P<.01
Accurate	IOS	0.985	2.957	P<.01
Complete	IOS	0.966	2.959	P<.01
Effective Decisions	JPDM Buying Co.	0.828	3.808	P<.01
Positive Results	JPDM Buying Co.	0.960	4.340	P<.01
Purchase Price Reduction	Performance	0.870	3.127	P<.01
Purchase Price Reduction – Compared to Market	Performance	0.836	3.049	P<.01
Total Cost Reduction	Performance	0.833	3.014	P<.01

Table 46: CFA – Sourcing and Supply Proposal Evaluation - Fit Statistics

Chi-Square =	35.832
Degrees of Freedom =	37
P =	0.52369
BENTLER-BONETT NORMED FIT INDEX =	0.839
BENTLER-BONETT NONNORMED FIT INDEX =	1.010
COMPARATIVE FIT INDEX =	1.000

Table 47: CFA – Sourcing and Supply Proposal Evaluation – Measurement Error Correlations

		IOS – Enabled		
Non-IOS Enabled		Current	Accurate	Complete
	Current	0.360 (p<.01)		
	Accurate		-0.334 (p=n.s.)	
	Complete			0.141 (p=n.s.)

Part/Material Standardization

Table 48: CFA – Part/Material Standardization

Manifest Variable	Latent Variable	Standardized λ	Z-Value	Statistical Significance
Current	N-IOS	0.913	4.209	P<.01
Accurate	N-IOS	0.975	4.189	P<.01
Complete	N-IOS	0.955	4.177	P<.01
Current	IOS	0.956	4.326	P<.01
Accurate	IOS	0.977	4.366	P<.01
Complete	IOS	0.950	4.328	P<.01
Effective Decisions	JPDM Buying Co.	0.956	6.153	P<.01
Positive Results	JPDM Buying Co.	0.982	6.221	P<.01
Total Inventory Turnover	Performance	0.665	1.426	P<.2
Supplier On-Time Delivery	Performance	0.726	1.427	P<.2
Purchase Price Reduction	Performance	0.378	1.349	P<.2

Table 49: CFA – Part/Material Standardization - Fit Statistics

Chi-Square =	34.738
Degrees of Freedom =	37
P =	0.57556
BENTLER-BONETT NORMED FIT INDEX =	0.850
BENTLER-BONETT NONNORMED FIT INDEX =	1.019
COMPARATIVE FIT INDEX =	1.000

Table 50: CFA – Part/Material Standardization – Measurement Error Correlations

	IOS – Enabled			
		Current	Accurate	Complete
Non-IOS Enabled	Current	0.334 (p<.01)		
	Accurate		0.271 (p=n.s.)	
	Complete			0.359 (p<.05)

Supplier Scheduling

Table 51: CFA – Supplier Scheduling

Manifest Variable	Latent Variable	Standardized λ	Z-Value	Statistical Significance
Current	N-IOS	0.922	1.920	P<.1
Accurate	N-IOS	0.979	1.933	P<.1
Complete	N-IOS	0.957	1.911	P<.1
Current	IOS	0.911	3.214	P<.01
Accurate	IOS	0.968	3.237	P<.01
Complete	IOS	0.961	3.257	P<.01
Effective Decisions	JPDM Buying Co.	0.943	3.933	P<.01
Positive Results	JPDM Buying Co.	0.955	3.972	P<.01
Profit Margin	Performance	0.711	2.269	P<.05
Cash to Cash Cycle Time	Performance	0.796	2.357	P<.01
Supplier On-Time Delivery	Performance	0.442	2.065	P<.05

Table 52: CFA – Supplier Scheduling - Fit Statistics

Chi-Square =	36.387
Degrees of Freedom =	37
P =	0.49757
BENTLER-BONETT NORMED FIT INDEX =	0.835
BENTLER-BONETT NONNORMED FIT INDEX =	1.005
COMPARATIVE FIT INDEX =	1.000

Table 53: CFA – Supplier Scheduling – Measurement Error Correlations

		IOS – Enabled		
		Current	Accurate	Complete
Non-IOS Enabled	Current	-0.62 (p=n.s.)		
	Accurate		-0.078 (p=n.s.)	
	Complete			0.69 (p=n.s.)

Joint Goal/Target Setting

Table 54: CFA – Joint Goal/Target Setting

Manifest Variable	Latent Variable	Standardized λ	Z-Value	Statistical Significance
Current	N-IOS	0.926	6.824	P<.01
Accurate	N-IOS	0.964	6.769	P<.01
Complete	N-IOS	0.944	6.679	P<.01
Current	IOS	0.985	4.539	P<.01
Accurate	IOS	0.993	4.549	P<.01
Complete	IOS	0.961	4.521	P<.01
Effective Decisions	JPDM Buying Co.	0.978	8.448	P<.01
Positive Results	JPDM Buying Co.	0.937	8.012	P<.01
Purchase Price Reduction	Performance	0.807	3.225	P<.01
Total Cost Reduction	Performance	0.785	3.056	P<.01

Table 55: CFA – Joint Goal/Target Setting - Fit Statistics

Chi-Square =	31.439
Degrees of Freedom =	28
P =	0.29793
BENTLER-BONETT NORMED FIT INDEX =	0.864
BENTLER-BONETT NONNORMED FIT INDEX =	0.970
COMPARATIVE FIT INDEX =	0.981

Table 56: CFA – Joint Goal/Target Setting – Measurement Error Correlations

	IOS – Enabled			
		Current	Accurate	Complete
Non-IOS Enabled	Current	0.563 (p<.01)		
	Accurate		-0.461 (p<.05)	
	Complete			0.393 (p<.01)

Appendix H: Structural Equation Models

Forecasting and Inventory Positioning

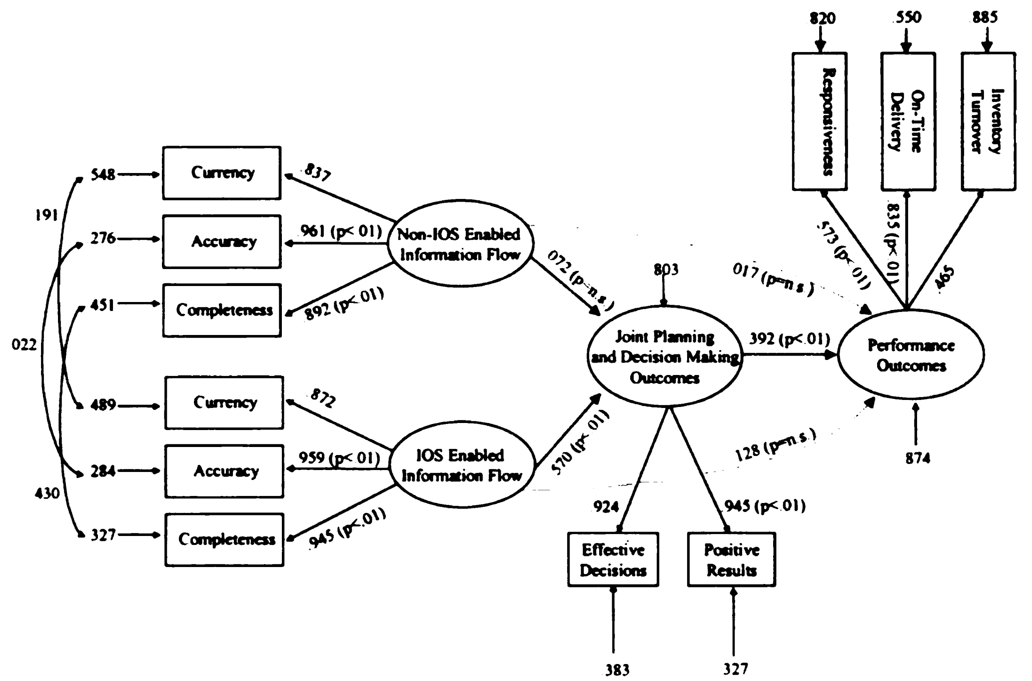

Figure 21: SEM - Forecasting & Inventory Positioning

Table 57: SEM - Forecasting & Inventory Positioning - Fit Statistics

Chi-Square =	35.518	
Degrees of Freedom =	35	
P =	.53970	
BENTLER-BONETT NORMED FIT INDEX =		0.850
BENTLER-BONETT NONNORMED FIT INDEX =		1.014
COMPARATIVE FIT INDEX =		1.000

Inventory Visibility

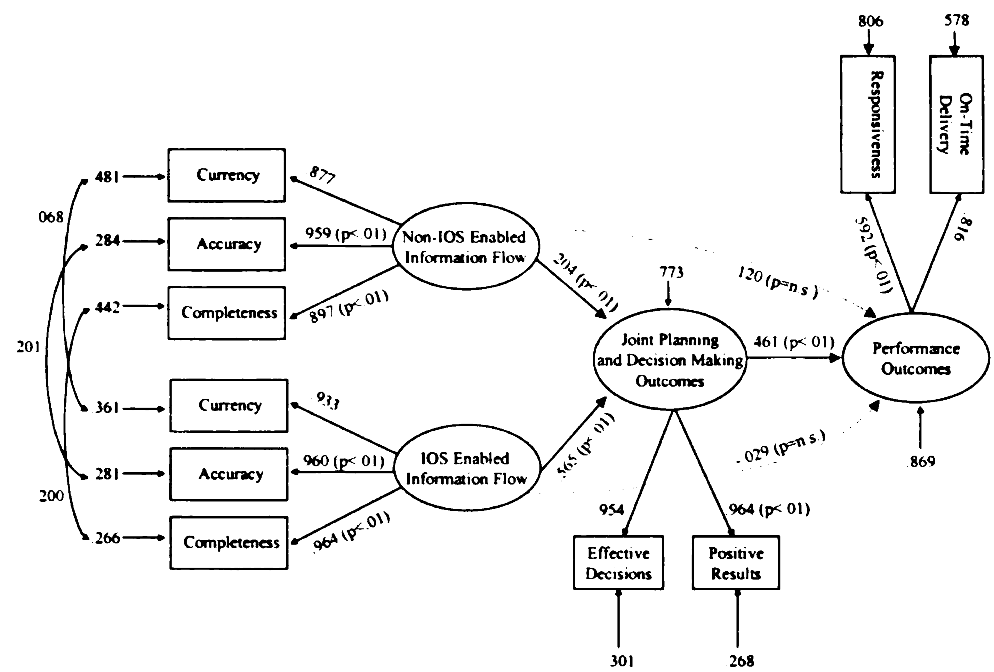

Figure 22: SEM - Inventory Visibility

Table 58: SEM – Inventory Visibility – Fit Statistics

Chi-Square =	23.457
Degrees of Freedom =	26
P =	0.60701
BENTLER-BONETT NORMED FIT INDEX =	0.890
BENTLER-BONETT NONNORMED FIT INDEX =	1.026
COMPARATIVE FIT INDEX =	1.000

Capacity Planning

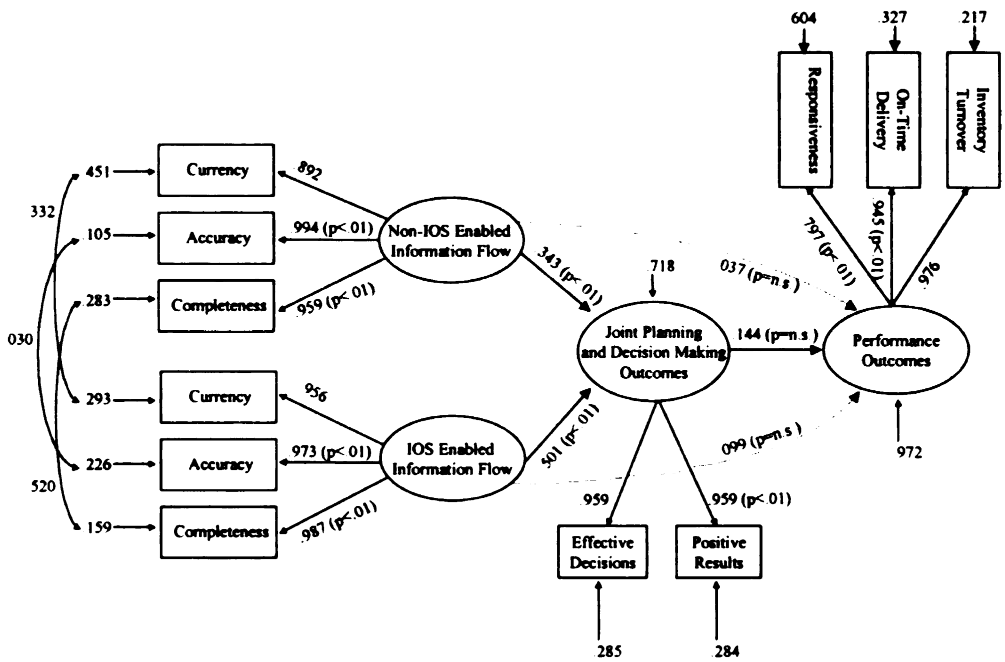

Figure 23: SEM - Capacity Planning

Table 59: SEM – Capacity Planning – Fit Statistics

Chi-Square =	27.000	
Degrees of Freedom =	35	
P =	0.83129	
BENTLER-BONETT NORMED FIT INDEX =		0.896
BENTLER-BONETT NONNORMED FIT INDEX =		1.061
COMPARATIVE FIT INDEX =		1.000

Post Supplier Selection Performance Evaluation/Feedback and Conformance

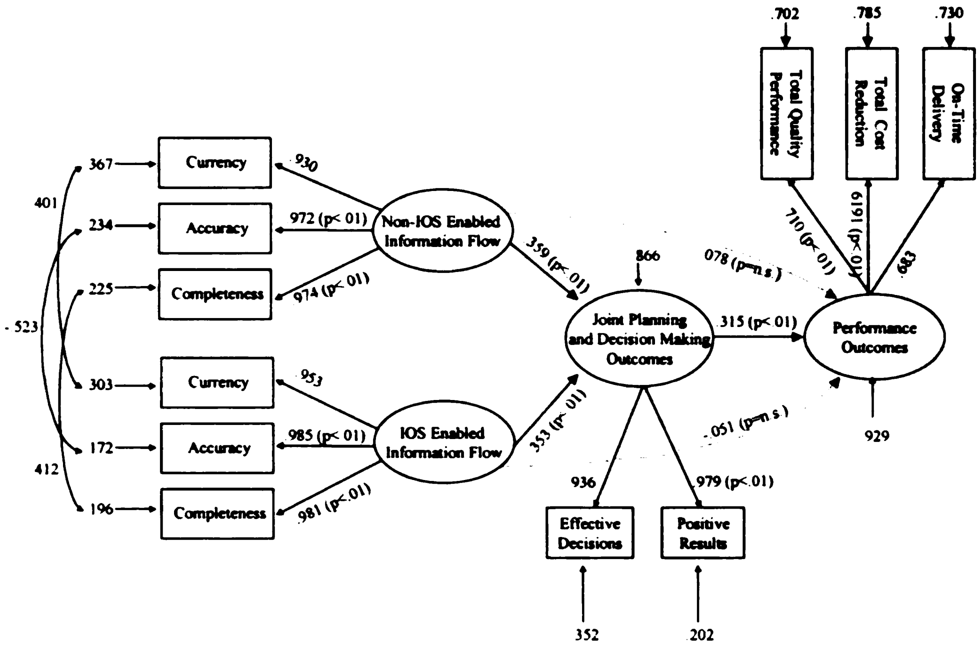

Figure 24: SEM - Post Supplier Selection Performance Evaluation/Feedback and Conformance

Table 60: SEM – Post Supplier Selection Performance Evaluation/Feedback and Conformance – Fit Statistics

Chi-Square =	40.701
Degrees of Freedom =	35
P =	0.23383
BENTLER-BONETT NORMED FIT INDEX =	0.824
BENTLER-BONETT NONNORMED FIT INDEX =	0.949
COMPARATIVE FIT INDEX =	0.968

Sourcing and Supply Proposal Evaluation

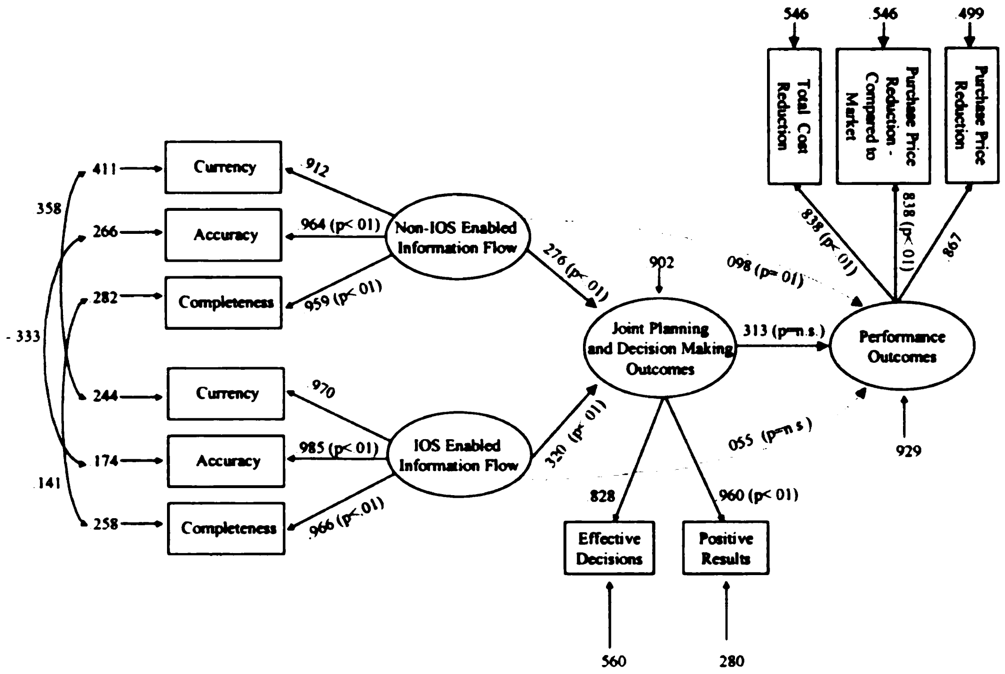

Figure 25: SEM: Sourcing and Supply Proposal Evaluation

Table 61: SEM – Sourcing and Supply Proposal Evaluation – Fit Statistics

Chi-Square =	34.900
Degrees of Freedom =	35
P =	0.47298
BENTLER-BONETT NORMED FIT INDEX =	0.843
BENTLER-BONETT NONNORMED FIT INDEX =	1.001
COMPARATIVE FIT INDEX =	1.000

Part/Material Standardization

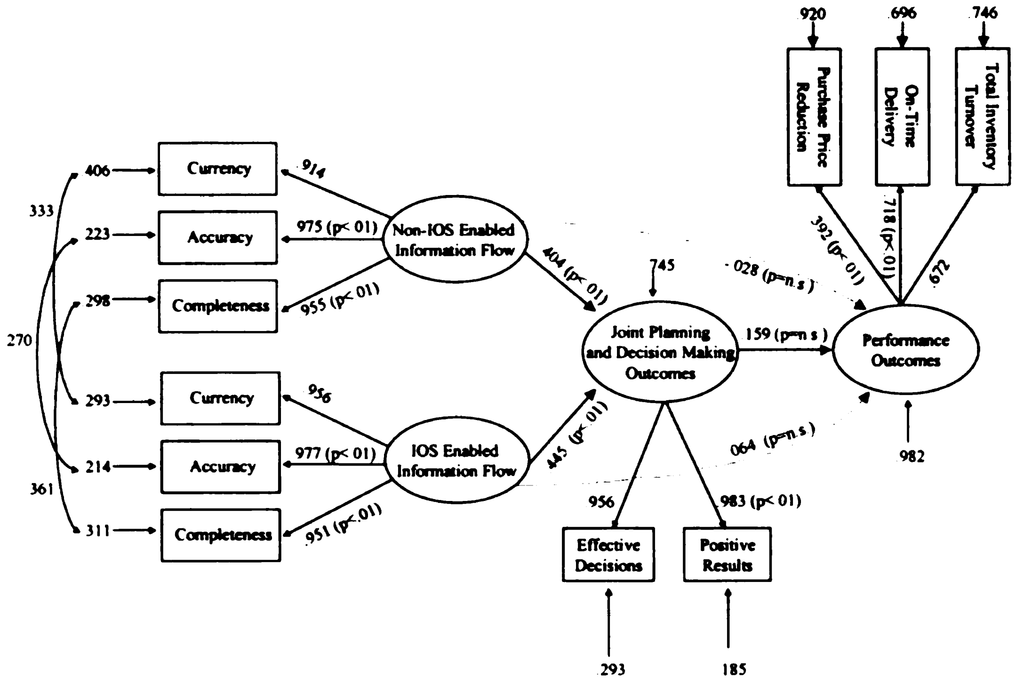

Figure 26: SEM - Part/Material Standardization

Table 62: SEM – Part/Material Standardization – Fit Statistics

Chi-Square =	34.402
Degrees of Freedom =	35
P =	0.49678
BENTLER-BONETT NORMED FIT INDEX =	0.851
BENTLER-BONETT NONNORMED FIT INDEX =	1.005
COMPARATIVE FIT INDEX =	1.000

Supplier Scheduling

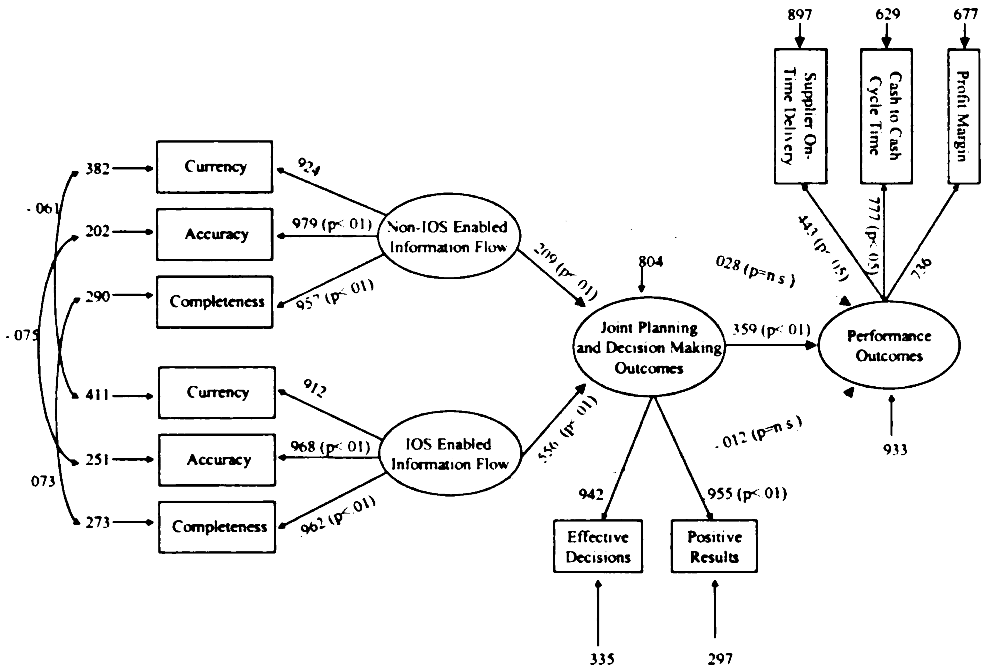

Figure 27: SEM - Supplier Scheduling

Table 63: SEM – Supplier Scheduling – Fit Statistics

Chi-Square =	34.945
Degrees of Freedom =	35
P =	0.47082
BENTLER-BONETT NORMED FIT INDEX =	0.842
BENTLER-BONETT NONNORMED FIT INDEX =	1.001
COMPARATIVE FIT INDEX =	1.000

Joint Goal/Target Setting

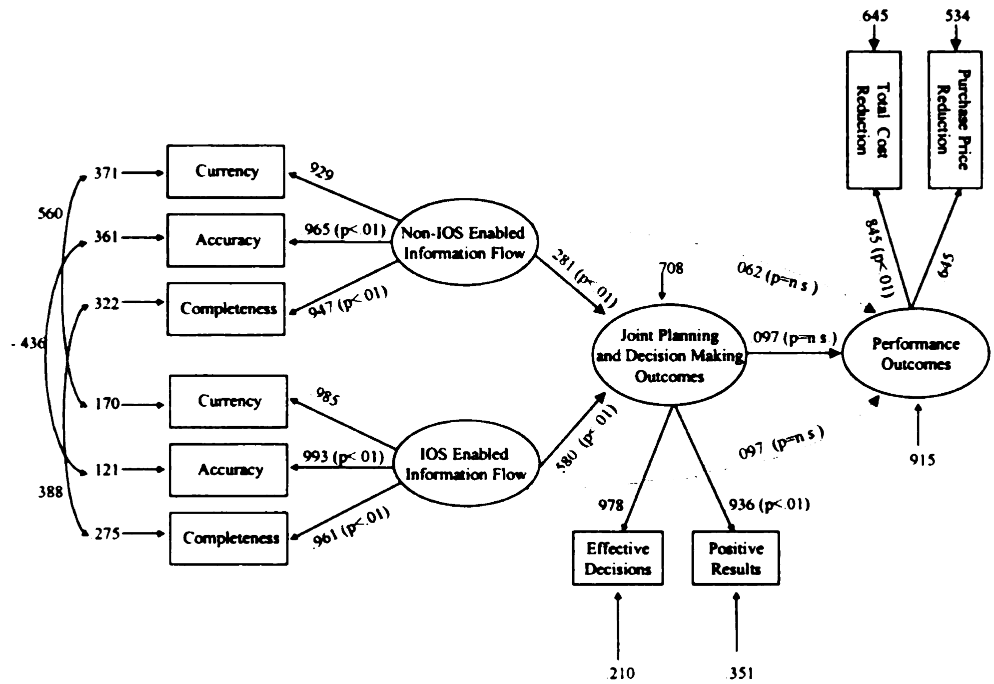

Figure 28: SEM - Joint Goal/Target Setting

Table 64: SEM – Joint Goal/Target Setting – Fit Statistics

Chi-Square =	27.442
Degrees of Freedom =	26
P =	0.38647
BENTLER-BONETT NORMED FIT INDEX =	0.881
BENTLER-BONETT NONNORMED FIT INDEX =	0.987
COMPARATIVE FIT INDEX =	0.992

Appendix I: Descriptive Statistics

Table 65: Descriptive Statistics - Forecasting and Inventory Positioning

Item	Mean	Std. Dev.	Skewness	Kurtosis
IOS Currency	3.06	1.66	0.79	-0.20
IOS Accuracy	3.03	1.62	0.80	-0.07
IOS Completeness	3.13	1.62	0.71	-0.40
N-IOS-Currency	2.33	1.64	1.53	1.47
N-IOS-Accuracy	2.53	1.54	1.25	1.12
N-IOS-Completeness	2.65	1.54	1.19	0.93
Effective Decisions	2.64	1.46	1.13	0.81
Positive Results	2.42	1.42	1.34	1.62
Inventory Turnover	3.07	1.21	0.43	-0.15
On-Time Delivery	2.87	1.03	0.44	0.24
Responsiveness	2.67	0.99	0.50	-0.33

Table 66: Descriptive Statistics - Inventory Visibility

Item	Mean	Std. Dev.	Skewness	Kurtosis
IOS Currency	3.73	1.77	0.28	-1.07
IOS Accuracy	3.64	1.73	0.41	-0.97
IOS Completeness	3.80	1.66	0.27	-0.85
N-IOS-Currency	2.57	1.61	1.42	1.24
N-IOS-Accuracy	2.69	1.59	1.28	0.95
N-IOS-Completeness	2.78	1.57	1.22	0.96
Effective Decisions	2.88	1.56	0.93	0.40
Positive Results	2.81	1.53	0.92	0.32
Inventory Turnover	2.89	1.03	0.40	0.24
Responsiveness	2.67	0.99	0.50	-0.30

Table 67: Descriptive Statistics - Capacity Planning

Item	Mean	Std. Dev.	Skewness	Kurtosis
IOS Currency	3.62	1.62	0.41	-0.54
IOS Accuracy	3.62	1.54	0.39	-0.31
IOS Completeness	3.68	1.57	0.37	-0.44
N-IOS-Currency	3.03	1.63	0.89	0.15
N-IOS-Accuracy	3.11	1.62	0.80	0.06
N-IOS-Completeness	3.13	1.56	0.90	0.34
Effective Decisions	3.02	1.45	0.86	0.48
Positive Results	3.08	1.49	0.74	0.39
Inventory Turnover	3.12	1.24	0.31	-0.31
On-time Delivery	3.12	1.25	0.24	-0.51
Responsiveness	3.48	1.50	0.32	-0.71

Table 68: Descriptive Statistics - Post Supplier Selection Performance Evaluation/Feedback and Conformance

Item	Mean	Std. Dev.	Skewness	Kurtosis
IOS Currency	3.21	1.55	0.63	-0.36
IOS Accuracy	3.14	1.52	0.72	-0.17
IOS Completeness	3.30	1.61	0.59	-0.37
N-IOS-Currency	2.71	1.58	1.24	0.92
N-IOS-Accuracy	2.85	1.57	1.04	0.60
N-IOS-Completeness	2.92	1.56	0.96	0.46
Effective Decisions	2.50	1.21	1.25	2.50
Positive Results	2.41	1.18	1.17	2.15
On-time Delivery	2.82	0.97	0.37	0.30
Cost Reduction	2.64	1.02	0.62	0.40
Quality	2.82	0.95	0.42	0.16

Table 69: Descriptive Statistics - Sourcing and Supply Proposal Evaluation

Item	Mean	Std. Dev.	Skewness	Kurtosis
IOS Currency	2.53	1.36	1.07	1.05
IOS Accuracy	2.53	1.36	1.22	1.41
IOS Completeness	2.60	1.40	0.95	0.59
N-IOS-Currency	2.43	1.40	1.28	1.76
N-IOS-Accuracy	2.52	1.41	1.28	1.76
N-IOS-Completeness	2.59	1.41	1.20	1.60
Effective Decisions	2.16	0.89	0.55	-0.02
Positive Results	2.14	0.88	0.56	0.09
On-time Delivery	2.74	1.14	0.70	0.89
Cost Reduction	2.91	1.05	0.27	-0.34
Quality	2.62	1.03	0.62	0.39

Table 70: Descriptive Statistics - Part/Material Standardization

Item	Mean	Std. Dev.	Skewness	Kurtosis
IOS Currency	3.31	1.56	0.51	-0.44
IOS Accuracy	3.28	1.55	0.58	-0.12
IOS Completeness	3.45	1.65	0.43	-0.54
N-IOS-Currency	2.98	1.56	0.81	0.32
N-IOS-Accuracy	3.00	1.58	0.81	0.22
N-IOS-Completeness	3.17	1.51	0.71	0.24
Effective Decisions	2.97	1.40	0.57	0.15
Positive Results	2.96	1.41	0.49	-0.01
Inventory Turnover	3.14	1.23	0.35	-0.32
On-time Delivery	2.86	0.99	0.29	0.21
Price Reduction	2.73	1.14	0.69	0.94

Table 71: Descriptive Statistics - Supplier Scheduling

Item	Mean	Std. Dev.	Skewness	Kurtosis
IOS Currency	3.12	1.62	0.62	-0.40
IOS Accuracy	3.15	1.61	0.81	0.08
IOS Completeness	3.15	1.50	0.62	-0.13
N-IOS-Currency	2.14	1.28	1.60	2.86
N-IOS-Accuracy	2.28	1.32	1.55	2.72
N-IOS-Completeness	2.34	1.27	1.46	2.48
Effective Decisions	2.28	1.02	0.86	0.69
Positive Results	2.30	1.07	0.77	0.41
Profit Margin	3.41	1.49	0.36	-0.65
Cash-Cash Cycle Time	3.19	1.18	0.31	0.09
On-Time Delivery	2.82	0.96	0.32	0.32

Table 72: Descriptive Statistics - Joint Goal/Target Setting

Item	Mean	Std. Dev.	Skewness	Kurtosis
IOS Currency	2.90	1.41	0.76	0.06
IOS Accuracy	2.86	1.45	0.69	-0.11
IOS Completeness	3.01	1.45	0.57	-0.23
N-IOS-Currency	2.85	1.63	0.97	0.33
N-IOS-Accuracy	2.88	1.64	0.92	0.21
N-IOS-Completeness	2.98	1.63	0.95	0.40
Effective Decisions	2.43	1.19	1.22	2.40
Positive Results	2.52	1.23	1.01	1.65
Price Reduction	2.74	1.13	0.73	0.97
Total Cost	2.65	1.01	0.64	0.42

Appendix J: Post Hoc Analysis

Note: shading in the following tables indicates statistical significance at the p<.1 level.

Table 73: Forecasting and Inventory Positioning – Associations of Joint Planning and Decision Making Outcomes and Firm Performance Dimensions

	r	p	n
Supplier on-time delivery	0.35	0.00	129
Supplier responsiveness	0.26	0.00	129
Total inventory turnover rate	0.22	0.01	129
Cash-to-cash cycle time	0.19	0.03	129
Purchase price reduction compared to market	0.15	0.08	129
Supplier quality performance	0.14	0.11	129
Profit margin	0.11	0.23	129
Purchase price reduction	0.10	0.24	129
External customer service levels	0.10	0.26	129
Return on equity (ROE)	0.10	0.27	129
Total cost reduction	0.09	0.31	129
Return on investment(ROI)	0.08	0.38	129

Table 74: Inventory Visibility – Associations of Joint Planning and Decision Making Outcomes and Firm Performance Dimensions

	r	p	n
Supplier on-time delivery	0.37	0.00	131
Supplier responsiveness	0.29	0.00	131
Purchase price reduction compared to market	0.22	0.01	131
Total inventory turnover rate	0.22	0.01	131
Return on equity (ROE)	0.19	0.03	131
Cash-to-cash cycle time	0.19	0.03	131
Purchase price reduction	0.17	0.05	131
Return of investment(ROI)	0.17	0.06	131
Profit margin	0.12	0.17	131
Supplier quality performance	0.12	0.18	131
External customer service levels	0.11	0.20	131
Total cost reduction	0.10	0.25	131

Table 75: Capacity Planning – Associations of Joint Planning and Decision Making Outcomes and Firm Performance Dimensions

	r	p	n
Total inventory turnover rate	0.25	0.00	122
Purchase price reduction compared to market	0.25	0.01	122
Supplier on-time delivery	0.23	0.01	122
Supplier responsiveness	0.22	0.01	122
Total cost reduction	0.22	0.01	122
Return of investment(ROI)	0.20	0.03	122
Profit margin	0.19	0.04	122
Return on equity (ROE)	0.19	0.04	122
Purchase price reduction	0.18	0.05	122
Cash-to-cash cycle time	0.12	0.17	122
Supplier quality performance	0.12	0.20	122
External customer service levels	0.01	0.94	122

Table 76: Post Supplier Selection Performance Evaluation/Feedback and Conformance – Associations of Joint Planning and Decision Making Outcomes and Firm Performance Dimensions

	r	p	n
Supplier responsiveness	0.29	0.00	117
Supplier on-time delivery	0.28	0.00	117
Purchase price reduction compared to market	0.23	0.01	117
Supplier quality performance	0.21	0.02	117
Return of investment(ROI)	0.18	0.05	117
Return on equity (ROE)	0.17	0.06	117
Total cost reduction	0.17	0.07	117
External customer service levels	0.17	0.07	117
Profit margin	0.15	0.11	117
Total inventory turnover rate	0.14	0.12	117
Purchase price reduction	0.12	0.19	117
Cash-to-cash cycle time	0.11	0.25	117

Table 77: Sourcing and Supply Proposal Evaluation – Associations of Joint Planning and Decision Making Outcomes and Firm Performance Dimensions

	r	p	n
Total cost reduction	0.30	0.00	119
Purchase price reduction	0.29	0.00	119
Supplier on-time delivery	0.23	0.01	119
Purchase price reduction compared to market	0.19	0.04	119
Return on equity (ROE)	0.18	0.05	119
Supplier responsiveness	0.16	0.08	119
Return of investment(ROI)	0.16	0.09	119
Supplier quality performance	0.14	0.13	119
Cash-to-cash cycle time	0.13	0.17	119
Total inventory turnover rate	0.12	0.20	119
Profit margin	0.09	0.31	119
External customer service levels	0.09	0.35	119

Table 78: Part/Material Standardization – Associations of Joint Planning and Decision Making Outcomes and Firm Performance Dimensions

	r	p	n
Cash-to-cash cycle time	0.29	0.00	125
Supplier on-time delivery	0.25	0.01	125
Supplier quality performance	0.19	0.03	125
Total inventory turnover rate	0.18	0.04	125
Profit margin	0.17	0.06	125
Supplier responsiveness	0.14	0.12	125
External customer service levels	0.12	0.18	125
Purchase price reduction compared to market	0.12	0.20	125
Return on equity (ROE)	0.07	0.45	125
Total cost reduction	0.05	0.55	125
Return of investment(ROI)	0.02	0.81	125
Purchase price reduction	-0.02	0.86	125

Table 79: Supplier Scheduling – Associations of Joint Planning and Decision Making Outcomes and Firm Performance Dimensions

	r	p	n
Cash-to-cash cycle time	0.29	0.00	125
Supplier on-time delivery	0.25	0.01	125
Supplier quality performance	0.19	0.03	125
Total inventory turnover rate	0.18	0.04	125
Profit margin	0.17	0.06	125
Supplier responsiveness	0.14	0.12	125
External customer service levels	0.12	0.18	125
Purchase price reduction compared to market	0.12	0.20	125
Return on equity (ROE)	0.07	0.45	125
Total cost reduction	0.05	0.55	125
Return of investment(ROI)	0.02	0.81	125
Purchase price reduction	-0.02	0.86	125

Table 80: Joint Goal and Target Setting – Associations of Joint Planning and Decision Making Outcomes and Firm Performance Dimensions

	r	p	n
Purchase price reduction compared to market	0.30	0.00	120
Purchase price reduction	0.28	0.00	120
Total cost reduction	0.25	0.01	120
Supplier responsiveness	0.22	0.01	120
Supplier on-time delivery	0.21	0.02	120
Total inventory turnover rate	0.20	0.03	120
Profit margin	0.19	0.03	120
Return on equity (ROE)	0.19	0.04	120
Return of investment(ROI)	0.17	0.06	120
Cash-to-cash cycle time	0.12	0.20	120
Supplier quality performance	0.10	0.29	120
External customer service levels	0.05	0.60	120

Appendix K: Information Quality Paired Samples T-Tests

Table 81: Paired Sample T-Test - Forecasting and Inventory

		Mean *	Paired Difference	Std. Dev.	t	Sig. (2-tailed)
Pair 1	Non-IOS Current	3.10				
	IOS Current	2.35	0.74	1.98	4.38	0.00
Pair 2	Non-IOS Accurate	3.06				
	IOS Accurate	2.57	0.49	1.76	3.27	0.00
Pair 3	Non-IOS Complete	3.16				
	IOS Complete	2.71	0.44	1.86	2.78	0.01
Pair 4	Non-IOS Compatible	3.40				
	IOS Compatible	2.84	0.56	2.18	2.96	0.00
Pair 5	Non-IOS Convenient to Access	3.82				
	IOS Convenient to Access	2.61	1.21	2.42	5.78	0.00

Table 82: Paired Sample T-Test - Inventory Visibility

		Mean *	Paired Difference	Std. Dev.	t	Sig. (2-tailed)
Pair 1	Non-IOS Current	3.73				
	IOS Current	2.56	1.16	2.25	5.91	0.00
Pair 2	Non-IOS Accurate	3.64				
	IOS Accurate	2.68	0.95	2.11	5.20	0.00
Pair 3	Non-IOS Complete	3.80				
	IOS Complete	2.77	1.02	2.06	5.71	0.00
Pair 4	Non-IOS Compatible	3.74				
	IOS Compatible	2.92	0.82	2.13	4.41	0.00
Pair 5	Non-IOS Convenient to Access	4.14				
	IOS Convenient to Access	2.75	1.39	2.16	7.37	0.00

Table 83: Paired Sample T-Test - Capacity Planning

		Mean *	Paired Difference	Std. Dev.	t	Sig. (2-tailed)
Pair 1	Non-IOS Current	3.58				
	IOS Current	3.00	0.58	2.00	3.30	0.00
Pair 2	Non-IOS Accurate	3.57				
	IOS Accurate	3.09	0.48	1.89	2.89	0.00
Pair 3	Non-IOS Complete	3.71				
	IOS Complete	3.14	0.57	1.81	3.61	0.00
Pair 4	Non-IOS Compatible	3.74				
	IOS Compatible	3.26	0.49	2.08	2.67	0.01
Pair 5	Non-IOS Convenient to Access	4.01				
	IOS Convenient to Access	3.06	0.95	2.09	5.13	0.00

Table 84: Paired Sample T-Test - Post Supplier Selection Performance Evaluation/Feedback and Conformance

		Mean *	Paired Difference	Std. Dev.	t	Sig. (2-tailed)
Pair 1	Non-IOS Current	3.22				
	IOS Current	2.71	0.52	2.34	2.47	0.01
Pair 2	Non-IOS Accurate	3.13				
	IOS Accurate	2.94	0.19	2.23	0.96	0.34
Pair 3	Non-IOS Complete	3.29				
	IOS Complete	3.02	0.26	2.20	1.34	0.18
Pair 4	Non-IOS Compatible	3.21				
	IOS Compatible	2.98	0.23	2.35	1.10	0.27
Pair 5	Non-IOS Convenient to Access	3.60				
	IOS Convenient to Access	2.86	0.74	2.43	3.40	0.00

Table 85: Paired Sample T-Test - Sourcing and Supply Proposal Evaluation

		Mean *	Paired Difference	Std. Dev.	t	Sig. (2-tailed)
Pair 1	Non-IOS Current	2.52				
	IOS Current	2.41	0.12	2.08	0.64	0.52
Pair 2	Non-IOS Accurate	2.50				
	IOS Accurate	2.52	-0.02	1.89	-0.09	0.93
Pair 3	Non-IOS Complete	2.55				
	IOS Complete	2.66	-0.11	2.06	-0.60	0.55
Pair 4	Non-IOS Compatible	2.74				
	IOS Compatible	2.80	-0.06	2.13	-0.33	0.74
Pair 5	Non-IOS Convenient to Access	3.06				
	IOS Convenient to Access	2.57	0.48	2.37	2.28	0.02

Table 86: Paired Sample T-Test - Part/Material Standardization

		Mean *	Paired Difference	Std. Dev.	t	Sig. (2-tailed)
Pair 1	Non-IOS Current	3.30				
	IOS Current	2.96	0.34	1.98	1.87	0.06
Pair 2	Non-IOS Accurate	3.26				
	IOS Accurate	3.02	0.24	1.96	1.35	0.18
Pair 3	Non-IOS Complete	3.44				
	IOS Complete	3.19	0.25	2.02	1.35	0.18
Pair 4	Non-IOS Compatible	3.44				
	IOS Compatible	3.20	0.24	2.27	1.16	0.25
Pair 5	Non-IOS Convenient to Access	3.64				
	IOS Convenient to Access	3.04	0.60	2.31	2.87	0.00

Table 87: Paired Sample T-Test - Supplier Scheduling

		Mean *	Paired Difference	Std. Dev.	t	Sig. (2-tailed)
Pair 1	Non-IOS Current	3.09				
	IOS Current	2.11	0.98	2.04	5.55	0.00
Pair 2	Non-IOS Accurate	3.15				
	IOS Accurate	2.25	0.90	2.07	5.01	0.00
Pair 3	Non-IOS Complete	3.11				
	IOS Complete	2.36	0.76	1.94	4.49	0.00
Pair 4	Non-IOS Compatible	3.21				
	IOS Compatible	2.55	0.66	2.25	3.39	0.00
Pair 5	Non-IOS Convenient to Access	3.46				
	IOS Convenient to Access	2.32	1.14	2.27	5.79	0.00

Table 88: Paired Sample T-Test - Joint Goal and Target Setting

		Mean *	Paired Difference	Std. Dev.	t	Sig. (2-tailed)
Pair 1	Non-IOS Current	2.87	0.02	1.96	0.14	0.89
	IOS Current	2.85				
Pair 2	Non-IOS Accurate	2.83	-0.04	1.94	-0.23	0.82
	IOS Accurate	2.87				
Pair 3	Non-IOS Complete	2.98	0.01	1.88	0.05	0.96
	IOS Complete	2.98				
Pair 4	Non-IOS Compatible	2.96	-0.08	1.85	-0.49	0.63
	IOS Compatible	3.04				
Pair 5	Non-IOS Convenient to Access	3.14	0.28	2.16	1.42	0.16
	IOS Convenient to Access	2.86				

Appendix L: Multiple Regression Difference Tests

Table 89: Forecasting and Inventory Positioning Beta Difference Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.222	.251		4.868	.000	.725	1.718
	NIOS_6	2.245E-02	.070	.025	.319	.750	-.117	.161
	IOS_6	.492	.070	.540	7.005	.000	.353	.631

a. Dependent Variable: JPDM_6

Table 90: Inventory Visibility Beta Difference Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.685	.300		2.282	.024	.091	1.279
	NIOS_7	.191	.066	.204	2.897	.004	.060	.321
	IOS_7	.540	.069	.549	7.817	.000	.403	.677

a. Dependent Variable: JPDM_7

Table 91: Capacity Planning Beta Difference Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.579	.276		2.100	.038	.033	1.125
	NIOS_8	.331	.067	.352	4.965	.000	.199	.462
	IOS_8	.411	.064	.458	6.461	.000	.285	.537

a. Dependent Variable: JPDM_8

Table 92: Post Supplier Selection Performance Evaluation/Feedback and Conformance Beta Difference Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.914	.293		3.118	.002	.334	1.494
	NIOS_9	.261	.065	.324	4.040	.000	.133	.389
	IOS_9	.256	.062	.333	4.148	.000	.134	.378

a. Dependent Variable: JPDM_9

Table 93: Sourcing and Supply Proposal Evaluation Beta Difference Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	1.322	.200		6.607	.000	.926	1.718
	NIOS_10	.158	.053	.251	3.015	.003	.054	.263
	IOS_10	.172	.051	.279	3.352	.001	.070	.273

a. Dependent Variable: JPDM_10

Table 94: Part/Material Standardization Beta Difference Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.684	.299		2.291	.024	.093	1.276
	NIOS_11	.334	.069	.366	4.872	.000	.198	.470
	IOS_11	.373	.070	.403	5.359	.000	.235	.511

a. Dependent Variable: JPDM_11

Table 95: Supplier Scheduling Beta Difference Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.936	.214		4.365	.000	.511	1.360
	NIOS_12	.121	.049	.177	2.444	.016	.023	.218
	IOS_12	.445	.060	.533	7.358	.000	.325	.564

a. Dependent Variable: JPDM_12

Table 96: Joint Goal/Target Setting Beta Difference Test

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	.448	.213		2.102	.038	.026	.870
	NIOS_13	.467	.058	.551	8.103	.000	.353	.581
	IOS_13	.225	.050	.308	4.533	.000	.127	.323

a. Dependent Variable: JPDM_13

Appendix M: University Committee on Research Involving Human Subjects

MICHIGAN STATE
UNIVERSITY

November 17, 1998

TO: Dr. Robert M. Monczka
N505 N. Business Complex
Eli Broad Grad School of Mgt

APPROVAL DATE: November 16, 1998

RE: **IRB # 98744** CATEGORY: 1-C

TITLE: THE IMPACT OF INFORMATION SYSTEMS ON ACHIEVING SUPPLY CHAIN INTEGRATION

The University Committee on Research Involving Human Subjects' (UCRIHS) review of this project is complete and I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the UCRIHS approved this project.

RENEWALS: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Projects continuing beyond one year must be renewed with the green renewal form. A maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for a complete review.

REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB# and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.

PROBLEMS/CHANGES: Should either of the following arise during the course of the work, notify UCRIHS promptly: 1) problems (unexpected side effects, complaints, etc.) involving human subjects or 2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of further assistance, please contact us at 517 355-2180 or via email: UCRIHS@pilot.msu.edu. Please note that all UCRIHS forms and instruction are located via the web: http://www.msu.edu/unit/vprgs/UCRIHS/

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University Committee on Research Involving Human Subjects (UCRIHS)

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Sincerely,

David E. Wright

David E. Wright, Ph.D.
UCRIHS Chair

DEW

cc Kenneth Petersen

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