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Bridging the Operational Divide: An Information-Processing Model of Internal Supply Chain Integration

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BRIDGING THE OPERATIONAL DIVIDE:
AN INFORMATION-PROCESSING MODEL OF
INTERNAL SUPPLY CHAIN INTEGRATION

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ABSTRACT

Supply Chain Management, the coordination of upstream and downstream flows of product, services, finances, and information from a source to a customer, has risen in prominence over the past fifteen years. The delivery of a product to the consumer is a complex process requiring action from several independent entities. An individual firm consists of multiple functional departments, each responsible for one aspect of customer service. In the traditional corporate structure of functional silos, there is little communication between Purchasing, Manufacturing, and Logistics, and yet these departments comprise three core supply chain processes of a firm. Ironically, managers report that it is easier for Purchasing to integrate with suppliers and Logistics to integrate with customers than it is for either group to integrate within the firm.

This study develops and tests a model of factors that influence the level of internal integration of three key internal supply chain management functions: Purchasing, Operations, and Logistics. These three functions define the internal supply chain because they are responsible for the introduction of raw materials, transformation into product, and movement of the product to the customer. Prior research has established that interdepartmental integration improves performance in various contexts. However, given the vast range of diversity in firms and industry environments, it is unlikely that there is only one way to accomplish interdepartmental integration.

The research model is grounded in Organizational Information Processing Theory (OIPT). Conceptually, OIPT posits that the performance of a firm is a function of the fit between the information processing requirements created by the environment and the information processing capabilities created by the organizational design. The purpose of this research is to answer the following research questions. First, what factors influence the level of internal integration within a manufacturing firm? Second, how are these factors interrelated? Third, do the relationships between the factors vary depending on the task environment?

The methodology selected was a cross-sectional survey of manufacturers in the United States. Path analysis was used to test the research hypotheses.

Results generally support the research model. Several factors included within the research model have significant effects on Collaboration and Strategic Consensus, the outcome variables used as indicators of integration. Hypothesized mediation effects are also supported. Moreover, the level of Uncertainty moderates two of these relationships, supporting the use of the OIPT theoretical lens.

DEDICATION

Those that come before us, shape us:

Rosa Rivera Colon
In loving memory

Manuelita Muñoz Rivera

Carlos E. Rosado Navedo
In loving memory

Those that march with us, support us:

Christopher Robert Feger

And those whom we lead, give us hope for the future.

Christopher Francis Feger

Ryan Manuel Feger

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Some say it takes a village to raise a child, I'm here to say it takes a small city to raise a dissertation. The past six years have brought a number of exceptional individuals into my personal and professional life, and I sincerely thank all of you who have made this day possible.

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Although the dissertation is an individual event, the journey through graduate school is a group effort. My fellow graduate students have helped develop my teaching and research skills, providing celebrations when progress was made and encouragement during the difficult times. We have come a long way since discussing Kuhn's philosophy of science into the late hours.

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TABLE OF CONTENTS

Table of Contents (Continued)

Page

Table of Contents (Continued)

Table of Contents (Continued)

LIST OF TABLES

List of Tables (continued)

Page

List of Tables (continued)

Page

List of Tables (continued)

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

In 1958, Forrester proposed that: "There will come general recognition of the advantage enjoyed by pioneering management who have been the first to improve their understanding of the interrelationships between separate company functions and between the company and its markets, its industry, and the national economy." (Forrester, 1958, p. 52) Almost thirty years later, Porter stated: "Competitive advantage frequently derives from linkages among activities just as it does from the individual activities themselves" (Porter, 1985, p. 48).

These two quotes frame the concept known today as Supply Chain Management (SCM), which has risen in prominence over the past fifteen years (Cooper, Lambert, and Pagh 1997; Mentzer, DeWitt, Keebler, Min, Nix, Smith and Zacharia, 2001). Researchers have proposed several definitions of supply chains (e.g., Cooper and Ellram 1993; LaLonde and Masters 1994; Lambert, Stock and Ellram 1998). For the purposes of this research, a supply chain is defined as a "set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of product, services, finances, and/or information from a source to a customer" (Mentzer et al. 2001). Supply chain management concerns the coordination of these flows, from the provider of the raw materials to the consumer or end user of a product.

In the hypothetical supply chain, materials flow from the fields and mines to the factories, where they are processed into products and shipped to the consumer. Information flows back from the consumer in the form of demand rates, desirable product attributes, and cost considerations. In the perfect world, the entire supply chain behaves as one coordinated entity, smoothly transmitting the information to efficiently meet demand.

Supply Chain Management is popular in industry in part because at this macroscopic level, the concept is intuitively appealing. Min and Mentzer (2004) state that the SCM concept has evolved to integrate major business processes through interfunctional coordination and interfirm cooperation for better customer service and cost savings. Each consumer gets exactly what is wanted, at the time that it is wanted. Demand information is transmitted instantly and without error, and the producers can react immediately to the new requirements, thus eliminating inventories of potentially obsolete product. The idealized supply chain is both effective and efficient (Mentzer et al 2001).

Supply chain reality is far from ideal. The delivery of even the simplest product to the ultimate consumer is a complex process requiring action from independent entities, often with little or no communication beyond immediate suppliers and customers (Fawcett and Magnan 2002). Each firm has its own stakeholders to whom it is beholden, and hence each one attempts to maximize its own profits and performance (Mentzer 1991; Reyes, Raisinghani, and Singh 2002). However, multiple local optima often do not add up to a global optimum (Fawcett and Cooper 2001; Hall, Rosenthal, and Wade 1993; Heyer and van Lee 1992; Stonebraker and Liao 2004). Hence, the result of each firm's rational optimization behavior can be a decrease in overall supply chain performance.

Individual "efficiencies" contribute to excess cost for the ultimate consumer (Yuva 2000).

A single firm is more often than not a member of several supply chains (Mentzer et al. 2001). Upstream, individual firms often supply various customers who are downstream competitors. Downstream, individual firms purchase their raw materials from multiple suppliers, who may be upstream competitors. Although researchers conceptualize the marketplace as "Supply chain vs. supply chain," (Christopher 1992), the market reality is a tangled web of interdependencies and competition (Mentzer et al. 2001; Stonebraker and Liao 2004).

In addition, an individual firm consists of multiple functional departments, each responsible for one aspect of customer service. Purchasing strives to reduce the costs of obtaining raw materials and components while delivering the necessary quality. Logistics strives to reduce the costs of transporting product to customers while ensuring timely deliveries. In the middle, Manufacturing strives to reduce production costs while maintaining both high product quality and delivery reliability (Villa 2002). In the traditional corporate structure of functional silos, there is little communication between Purchasing, Manufacturing, and Logistics, and yet these three departments together comprise three core supply chain processes of a firm (Fawcett and Magnan 2002; Pagell 2004; Tyndall 1998). Ironically, managers report that it is easier for Purchasing to integrate with suppliers and Logistics to integrate with customers than it is for either group to integrate within the firm (Sabath and Whipple 2004). This internal separation has been coined the *Great Operating Divide* by Bowersox et al. (1999).

Aiken and Hage (1968) determined that interdependent relationships with external entities, such as those envisioned in SCM, require greater internal coordination. Lewis (2006, p. 32) noted that organizations are undergoing transformations that include "changing structures and processes to be more global, more team oriented, more networked, and more responsive." Hillebrand and Biemans (2003, p. 741) concluded that "internal cooperation is a prerequisite for effective and efficient external cooperation." Lambert, Stock, and Ellram (1998) propose that all firms within a supply chain must first overcome their own functional silos in order to successfully implement SCM. Mentzer et al. (2001) conclude that without inter-functional coordination, SCM cannot achieve its full potential.

Fawcett and Magnan (2002) surveyed managers within these three core SCM functions, and discovered that although the rhetoric of inter-firm supply chain integration is alive and well, the practice is far removed from the ideal. They identified four types of supply chain integration:

Type 1: Internal, cross functional process integration.
Type 2: Backward integration with first-tier suppliers.
Type 3: Forward integration with first-tier customers.
Type 4: Complete backward and forward integration.

Their survey results indicated that the largest percentage of their respondents (47%) had only attempted internal integration. In addition, they found that first-tier integration efforts (Types 2 and 3) were often confined to a single function, for example purchasing working with first-tier suppliers, or logistics working with first-tier customers. Most importantly, they found that functional managers differed in their conceptualization of supply chain integration and SCM. Without a clear and shared vision, these departments often worked at cross-purposes instead of moving towards a common goal.

Although the macroscopic view facilitates an overall understanding of the concept of SCM, implementation ultimately comes down to the actions of the individual supply chain members. The strength of any supply chain is determined by its weakest link, from the raw material supplier to the end customer. Each firm retains control of its internal functions, and the links between their internal activities have a direct bearing on the health of the supply chain as a whole.

Previous researchers have studied internal integration in a supply chain management context. Houlihan (1988) highlighted the differences between supply chain management and classical materials and manufacturing control, emphasizing the need for integration of internal departments. Monczka, Trent and Handfield (1998) describe the objective of SCM as integration of and management of the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers. Other researchers have stated that the implementation of SCM needs the integration of processes from sourcing, to manufacturing, and to distribution across the supply chain (e.g., Cooper et al. 1997; Ellram and Cooper 1990; Tyndall, Gopal, Partshe, and Kamauff 1998).

Internal integration is important to industry practitioners because it is within their span of control. While the relationships with their customers and/or suppliers are subject to environmental and industry pressures, the leadership of a firm controls what takes place within its confines. In order for the entire supply chain to achieve overall optimum profits, individual players must sometimes give up some of their potential gains. This local vs. global optimization problem is not only a problem in the macro supply chain, it is plainly an issue that needs to be addressed within each individual firm. Although certain actions may benefit individual departments, in order for the firm as a whole to achieve higher performance each link in the chain must act in accordance to what is best for the entire company.

There is a long history of academic research into interdepartmental integration. Adam Smith, who first argued for productivity gains from division of labor and specialization, also emphasized the interdependence between the laborers (Smith, R., 2002). Follett (1987, cited in Ettlie and Reza 1992) described three ways of settling differences in an organization: domination, compromise, and integration. She defined integration as a system of cross-functioning and a sense of collective responsibility. Lawrence and Lorsch (1967) define integration as "unity of purpose," and argue that a successful firm must manage both differentiation and integration. Wheelwright and Hayes (1985) considered "attention to manufacturing infrastructure", including integrated measurement systems, planning and control procedures, and work force policies, as a characteristic of firms that had achieved world-class performance. Ettlie and Reza (1992) determined that successful adoption of process innovation requires simultaneous use of internal and external integrative practices.

Cross-functional integration has been studied within the context of many fields, including strategy (Dean and Snell 1986, St.John and Rue 1991), organizational behavior (Barki and Pinsonneault 2005, Dougherty 2001), and management information systems

(Johnston and Carrico 1988, Reich and Benbasat 2000). In the SCM literature, there are a number of studies investigating the effect of inter-departmental relationships on firm performance (e.g., Gimenez and Ventura 2005, Kim 2006), as well a number of studies focusing on the effect of single factors on the level of integration (e.g., purchasing techniques in Narasimhan and Kim 2001, information technology in Vickery et al 2003). Many of these studies focus on the relationship between integration and performance, generally concurring on the positive effects of integration.

However, knowing that integration is beneficial does not help practitioners elucidate how it can best be achieved. Several models have been developed to provide guidance to practitioners. In the United States, the Supply Chain Council has developed the Supply-Chain Operations Reference-model, or SCOR (Supply Chain Council, 2006). SCOR is a process reference model intended as a cross-industry standard for supply chain management. It is based on five management processes: Plan, Source, Make, Deliver, and Return. The goal of SCOR is to develop a toolkit that allows managers to analyze their management processes in light of the process reference model, thus allowing them to identify opportunities for improvement (Allnoch 1997, Saccomano 1998). Although SCOR is useful for continuous improvement and process mapping, it does not explicitly address factors that researchers have considered important for supply chain management, such as information technology (St.John et al 2001).

Academic researchers have also attempted to develop models of integration. Kahn and Mentzer (1996) define interdepartmental integration as consisting of both interaction and collaboration. Gupta (1984) modeled the effect of organizational strategy, environmental uncertainty, organizational factors and individual factors on the success of a new product, mediated by the perceived need for and degree of integration achieved. Flynn and Flynn (1999) use information processing theory "to test the role of various information-processing alternatives for coping with increased environmental complexity" in the context of world-class manufacturing. More recently, Pagell (2004) developed a model specifically addressing the integration between purchasing, operations, and logistics.

This study examines factors that influence the level of collaboration and strategic consensus between three key internal supply chain management functions: Purchasing, Operations, and Logistics. These three functions define the internal supply chain because they are responsible for the introduction of raw materials, transformation into product, and movement of the product to the customer. For manufacturing firms, these functions embody three of the five key management processes identified within the SCOR framework (Supply Chain Council, 2006): Source, Make, and Deliver.

The strategic importance of Purchasing has been established by prior research (Chen, Paulraj and Lado 2004; Dyer 1996, Ellram and Carr 1994). In the context of SCM, the role of Purchasing is two-fold. Upstream, purchasing is a customer, managing the important external linkage between a firm and its suppliers. In this role, Purchasing is responsible for supplier selection and management. Downstream, Purchasing is a supplier of materials and services to internal customers. In this study, the focus is on the relationship between Purchasing and its Operations customer. How this internal linkage is managed determines the level of integration between these two functions.

In a manufacturing firm, Operations is the primary value-adding mechanism. It transforms raw materials into the firm's products, to be sold to the firm's customers. However, Operations does not exist in a vacuum. Raw materials are acquired through interactions with Purchasing, while finished goods are delivered to Outbound Logistics. However, the firm does not realize any benefit from its operations until the products are delivered to the customer. Outbound Logistics is a key component of the intra-firm supply chain. Whether the firm uses its own delivery service or an external provider, there is a linkage between the production of the goods and their delivery, and this linkage must be managed. Gimenez and Ventura (2005) determined that the integration of logistics and production significantly improved logistical performance, even in the absence of external integration with customers. Kahn and Mentzer (1996) studied the nature of internal integration from a logistics perspective, suggesting that departments need to both interact and collaborate. Gimenez (2006) identified three stages in the internal integration of firms in the food industry, focusing on the integration between logistics and production and logistics and marketing. Stock et al. (2000) develop the concept of enterprise logistics as a tool for integrating logistics activities both within the organization and with its external supply chain partners. In all of these studies, the common theme is that integrating logistics with other functions results in higher performance.

Prior research has established that interdepartmental integration improves performance in various contexts. This research develops and tests a model of factors that influence the level of internal integration. However, given the vast range of diversity in firms and industry environments, it is unlikely that there is only one way to accomplish interdepartmental integration (Hillebrand and Biemans 2003). Practitioners not only need tools for fostering integration, they also need guidance as to which tools might best fit their circumstances.

Organizational Information Processing Theory provides the theoretical foundation for this research. Information processing in organizations has been defined as including the gathering of data, the transformation of data into information, and the communication and storage of information in the organization (Egelhoff 1991; Galbraith 1973; Tushman and Nadler 1978). The information processing perspective defines organizations as open systems that must respond to the environment in which they operate (Thompson 1967, p.10) and considers managing uncertainty as the key task of the firm (Thompson 1967, p. 13). Galbraith (1969, 1973, 1977) extended this conceptual argument and developed an operational framework and model which is currently referred to as Organizational Information Processing Theory (OIPT). According to Galbraith (1974), organizations manage uncertainty by deploying the information-processing mechanism, or combinations of mechanisms, which best address the amount and type of uncertainty faced by the firm. The level of fit between information processing mechanisms and organizational context influences the firm's performance. Uncertainty and information-processing concepts have been the basis for a number of conceptual as well as empirical studies (Anandarajan et al 1998; Cooper and Wolfe 2005; Duncan 1973; Egelhoff 1982; Egelhoff 1991; Fairbank et al 2006; Flynn and Flynn 1999; Galbraith 1970; Galbraith 1974; Gattiker and Goodhue 2004; Jarvenpaa et al 1993; Kim et al 2006; Kmetz 1984;

Lawrence and Lorsch 1967; Tushman 1978; Van de Ven et al 1976). These studies span a number of fields including Strategy, Operations Management, Organizational Behavior, and Information Systems.

Researchers have used OIPT to explore Supply Chain Management issues. Gattiker (2006) uses OIPT to analyze the impact of Enterprise Resource Systems on the manufacturing-marketing interface. Other researchers using OIPT include Flynn and Flynn (1999) who found a negative relationship between environmental complexity and firm performance. This relationship, as predicted by OIPT, was moderated by at least one information-processing mechanism for each of their dependent variables. In a supply chain management context, Bensaou and Venkatraman (1995) found that matching the level of uncertainty in an inter-organizational relationship with information-processing capacity (in the form of Information Technology) increased performance outcomes. With regard to internal integration, Adler (1995) suggested increasing interdepartmental integration as a way to improve the flow of information within the firm and thus counter uncertainty.

Conceptually, OIPT posits that the performance of a firm is a function of the fit between the information processing requirements created by the environment and the information processing capabilities created by the organizational design. A basic proposition of OIPT is that as the amount of uncertainty involved in completing a task increases, more information must be processed in order to execute the task (Galbraith 1974). For large, complex tasks such as the management of internal supply chain functions studied here, tasks are divided between specialist subgroups (i.e.—the

Purchasing, Operations, and Logistics departments). The work performed within each of these subgroups must be coordinated so the overarching goal of profitability can be achieved, and the firm remains a viable entity.

Galbraith (1973, 1974, 1977) identifies three progressive methods of coordination, by order of their ability to handle uncertainty: rules and procedures, hierarchical referral, and targets or goals. March and Simon (1958) report that goals and targets are used to coordinate within sub-groups. Rather than prescribing behavior by rules and procedures, coordinating by goals and targets allow employees discretion to select behaviors that will result in goal accomplishment. Exceptions are handled through hierarchical referral, hence, the extent to which meaningful goals and sub-goals can be formulated and implemented constrains the ability of the organization to coordinate though this mechanism.

As uncertainty increases, firms are left with two major options: reduce the level of information processing requirements by creating slack resources or self-contained tasks, or increase the information processing capacity by investment in vertical information systems or creating lateral relations. Each of these strategies (reducing needs or increasing capacity) has implications regarding the management of the firm's internal supply chain functions. Slack resources such as excess capacity and buffer inventories can reduce the impact of uncertainty, but they also impose additional costs (Gattiker 2006). Organizing by self-contained tasks, such as organizing around product lines or market segments, often requires cooperation from multiple functional groups, which requires significant management effort (Lambert et al 2005; Weber 2002) and can result in loss of specialized skills as well as elimination of economies of scale (Galbraith 1974). Implementing vertical information systems such as ERP require significant financial investment as well as time (Davenport 1998; Gattiker and Goodhue 2004; Gattiker 2006). Implementing lateral relations involve creating horizontal links between task sub-groups, such as direct contact between members or different groups, the creation of liaison roles, or ultimately, the implementation of a matrix organization (Galbraith 1974; Mintzberg 1980).

The precepts of OIPT drive the research questions to be addressed. Inter-functional integration can be considered a measure of the information-processing capacity of the organization (Adler 1995; Bensaou and Venkatraman 1995; Kim et al 2006). The factors considered within the research model represent choices in organizational design.

The purpose of this research, then, is to answer the following series of research questions. First, what factors influence the level of internal integration within a manufacturing firm? This question will be addressed by testing a model that includes factors culled from the Operations Management, Supply Chain Management, Purchasing, Information Systems, Human Resource Management, and Logistics literatures.

Second, how are these factors interrelated? Although each could be hypothesized to have a direct effect on integration, it is unlikely that simple effects have sufficient explanatory power for the complex system studied. Moreover, some factors may only have completely mediated effects, which would be missed in a simple direct-effect model.

Third, do the relationships between the factors vary depending on the task environment? Different manufacturing plants face different levels of uncertainty. Information processing requirements are driven by the amount and type of uncertainty faced by the organization. In the supply chain context, relevant sources of uncertainty include uncertainty of supply and uncertainty of demand (Kim et al 2006).

This research has two primary contributions. For academics, it contributes to the further development of theory in supply chain management. OIPT studies related to supply chain management have primarily dealt with Information Systems implications (Gattiker 2006; Goodhue et al 1992; Jarvenpaa at al 1993). The other factors included within the current research model are derived from the research literature in several fields. However, these factors have not been studied as a comprehensive model for information processing, within the precepts of OIPT. If one of the goals of supply chain management is to reduce costs by replacing inventory with information, then it is crucial to understand how to develop information processing capabilities that match the processing requirements.

In addition, this study extends OIPT by explicitly considering and testing relationships between factors. Galbraith's (1974) conceptualization identified four strategies for improving the fit between processing requirements and processing capabilities. These strategies are described as not being mutually exclusive, with firms free to select combinations to fit their perceived needs (Galbraith 1977). Bensaou and Venkatraman (1995) used OIPT to study configurations of interorganizational relationships. Flynn and Flynn (1999) considering the relationship between uncertainty and performance, finding that the relationships with the dependent variables were, in every case, moderated by at least one information-processing mechanism. However, the information-processing mechanisms themselves, and the relationships between them, were not the subject of the study, as they are in this research.

The second contribution is for practitioners. Regardless of the industry or environment, all firms can benefit from improvements in efficiency and effectiveness. Internal integration can assist in both of these dimensions of performance. In the past, firms countered uncertainty by creating buffers of time and/or inventory (Galbraith 1973; Pagell et al. 2000; Thompson 1967). However, the competitive environment has reduced tolerance for the costs associated with these strategies (Gattiker 2006). Moreover, the customer's view of the firm focuses on the end result, not the individual processes leading up to delivery, and serving the customer is ultimately the goal of all firms. Knowing which factors best match the firm's individual situation can help managers improve the performance of their firm. An integrated firm can also serve as a springboard for growth and the development of innovation.

The following chapter contains a review of the relevant research literature for this study as well as the research model and the research hypotheses. The third chapter describes the operationalization of the research factors, as well as development and validation of the survey instrument. The fourth chapter describes the methods of data collection and analysis. The fifth chapter reviews the results of the analysis, while the sixth chapter outlines conclusions about the hypotheses, summarizes the limitations of this research and suggests avenues for future development.

CHAPTER TWO

LITERATURE REVIEW

2.1 Building a Model of Internal Supply Chain Integration

The fundamental research issue addressed by this research concerns the building blocks of supply chain management. Researchers have proposed that firms should first work out the details of the integration of their own internal processes to achieve a successful inter-firm integration strategy (Lambert et al. 1998; Stevens 1989). In order to do this, however, firms need a framework to guide their efforts at integration. This research tests a model of factors that contribute to internal integration of three key areas of internal supply chain management: purchasing, operations, and logistics.

Pagell (2004) used case studies to develop a preliminary model of factors that enable internal integration. Although the research protocol was informed by a thorough review of relevant literatures, the study is strictly descriptive and does not reflect any particular theoretical lens. Handfield and Melnyk (1998) describe a theory-building process map in an Operations Management context, beginning with discovery of a phenomenon and proceeding through description, mapping, relationship building, hypotheses testing, and finally theory extension or refinement. Pagell's (2004) model provides description and mapping of proposed factors. This research builds upon Pagell's (2004) model, as viewed through the lens of organizational information processing theory.

2.1.1 Internal Integration

Specialization and division of labor have been a guiding principle of economic growth since the time of Adam Smith (Smith, R. 2002), who argued that increased productivity resulted from breaking down complicated operations into simple tasks and then distributing the labor between members of an organization. This division and specialization enhanced the efficiency of the operation, and thus improved productivity, which Smith considered key to economic growth. However, Smith also emphasized that all the workers performing the task are interdependent, and are in fact collaborating in the production of the final good. No one laborer alone could account for the collective output.

Although the theme of division of labor remained important for the development of the modern industrial enterprise (Smith, R. 2002), the accompanying concept of collaboration was deemphasized. Around the turn of the 20th century, Frederick Taylor further refined the division of labor by creating a process by which each task was analyzed, optimized, and institutionalized (Taylor, 1967). The development of the method of scientific management, combined with the rising complexity of organizations, gave rise to the new class of professional managers, whose role was to coordinate and control the work of independent departments. In the early 20th century, Henry Ford and Alfred Sloan organized their respective firms around a business model that emphasized "command and control, centralization, central staff, the concept of personnel management, and budgets and controls" (McCormack and Johnson 2003, p. 12). This model developed into today's functionally oriented organization.

Departmentalization and division of labor are not inherently deleterious. Specialized knowledge is required in a number of disciplines (e.g., accounting, engineering) to sustain the operation of a complex business endeavor. However, there is a delicate balance to be maintained between performing the required discipline- or department-specific tasks, and contributing to the operation of the enterprise as a whole.

Lawrence and Lorsch (1967, p. 3-4) studied differentiation ("the state of separation of the organizational system into subsystems"), and integration ("the process of achieving unity of effort among the various subsystems in the accomplishment of the organization's task") in complex organizations, and their impact on performance. They came to the conclusion that organizational performance is related to the firm's management of resources along both of these dimensions, with the highest-performing firms having both high differentiation and high integration. However, they also point out that these are "antagonistic states" (Lawrence and Lorsch 1967, Abstract). Companies that tend to emphasize differentiation at the expense of integration run the risk of inefficiency and duplication of effort. Companies that emphasize integration at the expense of differentiation risk diluting their expertise and reducing their ability to innovate (Kratzer et al 2004; Nicholas 1994; Nystrom 1979).

The focus of this research is on achieving the integration of effort. Although there are many circulating definitions of supply chain management (Ho et al 2002), they all include integration and refer to the management of linkages, the relationship between the way in which one value activity is performed and the cost or performance of another

(Porter 1985; Vickery et al 2003). The notion of managing linkages can be traced back to Porter (1985), and his conceptualization of the value chain. In his own words:

> "Competitive advantage frequently derives from linkages among activities just as it does from the individual activities themselves." (Porter 1985, p. 48)

and

> "Linkages lead to competitive advantage in two ways: optimization and coordination." (Porter 1985, p. 48)

Other researchers have also noted the value of integration, citing reductions in lead-time (Goldhar and Lei 1991), inventory levels (Levary 2000; Stank et al. 1999), and improved operational performance (Rosenzweig et al. 2003; Vickery et al. 2003).

Although the benefits of "integration" have been the subject of the studies cited, a fundamental issue has not been resolved: there is no widely accepted definition for the construct of "integration." Pagell (2004) reviewed the definition of integration used in eighteen published studies. He determined that although the definitions varied, there were common themes. For his study, he combined the definitions of Kahn and Mentzer (1998, p.56):

> "a process of interdepartmental interaction and interdepartmental collaboration that brings departments together into a cohesive organization"

and O'Leary-Kelly and Flores (2002, p. 226):

> "the extent to which separate parties work together in a cooperative manner to arrive at mutually acceptable outcomes"

to formulate the definition adopted for his study:

> "Integration is a process of interaction and collaboration in which manufacturing, purchasing and logistics work together in a cooperative manner to arrive at mutually acceptable outcomes for their organization." (Pagell 2004, p. 460)

2.1.2 Outcome Variable 1: Strategic Consensus

At its simplest level, a goal is an objective, "the purpose toward which an endeavor is directed." (American Heritage Dictionary of the English Language, 2000). It is something that a firm wishes to accomplish. For an individual, goals serve as motivation to perform the actions that will allow the individual to move closer to a desired outcome (Locke and Latham 1990).

For a firm, a goal is a way to give direction to its members (Bateman et al 2002). Complex organizations incorporate the needs and wants of many assorted individuals. Coordinating their efforts into cohesive action requires an overarching structure that they can use as a guide regardless of their position (functional or hierarchical) within the firm.

Leaders of a firm have several types of goals, including ultimate, enterprise, strategic, project, and process, (Bateman et al 2002) but for the purposes of this research only strategic goals and their operational (functional) counterparts are considered. A strategic goal is a statement of the direction in which the firm wants to move in the long term. For example, a stated goal of "cost leadership within the industry" is a long-term strategic goal. It is specific in scope (cost, industry) but not in implementation.

Strategic goals generally cannot be implemented without translating into specific actions (Joshi et al 2003). Each functional department must consider how it can contribute to the overall strategic goals, and formulate its own operational goals (Skinner 1961). At each lower hierarchical level, the firm's strategic goals are progressively more and more specific, attuned to the capabilities of each organizational level. However, the translation of the original strategic goal can result in mismatch between functional goals. While ordering in large volumes may allow Purchasing to achieve a lower material cost, the firm as a whole may incur costs from carrying the excess inventory. These costs are not reflected in the purchase price, but they detract from the overall profitability of the plant. If each department pursues local optima in a similar way, the global performance towards the goal tends to suffer.

Hayes and Wheelwright (1984) posited that the firm's business strategy needs to be supported by internally consistent functional strategies to provide competitive advantage. Pagell's definition includes the phrase "mutually acceptable," key modifiers that reflect this interdependence . The implication is that there is some overlap in desired outcomes between the interested parties.

Strategic consensus is at the heart of the Hayes and Wheelwright (1984) model. To achieve the most competitive advantage, a firm must develop an overall business strategy. Each functional strategy should in turn support the overall goals and each other. In order to support each other, each function's leaders should be familiar with the other functions' strategic priorities. The last point is significant, as it is possible to achieve alignment with the business strategy within each function, without each function knowing about the actions of the others. However, true integration is reflected when all functions work toward the business goals cooperatively. Consensus implies more than alignment. As defined in Merriam Webster's online dictionary, consensus is: "general agreement; group solidarity in sentiment and belief." (Webster's Online, 2007). Strategic Consensus is defined as the extent to which a respondent is aware of the firm's overall competitive strategy and the extent to which their department's goals align with the strategy of the firm.

2.1.3 Outcome Variable 2: Collaboration

Organizational goals cannot be accomplished without effort. Lawrence and Lorsch (1967) provided some of the earliest measures of collaboration, asking members of various departments about their perceptions of "unity of effort."   Larson (1994) used three factors to measure integration: unity of purpose, coordination of effort and teamwork. Kahn (1996) defined collaboration as "a mutual/shared process where two or more departments work together, have mutual understanding, have a common vision, share resources, and achieve collective goals (p. 139)." Other researchers have followed Kahn's lead in developing measures of collaboration, including Ellinger et al. (2000), Mollenkopf et al. (2000) and Stank et al. (1999). Zacharia and Mentzer (2004) use a measure of cross-functional integration that focuses on collaboration, while Sanders and Premus (2005) measure internal integration as collaboration and information sharing. It is relevant to note that in accordance prior research (Te'eni 2001) this research considers communication and information sharing as an antecedent to integration. While it is possible that shared information will not result in action, it is difficult to envision the possibility of collaboration without communication and information sharing. Hence, the dependent variable does not include measures of information sharing or communication, but rather focuses on how the focal departments work together. A collaborative working environment contains fewer barriers to information processing such as functional silos, team member inaccessibility, and incompatible information systems (Swink et al 2006). Collaboration is the extent to which the departments work together to accomplish mutually acceptable outcomes.

Pagell (2004) used case studies to develop a preliminary model of factors that enable internal integration. Although the research protocol was informed by a thorough review of relevant literatures, the study is strictly descriptive and does not reflect any particular theoretical lens. Handfield and Melnyk (1998) describe a theory-building process map in an Operations Management context, beginning with discovery of a phenomenon and proceeding through description, mapping, relationship building, hypotheses testing, and finally theory extension or refinement. Pagell's (2004) model provides description and mapping of proposed factors. The current research model builds upon this model, as viewed through the lens of organizational information processing theory. The following sections will review the literature and present the research hypotheses relating to the factors considered to be driving Collaboration and Strategic Consensus: Management Support, Integrative Information Technology, Integrative Human Resource Management, Centralization, and Communication.

2.2 Independent Variables

2.2.1 Management Support

As with all multi-functional change initiatives, implementation of internal supply chain integration requires the support and leadership of management (Barnard 1968; Fawcett and Cooper 2001; Lawrence and Lorsch 1967). Prior research supports the fact that the degree of management support will lead to significant variations in the degree of acceptance or resistance to projects, and by extension, to the degree of success (Beck 1983; Manley 1975). Managers influence subordinates in a variety of ways, including role modeling, goal definition, reward allocation, resource distribution, communication of organizational norms and values, structuring of work group interactions, conditioning subordinates' perceptions of the work environment, and influence over processes and procedures used (Bass 1981; Bass 1985; James and James 1989; Ramus and Steger 2000; Yukl 1994).

Although Management Support is not an explicit construct in OIPT, the leaders of the organization make the decisions regarding implementation of various forms of information processing. Moreover, Management Support is a commonly used construct in management research (see for example: Marble 2003; Motwani and Khumar 1998; Ragu-Nathan et al 2004; and others in Table 2.2). It has been credited with the success or blamed for the failure of various corporate initiatives (Bhuiyan and Baghel 2005; Flynn et al 1995; Ogden 2004; Pagell 2004; Pinto 1990; Susman and Dean 1992; Swink 2000).

The role of managers has been studied from the perspectives of leadership (Howell and Avolio 1993; Jacobs and MacClelland 1994; Kendra and Taplin 2004), control (Dewitt et al 2003; Diaz and Rodriguez 2003; Martin et al 2005), and influence (Dulebohn et al 2004; Perrewé and Nelson 2004). Managers are also key elements of various theories used to understand organizational development and behavior, including institutional theory (Chatterjee et al 2002; Orlikowski et al 1995), and structuration theory (Keegan et al 1998; Spybey 1984.)

At the plant level, the person most directly associated with management and leadership is the plant manager. To explore the role of the plant manager in promoting internal supply chain integration, this study focuses on the contributions of Chester Barnard.

Like Taylor (1967) and Fayol (Reid 1995) before him, Chester Barnard came to his view of organizations and managerial work by personal experience. In contrast to Taylor and Fayol, however, Barnard's "Functions of the Executive" (1968) approaches the organization from a social perspective. Barnard dedicated a large part of his manuscript to an attempt to formulate a theory of the organization as he experienced it. He brought forth a view of the organization as an organic, cooperative system, in existence only because its members agreed to participate.

In the spirit of the organization as a cooperative system, Barnard narrowed down the functions of the executive to three: maintenance of organization communication, securing of essential services from individuals, and formulation of purpose and objectives. The executive's communication responsibilities are the primary function (Barnard 1968, p. 218), and stem from his position as the hub of the cooperative network. The managers transmit information from superiors, and in the same vein, are the conduit by which information is sent back up the chain of command and across the communication web formed by his peers. In terms of the requirements of organizational structure, Barnard's view is that the *system* (organizational charts/individual work positions) and the *individuals* (i.e. managers) available must be combined to serve the information needs of the firm. Hence, the role of the manager is to assess both the structural (position) needs and the assets at his disposal and make the best combination possible, continuously adjusting as circumstances require. In the ideal, each "executive" is matched with the position which best uses his talents and skills, and through their efforts communication flows smoothly throughout the organization. The needs of the position determine the attributes needed from the executive that fills it. If there is no executive available that matches those requirements, then the structure (positions) should be changed to keep the two elements in balance. As part of this primary function, the executive must decide whom and when to hire, promote, demote, and terminate within his or her organization, as well as ensure that the correct skill and temperament mix is developed within the organization.

The second function, securing the essential services of individuals, is derived directly from Barnard's view of the nature of authority and the management of the employees' zones of indifference. As with the communication function, the manager has a dual role: attracting the correct individuals into the organization and then ensuring that these individuals contribute as they are intended to. The recruitment effort is two-pronged: first, a suitable pool of talent must be created or developed within reach of the organization, though perhaps not yet directly associated with it. Then, selected individuals within that pool that match specific organizational needs must be convinced to join the organization. Creating the talent pool requires identifying desirable attributes and means to find those who possess them. Bringing specific individuals into the organization requires a combination of personal appeal and organizational characteristics.

The tasks assigned to a manager by virtue of Barnard's second function correspond to the responsibilities usually associated with Human Resources Management. These include:

> "…the maintenance of morale, the maintenance of the scheme of inducements, the maintenance of schemes of deterrents, supervision and control, inspection, education and training." (Barnard 1968, p. 231)

Although specialization and division of labor have created Human Resources departments to administer these issues within many organizations, managers retain responsibility for them.

Barnard's third executive function is the formulation of purpose and objectives, or, in his words: "…to formulate and define the purposes, objectives, ends, of the organization" (Barnard 1968, p. 231). This third function generally deploys from the top down. The leaders or executives of an organization formulate the firm's goals and direction, and it is the domain of the lower-level managers to translate the general organizational goals into specific courses of action for their divisions and departments. An important element of this function is the need to delegate authority. No single executive or indeed any individual person can create an action plan in the level of detail required to keep a complex organization going. The role of the top manager in this process is to create the vision and communicate it to his lieutenants. It is then the role of the organization's managers to perform their other two functions (manage communications and elicit efforts from the organization members) in order to realize the vision.

As with all multi-functional change initiatives, implementation of internal supply chain integration requires the support and leadership of management (Barnard 1968; Fawcett and Cooper 2001; Lawrence and Lorsch 1967). At the plant level, the person most directly associated with management and leadership is the plant manager. Prior research supports the fact that the degree of management support will lead to significant variations in the degree of acceptance or resistance to projects, and by extension, to the degree of success (Beck 1983; Manley 1975). Managers influence subordinates in a variety of ways, including role modeling, goal definition, reward allocation, resource distribution, communication of organizational norms and values, structuring of work group interactions, conditioning subordinates' perceptions of the work environment, and influence over processes and procedures used (Bass 1981; Bass 1985; James and James 1989; Ramus and Steger 2000; Yukl 1994).

Newman and Saberwhal (1996) reviewed the management information systems literature and identified two categories of support: Commitment to Resources and Commitment to Change Management. Commitment to Resources describes the extent to which management is determined to provide enough financial and technical resources to ensure smooth completion of implementation. Commitment to Change Management depicts the extent to which management engages in promoting organizational receptivity of innovation by training, formal presentation, and by establishing communication channels with targeted users.

In an Operations Management context, Sum et al. (1997) cited three main facets of top management support:

- Showing interest/personal involvement
- Providing necessary resources
- Providing leadership

Personal involvement took the form of participation in team meetings, willingness to spend time with people and listen to feedback, and willingness to help resolve problems. Providing resources included budgets, personnel, training, and other critical needs. Leadership required providing a vision, helping to translate plans into actions, and reviewing progress regularly. Other researchers have proposed various ways in which managers express support, including creating and communicating goals and vision, installing schedule/planning mechanisms, instituting a monitoring and feedback system, and trouble-shooting (Huber and Brown 1991; Pinto and Mantel 1990; Pinto and Slevin 1987). Top management support is seen as necessary for the project to secure important resources and to provide leadership in uncertain circumstances (Eisenhardt and Tabrizi, 1995; Pate-Cornell and Dillon, 2001; Swink et al 2006).

In accordance with Barnard's (1968) conceptualization of the role of the manager, the definition of Management Support adopted for this study is as follows: the actions of the Plant Manager aimed at fostering internal supply chain integration by maintaining organization communication, securing essential services from individuals, and formulation of purpose and objectives.

Prior research has established that the level of Management Support has an impact on the acceptance of innovation and change (Bhuiyan and Baghel 2005; Flynn et al 1995; Ogden 2004, Swink 2000; Susman and Dean 1992). Prior research has also established that managers exert this influence on subordinates indirectly, by defining goals, distributing resources, structuring work group interactions, and influencing the processes and procedures used (Bass 1981; Bass 1985; James and James 1989; Ramus and Steger 2000; Yukl 1994). These actions do not directly increase the level of integration between departments. However, they create an organizational environment conducive to the development of inter-departmental Collaboration and Strategic Consensus. Hence:

- Management Support has a positive effect on Collaboration. This effect is mediated by Communication, Job Rotation, Cross Functional Teams, and Integrative Employee Assessment

- Management Support has a positive effect on Strategic Consensus. This effect is mediated by Communication, Job Rotation, Cross Functional Teams, and Integrative Employee Assessment

These hypotheses correspond to Barnard's three executive functions: maintenance of organization communication, securing of essential services from individuals, and formulation of purpose and objectives. The first function is reflected by the impact of Management Support on Integration through the mediating effect Communication. The second and third functions are reflected in the impact of Management Support on Integration through the use of Integrative Human Resource Management (IHRM).

2.2.2 Integrative Information Technology

Supply chain management is concerned with two major flows: the flow of materials from raw materials, through the transformation processes and into finished goods delivered to the ultimate customers; and the flow of information both from the suppliers to the customers and from the customers back up to through the chain to the raw material suppliers. In the past, the speed of information flow was limited by the capacity of individuals and the limitations of geography and time. Information technology has removed these barriers, facilitating both flows. For example, current technology allows managers to collect real-time electronic Point-of-Sales data, quickly perform complex analyses, and transmit the resulting demand information instantly to their internal and external supply chain partners, whether they are in the same location or halfway around the world. On the other end of the supply chain, current technology allows firms to coordinate complicated production schedules with suppliers to enable Just-in-Time production systems. Better information exchange allows for more accurate inventory responses to changes in demand and thus more appropriate inventory levels throughout the supply chain (Levary 2000; Stank et al 1999).

Supply Chain Management would not be possible without two key information technology developments: the personal computer and the computer network. Although computer systems have been developed for business applications since the mid-1950's (Friedman and Cornford 1989, p. 5), early systems were large, unwieldy, and required specialized personnel to code and operate. The first implementations of information technology involved processing accounting transactions such as payroll (Friedman and Cornford, p. 83), where the objective was to increase the speed and accuracy of processing. As the hardware technology improved, it became possible to "wire in more and more software in smart machines" (Kraft 1977, p. 62) These "smart machines" evolved into the personal computer. The personal computer, now available with sophisticated software, allows individuals to manipulate and analyze data to satisfy their personal information needs. For managers, the combination of computing power and software allows them to apply business logic to data processing and generate actionable information (Venkatraman, 1991; Zeng, Chiang, and Yen 2003).

Stand-alone personal computers had one major drawback. Sharing information between managers and/or departments was still difficult. Moreover, software was often written specifically to meet the needs of a certain function, whether accounting or purchasing or production planning. Each function had a unique data structure (Goodhue et al. 1992). Sharing information between functional systems was, technologically, as difficult as sharing with external partners.

Networking technology, in both hardware and protocols, improved information transfer. Combined with the use of database management systems, multiple users could work from the same data source, and share their findings (Boar 1993; Madnick 1991,). The first generation of electronic data interchange (EDI) systems created data links between customers and suppliers, allowing the transmission of ordering data. However, the technical limitations of the original EDI systems limited their contribution to the management of the supply chain as a whole (Dougherty 1994). More recently, the development of the Internet allow managers to share and transfer information easily, both within their firm and with their customers and suppliers. (Yates and Benjamin 1991; Zeng et al. 2003)

Information technology is now considered a key facilitator of Supply Chain Management (St.John et al 2001; Vickery et al 2003). Although the problem of managing the supply chain is not new, the tools to access accurate, timely, and affordable information were not available until recently (Bowersox and Calantone 1998). Supply chain management requires extensive data management capabilities and advanced interorganizational information systems to enable greater information exchange (Patterson et al. 2004).

Galbraith identified "Investment in Vertical Information Systems" as one strategy for increasing the information processing capacity of the organization. In their study of the relationship between integration and performance, Vickery et al (2003) identify specific forms of integrative information technology that are used to manage the supply chain. Two of their categories of information technologies directly affect the internal operations of the firm. The first category consists of computerized production systems, and includes manufacturing planning and control systems such as MRP and MRPII. Computerized production systems integrate manufacturing activities into an overall planning system that encompasses functions beyond the boundaries of manufacturing, such as Finance, Purchasing and Sales/Marketing (Vickery et al 2003; Yusuf and Little 1998).

The second category of integrative information technologies is the integrated information system. These systems foster integration by allowing all functional areas within the firm to access and transmit information from one area to another (Bardi et al 1994; Vickery et al 2003). An example of this type of technology is Enterprise Resource Planning (Zeng et al. 2003), defined by Kumar and VonHillegersberg (2000, p. 23) as: "configurable information systems packages that integrate information and information-based processes within and across functional areas in an organization."

Although many firms have implemented ERP systems, results have been mixed. The major goal of ERP is to unite the various departments across an enterprise through one system application package (Tarn et al. 2002). ERP enables the integrated flow on information to be the core system that provides the data needed for all corporate components (Tarn et al. 2002), thus enhancing the integration of business processes throughout the firm. However, the magnitude and complexity of the task have made ERP implementation difficult and costly (Davenport 1998), with some firms abandoning the project in spite of significant investment (Bailey 1999).

Firms that do not have the resources or choose not to implement standard ERP packages can achieve integration by interfacing their functional systems through Applications Integration (AI) (Themistocleus and Irani 2001). Linthicum (1999, p. 354) defines AI as:

> "A set of technologies that allow the movement and exchange of information between different applications and business processes within and between organizations."

Applications integration combines traditional integration technologies such as database-oriented middleware with new integration technologies such as adapters and message brokers (e.g., XML) to support the efficient incorporation of information systems (Themistocleous 2000). By integrating their systems using AI, firms can maintain the functionality that legacy systems provide while still enabling inter-functional collaboration, without the expense of purchasing a commercial ERP system. For the purposes of this research, Integrative Information Technology is defined as the implementation of computerized production systems and integrated enterprise systems intended to facilitate data and information transfer between departments.

Galbraith (1974) proposed that vertical information systems increase the capacity for information processing. Prior research has established that Integrative Information Technology facilitates interfunctional collaboration (Bardi et al 1994; Tarn et al. 2002; Themistocleous 2000; Vickery et al 2003; Yusuf and Little 1998). Hence the formulation of the following hypotheses:

- Integrative Information Technology has a direct positive effect on Collaboration.
- Integrative Information Technology has a direct positive effect on Strategic Consensus.

2.2.3 Job rotation

Internal supply chain integration is an organizational phenomenon, but its implementation depends on the actions of individuals. While the technical elements of supply chain management can be easily replicated, the human capital can be a source of competitive advantage (Collins and Clark 2003). As firms become leaner, world-class performance will be a function of how well a company can manage its human resources (Murphy and Heberling 1994). One of the challenges facing the firm is to implement mechanisms that promote and support the acquisition and continuing usage of the capabilities that allow individuals to fully contribute to the supply chain management process. The human resources management literature suggests three mechanisms that firms can use to encourage integrative behavior: job rotation, use of cross-functional teams, and integrative employee assessment (Bishop, Scott, and Borroughs 2000; Eriksson and Ortega 2006; Ference et al 1977; Lawrence and Lorsch 1967; Pagell 2004; Vroom 1964; Wexley and Latham 1991).

According to Wexley and Latham (1991), job rotation provides employees with a series of lateral assignments throughout a company, with each resulting in a meaningful change in job content. There are three theories as to why firms implement job rotation programs (Eriksson and Ortega 2006). The first proposes job rotation keeps employees motivated by breaking up the monotony of work, thereby preventing boredom. Motivated employees would be expected to have better performance. The motivation theory of job rotation has been studied as a possible alternative for motivating employees who have reached a plateau level beyond which they either cannot be or do not desire to be promoted (Ference, Stoner, and Warren 1977).

The second theory proposes that job rotation improves employee skills through increased exposure to job-based experiential learning (Hall 1986; Morrison and Hock 1986; Noe and Ford 1992). A number of firms have implemented management training programs that use job rotation as a primary training tool for employee development (Brooks 1996; Burke and Steensma 1998). Supporters of these programs claim that broad exposure to all aspects of firm operations give managers a better grasp of strategic issues, as well as a network of contacts which facilitate collaboration (Eriksson and Ortega 2006).

The third theory proposes that job rotation allows the employer to learn more about the employees' abilities. The firm can then determine what part of the performance level can be attributed to an employee's general skills, to characteristics of the job itself, or to job-specific knowledge that the employee may or may not possess. Ortega (2001) showed that the benefits of job rotation are relatively higher when the abilities of the employees are unknown, or when the overall environment is more uncertain.

The benefits of job rotation accrue to both the individual and the firm (Campion, Chraskin and Stevens 1994; London 1989). The individual benefits from a broader view of the firm's product(s), an increased understanding of the organization, and a social support network (Fawcett and Cooper 2001). The firm benefits from improved collaboration between groups and improved decision-making. A "cross-experienced" management team facilitates effective integration (Fawcett and Cooper 2001).

In terms of OIPT, job rotation is a mechanism for creating lateral relations. Lateral relations are proposed as a way to increase the information-processing capabilities of the organization. Job rotation helps create social networks that support cross-functional communication (Fawcett and Cooper 2001). For those employees who are rotated or who interact with the rotated employees, it also fosters an increased understanding of how the various functional departments fit into the organization's overall mission (Fawcett and Cooper 2001). Employees involved in job rotation tend to create a network of contacts that can be drawn upon as needed, thus forming lateral relations as proposed by OIPT (Eriksson and Ortega 2006; Galbraith 1978).

For the purposes of this study, Job Rotation is defined as the implementation of policies and procedures that encourage employees to consider job assignments outside of their current functional area. This definition is meant to include efforts made on behalf of a particular department to encourage applications for job openings from members of other functional areas. This leads to the following hypotheses:

- Job Rotation has a positive direct effect on Collaboration.
- Job Rotations has a positive direct effect on Strategic Consensus
- Job Rotation has a positive indirect effect on Collaboration, mediated by Communication
- Job Rotation has a positive indirect effect on Strategic Consensus, mediated by Communication

2.2.4 Cross-functional teams

Using employee teams is a popular method of increasing worker productivity and flexibility (Bishop, Scott, and Borroughs 2000) as well as coordinating activities between separate groups (Gittel 2002). Firms that have a strong customer orientation use cross-functional teams to solve problems in a way that more closely addresses a customer's experience of the firm. One particular area that has received much attention is the use of cross-functional teams in sourcing and purchasing. Cross-functional teams have been used to speed up product development, to improve the effectiveness of the purchasing function, and to address quality issues (Chamberlain 1998; Chopra and Meindl 2003; Minahan 1998).

While job rotation results in a substantial change in job content for the affected employee, employees in cross-functional teams collaborate without changing the core nature of their jobs. The functional expertise of the individual team members is retained, and complementary skills can be brought to bear on the issue at hand. Cross-functional teams can bridge the differences between functional approaches (Larwrence and Lorsch 1967), and provide a more comprehensive perspective. Atwater and Bass (1994, p. 56-57) state that "groups are superior when…the groups contain members with diverse but relevant skills".

Fawcett and Cooper (2001) relate that managers at leading companies recognize that the key to competitive success is to meet the needs of the customer better than the competition. Doing so requires developing "core competencies" or "critical capabilities" within the firm, which will lead to improved customer satisfaction. Competencies and capabilities are "collective and cross-functional – a small part of many people's job" (Stalk et al. 1992, p. 63). Process integration is fundamental to these efforts.

The implementation of SCM needs the integration of processes throughout the firm (Mentzer et al. 2001). However, it is important to recognize that the adoption and management of business operations as processes will not replace the traditional business functions because it is within these functions that activities are performed and functional knowledge is developed, systematized and deployed throughout the organization (Womack and Jones 1994). Cross-functional teams are an integrative mechanism that bridges the differentiation divide (Lawrence and Lorsch 1967). Employees involved in cross-functional teams tend to create a network of contacts that can be drawn upon as needed, thus forming lateral relations as proposed by OIPT (Eriksson and Ortega 2006; Galbraith 1978).

For this research, Cross-Functional Teams is defined as the use of work groups that include members from different departments, all working on the same task. From this definition, the following hypotheses can be stated:

- Cross Functional Teams has a direct positive effect on Collaboration
- Cross Functional Teams has a direct positive effect on Strategic Consensus
- Cross Functional Teams has an indirect positive effect on Collaboration, mediated by Communication.

- Cross Functional Teams has an indirect positive effect on Strategic Consensus, mediated by Communication.

2.2.5 Integrative Employee Assessment

Individual performance appraisal is basic to the human resource management systems of most large corporations. Performance appraisals are used to determine reward levels, to validate tests, to aid career development, to improve communications, and to facilitate understanding of job duties (Bowen and Lawler 1992). Corporate pay systems have likewise focused on individuals. Job descriptions spell out what an individual is to do, job evaluation systems suggest how much the job is worth (and thus how much the individual is to be paid), and merit pay increases reflect how well the individual has done the job (Bowen and Lawler 1992). The way employees are measured and rewarded has long been linked to behavior (Pagell 2004; Vroom, 1964).

In the functionally oriented organization, individuals are measured and rewarded based on meeting individual and departmental objectives (Cooke, 2003). Therefore, a manager within this organization has no incentive to collaborate with his peers in other departments. He or she may even be penalized for committing to an action that is detrimental to the functional performance measures, though it may support the greater good of the firm. Optimizing the performance of a single department often does not support the performance of the firm as a whole.

An organization seeking to integrate its supply chain functions needs to design a performance management system that supports collaborative actions. Cooper (2003) suggests that organizations should move away from “Results” measures in favor of

“Process” measures, and ultimately to “Strategic” measures. Results measures focus on the activities and performance of an individual department. For example, purchasing personnel may be measured against a desired reduction in the cost of the purchased item. However, the lower-cost item may result in higher transportation costs, lower quality, or other difficulties in the production process. The purchasing manager receives his bonus, but the performance of the firm as a whole is worse.

Process measures focus on the needs of the customers rather than internal goals. For example, all of the managers involved in the process of purchasing, production, and delivery could be measured against on-time delivery performance. Process measures encourage collaboration between departments to satisfy customer needs (Imai 1986).

Strategic measures assess whether the overall goals of the firm are being met. For example, instead of being measured against a target reduction in cost, purchasing personnel could be measured by their contribution to reducing the total cost of ownership, which would include shipping, quality, disposal, and other dimensions as appropriate.

This discussion should not be interpreted as a condemnation of function-specific goals. Functional goals, like functional departments, are important to the continued operation of the firm (Womack and Jones 1994). However, having performance measures that require collaborative actions mitigates the problems of local optimization. The challenge for the firm is to balance the need for collaboration with the need for function-specific results. Using process or strategic goals to as part of an employee’s performance assessment is one way to align the goals of the individual with the goals of the organization. For the purpose of this research study, Integrative Employee

Assessment is defined as the use of compensation systems that reward contributions towards the overall goals of the manufacturing facility. From this the following hypotheses can be stated:

- Integrative Employee Assessment has a direct positive effect on Collaboration
- Integrative Employee Assessment has a direct positive effect on Strategic Consensus
- Integrative Employee Assessment has an indirect positive effect on Collaboration, mediated by Communication.
- Integrative Employee Assessment has an indirect positive effect on Strategic Consensus, mediated by Communication.

2.2.6 Centralization

While individuals perform the activities related to purchasing, operations, and logistics, they are part of the larger organization that is the firm. Daft (2004, p. 11) defines organizations as social entities that are goal-directed, designed as deliberately structured and coordinated activity systems, and are linked to the external environment. Structure refers to an organization's internal pattern of relationships, authority, and communication (Hage and Aiken 1967). The structure of the organization sets the stage for defining the roles and responsibilities of each individual. In this study, the organization refers to a single manufacturing facility.

Structural dimensions of an organization provide labels to describe the internal characteristics of the organization, creating a basis for measurement and comparison (Daft 2004, p. 17). Several dimensions of structure have been described in the literature, including centralization, formalization, complexity, span of control, and workforce composition (Child 1974; Ford and Slocum 1977; Ward et al. 1993). This study will focus on centralization, which has been considered a fundamental element in control and coordination (Hage 1965; Wang 2001).

Centralization is a dimension of structure that refers to the degree to which the authority to make decisions is concentrated (Child 1974; King and Sabherwal 1992; Lee and Choi 2003; Wang 2001). In a manufacturing plant, the Operations or Production Manager is usually within the Plant Manager's chain of command. This study examines the centralization of the Purchasing and Logistics functions, either or both of which may be outside the Plant Manager's chain of command. In this research, Centralization refers to the location of decision-making authority for Purchasing or Logistics. In a centralized organization, members of Purchasing and/or Logistics take direction and/or refer exceptions to routine tasks to their own respective hierarchies (Sathe 1974; Sathe 1978). Hence, the authority is retained within the Purchasing and/or Logistics functions. In a decentralized organization, lower-level employees have authority to make decisions. If hierarchical referral is necessary, the employee may refer the issue outside his or her department for a decision. A decentralized arrangement represents the sharing of authority between functions.

Prior research has established that centralization inhibits creative solutions to complex organizational problems (Graham and Pizzo 1996; Lee and Choi 2003). Centralization also inhibits interdepartmental collaboration and transfer of ideas (Woodman et al 1993) by interfering with communication channels (Bennett and Gabriel 1999; Hage et al 1971,). Hence the following hypotheses:

- Centralization has a direct negative effect on Collaboration
- Centralization has a direct negative effect on Strategic Consensus
- Centralization has an indirect negative effect on Collaboration, mediated by Communication
- Centralization has an indirect negative effect on Strategic Consensus, mediated by Communication

2.2.7 Communication

Supply chain management comprises two flows: goods and information flow downstream from the suppliers to the customer, and information (and perhaps product returns) flow upstream from the customers all the way to the raw materials suppliers (Handfield and Nichols 1999). Within a firm, the flow of information keeps the product moving from incoming raw materials to outgoing products. Channels of communication are important to creating and sustaining team processes, such as cross-functional integration (Pagell 2004; Pagell and LePine 2002).

Communication can occur informally or formally (March and Simon 1958). Informal communications take the form of person-to-person (relational) interactions, such as work-related discussions with co-workers (Johnson et al 1994). The literature on teams suggests that informal, real-time communication is a key contributor to team performance (Pagell and LePine 2002). While both formal and informal communications are necessary for information dissemination (March and Simon 1958), Pagell (2004) found that informal communications had a larger impact on integration. When individuals communicate person-to-person, relationship building occurs. However, when interactions are limited to position-to-position, the lack of a personal relationship may inhibit the quality of the information that is transferred. However, Johnson et al. (1994) determined that the forms are interrelated and the salience of either form is dependent on contextual factors.

Formal communication takes the form of scheduled meetings, published documents, and other non-relational interactions. A position-to-position outlook characterizes formal communication, with information transfer supporting the needs of the hierarchy of authority in the achievement of the organizational goals (Dow 1988, Jablin 1987).

Although a conceptual distinction can be made between formal and informal communication, these two elements are interrelated (Hartman and Johnson 1990), and both are essential to the organization's communication structure (March and Simon 1958). Formal communication establishes the framework for disseminating the goals of the organization and measuring performance. Informal communication responds the social needs of the organization's members, fostering cohesiveness and maintaining individuals' personal integrity or autonomy (Johnson et al. 1994).

Habermas (1998) proposed the theory of communicative action (TCA). Communicative action is defined as the interaction of two or more subjects capable of speech and action who establish interpersonal relationships. The subjects seek to reach an understanding about the action situation and their plans of action *in order to coordinate their action by way of agreement* (Habermas 1984, p. 86, emphasis added). TCA has been used in the information systems literature to understand organizational communication (Ngwenyama and Lee 1997; Ngwenyama and Lyytinen 1997; Te'eni 2001). TCA requires four conditions to be met in order for a communicative act to occur (Te'eni 2001): first, the receiver must be able to understand the sender; second, the act must be true so that the receiver can share the sender's knowledge; third, the receiver must trust the sender; and fourth, the act must be appropriate, so that the receiver can agree with the sender within the value system (Habermas 1984; Habermas 1987). If these four conditions have been met, then the outcomes of communication can be summarized as follows: successful communication results in mutual understanding regarding actions and relationship building, while poor communication results in impediments to action and relationships (Te'eni 2001). Hence, TCA posits that communication is an antecedent to mutual understanding and relationship building. Calantone et al (2002, p. 278) presented communication as an antecedent of relationship quality and integration between marketing and manufacturing, calling it a "vital prerequisite to harmonious interpersonal relationships." In this study, Communication is defined as the transfer of information through structured and unstructured interactions between members of different departments. The impact of Communication is hypothesized as follows:

- Communication has a direct positive effect on Collaboration.
- Communication has a direct positive effect on Strategic Consensus.

2.3 Organizational Information Processing Theory

Organizational Information Processing Theory provides the theoretical foundation for this research. Information processing in organizations has been defined as including the gathering of data, the transformation of data into information, and the communication and storage of information in the organization (Egelhoff 1991; Galbraith 1973;Tushman and Nadler 1978). The information processing perspective defines organizations as open systems that must respond to the environment in which they operate and considers managing uncertainty as the key task of the firm (Thompson 1967, p. 10, 13).

Galbraith (1969, 1973, 1974, 1977) extended Thompson's conceptual argument and developed an operational framework and model which is currently referred to as Organizational Information Processing Theory (OIPT). According to Galbraith (1974), organizations manage uncertainty by deploying the information-processing mechanism, or combinations of mechanisms, which best address the amount and type of uncertainty faced by the firm. Conceptually, OIPT posits that the performance of a firm is a function of the fit between the information processing requirements created by the environment and the information processing capabilities created by the organizational design.

2.3.1 Information processing requirements

Dill (1958, p. 409) proposed that "environmental factors constrain the structure of organizations and the behavior of organizational participants." What may be appropriate for one organization is not appropriate for another, if they operate within different task environments. The task environment of the firm includes all stimuli to which it is exposed, "inputs and information from external sources" (Dill 1958, p. 410).

Galbraith (1973) proposed that the key task of the firm is to manage uncertainty. The amount and types of uncertainty vary between organizations and include the stability of the external environment, the predictability of core processes, how tasks are subdivided, and the level of interdependence among those subdivisions (Galbraith 1973; Thompson 1967; Tushman and Nadler 1978). Information is processed to accomplish internal tasks, coordinate activities, and interpret the environment (Daft and Lengel 1986).

Firm responses to uncertainty have been the basis for a number of conceptual as well as empirical studies (Daft and Lengel 1986; Daft and MacIntosh 1981; Egelhoff 1982; Egelhoff 1991; Fairbank et al 2006; Flynn and Flynn 1999; Galbraith 1974; Gattiker and Goodhue 2004; Lawrence and Lorsch 1967; Premkumar et al 2005; Tushman 1978; Van de Ven et al 1976). These studies span a number of fields including Strategy, Operations Management, Organizational Behavior, and Information Systems. They are summarized in Table 2.1.

Lawrence and Lorsch (1967) studied the patterns of differentiation and integration associated with an organization's attempts at coping effectively with their external environment. Gerwin (1993) proposed a conceptual framework where environmental uncertainty drives manufacturing strategy, in an attempt to reduce and redefine the effect of the environmental uncertainty. Sawhney (2006) extended Gerwin's model to a supply chain context, and applied it to subunits within the supply chain. Other researchers concur, citing the management of uncertainty as a driver for implementing various manufacturing strategies (Beach et al. 2000; Correa 1994; Ketokivi 2006; Kulatilaka and Marks 1988). In a recent article Germain, Clayborne, and Droge (2008) concluded that in environments with high uncertainty, cross-functional integration leads to reduced supply chain process variability, which in turn leads to improved performance.

As shown in Table 2.1, there are two main conceptualizations of uncertainty within OIPT studies. One camp, following the definitions used by Thompson (1967) and Galbraith (1974), defines uncertainty as a lack of information, or a difference between the information at hand and the information required to make a decision. The other conceptualization focuses on the rate of change of conditions in the external environment (Egelhoff 1982; Flynn and Flynn 1999; Lawrence and Lorsch 1967; Van de Ven et al 1976). The rate of change in an external environment can be difficult to quantify, particularly for the level of respondents on which this study focuses. However, the personnel involved in Purchasing, Operations, and Outbound Logistics deal with production volumes daily. Hence, this study follows the example of Galbraith (1974), defining uncertainty as the lack of knowledge concerning the demand for a plant's product(s).

Table 2.1 Summary of OIPT research studies

	Type	Definition of Uncertainty	Major Findings
Rate of change			
Lawrence and Lorsch 1967	Empirical	Rate of change in conditions Certainty of information at a given time Time span of definitive feedback	High differentiation associated with higher uncertainty. Integrative devices required to achieve unity of effort.
Van de Ven et al 1976	Empirical	The difficulty and variability of the work undertaken by an organizational unit.	The modes of coordination used are affected by task uncertainty, work flow interdependence, and unit size.
Egelhoff 1982, 1991	Empirical	Product diversity, rate of product change, size/number of subsidiaries	Structure of a multi-national corporation was related to information processing requirements.
Flynn and Flynn 1999	Empirical	Environmental complexity: rate of product change, rate of process change, changes in customer needs.	The relationship between complexity and performance is moderated by information processing mechanisms.

	Type	Definition of Uncertainty	Major Findings
Amount of information			
Galbraith 1974	Conceptual	The difference between the information in hand and the information required for decision-making.	Task uncertainty is related to organizational form. Different forms provide different processing capabilities.
Tushman 1978	Conceptual	Task characteristics, task environment, task interdependence	Organization effectiveness is a function of matching information processing capacities with information processing requirements
Daft and MacIntosh 1981	Empirical	Equivocality: ambiguity, multiplicity of meaning	The equivocality of available information affects the required amount of information processing.
Daft and Lengel 1986	Conceptual	Uncertainty: absence of information Equivocality: ambiguity, multiplicity of meaning	Proposed frameworks for media richness and amount of information to match processing requirements.
Bensaou and Venkatraman 1995	Empirical	Environmental, Partnership, and Task Uncertainties	Identified five configurations of interorganizational relationships, matching differences in information processing requirements.
Premkumar et al 2005	Empirical	Environmental Uncertainty and Relationship Uncertainty	Taxonomy approach revealed two clusters of processing needs and three clusters of processing capabilities.
Ketokivi 2006	Empirical	Demand variability: volume Demand uncertainty: product mix	Managers use various flexibility strategies to protect the “technical core” from variations due to contingencies.

This study focuses on two forms of uncertainty: demand variability and demand predictability (Jack and Raturi 2003; Ketokivi 2006; Walker and Weber 1984). Demand variability is defined as the changes in required production levels for any one of the firm's products (i.e.—the product mix). Demand predictability refers to the ability of the firm to accurately predict the changes in demand for their products (i.e.—the production volumes). Different levels of uncertainty in these two dimensions may lead to differences in the strength of the relationships between the research model factors. Demand uncertainty is thus presented as a moderator for relationships within the research model.

Organizations must deploy the information-processing mechanism(s) most appropriate for managing the amount and type of uncertainty faced. Information processing mechanisms include but are not limited to hierarchies, different schemes of departmentalization, lateral relations, and computer systems (Daft and Lengel 1986). These are discussed more fully in the next section.

2.3.2 Information processing capabilities

A basic proposition of OIPT is that as the amount of uncertainty involved in completing a task increases, more information must be processed in order to execute the task (Galbraith 1974). For large, complex tasks such as the management of internal supply chain functions studied here, tasks are divided between specialist subgroups (i.e.—the Purchasing, Operations, and Logistics departments). The work performed within each of these subgroups must be coordinated so the overarching goal of profitability can be achieved, and the firm remains a viable entity. Galbraith (1973, 1974, 1977) identifies three progressive methods of coordination, by order of their ability to handle uncertainty: rules and procedures, hierarchical referral, and targets or goals. Rules and procedures suffice when uncertainty is low and responses to most scenarios can be codified into standard rules and procedures. Hierarchical referral (consulting up through the chain of command) is used to handle exceptions to established patterns, and depends on the processing capacity of individuals within the hierarchy. As uncertainty increases, more and more exceptions occur and the capacity of the hierarchy is overwhelmed. March and Simon (1958) report that goals and targets are then used to coordinate within sub-groups. Rather than prescribing behavior by rules and procedures, coordinating by goals and targets allow employees discretion to select behaviors that will result in goal accomplishment. As exceptions are handled through hierarchical referral, the extent to which meaningful goals and sub-goals can be formulated and implemented constrains the ability of the organization to coordinate though this mechanism.

As uncertainty continues to increase, firms are left with two options: reduce the level of information processing requirements, or increase the information processing capacity. Galbraith (1974) summarized these options as shown in Figure 2.1.

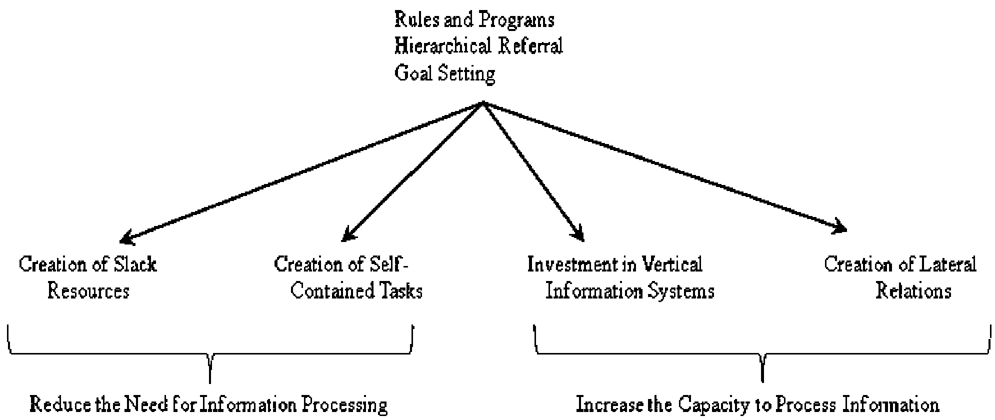


Figure 2.1. Organizational Design Strategies, reproduced from Galbraith (1974)

Each of these strategies (reducing needs or increasing capacity) has implications regarding the management of the firm's internal supply chain functions. For example, although slack resources such as excess capacity and buffer inventories can reduce the impact of uncertainty, they also impose additional costs (DeToni and Nassimbeni 2000). Organizing by self-contained tasks, such as organizing around product lines or market segments, often requires cooperation from multiple functional groups, which requires significant management effort (Lambert et al 2005; Weber 2002) and can result in loss of specialized skills as well as elimination of economies of scale (Galbraith 1974). Implementing vertical information systems such as ERP require significant financial investment as well as time (Davenport 1998; Gattiker and Goodhue 2004; Gattiker 2006). Implementing lateral relations involves creating horizontal links between task sub-groups, such as direct contact between members or different groups, the creation of liaison roles, or ultimately, the implementation of a matrix organization (Burns and Wholey 1993).

The four strategies are not mutually exclusive. Rather, the organization must choose which strategy or combination of strategies to pursue. Although the firm may choose to follow any one or more of the four strategies, when faced with an increase in uncertainty it *must* implement at least one. The alternative, according to OIPT, is reduced firm performance. (Galbraith 1974)

Researchers have used OIPT to explore Supply Chain Management issues (See Table 2.1). Gattiker (2006) uses OIPT to analyze the impact of Enterprise Resource Systems on the manufacturing-marketing interface. Flynn and Flynn (1999) found a negative relationship between environmental complexity and firm performance. This relationship, as predicted by OIPT, was moderated by at least one information-processing mechanism for each of their dependent variables. In a supply chain management context, Bensaou and Venkatraman (1995) found that matching the level of uncertainty in an inter-organizational relationship with information-processing capacity (in the form of Information Technology) increased performance outcomes. Adler (1995) suggested increasing interdepartmental integration as a way to improve the flow of information within the firm and thus counter uncertainty. Inter-functional integration can be considered a proxy for the information-processing capacity of the organization (Adler 1995; Bensaou and Venkatraman 1995; Kim et al 2006). The factors considered within the research model represent elements of organizational design.

2.3.3 Testing the Effect of Uncertainty

Demand uncertainty has been presented as a potential moderator for the relationships within the research model. In accordance with OIPT, it is expected that different types and/or levels of coordination mechanisms are deployed in response to the level of uncertainty faced by the individual firms. This leads us to the last hypothesis:

- Demand Uncertainty will moderate the relationships between the independent variables and the outcome variables.

CHAPTER THREE
SURVEY INSTRUMENT DEVELOPMENT

The goal of this research study is to provide an empirical test of a model developed partly through qualitative studies (Pagell 2004) and partly through theoretical analysis. The method to be used for data collection is a cross-sectional survey. The use of survey-based empirical research in Operations Management has grown and continues to develop (Menor and Roth 2006; Rungtusanatham et al. 2003; Scudder and Hill 1998). Gupta et al. (2006) report that close to one-third of empirical research articles published in *Production and Operations Management* between 1992 and 2005 used survey methods of data collection. This chapter describes the methodology used to develop the survey instrument used for data collection.

In developing and validating the data collection instrument, this research follows a two-stage strategy as described in Stratman and Roth (2002), Menor and Roth (2006) and Rosenzweig and Roth (2007). The first stage consists of identifying and defining each construct in the research model. The basis for identification of the constructs was a cross-disciplinary search of the relevant extant literature in the operations management, purchasing, logistics, information systems, organizational theory, and human resource management. The point of departure for the literature search was the work of Pagell (2004) and Fawcett and Magnan (2002), upon which this research builds.

3.1 Item Generation

Items were generated through a two-pronged approach. First, items and scales found in the literature were reviewed for their conceptual match with the definitions adopted for this study. Developing sound scales is a difficult and time-consuming process (Schmitt and Klimoski, 1991). Hinkin (1998) states "the success in observing true covariance between the variables of interest is dependent on the ability to accurately and reliably operationalize the unobservable construct". Effective scale development must be preceded by conceptual development of the constructs to be measured (Churchill 1979; Hinkin 1998; Menor and Roth 2006). The lack of established formal conceptual definitions (Wacker 2004) can result in finding multiple interpretations of the same construct in the literature. In this case items and/or scales were selected for testing if there was conceptual agreement and the items or scale had been previously tested for validity and reliability.

Based on the construct definitions, additional items were generated to measure various aspects of the content domain that may not have been explicitly addressed by extant literature. Item wording was selected carefully to reflect the conceptual domain of interest and to reduce the incidence of double-barreled, ambiguous, or redundant items. Additionally, an assortment of graduate students and working professionals were asked to suggest items based on the construct definitions given in the literature review. Vague or poorly worded items were not retained. The overall goal was to generate eight to ten items per construct (Hinkin and Tracey 1999), which were then submitted to an iterative sorting process.

3.2 Item Sorting

The goal of item sorting is to establish tentative item reliability and validity (Menor and Roth 2006). Following the advice of Hinkin (1998) an item-sorting instrument was developed. In a modified Q-sort approach, (McKeown and Thomas 1988; Menor and Roth 2006), the researcher provided respondents with definitions of each of the constructs in the model, a randomized list of prospective items (without the Likert responses), and instructions to match each item with the construct it fit most closely. The instrument was provided online through third-party survey host SurveyMonkey.com (Survey Monkey 2008). A printout of this instrument can be found in the Appendix. All respondents were asked to suggest changes to the instrument to improve its quality, including item modifications, item additions and item deletions.

Undergraduate students enrolled in Operations Management courses were asked to perform the item-sorting task first. Although undergraduates may lack the business experience to thoroughly assess the comprehensiveness of the items with regard to the conceptual domain of each construct, their "textbook" knowledge and cognition level provide a basic test of the item wording and clarity (Hinkin 1998). The survey instrument was distributed to students in two independent sections, taught by different professors. The students received extra credit for completing the survey. While this increased the response rate, it resulted in some students entering random responses (for example, one student assigned all items in the survey to the same category). As the purpose of this sorting task is to assess the correspondence of items to factors and definitions, the consensus view of the class was assessed by selecting the ten respondents who agreed the most with each other (as opposed to the ten respondents who agreed the most with the researcher), as determined by calculation of Cohen's kappa for each possible pair of respondents and selection of the highest values. This approach reduces the complexity of the analysis without affecting the quality of the item data.

A further round of sorting was conducted with doctoral students and working professionals (Sample Titles: Manufacturing Planner, Purchasing Clerk, Production Manager). These students are expected to have in-depth knowledge of the field as well as knowledge of research methods and requirements. A large proportion of these students also have considerable work experience. The combination of work experience and academic training makes their sorting process useful to ensuring the validity of the final instrument. Two doctoral students and four working professionals from a manufacturing facility located in South Carolina were used to confirm that items were clear and relevant.

Finally, the sorting instrument was administered to students in a part-time MBA program. These students generally hold full-time positions (Sample titles: Production Manager, Vice President of Operations, Logistics Supervisor) during the course of their studies. Four of them were selected for item sorting as their current work titles would identify them as target respondents for the final research survey instrument, and their input is intended to represent the target population. Content validity was assessed first by the depth and breadth of the literature search prior to item selection, and second by the comments and suggestions from respondents.

3.2.1 Interrater Reliability

Results from each sorting round were subjected to tests of interrater reliability, an assessment of the degree to which the measures are free from error. Sources of error can be systematic (due to an assignable cause) or unsystematic (random) (Singleton et al. 1993). Items are tested to determine whether systematic, and thus potentially preventable, errors are present. When multiple judges are used to classify items, the agreement between the judges can be used to measure reliability. Interrater reliability was assessed by using Cohen's kappa (Cohen 1960) and Rust and Cooil's (1994) Proportion Reduction of Loss. Reliability is a necessary yet insufficient condition for establishing construct validity. Reliable measures can be invalid if they do not measure the construct that they are intended to measure. Once reliability is established, the items were subjected to tests of construct validity. The results of this analysis are found in Appendix D.

3.2.2 Substantive Validity

Item-sorting analysis was used after each round of sorting. To assess substantive validity, responses for each item were analyzed to assess how many respondents assigned the item to the target construct, providing a value for the proportion of substantive agreement (p_{sa}) as described by Anderson and Gerbing (1991). Items with low p_{sa} are eliminated. Items with p_{sa} higher than the 80% guideline provided by Hinkin (1995) are retained for further analysis. When there were only 4 raters, a minimum p_{sa} of 75% was used.

Although the p_{sa} provides an efficient primary "filter" for proposed items, it does not indicate whether a particular item has been repeatedly assigned to a construct different from its target. Repeated assignment to a different construct would indicate the item could be reflecting multiple constructs, the item wording is unclear, or there are problems with the construct definitions. To address these potential issues, a coefficient of substantive validity was calculated using the formula:

$$c_{sv} = \frac{n_c - n_o}{N}$$

where n_c is the number of judges that assigned item to target construct, n_o is the highest number of judges that assigned the item to a different construct and N is the total number of judges. The value of c_{sv} varies from –1.0 to 1.0, with 1.0 indicating perfect assignment by all judges, reflective of greater substantive validity. The following sections summarize the items generated for each construct and the results of the sorting procedure. These results are organized by the construct that each scale was intended to measure.

3.3 Item Pools and Item Sorting Results

3.3.1 Strategic Consensus

The first factor considered is Strategic Consensus. Strategic Consensus was previously defined as the extent to which a respondent was aware of the firm's overall competitive strategy, the strategic goals of the respondent's function, and the strategic goals of the other two focal functions. The items used were adapted from Pagell (2004, p. 482-483). He asked them as open-ended questions to his case-study participants.

Table 3.1 Item pool for Strategic Consensus

	Round1		Round2		Round3		Round4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
I know how my company wants to compete in the market.	1	1	0.8	0.7	0.8	0.7	1	1	Pagell 2004	YES
My department has goals that support how the company competes in the market.	1	1	1	1	1	1	0.75	0.5	Pagell 2004	YES
I know how the other departments contribute to the company's competitive strategy.	0.7	0.5	0.8	0.7	0.8	0.7	1	1	Pagell 2004	NO
I know how my department contributes to our competitive strategy.	1	1	1	1	0.8	0.7	1	1	Pagell 2004	YES
When we make a decision in our department we consider how it will affect other departments.	0.5	0.3	0.9	0.8	0.7	0.3	0.25	-1	Pagell 2004	NO
I know how my company sets itself apart from its competitors.	1	1	1	1	0.7	0.3	0.75	0.5	Pagell 2004	YES
When the other departments make decisions they consider how it will affect our department.	0.6	0.3	0.8	0.6	0.5	0.2	0.5	0	Pagell 2004	NO
The other departments know how my department contributes to the company's competitive strategy.	0.7	0.5	1	1	0.8	0.7	0.75	0.5	Pagell 2004	YES

3.3.2 Collaboration

Collaboration as defined in this research measures the extent to which the focal departments work together towards achieving mutually acceptable goals. Pagell (2004) coded integration as the combined result of measures of interaction, collaboration, and working toward mutually acceptable outcomes (p. 467). In this research the interview questions are adapted to a questionnaire format. Additional items were also developed to further explore the extent to which the departments work together.

Table 3.2 Item pool for Collaboration

	Round 1		Round 2		Round 3		Round 4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
We work together to resolve problems.	0.7	0.5	0.9	0.8	1	1	1	1	Pagell 2004	YES
Short-term projects are accomplished by working together.	1	1	0.8	0.6	0.8	0.7	0.75	0.5	New	YES
Working together helps us prevent problems.	0.8	0.6	0.9	0.8	0.7	0.5	1	1	Pagell 2004	NO
We work together to develop business opportunities.	0.9	0.8	1	1	0.3	0	1	1	Pagell 2004	YES
We accomplish long-term goals by working together.	1	1	0.7	0.4	1	1	1	1	New	YES

3.3.3 Integrative Information Technology

Integrative information technology has been presented as a facilitator of Supply Chain Management, as described by Vickery et al. (2003) and St. John et al (2001). Two types of information systems are presented as influencing the level of internal integration: computerized production systems and integrated information systems. Computerized production systems such as MRP and MRPII are used to plan and control production cycles. Integrated information systems such as ERP are intended to provide further information sharing capabilities and data integration throughout the entire company, including support functions such as Accounting and Human Resources.

However, the presence of an information system does not necessarily guarantee its use. Moreover, integrated information systems are collections of modules, not all of which are implemented by all firms. The items generated for this construct seek to determine whether either or both types of Information Technology are in use at the plant.

Table 3.3 Item pool for Integrative Information Technology

	Round1		Round2		Round3		Round4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
Members of one department can access data in another department's computer system.	1	1	1	1	1.0	1.0	1	1	Themistocleus et al 2004	NO
Purchasing personnel can access the data in the computerized production system.	1	1	0.8	0.6	1.0	1.0	1	1	Vickery et al 2003	NO
Our plant uses a commercial ERP system such as SAP, Oracle or Microsoft Dynamics.	1	1	1	1	1.0	1.0	0.75	0.5	Vickery et al 2003	YES
Our plant uses a computerized system to plan production.	0.9	0.8	1	1	1.0	1.0	1	1	Vickery et al 2003	YES
Each department in our plant has its own computer system. (Reverse Coded)	1	1	1	1	1.0	1.0	1	1	Themistocleus et al 2004	YES
People in Purchasing, Production, and Logistics can access data in each other's computer systems.	0.9	0.8	0.8	0.6	0.8	0.7	1	1	Vickery et al 2003	YES
The computer systems in our plant can communicate with each other.	1	1	1	1	1.0	1.0	1	1	Vickery et al 2003	YES

3.3.4 Centralization

Centralization was previously defined as the degree to which the authority to make decisions is concentrated (King And Sabherwal 1992; Lee and Choi 2003; Wang 2001). Hage and Aiken (1967) used two approaches to measuring Centralization. The first entails assessing the participation in decision-making regarding resource allocation while the second focuses on the use of hierarchy or chains of command when making decisions regarding work. This study takes the second approach.

In a manufacturing plant, the Operations or Production Manager is usually within the Plant Manager's chain of command. This study examines the centralization of the Purchasing and Logistics functions, either or both of which may be outside the Plant Manager's chain of command. In this context, centralization refers to the location of decision-making authority for Purchasing or Logistics. Items to measure Centralization are adapted from Sathe (1974).

Table 3.4 Item pool for Centralization

	Round 1		Round 2		Round 3		Round 4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
Employees in Purchasing and/or Shipping who do not report to the Plant Manager need to have approval from their boss before making decisions that concern our plant.	0.9	0.8	1	1	1.0	1.0	1	1	Sathe 1974	YES
The plant manager has no supervisory authority over the employees who do Purchasing and/or Shipping for this plant.	1	1	1	1	0.8	0.7	0.75	0.5	New	NO
Employees who do Purchasing and/or Shipping for this plant rely on their Purchasing/Shipping chain of commands to make decisions.	0.9	0.8	1	1	1.0	1.0	1	1	Sathe 1974	YES
Employees who do Purchasing and/or Shipping for our plant can proceed without checking first with their boss. (Reverse)	1	1	1	1	0.8	0.7	0.75	0.5	Sathe 1974	YES
The reporting structures of the people who do Purchasing and/or Logistics in this plant do not include the Plant Manager.	1	1	1	1	0.8	0.7	1	1	New	YES
People who do Purchasing and/or Shipping for our plant make decisions without having to refer the problem to their chain of command.	1	1	1	1	0.8	0.7	0.75	0.5	Sathe 1974	NO

	Round 1		Round 2		Round 3		Round 4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
People who do Purchasing and/or Shipping for this plant and do not report to the plant manager get their instructions only from their boss.	0.9	0.8	1	1	1.0	1.0	1	1	Sathe 1974	YES

3.3.5 Communication

The construct of Communication in this research is meant to include all formal and informal means by which employees of an organization share, transmit, and disseminate information. The literature reflects multiple approaches to operationalizing the construct of Communication. One approach is to use a frequency count, as seen in Ellinger et al. (2000), Kahn (1996), and Mollenkopf (2000). This approach results in a formative definition of the construct and a formative measure. Although formative measures are not uncommon in the literature, they can be subject to intepretational confounding (Cohen et al 1990; Howell et al 2007) and problems with identification (Chin 1998) when analyzed using Structural Equation Modeling. Moreover, a simple count of the use of communication mechanisms does not indicate whether the communication is effective.

An alternate approach to measuring Communication is to consider how it takes place. In this study, Communication is defined as the transfer of information through structured and unstructured interactions between members of different departments. In line with the Theory of Communicative Action, successful communication results in mutual understanding and relationship building. Research has concluded that it is the act of communication rather than the content that is responsible for this effect (Huff et al 1989). Based on this definition, the following items were generated:

Table 3.5 Item pool for Communication

	Round 1		Round 2		Round 3		Round 4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
People in my department frequently contact people in the other departments regarding work issues.	0.6	0.2	0.8	0.7	0.3	-0.2	0.5	0.3	New	NO
We have open lines of communication between departments.	1	1	1	1	0.8	0.7	1	1	New	YES
People in other departments respond promptly when contacted by someone in my department.	0.9	0.8	1	1	0.8	0.7	0.5	0	New	YES
People in other departments often contact my department regarding work issues.	0.9	0.8	0.9	0.8	0.8	0.7	0.75	0.5	New	YES
If I have a question about something done by another department, I know who I could contact for help.	0.8	0.7	0.9	0.8	1	1	0.75	0.5	New	YES
We respond promptly when someone from another department contacts us regarding a work issue.	0.8	0.6	1	1	0.7	0.3	0.25	-0.2	New	NO
It is difficult to get a response from the other departments. (Reverse Coded)	1	1	0.9	0.8	0.7	0.5	0.5	0.3	New	YES

3.3.6. Job rotation

Job rotation entails the lateral movement of employees from one department to another. The rotation results in substantial change to the employee's work content, responsibilities, and in some cases, reporting relationships. Job rotation can be implemented formally through a corporate policy or training program, or informally as employees apply for and are considered for positions outside their current departments. Items chosen to measure this construct include adaptations from Pagell (2004) as well as new items developed specifically for this research.

Table 3.6 Item pool for Job Rotation

	Round1		Round2		Round3		Round4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
Experience in another department is highly regarded in my department.	0.5	0.5	0.8	0.6	0.3	-0.3	0.25	-1	New	NO
Employees from other departments are encouraged to apply for job openings in my department.	0.9	0.8	1	1	1.0	1.0	1	1	New	YES
My company has a training program where employees move to work assignments in different departments.	0.9	0.8	1	1	1.0	1.0	1	1	Pagell 2004	YES
Managers in other departments have significant experience in my department.	0.9	0.8	0.9	0.8	0.7	0.3	0.75	0.5	Pagell 2004	NO
People from my department are encouraged to apply for job openings in other departments.	0.9	0.8	1	1	1.0	1.0	1	1	New	YES
The manager of our department has significant experience in another department.	0.9	0.8	1	1	0.7	0.5	1	1	Pagell 2004	NO
Managers at my company move from one department to another.	1	1	1	1	1.0	1.0	1	1	Pagell 2004	YES

My department seeks out employees with experience in other departments.	1	1	1	1	1	1	1	1	New	YES

3.3.7 Cross-functional teams

Cross-functional teams allow personnel to work with members of other departments while retaining their job content. Cross-functional teams are formed to address issues that require effort from more than one area of expertise. The teams can be organized around product lines, customer/market segments, and/or supplier characteristics.

Table 3.7 Item pool for Cross-Functional Teams

	Round1		Round2		Round 3		Round 4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
Our plant has established work teams of employees from multiple departments to address supplier issues.	0.9	0.8	1	1	0.7	0.5	1	1	Pagell 2004	YES
Members of my department participate in ongoing work teams with members from other departments.	0.8	0.6	1	1	0.8	0.7	0.75	0.5	Pagell 2004	YES
Our plant has established work teams of employees from several departments to address internal problems.	0.9	0.8	1	1	0.5	0	1	1	Pagell 2004	YES
Members of my department participate in teams with members from other departments to work on specific projects.	0.9	0.8	0.8	0.7	0.7	0.3	0.75	0.5	Pagell 2004	NO
I belong to a work team that has members from different departments.	1	1	1	1	0.7	0.3	1	1	Pagell 2004	YES
Our plant has established work teams of employees from different departments to address customer problems.	1	1	0.9	0.8	0.5	0	0.75	0.5	Pagell 2004	YES

3.3.8 Integrative Employee Assessment

Items developed to measure this construct reflect the nature of individual performance appraisals. The items are adapted from Pagell (2004).

Table 3.8 Item pool for Integrative Employee Assessment

	Round1		Round2		Round 3		Round 4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
The performance of the entire plant is part of the managers' performance rating.	0.9	0.8	1	1	1	1	1	1	Pagell 2004	YES
I know which measures will be the most important in my performance review.	1	1	1	1	1	1	1	1	Pagell 2004	YES
Managers in our plant have regular performance reviews.	0.9	0.8	1	1	1	1	0.75	0.5	New	YES
Managers' merit raises are based on how well the plant meets its goals.	0.9	0.8	1	1	1	1	1	1	Pagell 2004	YES
Managers' performance reviews are based only on how much they achieve the goals of their department. (Reverse)	0.9	0.8	1	1	1	1	1	1	Pagell 2004	YES
Managers receive performance feedback from their internal "customers".	0.9	0.8	1	1	0.8	0.7	0.75	0.5	New	NO

3.3.9 Management Support

In accordance with Barnard’s (1968) conceptualization of the role of the manager, the definition of Management Support adopted for this study is as follows: the actions of the Plant Manager aimed at fostering internal supply chain integration by maintaining organization communication, securing essential services from individuals, and formulation of purpose and objectives. This research follows the approach of Sum et al.

(1997) for measuring Management Support. In an Operations Management context, Sum et al. (1997) cited three main facets of top management support:

- Showing interest/personal involvement
- Providing necessary resources
- Providing leadership

Personal involvement took the form of participation in team meetings, willingness to spend time with people and listen to feedback, and willingness to help resolve problems (i.e.—maintaining organization communication). Providing resources included budgets, personnel, training, and other critical needs (i.e.—securing essential services). Leadership required providing a vision, helping to translate plans into actions, and reviewing progress regularly (i.e.—formulation of purpose and objectives). The items used to measure this construct are derived from this description.

Table 3.9 Item pool for Management Support construct

	Round1		Round2		Round3		Round4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
The plant manager has provided resources needed to encourage integration between departments.	1	1	0.8	0.6	0.8	0.7	1	1	Sum et al 1997	NO
The plant manager encourages departments to work together.	1	1	1	1	0.8	0.7	1	1	Sum et al 1997	YES
The plant manager monitors the progress of interdepartmental collaboration.	0.8	0.7	1	1	0.7	0.3	0.75	0.5	Sum et al 1997	NO
The plant manager's staff knows that he/she wants the departments to work together.	1	1	0.9	0.8	0.8	0.7	1	1	Sum et al 1997	YES

	Round1		Round2		Round3		Round4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
The plant manager has allocated the manpower that we need to support efforts to work with the other departments.	0.8	0.6	0.7	0.4	0.8	0.7	1	1	Sum et al 1997	NO
The plant manager is willing to clear obstacles to collaboration that are outside our plant.	1	1	1	1	1.0	1.0	1	1	Sum et al 1997	YES
The Plant Manager has attended meetings intended to promote efforts of departments to work together.	0.9	0.8	0.9	0.8	0.8	0.7	1	1	Sum et al 1997	YES
The plant manager understands what is needed to support efforts to work with the other departments.	0.9	0.8	0.8	0.7	1.0	1.0	1	1	Sum et al 1997	YES

3.3.10 Demand Uncertainty

Uncertainty was previously defined as the difference between the information at hand and the information required (Galbraith 1974). In particular, for the purposes of this study uncertainty refers to the lack of knowledge concerning the demand for a plant's product(s). This study focuses on two forms of uncertainty: demand variability and demand predictability (Jack and Raturi 2003; Ketokivi 2006; Walker and Weber 1984). Demand variability is defined as the changes in required production levels for any one of the firm's products. Some products are observed to have steady demand, while others vary. Demand predictability refers to the ability of the firm to accurately predict the changes in demand for each product. Seasonal products have demand that varies according to a regular and predictable pattern, i.e.—seasons. Other products such as electronics or fashion goods fall in and out of favor quickly and are therefore more difficult to forecast. In his case study, Ketokivi (2006) operationalized the demand variability dimension by using the weighted average of the Coefficient of Variance for the demand of each product. In the same study, demand predictability was operationalized by using the weighted average of the squared autocorrelation index, indicating the predictability of demand based on past performance. An objective operationalization is not appropriate for the current study due to the different methodology and the cross-sectional, multi-industry nature of the sample frame. Ketokivi and Schroeder (2004) propose that perceptual measures are appropriate provided that multiple items are used to assess the construct and multiple respondents are used as data sources.

Different levels of uncertainty may lead to differences in the strength of the relationships between the research model factors. Demand uncertainty is thus presented as a moderator for relationships within the research model. The items used to assess Demand Uncertainty are adopted from van Hoek (1998).

Table 3.10 Item pool for Demand Uncertainty

	Round 1		Round 2		Round 3		Round 4		Source	Selected for Scale
	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}	p_{sa}	c_{sv}		
Demand for our products is variable/heterogeneous.	0.9	0.8	0.9	0.8	1	1	0.75	0.5	van Hoek 1998	YES
Our products have short lifecycles.	0.7	0.5	0.9	0.8	1	1	0.75	0.5	van Hoek 1998	NO
The volume of demand is difficult to predict.	1	1	1	1	1	1	1	1	van Hoek 1998	YES
Our production schedule changes unexpectedly.	1	1	1	1	1	1	1	1	New	YES
The composition of demand (the product mix) is difficult to predict.	1	1	1	1	1	1	1	1	van Hoek 1998	YES
The production forecasts for each item in our product line are very accurate.	0.5	0	0.4	-0	0.3	0	0.25	-0	New	NO

3.4 Trait Validity

Trait validity is the convergence between the measure of interest and other measures intended to represent the same construct, and the divergence from measures intended to represent different constructs (Campbell 1960). Menor and Roth (2006) espouse the use of Moore and Benbasat's (1991) Overall Placement Ratio (OPR) to assess trait validity. The OPR indicates the frequency with which judges correctly classify items relative to the total number of possible classifications. High "Hit Rates" (OPR > 75%) can be considered to be a sign of high construct validity (Menor and Roth 2006).

Having provided evidence of construct validity, the survey instrument was reformatted to include the intended Likert-scale responses and administered to the target population. The instrument was formatted for online hosting at SurveyMonkey.com (Survey Monkey 2008) as well as available in a table/spreadsheet form to accommodate respondents who are unable to access the SurveyMonkey website. In either case the questions were identical.

CHAPTER FOUR
DATA COLLECTION AND PILOT STUDY

This section describes the unit of analysis, the target respondents, the sampling frame, and the survey administration method, as well as the results of the pilot study.

4.1 Unit of Analysis

The model that motivated this study was proposed by Pagell (2004) and focuses on the integration of Purchasing, Operations and Logistics within an individual manufacturing plant. This unit of analysis was chosen because it represents the smallest grouping within a manufacturing firm that still contains the essential elements of internal supply chain management. In addition, prior scholars using an OIPT lens use the individual plant as the unit of analysis (De Toni and Nassimbeni 2000; Gattiker 2004; Gattiker 2006).

4.2 Target Respondents

The survey items in this study consist largely of perceptual measures. Ketokivi and Schroeder (2004) suggest that inherent bias in perceptual measures can be minimized by using multiple items and multiple respondents from the same organization. The invitation to participate in the survey requested multiple respondents from each firm. The target respondents for this study were the most senior employees performing the Purchasing, Operations, and (Outgoing) Logistics functions within the manufacturing plant. Sample target titles include Operations Manager, Purchasing Manager, Supply Chain Manager, and Logistics Manager. Some firms may decide to combine any two of these roles, reducing the number of potential respondents per firm.

4.3 Pilot Study

The final step in validating the survey instrument was to perform a pilot study using the previously developed survey instrument. The results from this pilot study can be used to perform "back-end" statistical analyses (Menor and Roth 2006) to evaluate construct validity. Construct validity can be divided into convergent validity and discriminant validity. Convergent validity indicates that a scale is measuring the construct that it is intended to measure. Discriminant validity indicates that a scale does not measure a construct that it is not intended to measure.

The theoretical domain of the proposed research model includes all manufacturing firms regardless of industry, size, or location. However, achieving a desirable number of survey responses requires a targeted strategy of acquiring personal contact information for potential respondents. Therefore, a list of potential respondents for the pilot study was developed from the alumni database of an American research university. Using the online alumni directory, a search was conducted for alumni whose work address was in the United States and who had "Manufacturing" as a term in either the "Job Function" or "Industry" fields. This simple search generated approximately 800 matches, from which potential respondents were selected at random. After developing a contact list with 450 eligible Alumni, an email was sent to each potential respondent, describing the nature of the study and requesting participation. The email followed the format and content of the solicitation letter filed with the Clemson University Institutional Review Board. Alumni who agreed to participate were asked to provide the contact information for at least one other individual who worked in the same plant but in another department. The contact email had an embedded link to the online version of the survey as well as an Excel attachment containing the survey. The contact letter requested either participation from the alumni or for the alumni to forward the invitation to an appropriate respondent within their place of employment.

The purpose of the pilot study was to determine the underlying factor structure of the data. Following the example of Shah and Ward (2007), Exploratory Factor Analysis was used on the pilot data to test for scale reliability as well as convergent and discriminant validity. Data from plants that had more than one responder were also used to test for method bias using the methods described by Boyer and Verma (2002).

Analysis proceeded as follows. First, descriptive statistics were calculated for each of the items. Missing data was then analyzed and imputed. Second, a Corrected Item to Total Correlation (CITC) score was calculated to assess item reliability. Finally, the data was analyzed using exploratory factor analysis as suggested by Shaw and Ward (2007).

4.4 Results of the Pilot Study

A total of seventy-two usable (72) responses were obtained from the sample frame. Although this number is small, it is comparable to the sample size used in other studies where a pilot sample was conducted as part of the research design (Koufteros et at 1998, Shah and Ward 2007). Characteristics of the sample are presented below. The sample is biased toward larger facilities.

Table 4.1a Pilot Study Respondents by Size

Employees	Number / % in Population	Number / % in Pilot Sample
20 – 49	51,660 / 48%	9 / 12.5%
50 – 99	25,883 / 24%	14 / 19%
100 – 249	20,346 / 19%	24 / 33%
250 – 499	6,853 / 6%	12 / 17%
500 - 999	2,720 / 3%	7 / 10%
>1000	1,266 / 1%	6 / 8%
TOTAL	108,728 / 100%	72 / 100%

Table 4.1b Pilot Study Respondents by Industry

NAICS 31-33	Manufacturing	Number, % in Population	Number, % in Pilot
311	Food Manufacturing	27,915 7.9%	1 1%
312	Beverage & tobacco product manufacturing	3,025 0.8%	
313	Textile mills	3,932 1.1%	1 1%
314	Textile product mills	7,304 2.1%	
315	Apparel manufacturing	13,038 3.7%	
316	Leather & allied product manufacturing	1,522 0.4%	
321	Wood product manufacturing	17,202 4.9%	2 3%
322	Paper manufacturing	5,520 1.6%	2 3%
323	Printing & related activities	37,538 10.7%	
324	Petroleum & coal products manufacturing	2,262 0.6%	1 1%
325	Chemical manufacturing	13,476 3.8%	5 7%
326	Plastics & rubber products manufacturing	15,529 4.4%	3 4%
327	Nonmetallic mineral product manufacturing	16,706 4.8%	2 3%

NAICS 31-33	Manufacturing	Number, % in Population	Number, % in Pilot
331	Primary metal manufacturing	5,194 1.5%	1 1%
332	Fabricated metal product manufacturing	62,219 17.7%	10 14%
333	Machinery manufacturing	28,306 8.1%	6 8%
334	Computer & electronic product manufacturing	15,910 4.5%	11 15%
335	Electrical equipment, appliance, & component manufacturing	6,499 1.9%	4 5%
336	Transportation Equipment	10,905 3%	10 14%
337	Furniture & related product manufacturing	22,523 6.4%	3 4%
339	Miscellaneous manufacturing	32,569 9.3%	10 14%
	TOTAL	350,828 100%	72 100%

Table 4.1c Pilot Study Respondents by Area of Responsibility

Area of Responsibility	**Number**	**Percentage**
Operations	40	56%
Purchasing	9	13%
Logistics	8	11%
Purchasing and Logistics	6	8%
Purchasing and Operations	5	6%
Operations and Logistics	5	6%

4.4.1 Non-response bias

Table 4.2 Response rate

	Total valid email addresses	Total survey responses	Response rate	Total "Opted Out"
Northeast Alumni	431	72	16.7%	82 (19.2%)

Table 4.2 reflects counts of organizations, where multiple respondents from the same organization are counted only once. SurveyMonkey.com (2008) requires that all survey invitations include an option for potential respondents to "Opt-out" of any future mailings. The user agreement with the website includes a clause that requires users to cease attempts to contact that particular email address. As the recipient had to read the email in order to select the "Opt-out" link, the characteristics of these individuals can be used to estimate non-response bias. The "Opted Out" column captures the number of potential respondents who are known to have read the survey invitation and chose to "Opt Out."

In order to determine whether non-response bias exists, the respondent and "Opt-out" groups were compared in time elapsed since graduation (a proxy for work experience), geographical location (East, West, or Central USA), and industry. The results are summarized in Table 4.3. Both groups have very similar work experience and geographical distribution. Although the potential respondents were identified by using "Manufacturing" as a search term, 22% of those who opted out were actually service providers to manufacturing firms. As such they were not representative of the target respondents for this study. The four largest "Industry" categories are included in the table. There is a much higher proportion of transportation and electronic manufacturers among respondents. The pilot sample is biased towards these two industries.

Table 4.3 Summary of Characteristics of Respondents vs. "Opt-outs"

Group	Time since graduation	Location	Industry
Respondents	Mean= 23.6, σ = 11 Min = 2, Max = 57	East = 60.5% Central = 23.5% West = 16.0%	22%: Service 9.9% Chemicals 5% Transportation 3.7% Electronics 3.7% Computers
"Opt-outs"	Mean = 22.3, σ = 12.3 Min = 4, Max = 64	East = 57.4% Central = 22.9% West = 19.7%	23% Transportation 21.3% Electronics 9.8% Chemicals 3.3% Computers

4.4.2 Missing Data

Due to some minor changes during the pilot study, there was a small amount of missing data (183 out of 3753 observations). As Recommended by Kline (2005), missing data was imputed using the Expectation Maximization (EM) algorithm implemented within EQS (2004).

Table 4.4a Descriptive Statistics Before EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Err.	Value	Std. Err.
Centralization							
CEN1	72	3.21	1.221	-.221	0.283	-1.088	0.559
CEN2R	69	2.99	.962	-.378	0.289	-1.085	0.570
CEN3	67	2.61	.920	.140	0.293	-.902	0.578
CEN4	64	3.41	.849	-.580	0.299	-.850	0.590
CEN5	66	2.56	1.266	.703	0.295	-.573	0.582
Cross Functional Teams							
CF1	72	3.43	1.254	-.433	0.283	-.876	0.559
CF2	72	3.47	1.048	-.453	0.283	-.306	0.559
CF3	72	4.11	.832	-1.724	0.283	4.710	0.559
CF4	67	3.93	.858	-1.336	0.293	2.949	0.578
CF5	67	3.36	1.069	-.308	0.293	-.556	0.578
Collaboration							
COL1	70	4.00	.761	-.608	0.287	.440	0.566
COL2	70	4.16	.629	-.128	0.287	-.478	0.566
COL3	66	3.94	.653	-.622	0.295	1.366	0.582
COL4	65	4.23	.606	-.151	0.297	-.453	0.586
Communication							
COM1	71	4.00	.811	-1.159	0.285	2.418	0.563
COM2	69	3.72	.765	-1.108	0.289	2.052	0.570
COM3R	64	2.58	.832	.427	0.299	.194	0.590
COM4	64	4.06	.639	-.805	0.299	2.350	0.590
COM5	62	4.05	.585	-.511	0.304	2.089	0.599
Integrative Employee Assessment							
IEA1	72	4.21	.838	-1.152	0.283	1.183	0.559
IEA2R	72	3.01	1.068	.257	0.283	-1.061	0.559
IEA3	67	4.12	.686	-.738	0.293	1.404	0.578

Table 4.4a Descriptive Statistics Before EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Err.	Value	Std. Err.
IEA4	64	3.73	.877	-.611	0.299	-.159	0.590
IEA5	63	4.03	.740	-1.038	0.302	1.890	0.595
Integrative Info. Tech.							
IIT1	72	3.85	1.218	-.806	0.283	-.660	0.559
IIT2	72	3.69	1.535	-.788	0.283	-.957	0.559
IIT3R	72	2.35	1.189	.789	0.283	-.242	0.559
IIT4	66	3.65	1.074	-.945	0.295	.463	0.582
IIT5	66	3.48	1.180	-.455	0.295	-.687	0.582
Job Rotation							
JR1	72	2.36	1.066	.590	0.283	-.390	0.559
JR2	72	2.93	1.066	.213	0.283	-1.140	0.559
JR3	70	3.39	.997	-.397	0.287	-.112	0.566
JR4	67	3.39	.778	-.212	0.293	-.495	0.578
JR5	63	3.54	.820	-.767	0.302	0.651	0.595
Management Support							
MS1	72	4.14	.893	-.891	0.283	0.141	0.559
MS2	72	3.92	.818	-.479	0.283	-.118	0.559
MS3	72	3.90	.995	-.859	0.283	0.186	0.559
MS4	72	4.04	.759	-.468	0.283	-.036	0.559
MS5	63	4.11	.675	-.135	0.302	-.749	0.595
MS6	62	3.77	.931	-.536	0.304	-.438	0.599
Strategic Consensus							
SC1	72	4.28	.676	-.684	0.283	.594	0.559
SC2	67	3.70	.817	-.596	0.293	.032	0.578
SC3	62	4.26	.510	.338	0.304	-.307	0.599
SC4	65	4.12	.650	-.829	0.297	2.293	0.586
SC5	65	3.97	.865	-1.432	0.297	3.236	0.586

Table 4.4a Descriptive Statistics Before EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Err.	Value	Std. Err.
Uncertainty							
UNC1	72	3.65	1.269	-.673	0.283	-.699	0.559
UNC2	72	3.90	.952	-.910	0.283	0.535	0.559
UNC3	69	3.87	1.097	-.973	0.289	0.395	0.570
UNC4	67	3.51	1.035	-.232	0.293	-1.124	0.578

Table 4.4b Descriptive Statistics After EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Err.	Value	Std.Err.
Centralization							
CEN1	72	3.21	1.221	-.221	0.283	-1.088	0.559
CEN2R	72	2.99	0.863	.401	0.283	-.699	0.559
CEN3	72	2.59	0.843	-.039	0.283	-.367	0.559
CEN4	72	3.39	0.744	-.778	0.283	-.308	0.559
CEN5	72	2.34	0.980	.823	0.283	.823	0.559
Cross Functional Teams							
CF1	72	3.43	1.254	-.433	0.283	-.876	0.559
CF2	72	3.47	1.048	-.453	0.283	-.306	0.559
CF3	72	4.11	.832	-1.724	0.283	4.710	0.559
CF4	72	3.76	0.926	-1.144	0.283	1.294	0.559
CF5	72	3.46	0.934	-.364	0.283	-.262	0.559
Collaboration							
COL1	72	3.77	0.791	-.105	0.283	-.492	0.559
COL2	72	3.97	0.691	.036	0.283	-.856	0.559
COL3	72	3.90	0.671	.147	0.283	-.756	0.559
COL4	72	4.06	0.685	-.074	0.283	-.864	0.559
Communication							
COM1	72	4.00	0.713	-.722	0.283	1.161	0.559
COM2	72	3.72	0.730	-.830	0.283	.811	0.559
COM3R	72	3.57	0.686	-.387	0.283	-.074	0.559
COM4	72	4.09	0.532	-.034	0.283	.394	0.559
COM5	72	4.11	0.469	-.062	0.283	1.189	0.559
Integrative Employee Assessment							
IEA1	72	4.21	.838	-1.152	0.283	1.183	0.559
IEA2R	72	3.01	1.068	.257	0.283	-1.061	0.559
IEA3	72	3.96	0.562	-.310	0.283	1.982	0.559

Table 4.4b Descriptive Statistics After EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Err.	Value	Std.Err.
IEA4	72	3.69	0.781	-.786	0.283	.545	0.559
IEA5	72	4.12	0.447	.157	0.283	1.610	0.559
Integrative Info. Tech.							
IIT1	72	3.85	1.218	-.806	0.283	-.660	0.559
IIT2	72	3.69	1.535	-.788	0.283	-.957	0.559
IIT3R	72	2.35	1.189	.789	0.283	-.242	0.559
IIT4	72	3.82	0.804	-.963	0.283	1.785	0.559
IIT5	72	3.68	0.914	-.566	0.283	.139	0.559
Job Rotation							
JR1	72	2.36	1.066	.590	0.283	-.390	0.559
JR2	72	2.93	1.066	.213	0.283	-1.140	0.559
JR3	72	3.38	0.831	-.300	0.283	.191	0.559
JR4	72	3.38	0.652	-.196	0.283	.235	0.559
JR5	72	3.79	0.650	-1.085	0.283	1.601	0.559
Management Support							
MS1	72	4.14	.893	-.891	0.283	0.141	0.559
MS2	72	3.92	.818	-.479	0.283	-.118	0.559
MS3	72	3.90	.995	-.859	0.283	0.186	0.559
MS4	72	4.04	.759	-.468	0.283	-.036	0.559
MS5	72	4.14	0.583	-.200	0.283	-.285	0.559
MS6	72	3.96	0.738	-.683	0.283	.521	0.559
Strategic Consensus							
SC1	72	4.28	.676	-.684	0.283	.594	0.559
SC2	72	3.66	0.742	-.392	0.283	.149	0.559
SC3	72	4.09	0.586	-.202	0.283	-.088	0.559
SC4	72	3.98	0.700	-.497	0.283	.495	0.559
SC5	72	3.90	0.734	-.477	0.283	.392	0.559

Table 4.4b Descriptive Statistics After EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Err.	Value	Std.Err.
Uncertainty							
UNC1	72	3.65	1.269	-.673	0.283	-.699	0.559
UNC2	72	3.90	.952	-.910	0.283	0.535	0.559
UNC3	72	3.80	1.005	-.824	0.283	.342	0.559
UNC4	72	3.51	.968	-.282	0.283	-.946	0.559

4.4.3 Exploratory data analysis

The factor structure of the measurement model was tested using several techniques: reliability analysis with SPSS 16.0 (SPSS Inc., 2008), exploratory factor analysis with CEFA (Comprehensive Exploratory Factor Analysis, v. 3.02, Browne et al 2008), and exploratory factor analysis using SPSS 16.0 (SPSS Inc., 2008).

Item reliability was assessed by calculating a Corrected Item to Total Correlation (CITC) score for each of the original 52 items. Seven items with CITC values below 0.30 were removed, (Shah and Ward 2007) and the scale reliability calculated again. These results are summarized in Appendix E. With the exception of the Integrative Employee Assessment factor, each factor had at least three indicators with good CITC scores.

To assess discriminant validity, the items with acceptable CITC measuring the predictor variables were subjected to exploratory factor analysis (EFA). Following the example of Shah and Ward (2007), Comprehensive Exploratory Factor Analysis (CEFA)

(Browne et al 2008) was used to conduct the analysis, using Maximum Likelihood (ML) and the Crawford-Ferguson equivalent of Varimax rotation (CF-VARIMAX) (Crawford and Ferguson, 1970) as an oblique rotation to estimate the common factor model. CEFA (Browne et al 2008) was used to conduct the analysis as it provides a variety of factor rotations better suited for complex situations as well as providing asymptotic standard errors for rotated item loadings and 90% confidence intervals of the factor loadings. A summary table of the results can be found in Appendix E. Following both of these anlyses, three issues are evident.

First, the Integrative Employee Assessment suffers from a number of issues. The CITC scores were very low, ranging from 0.199 to 0.240 for the items and the items did not load significantly on any single factor. As this construct was still considered important within the model, it was retained in the final survey, but all items were reworded and they are not included in the exploratory factor analysis. Second, item IIT4 had significant loadings on both the Integrated Information Technology and Cross Functional Teams factors. This item was reworded for clarity but retained. Third, item JR5 had significant loadings on both Job Rotation and Centralization. This item was removed from analysis.

Exploratory factor analysis was used to test the unidimensionality of the proposed latent variables, with the exception of Integrative Employee Assessment. This factor is flagged for modification and must be reassessed upon analysis of the data from the main study. Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin measure of sampling adequacy were performed to confirm that factor analysis was appropriate, as described by Dziuban and Shirkey (1974). The null hypothesis of the Bartlett's Test is that the variables of interest are independent, hence rejection of this hypothesis indicates that the correlation matrix is appropriate for factor analysis (Tobias and Carlson 1969). The Kaiser-Meyer-Olkin measure indicates whether the items belong together psychometrically and therefore the correlation matrix is suitable for factor analysis (Dziuban and Shirkey 1974). The KMO measure ranges from 0 to 1, with 1 indicating the optimum condition. Kaiser (1974) suggested that the minimum acceptable value of this index is 0.5. Items that did not load onto the factors or which were highly correlated with other items were flagged for modification.

Factor reliabilities were estimated using Cronbach's alpha and ranged from 0.682 to 0.907. Traditionally, scale reliability has been assessed using Cronbach's alpha (Cronbach 1951). A scale was considered reliable if alpha was greater than 0.7 (Nunnally 1967). However, coefficient alpha is calculated under the assumption that the items included within the scale all have the same true-score variance, that is, that they are tau-equivalent (Bacon, Sauer and Young 1995). This assumption rarely holds up in practice, and violations to it cause coefficient alpha to underestimate the true reliability (Miller 1995). More commonly, items included within a scale are unidimensional, i.e. they measure one and only construct, but their scales, precision, and magnitude of error can vary (the items are congeneric). Congeneric items (but not tau-equivalent) can result in artificially low values of Cronbach's alpha (Graham 2006). Garver and Mentzer (1999) recommend the use of additional measures of reliability. In particular, they recommend that Composite Reliability should be greater than 0.7 and Average Variance Extracted should be higher than 0.5.

Factor loadings were calculated using Maximum Likelihood (ML). The Average Variance Extracted (AVE) represents the total amount of variance that the items share with the common factor, and excludes random error or measure-specific variance components that are not of theoretical interest (Anderson and Gerbing, 1988). The "unwanted" part of the observed measures is modeled separately. When using ML to estimate a measurement model, covariances among the latent constructs are adjusted to reflect the attenuation due to these extraneous sources of variance. According to Anderson and Gerbing (1988), because of this assumption, the amount of variance explained in the set of observed measures is not of primary concern.

4.4.4 Centralization

Centralization (CEN) was operationalized using five variables, CEN1 through CEN5 as listed in Table 4.5. Items CEN3 and CEN5 were removed from analysis due to low CITC scores and insignificant factor loadings during the assessment of divergent validity.

Table 4.5 Survey items and factor analysis results for Centralization

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.44	0.695	0.701
CEN1	Employees in Purchasing and/or Shipping who do not report to the Plant Manager need to have approval from their boss before making decisions that concern our plant.	0.773			
CEN2	Employees who do Purchasing and/or Shipping for our plant can proceed without having to check first with their boss.	0.610			
CEN3	People who do Purchasing and/or Shipping for our plant and do not report to the Plant Manager get their instructions only from their boss.				
CEN4	Employees who do Purchasing and/or Shipping for this plant rely on their Purchasing/Shipping chains of command to make decisions.	0.595			
CEN5	The reporting structures of the people who do Purchasing and/or Shipping for this plant do not include the Plant Manager.				
KMO = 0.658, Sig. for Bartlett's test =0.000					

4.4.5 Collaboration

Collaboration (COL) was operationalized using four variables, COL1 through COL4, as shown in Table 4.6.

Table 4.6 Survey items and factor analysis results for Collaboration

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.605	0.855	0.858
COL1	We work together to develop business opportunities.	0.756			
COL2	We work together to resolve problems.	0.923			
COL3	Short-term projects are accomplished by working together.	0.706			
COL4	We accomplish long-term goals by working together.	0.707			
KMO = 0.791, Sig. for Bartlett's test = 0.000					

4.4.6 Communication

The Communication (COM) factor was operationalized using five variables, COM1 through COM 5, as shown in the table below. One item, COM4, was eliminated due to low CITC.

Table 4.7 Survey items and factor analysis results for Communication

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.555	0.787	0.870
COM1	We have open lines of communication between departments.	0.726			
COM2	Employees in the other departments respond promptly when contacted by someone in my department regarding work issues.	0.832			
COM3R	It is difficult to get a response from the other departments. *Reworded to: We have trouble getting a response from other departments when we contact them regarding work issues.*	0.767			
COM4	People in other departments often contact my department regarding work issues. *Reworded to: Employees in other departments do not hesitate to contact us to resolve work issues.*				
COM5	If I have a question about something done by another department, I know whom I could	0.668			

	contact for help.		
KMO = 0.749, Sig. for Bartlett's test = 0.000			

4.4.7 Cross-Functional Teams

The use of Cross-Functional Teams (CF) was operationalized by five variables, CF1 through CF5, as shown in Table 4.8. CF4 was eliminated due to its low CITC score.

Table 4.8 Survey items and factor analysis results for Cross-Functional Teams

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.543	0.824	0.883
CF1	Our plant has established work teams of employees from multiple departments to address customer problems.	0.638			
CF2	Our plant has established work teams of employees from different departments to address internal problems.	0.787			
CF3	Members of my department participate in teams with members from other departments.	0.653			
CF4	I belong to a work team that has members from different departments.				
CF5	Our plant has established work teams of employees from different departments to address supplier issues.	0.848			
KMO = 0.737, Sig. for Bartlett's test = 0.000					

This factor has severe cross-loading problems with the Job Rotation factor. Although it is possible to obtain an admissible solution to a factor analysis using these items, it fails the test of discriminant validity when combined with other items. The items are retained as the factor is considered theoretically relevant, and will be re-assessed with the data from the main study.

4.4.8 Integrative Employee Assessment

The Integrative Employee Assessment (IEA) factor was operationalized by five variables, IEA1 through IEA5, as shown in Table 4.9.

Table 4.9 Survey items for Integrative Employee Assessment

Variable	Item Wording	Retained?
IEA1	Managers in our plant have regular performance reviews. *Reworded to: Supervisors/managers review each employee's performance on a regular basis.*	Modified
IEA2	Managers' appraisals are based only on how much they achieve the goals of their department. *Reworded to: Employees' individual performance reviews focus exclusively on how they have contributed to the goals of their own department.*	Modified
IEA3	Managers' merit rises are based at least in part on how well the plant meets its goals. *Reworded to: Employees' merit raises are based at least in part on how well the entire plant meets its goals.*	Modified
IEA4	The performance of the entire plant is part of each managers' performance rating. *Reworded to: Employees are rewarded for their contribution to the overall performance of the plant.*	Modified
IEA5	I know which measures will be the most important in my performance review. *Reworded to: My contribution to the overall performance of the plant is an important part of my individual performance review.*	Modified

The items previously selected to measure this construct had a number of issues. First, item IEA5 had extremely small variance and very high kurtosis, as fifty-two of the respondents provided the same answer (4, or Agree). This item was reworded to more appropriately address the definition of the construct. The other items had very low CITC scores ranging from -0.166 to 0.290.

Item IEA2 was originally conceived as a reverse-coded item intended to measure a focus on department-specific rather than global plant performance. However, this variable proved to be poorly correlated to the other variables in the scale. Item IEA1 showed significant correlations to IEA3 and IEA5, but very poor factor loading. All of the items for this factor were reworded to reflect a more general applicability (the term "employees" replaced "managers") and to improve structure and clarity. This scale must be re-assessed with the main study data to determine whether the factor is viable.

4.4.9 Integrative Information Technology

Integrative Information Technology (IIT) was operationalized using five variables, IIT1 through IIT5. Item IIT3 was deleted due to low CITC score. Item IIT2 was reworded for the final survey due to comments from respondents who interpreted the item as excluding other vendors' products.

Table 4.10 Survey items and factor analysis results for Integrative Information Technology

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root statement: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.505	0.798	0.802
IIT1	Our plant uses a computerized system to plan production.	0.809			
IIT2	Our plant uses a commercial ERP system such as SAP, Oracle or Microsoft Dynamics. *Reworded to: Our plant uses a commercially available ERP package.*	0.630			
IIT3	Each department at our plant has its own computer system. *Reworded to: The Purchasing, Production, and Shipping departments each have their own dedicated computer software.*				
IIT4	People in Purchasing, Production/Operations, and Shipping can access data in each other's computer systems.	0.688			
IIT5	The computer systems in our plant can communicate with each other.	0.703			
KMO = 0.737, Sig. for Bartlett's test = 0.000					

4.4.10 Job Rotation

The Job Rotation (JR) factor was operationalized using five variables, JR1 through JR5, as listed in Table 4.11. Two items, JR3 and JR4, were deleted due to low

CITC scores. These two items also correlated highly (r= 0.82) to each other but not to any other items in the scale. JR5 was modified to avoid having two items that mention "managers" and one item that refers to "employees," thus creating an artificial separation within the factor.

Table 4.11 Survey items and factor analysis results for Job Rotation

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.412	0.682	0.683
JR1	My company has a training program where employees rotate through work assignments in different departments.	0.646			
JR2	Managers at our company move from one department to another.	0.593			
JR3	People from my department are encouraged to apply for job opening in other departments.				
JR4	Employees from other departments are encouraged to apply for job openings in my department.				
JR5	My department seeks out employees with experience in other departments. *Reworded to: We consider work experience in more than one area to be valuable.*	0.700			
KMO = 0.663, Sig. for Bartlett's test = 0.000					

4.4.11 Management Support

The Management Support (MS) factor was operationalized using six variables, MS1 through MS6. MS3 was eliminated due to high inter-item correlations with three other items within the scale.

Table 4.12 Survey items and factor analysis results for Management Support

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.599	0.875	0.881
MS1	The Plant Manager encourages departments to work together.	0.837			
MS2	The Plant Manager has attended meetings intended to promote efforts of departments to work together.	0.707			
MS3	The plant manager is willing to clear obstacles to collaboration that are within our plant.				
MS4	The plant manager is willing to clear obstacles to collaboration that are outside our plant.	0.759			
MS5	The Plant Manager's staff knows he/she wants them to work together.	0.805			
MS6	The Plant Manager understands what is needed to support efforts to work with the other departments.	0.755			
KMO = 0.811, Sig. for Bartlett's test = 0.000					

4.4.12 Strategic Consensus

The Strategic Consensus (SC) factor was operationalized using five variables, SC1 through SC5. Item SC2 was removed due to poor loading. Items SC1, SC3, and SC5 were reworded to improve clarity.

Table 4.13 Survey items and factor analysis results for Strategic Consensus factor

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root statement: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.640	0.864	0.875
SC1	I know how my company wants to compete in the market. *Reworded to: I know my company's competitive strategy.*	0.802			
SC2	The other departments know how my department contributes to the company's competitive strategy.				
SC3	I know how my department contributes to our competitive strategy. *Reworded to: I know how my work contributes to my company's plan to set itself apart from the competition.*	0.898			
SC4	I know how my company sets itself apart from its competitors.	0.831			
SC5	My department has goals that support how our company wants to compete in the market. *Reworded to: Our long-term performance goals are aligned with our company's competitive strategy.*	0.649			

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
KMO = 0.812, Sig. for Bartlett's test = 0.000					

4.4.13 Uncertainty

The Uncertainty (UNC) factor is operationalized using four variables, UNC1 through UNC4, as shown in Table 4.14.

Table 4.14 Survey items and factor analysis results for Demand Uncertainty

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			0.536	0.807	0.818
UNC1	The composition of demand (the product mix) is difficult to predict.	0.588			
UNC2	Demand for our products is variable/heterogeneous. *Reworded to: Demand for our products varies unpredictably.*	0.608			
UNC3	Our production schedule changes unexpectedly.	0.804			
UNC4	The volume of demand is difficult to predict.	0.885			
KMO = 0.812, Sig. for Bartlett's test = 0.000					

4.5 Method Bias

Although the survey instrument underwent a rigorous evaluation process, this research is still subject to method bias, or variance that is attributable to the measurement method rather than any real difference in the latent construct. Podsakoff et al (2003) provide a comprehensive review of the sources and remedies for method bias. According to their classification, the current research suffers from the threat of method bias arising from having a common rater, a common measurement context, a common item context, or from the characteristics of the items themselves. There are two strategies to mitigate method bias: modifying the study's procedures or using statistical controls. This section describes the countermeasures used to mitigate the threat of method bias.

Having the same respondent provide ratings for both the predictor and the response variable can result in spurious covariance between the variables. To counterbalance this effect, Podsakoff et al (2003) suggest using different respondents to measure predictors and effects, separating the predictor assessment from the response assessment, and protecting respondent anonymity to reduce social response bias. These procedural suggestions were incorporated into this research study.

The survey requested multiple responses from each organization. However, this proved problematic during implementation, as many respondents were hesitant to involve other members of their organizations. Even in organizations where the Plant Manager was the initial contact, multiple respondents were rare. Some facilities had a response from a single person, but this person was responsible for more than one department. A total of thirteen (13) organizations that submitted responses for the pilot had multiple respondents as seen in Table 4.15.

Table 4.15 Characteristics of Firms with Multiple Respondents

Firm	Size	Industry	Number of responses	Respondent Department(s)		
				Purchasing	Operations	Logistics
1	500	35	2		x	x
2	280	33	2		x	x
3	25	36	2	x	x	
4	700	38	2	x	x	
5	90	38	2	x	x	x
6	175	39	3	x	x	x
7	150	28	3	x	x	x
8	275	38	2		x	x
9	55	34	2		x	x
10	500	37	3	x	x	x
11	175	35	2		x	x
12	160	26	2	x	x	
13	250	32	3	x	x	x

These cases were analyzed for overall agreement between respondents (within each facility). Boyer and Verma (2002) describe three methods of assessing inter-rater agreement: ratio, percentage, and interclass correlation (ICC). Of these, they suggest that researchers use the ICC method as it is applicable to multiple raters, provides a test of statistical significance, and is easily interpretable as a percentage of variance that is free from within-group variance. However, there is no established method for calculating ICC for constructs with multiple item measures, such as those used in this study. The ICC was calculated using all of the measurement items without regard for constructs. The results indicate that there is moderate overall agreement (average ICC for 2-way mixed model of consistency of agreement = 0.544, range 0.371 – 0.693) between the raters, slightly lower than the 0.60 guideline proposed by Boyer and Verma (2002).

To further examine the level of agreement on specific constructs, the Ratio Method developed by James, Demaree and Wolf (1984) for multiple-item constructs was calculated. This method estimates the proportion of true variance relative to true variance plus error variance. In this sense it is similar to the ICC but there is no test for its statistical significance. The Ratio method consists of calculation of an index (r_{WG}) of inter-rater agreement with a maximum value of 1, indicating perfect agreement. This index takes into account the variance that would be expected from random measurement errors, the number of potential responses for each item (in this case, 5), and the number of items included within each construct (in this case, 3, 4, or 5 depending on the construct). With this data, agreement was assessed as an average of the agreement ratios for each construct, within each firm. For the individual firms, the average ratio ranged from 0.923 to 0.980. This would indicate that the individuals from the same firm agreed with each other 92.3% to 98% of the time. While there is no established standard for this method, Boyer and Verma (2002) suggest that this value should be higher than 0.80. The respondents for this survey meet this standard.

As an overall check of survey reliability, an average ratio for each construct (across the 13 firms) was also calculated and is presented below. For the individual factors, the averages ranged from 0.875 to 0.976, also meeting the Boyer and Verma (2002) standard.

Table 4.16 Average agreement ratios for individual factors

Factor	Average agreement ratio
Integrative Information Technology	0.963
Centralization	0.875
Cross Functional Teams	0.960
Job Rotation	0.957
Management Support	0.967
Communication	0.972
Collaboration	0.951
Integrative Employee Assessment	0.953
Integrative Human Resource Management	0.957
Strategic Consensus	0.976

In a recent essay, Pagell and Krause (2008) argue that although multiple respondents are the ideal situation, a single respondent may be able to appropriately represent an organization. They suggest that if the study seeks information on function-specific practices or decision-making, one respondent is not sufficient. However, if the study seeks information about plant- or firm-level topics, a single respondent within that internal supply chain can provide a valid response. Given the level of agreement between the respondents and the plant-level focus of this study, single respondents were deemed acceptable for analysis.

Additional measures were implemented to mitigate method bias. Items were distributed randomly throughout the survey instrument. The response format for the Internal Integration items was different from that for the rest of the survey, providing some psychological distance. Finally, respondents were reassured several times of their status as anonymous participants. Systemic departmental bias was examined by the analysis of inter-rater agreement in this pilot sample. For the main survey, method bias will be assessed using the partial correlation analysis recommended by Lindell and Whitney (2001).

4.6 Aggregating Multiple Responses

Multiple respondents mitigate the effects of method bias but they also create a problem of how to incorporate them into the research model. The ideal response profile is to have one responder from each of the three target departments. However, this may be unfeasible for two reasons: in some plants, one person may be responsible for two of these departments; in other plants, one or more departments may choose not to participate. The issue of aggregation was limited to a relatively small portion of the sample, and is present only in the pilot stage. Where multiple responses were provided, they were averaged for analysis.

4.7 Conclusions

The pilot study resulted in seventy-two valid data points. Analysis of this data was used to modify or delete survey items. Seven items were removed due to low CITC scores. Two additional items were removed due to cross-loadings. The analysis supported the factor structure of the proposed research instrument.

Table 4.17 Items retained for main study

	Mean	Std. Dev.	Factor Loadings (ML)	Cronbach's alpha	AVE	CR
Centralization				0.695	0.440	0.701
CEN1	3.15	1.154	0.773			
CEN2R	2.99	0.863	0.610			
CEN4	3.39	0.744	0.595			
Cross Functional Teams				0.824	0.543	0.824
CF1	3.52	1.1	0.638			
CF2	3.52	0.978	0.787			
CF3	4.08	0.664	0.653			
CF5	3.46	0.934	0.848			
Collaboration				0.855	0.605	0.858
COL1	3.77	0.791	0.756			
COL2	3.97	0.691	0.923			
COL3	3.9	0.671	0.706			
COL4	4.06	0.685	0.707			
Communication				0.787	0.563	0.834
COM1	4.00	0.71	0.726			
COM2	3.72	0.73	0.832			
COM3R	3.57	0.686	0.767			
COM5	4.11	0.469	0.668			
Integrative Employee Assessment	*All items modified for main survey.*					
IEA1	4.2	0.838	N/A			
IEA2R	2.85	0.983				
IEA3	3.96	0.562				
IEA4	3.69	0.781				
IEA5	4.12	0.447				
Integrative HRM				0.907	0.766	0.907
IHRM1	3.51	0.787	0.873			
IHRM2	3.55	0.713	0.866			
IHRM3	3.47	0.767	0.886			

	Mean	Std. Dev.	Factor Loadings (ML)	Cronbach's alpha	AVE	CR
Integrative Info. Tech.				0.798	0.505	0.802
IIT1	3.81	1.202	0.809			
IIT2	3.68	1.451	0.63			
IIT4	3.82	0.804	0.688			
IIT5	3.68	0.914	0.703			
Job Rotation				0.682	0.420	0.683
JR1	2.7	1.08	0.646			
JR2	2.93	1.039	0.593			
JR5	3.79	0.65	0.7			
Management Support				0.875	0.599	0.881
MS1	4.18	0.827	0.837			
MS2	3.87	0.854	0.707			
MS4	4.01	0.768	0.759			
MS5	4.14	0.583	0.805			
MS6	3.96	0.0738	0.755			
Strategic Consensus				0.864	0.64	0.875
SC1	4.11	0.722	0.802			
SC3	4.09	0.586	0.898			
SC4	3.98	0.7	0.831			
SC5	3.9	0.734	0.649			
Uncertainty				0.807	0.536	0.818
UNC1	3.65	1.165	0.588			
UNC2	3.83	0.949	0.608			
UNC3	3.8	1.005	0.804			
UNC4	3.51	0.968	0.885			

CHAPTER FIVE

RESULTS

5.1 Demographics for the Population and Sample

The population of interest for this study is manufacturing firms in the United States. Potential survey respondents were identified using a variety of sources, including but not limited to: public information such as websites and telephone directories, directories of manufacturing associations and/or chambers of commerce, and online alumni directories. A number of states have active Manufacturers Associations (e.g.—South Carolina Manufacturers Alliance, Delaware Manufacturers Association, Texas Alliance of Manufacturers' Associations). Several of these had online member directories with contact information. These directories represent a cross-section of manufacturers in a variety of industries, hence they provided a comprehensive pool of potential survey respondents. Initial contact was made with one individual at a firm, and this individual was asked to complete the survey, forward it to an appropriate respondent, or provide contact information for an appropriate respondent. Manufacturers' associations in South Carolina, Vermont, Massachusetts, New Hampshire, North Carolina, Texas, Arizona, California, Oregon, and New Mexico, which did not have a public directory, were contacted to request participation in the study, but they declined to participate, citing a policy of not revealing member firms' contact information to non-member entities. The following public directories were used to develop lists of potential respondents:

- Manufacturers Association of Central New York (www.macny.org)
- Delaware Chamber of Commerce Directory (www.dscc.com)
- Manufacturers Directory, Dept. of Economic Development, State of Nebraska (www.neded.org)
- Manufacturers Association of Central Florida (www.macf.biz)
- Manufacturers Association of Maine (www.maine-metals.org)
- Central Arkansas Manufacturing Directory (www.arkansasbusiness.com)
- Georgia Manufacturing Directory (www.georgiafacts.net)

From these directories, firms were selected if they had 20 or more employees and had an email address listed within their contact information. Hence this sample is biased towards those firms willing to publish an electronic contact.

In addition to these sources, potential respondents were identified from the online alumni directories of a private university in the northeastern United States and a public university in the southeastern United States. For the public university, the alumni database was searched for alumni who had listed "Manufacturing" within their profile, or who had listed Industrial Management, Management, or Business Administration as their major course of study, and had provided an email address for contact.

The contact list from the private university consisted of valid email addresses left over from the pilot study. These individuals had not provided any sort of response to the pilot survey (did not fill out survey and did not "Opt-out" from the survey mailing list). Those who responded during the pilot survey were removed from the contact list, and are not included within the main study.

5.2 Survey Administration

The survey administration followed the Tailored Design Method proposed by Dillman (2000). Target respondents were contacted via email and asked to participate. The invitation contained a link to the online survey, as well as an invitation to request a fax, letter, or email with the survey instrument. Reminder messages were sent two and four weeks after the initial survey was sent.

Respondents were assured that their participation was voluntary and that their responses would only be used in summary. The personal identity of individual responders was not recorded; however, each potential first responder was provided with a four-digit code to identify their facility. This code was originally intended to link multiple respondents, however, at this stage multiple respondents were not actively sought. The online survey also included an alternate method of identification, using the name of the responder's company and the postal ZIP code in which the plant is located. Respondents who wished to receive a summary of results were invited to send their contact information but this information was maintained separately from the survey data.

5.3 Response Rates

The response rates varied greatly among the groups contacted. The low response rate from the alumni of the private university (Northeast) can be attributed in part to the fact that these individuals had previously not responded to repeated requests to participate in this survey at the pilot stage. Details of each group's response rates are listed in Table 5.1:

Table 5.1 Response rates

Group	Total valid email addresses	Total survey responses	Response rate
Northeast Alumni	251	10	3.98%
Southeast Alumni	266	54	20.3%
Manufacturers Association of Central New York	129	11	8.53%
Delaware Chamber of Commerce	22	2	9.09%
Nebraska Manufacturers Directory	140	7	5.00%
Manufacturers Association of Central Florida	16	2	12.5%
Manufacturers Association of Maine	83	15	18.07%
Central Arkansas Manufacturing Directory	47	6	12.77%
Georgia Manufacturing Directory	248	23	9.27%
TOTAL	1355	130	9.59%

The sample frame for this study consisted of manufacturing facilities in the United States that had more than 20 employees. The employee cutoff was selected to screen out smaller companies where interdepartmental integration is not expected to require more than simple modes of coordination. The population parameters are obtained from the 2002 US Economic Census, as per reports released on the US Economic Census website between 2004 and 2006 and found online at http://www.census.gov/econ/census02/index.html. The Census reports its summary data using two employee size categories: total number of establishments, and establishments with greater than 20 employees. More detailed reports break out employee size into the following categories: 1-19, 20-49, 50-99, 100-249, 250-499, 500-999, and >1000. The census reports statistics based on NAICS industry classifications, whereas the study sample used older SIC classifications. The SIC codes were converted to NAICS codes for analysis.

According to the United States Department of Commerce, there were 350,828 manufacturing establishments in the United States in 2002, of which 108,728 had greater than 20 employees. A manufacturing establishment is a single location which performs manufacturing activities. A single firm can have several establishments. Table 5.2 reports the demographics of the population and the sample, by number of employees:

Table 5.2 Population and sample demographics by establishment size

Employees	Number / % in Population	Number / % in Survey Sample
20 – 49	51,660 / 48%	16 / 11.7%
50 – 99	25,883 / 24%	34 / 25.8%
100 - 249	20,346 / 19%	36 / 28.3%
250 - 499	6,853 / 6%	23 / 18.3%
500 – 999	2,720 / 3%	12 / 9.2%
>1000	1,266 / 1%	9 / 6.7%
TOTAL	108, 278 / 100%	130 / 100%

Source: US Census Bureau 2005

Compared to the population, the sample is biased toward larger facilities (Chi-Sq. = 118.03, $p < 0.001$). This is not an unexpected finding. Some respondents who declined to participate mentioned that their facilities were too small to support having different departments and all work was done by a small group of employees or by one person. The modes of coordination considered for this study are more typical of larger facilities that have outgrown the feasibility of exclusively using informal coordination.

The sample frame included facilities from SIC codes 20-39, which consists of companies identified as belonging to the Manufacturing sector. Manufacturing is defined by the Census as consisting of establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. Respondents were able to select their classification from a drop-down menu of SIC codes. However, the 2002 Census is reported as NAICS codes, which had to be converted to SIC codes for comparison.

Table 5.3 Population and Sample demographics by Industry

NAICS 31-33	SIC 20-39	Manufacturing	Population	Survey Sample	Over/ Under*
311	20	Food manufacturing	8,736 / 8%	3 / 2.3%	-
312	21	Beverage & tobacco product manufacturing	987 / 0.9%	1 / 0.8%	
313	22	Textile mills	1,671 / 1.5%	4 / 3.1%	
314	22	Textile product mills	1,535 / 1.4%	0 / 0%	-
315	23	Apparel manufacturing	3,269 / 3%	2 / 1%	
316	31	Leather & allied product manufacturing	394 / 0.4%	1 / 0.8%	
321	24	Wood product manufacturing	5,655 / 5.2%	1 / 0.8%	-
322	26	Paper manufacturing	3540 / 3.3%	7 / 5.4%	
323	27	Printing & related support activities	7134 / 6.6%	2 / 1.5%	-
324	29	Petroleum & coal products manufacturing	652 / 0.6%	1 / 0.8%	
325	28	Chemical manufacturing	5500 / 5.1%	11 / 8.5%	
326	30	Plastics & rubber products manufacturing	7893 / 7.3%	6 / 4.6%	
327	32	Nonmetallic mineral product manufacturing	5430 / 4.8%	2 / 1.5%	-
331	33	Primary metal manufacturing	2807 / 2.6%	3 / 2.3%	
332	34	Fabricated metal product manufacturing	17197 / 15.8%	20 /15.4%	
333	37	Machinery manufacturing	9850 / 9.1%	9 / 6.9%	
334	36	Computer & electronic product manufacturing	6563 / 6.0%	10 / 7.7%	
335	35	Electrical equipment, appliance, & component manufacturing	2879 / 2.7%	12 / 9.23%	+
336	38	Transportation Equipment	5589 / 5%	10 / 7.7%	
337	25http://www.census.gov/econ/census02/data/us/US000_31.HTM - N339	Furniture & related product manufacturing	4878 / 4.5%	3 / 2.3%	

339	39	Miscellaneous manufacturing	6569 / 6%	22 / 16.9%	++
		TOTAL	108,728	130	

*Note: For Over/Under column, '+' represents a difference of greater than 5% OVER the expected distribution; '-' identifies a difference of more than 5% UNDER the expected distribution. '++' is more than 10% OVER.

A Chi-Sq test performed on this data proved to be highly significant (Chi-Sq = 56.34, $p < 0.001$), even when excluding the abnormal result for the category labeled "Miscellaneous." This table indicates that the sample is biased towards producers of appliances and other electrical equipment, with a smaller bias towards computer equipment and chemicals, as well as including almost three times as many firms in the "Miscellaneous" category as would be expected from the general population. Certain industries are under-represented, including food products, wood products, and non-metallic mineral products. This may be influenced in part by imperfect correspondence between NAICS codes and SIC codes, unfamiliarity of the respondents with their company's SIC codes, and the nature of the sampling frame, which lists firms that are *members* of a particular association of manufacturers. The respondents were asked to select a primary two-digit SIC code from a drop-down list. However, some of the descriptors may not have provided enough guidance for users unfamiliar with the SIC classifications.

The purpose of this research is to examine factors that may affect the integration between three departments: Purchasing, Outbound Logistics, and Operations. As stated previously, the pilot study results indicate that at the firm level of analysis, members of different departments appear to agree in their responses to the survey items. However, there is still the possibility that there is some systemic bias due to a respondent's area of responsibility. Respondents were asked the following question to determine their area of responsibility: "Which department(s) most closely fit(s) your job duties?" They selected from the following three categories: Purchasing, Operations/Production, and Outbound Logistics/Shipping. The sample was distributed as follows:

Table 5.4 Sample Demographics by Area of Responsibility

Area of Responsibility	Number	Percentage
Operations	85	65.4%
Operations / Purchasing	7	5.4%
Operations / Logistics	10	7.7%
Purchasing	10	7.7%
Logistics	14	10.8%
Purchasing / Logistics	4	3.1%

A majority of respondents come from Operations. This is not a surprise, given that membership lists for the manufacturers' organizations contacted tend to provide a contact person within the management structure of the manufacturing facility. Although the level of agreement between the multiple respondents in the pilot study is high as measured by the Ratio Method (James, Demaree and Wolf 1984); the results of this study must be applied with caution to employees outside of the Operations function. To confirm that the data can be pooled, an assessment of measurement invariance between two groups: (i) respondents who self-identified as working solely within the Operations function and (ii) those who identified as having combined responsibilities or who worked solely for Purchasing or Outbound Logistics was performed as part of the analysis.

There is not sufficient data to determine the location of all of the facilities in the sample. Although some can be ascertained from their membership in a regional organization, for a large fraction of respondents this data is not available. In some cases, the initial email contact did not provide the survey response but instead forwarded it to someone else within their company. In several known cases, the respondent was actually in a different location from the initial contact. As contact data for respondents was maintained separately, and only for those who wished to receive a copy of the results, this study can make no inferences with regard to location. As to the characteristics of the sample frame, the alumni databases represented a broad geographical distribution, while the manufacturers' associations represent specific states.

5.4 Summary of Non-Response Bias

Given the nature of this study, it is likely that smaller firms are less likely to respond to this study. In terms of Industry representation, there are respondents in every NAICS category except for Textile Product Mills. During the conversion from SIC to NAICS, the SIC 22 category was split. However, the study sample is listed by SIC code, hence it is not possible to distinguish between NAICS codes 313 and 314, and it is likely that the sample contains firms from both of these classifications. The survey sample is biased toward larger companies, toward employees within the Operations function, and toward firms in two NAICS categories: Miscellaneous (NAICS 339) and Industrial Equipment/Appliances/Electrical Equipment (NAICS 335).

5.5 Data Analysis

5.5.1 Data Screening

The data file contained a total of 130 firms. Of these, six were eliminated due to insufficient data. The remaining data for the survey respondents was screened for univariate and multivariate outliers. Univariate outliers were screened using a 3.0 sigma standard. Tabachnik and Fidell (2001, p. 71) suggest that in order to preserve sample size for analysis, these cases can be re-coded to the next possible value, for example, from a value of 5 to a value of 4 or from a value of 1 to a value of 2. These cases were re-coded for the individual affected variables (see Table 5.5), and the sample submitted for analysis of multivariate outliers.

Table 5.5 Summary of cases recoded due to univariate outliers

Variable	Number of outliers	Variable	Number of outliers
CEN3*	1	COL3	1
CEN4*	2	COL4	1
CEN5*	2	IIT4	1
CF1*	1	IIT5	1
CF3*	2	MS1	2
COM1*	1	SC2*	3
COL2	1	UNC2	1

*: These items were subsequently removed from analysis

Multivariate outliers have unusual combinations of scores, although the individual scores may be within the 3.0 sigma limit. Mahalanobis distance indicates the distance in standard deviation units between a set of scores for an individual case and the sample means for all variables, and is distributed as a Chi-sq. statistic with degrees of freedom equal to the number of variables. Mahalanobis distance was used to determine multivariate outliers, using a critical Chi-Sq value of 74.75 ($df = 41$, $p<0.001$). The degrees of freedom for the critical Mahalanobis distance is determined by the number of variables in the analysis. Four cases had high Mahalanobis distance, and they were dropped from analysis as it is difficult to determine which combination of variables within forty-one items is causing the problem. Hence the final sample contains one hundred and twenty firms.

5.5.2 Assessment of normality

SEM analysis assumes that variables are distributed normally. To assess whether the variables were normally distributed, univariate skew and kurtosis values were generated by dividing the value of the statistic by its standard error. For the screened data, the results are presented in Table 5.6:

Table 5.6 Normality assessment

	Mean	Std. Dev	Skewness (Stat/ Std.Error)	Kurtosis (Stat/ Std.Error)
Centralization				
CEN1	3.20	1.05	-1.60	-2.27
CEN2R	2.99	1.05	1.26	-2.38
CEN4	3.37	0.87	-3.62	0.12
Cross Functional Teams				
CF1	3.33	1.05	-2.61	-0.93
CF2	3.28	1.00	-0.55	-2.14
CF3	3.93	0.84	-3.77	1.12
CF5	3.29	0.95	-0.37	-2.41
Collaboration				
COL1	3.75	0.86	-2.86	-0.05
COL2	4.14	0.55	0.32	0.39
COL3	4.01	0.52	-0.04	1.83
COL4	4.08	0.52	0.55	1.49
Communication				
COM1	4.04	0.67	-3.35	3.71
COM2	3.71	0.77	-3.84	1.00
COM3R	2.41	0.83	-2.16	-0.51
COM5	4.24	0.52	0.69	0.57
Integrative Employee Assessment				
IEA1	3.92	0.88	-2.85	-0.32
IEA2R	3.13	1.03	0.40	-2.54
IEA3	3.72	0.86	-2.98	-0.04
IEA4	3.88	0.68	-2.11	1.43
IEA5	4.08	0.59	-0.22	-0.21
Integrative Human Resource Management				
IHRM1	3.68	0.86	-1.38	-1.07
IHRM2	3.76	0.69	-1.58	0.59
IHRM3	3.56	0.77	-0.30	-0.73

Table 5.6 Normality assessment

	Mean	Std. Dev	Skewness (Stat/ Std.Error)	Kurtosis (Stat/ Std.Error)
Integrative Information Technology				
IIT1	3.93	1.08	-5.30	2.07
IIT2	3.59	1.14	-1.61	-1.93
IIT4	3.66	0.94	-2.44	-0.57
IIT5	3.77	0.89	-4.01	2.38
Job Rotation				
JR1	2.65	1.14	1.46	-2.03
JR2	2.99	1.03	0.43	-2.16
JR5	4.19	0.62	-1.49	1.19
Management Support				
MS1	4.22	0.71	-2.77	0.52
MS2	3.83	0.85	-2.42	-0.29
MS4	3.92	0.71	-2.26	1.21
MS5	4.15	0.62	-2.32	3.12
MS6	3.96	0.66	-2.77	3.00
Strategic Consensus				
SC1	4.12	0.71	-3.53	2.47
SC3	4.23	0.57	-0.26	-0.89
SC4	4.10	0.76	-3.53	1.72
SC5	3.92	0.56	-1.31	2.49
Uncertainty				
UNC1	3.57	1.172	-2.20	-2.351
UNC2	3.59	1.041	-2.36	-1.46
UNC3	3.71	1.103	-3.32	-0.73
UNC4	3.38	1.150	-2.31	-1.64

Non-normality is an issue within SEM because fit indices derived from models fitted with non-normal data can exhibit inflated Chi-Sq. values and moderately deflated fit indices. These conditions result in unnecessary, unproductive, and in some cases non-replicable modifications to the model in search of a non-significant Chi-Sq. (Byrne 2001). In addition, the standard errors derived from Maximum Likelihood estimation can be spuriously low when the sample is non-normal, resulting in erroneous conclusions about the statistical significance of regression paths and factor-error covariances (Byrne 2001).

This analysis revealed that nine of the items (CEN4, CF3, COM1, COM2, IIT1, IIT5, SC1, SC4, and UNC3) had high values of skewness (beyond +/- 3). SEM analysis assumes that the variables are both univariate and multivariate normal when reporting results of the model fit. In order to achieve normality, the variables with high skewness were transformed by taking the square root of the values. This brought skewness and kurtosis into the desired range (-3.0 to 3.0), per Tabachnik and Fidell (2001). However, this transformation resulted in four cases becoming multivariate outliers. The resulting loss of data was deemed undesirable due to its impact on the statistical power of the analysis.

As data transformation was not a viable alternative, the analysis was conducted by invoking the bootstrapping functions available within AMOS 16.0.1 (2007). The bootstrapping procedures provide tests of the overall model fit by use of the Bollen-Stine bootstrap (Bollen and Stine 1992). The Bollen-Stine bootstrap provides a corrected value of the critical Chi-Sq. statistic used to determine overall model fit. Bias-corrected standard errors and 90% confidence intervals for parameter estimates (by using the ML bootstrapping procedure) were used to assess the significance of individual parameters, as recommended by Byrne (2001).

5.5.3 Missing Data

The sample contained a small amount of missing data (~1%). The missing data was imputed using the Expectation Maximization (EM) algorithm implemented within EQS (2004). Descriptive Statistics for the sample before and after EM imputation are shown in Tables 5.7a and 5.7b below.

Table 5.7a Descriptive statistics before EM imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Error	Value	Std. Error
Centralization							
CEN1	120	3.20	1.149	-.300	.221	-1.078	.438
CEN2	120	2.99	1.126	-.055	.221	-1.064	.438
CEN4	119	3.37	.929	-.806	.222	.078	.440
Cross-functional Teams							
CF1	120	3.33	1.124	-.492	.221	-.593	.438
CF2	120	3.28	1.070	-.130	.221	-1.027	.438
CF3	120	3.93	.905	-1.112	.221	1.319	.438
CF5	119	3.29	1.020	-.132	.222	-.970	.440
Collaboration							
COL1	120	3.75	.955	-.891	.221	.581	.438
COL2	120	4.14	.539	.107	.221	.236	.438
COL3	118	4.01	.577	-.271	.223	1.068	.442
COL4	118	4.08	.681	-1.250	.223	4.227	.442
Communication							
COM1	120	4.04	.666	-.741	.221	1.625	.438
COM2	120	3.71	.793	-.868	.221	.390	.438
COM3	119	2.41	.877	.542	.222	-.110	.440
COM5	118	4.24	.565	-.297	.223	1.234	.442
Integrative Employee Assessment							
IEA1	120	3.92	.931	-.785	.221	.203	.438
IEA2	120	3.13	1.069	-.187	.221	-1.005	.438
IEA3	120	3.72	1.020	-.871	.221	.288	.438
IEA4	119	3.88	.691	-.468	.222	.553	.440
IEA5	118	4.08	.661	-.634	.223	1.296	.442
Integrative Information Tech.							
IIT1	120	3.93	1.090	-1.171	.221	.868	.438
IIT2	120	3.59	1.141	-.385	.221	-.810	.438
IIT4	118	3.66	1.048	-.732	.223	-.087	.442

Table 5.7a Descriptive statistics before EM imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Error	Value	Std. Error
IIT5	118	3.77	.973	-.939	.223	.800	.442
Job Rotation							
JR1	120	2.65	1.157	.355	.221	-.881	.438
JR2	120	2.99	1.049	.061	.221	-.982	.438
JR5	118	4.19	.727	-1.251	.223	3.423	.442
Management Support							
MS1	120	4.22	.772	-1.082	.221	1.988	.438
MS2	120	3.83	.873	-.670	.221	.334	.438
MS4	120	3.92	.805	-1.025	.221	2.091	.438
MS5	118	4.15	.662	-.716	.223	1.485	.442
MS6	120	3.96	.661	-.616	.221	1.322	.438
Strategic Consensus							
SC1	120	4.12	.795	-1.148	.221	2.148	.438
SC3	118	4.23	.685	-1.140	.223	3.721	.442
SC4	118	4.10	.767	-.754	.223	.609	.442
SC5	118	3.92	.706	-1.226	.223	4.086	.442
Uncertainty							
UNC1	120	3.57	1.172	-.487	.221	-1.029	.438
UNC2	120	3.59	1.041	-.521	.221	-.638	.438
UNC3	120	3.71	1.103	-.734	.221	-.321	.438
UNC4	119	3.38	1.150	-.513	.222	-.723	.440

Table 5.7b. Descriptive Statistics after EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Error	Value	Std. Error
Centralization							
CEN1	120	3.20	1.149	-.300	.221	-1.078	.438
CEN2R	120	2.99	1.126	-.055	.221	-1.064	.438
CEN4	120	3.39	.869	-.800	.221	.051	.438
Cross-Func. Teams							
CF1	120	3.33	1.124	-.492	.221	-.593	.438
CF2	120	3.28	1.070	-.130	.221	-1.027	.438
CF3	120	3.93	.905	-1.112	.221	1.319	.438
CF5	120	3.34	.953	-.082	.221	-1.055	.438
Collaboration							
COL1	120	3.75	.955	-.891	.221	.581	.438
COL2	120	4.14	.539	.107	.221	.236	.438
COL3	120	3.98	.519	-.008	.221	.804	.438
COL4	120	4.09	.519	.122	.221	.653	.438
Communication							
COM1	120	4.04	.666	-.741	.221	1.625	.438
COM2	120	3.71	.793	-.868	.221	.390	.438
COM3R	120	3.63	.826	-.477	.221	-.223	.438
COM5	120	4.17	.523	.152	.221	.248	.438
Integrative Employee Assessment							
IEA1	120	3.92	.931	-.785	.221	.203	.438
IEA2R	120	3.13	1.069	-.187	.221	-1.005	.438
IEA3	120	3.72	1.020	-.871	.221	.288	.438
IEA4	120	3.86	.677	-.465	.221	.628	.438
IEA5	120	4.11	.585	-.049	.221	-.094	.438

Table 5.7b. Descriptive Statistics after EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Error	Value	Std. Error
Integrative Information Tech.							
IIT1	120	3.93	1.090	-1.171	.221	.868	.438
IIT2	120	3.59	1.141	-.385	.221	-.810	.438
IIT4	120	3.70	.938	-.539	.221	-.252	.438
IIT5	120	3.74	.893	-.886	.221	1.044	.438
Job Rotation							
JR1	120	2.65	1.157	.355	.221	-.881	.438
JR2	120	2.99	1.049	.061	.221	-.982	.438
JR3	120	3.50	.867	-.396	.221	.133	.438
JR5	120	4.15	.617	-.329	.221	.522	.438
Management support							
MS1	120	4.22	.772	-1.082	.221	1.988	.438
MS2	120	3.83	.873	-.670	.221	.334	.438
MS4	120	3.92	.805	-1.025	.221	2.091	.438
MS5	120	4.14	.621	-.513	.221	1.368	.438
MS6	120	3.96	.661	-.616	.221	1.322	.438
Strategic consensus							
SC1	120	4.12	.795	-1.148	.221	2.148	.438
SC3	120	4.26	.565	-.057	.221	-.391	.438
SC4	120	4.11	.755	-.779	.221	.752	.438
SC5	120	3.93	.562	-.290	.221	1.091	.438
Uncertainty							
UNC1	120	3.57	1.172	-.487	.221	-1.029	.438
UNC2	120	3.59	1.041	-.521	.221	-.638	.438

Table 5.7b. Descriptive Statistics after EM Imputation

	N	Mean	Std. Dev.	Skewness		Kurtosis	
				Value	Std. Error	Value	Std. Error
UNC3	120	3.71	1.103	-.734	.221	-.321	.438
UNC4	120	3.45	1.030	-.381	.221	-.848	.438

5.6 Re-assessing scale problems identified during the pilot study

As stated earlier, the pilot study uncovered potential problems with three factors: Integrated Employee Assessment, Job Rotation, and Cross Functional Teams. These factors were considered relevant to the theoretical model, as they represent different forms of coordination mechanisms which encourage lateral relations. All the items for Integrative Employee Assessment were reworded after the pilot. Replicating the procedures used with the pilot data, a second exploratory analysis was conducted to re-evaluate these factors using the data collected during the main survey. This additional analysis also serves to confirm the results obtained during the pilot study.

Item reliability for these scales was assessed by calculating a Corrected Item to Total Correlation score. Items with CITC scores lower than 0.3 were eliminated from the scales (Shah and Ward 2007). The resulting scales for the Integrative Human Resource Management, Job Rotation, and Cross Functional Teams are presented below.

5.6.1 Integrative Employee Assessment

The items used for this scale were all reworded after the pilot study. The items used for the pilot study all had very poor CITC scores, under 0.3. The data was not suitable for factor analysis and indicated by a low KMO and non-significant Bartlett's test. Those items were replaced with the items found in the following table. Two items, IEA1 and IEA2, had CITC scores lower than 0.3 (0.187 and 0.276 respectively) and thus were eliminated.

Table 5.8 Items and factor analysis results for Integrative Employee Assessment

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
			0.416	0.644	0.670
IEA1	Supervisors/managers review each employee's performance on a regular basis.				
IEA2(R)	Employees' individual performance reviews focus exclusively on how they have contributed to the goals of their own department.				
IEA3	Employees' merit raises are based at least in part on how well the entire plant meets its goals.	0.583			
IEA4	Employees are rewarded for their contribution to the overall performance of the plant.	0.818			
IEA5	My contribution to the overall performance of the plant is an important part of my individual performance review.	0.488			

KMO = 0.624, Sig. for Bartlett's test = 0.000.
(R) = reverse-coded

5.6.2 Cross Functional Teams

The items used for this scale were retained after the pilot study. Prior problems with this scale arose due to cross-loadings and the inability to distinguish this factor from the Job Rotation factor, rather than the internal consistency or reliability of the scale itself. However, for completeness, the factor analysis of the individual factor is reproduced here using the data from the main survey. The results are comparable to those obtained with the pilot study data.

Table 5.9 Items and factor analysis results for Cross-Functional Teams

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
			0.533	0.807	0.814
CF1	Our plant has established work teams of employees from multiple departments to address customer problems.	0.543			
CF2	Our plant has established work teams of employees from different departments to address internal issues.	0.882			
CF3	Members of my department participate in teams with members from other departments.	0.596			
CF5	Our plant has established work teams of employees from different departments to address supplier issues.	0.840			

KMO = 0.744, Sig. for Bartlett's test = 0.000

5.6.3 Job Rotation

The items used for this scale were retained after the pilot study for re-analysis with the main sample. Prior problems with this scale arose due to cross-loadings and the inability to distinguish this factor from the Cross Functional Teams factor, rather than the internal consistency or reliability of the scale. The factor analysis of the individual factor is reproduced here using the data from the main survey. Item JR5 was reworded after the results of the pilot data. Unfortunately, the rewording did not improve the item. The CITC score for item JR5 was below 0.3 (0.269), and the item was eliminated from the analysis. Unfortunately that reduces the number of available items to measure this factor. Three or more items are desirable for analysis, and this two-item scale is a limitation of this research.

Table 5.10 Survey items and factor analysis results for Job Rotation

Variable	Item Wording	Factor Loadings	AVE	Cronbach's alpha	CR
			0.667	0.501	0.880
JR1	My company has a training program where employees rotate through work assignments in different departments.	0.817			
JR2	Managers at our company move from one department to another.	0.817			
JR5	We consider work experience in more than one area to be valuable.				

KMO = 0.500, Sig. for Bartlett's test = 0.000

5.6.4 Discriminant Validity

The analysis described in the previous sections was performed due to the failure of the Integrative Employee Assessment factor to converge to an acceptable factor solution and the presence of cross-loadings in the pilot sample, which did not allow for a clear separation between the Job Rotation and Cross Functional Teams factors. The analysis of divergent validity is repeated again here to determine whether the item modifications have resolved these issues. Individually, the factors demonstrate potentially acceptable psychometric properties.

Collectively, the modifications to the three factors appear to have helped the problem with cross loadings. Using CEFA to perform factor analysis with CF-VARIMAX rotation provides the following rotated structure matrix:

Table 5.11. Factor analysis results, rotated structure matrix

	Cross Functional Teams	Int. Emp. Assessment	Job Rotation
cf1	0.38	0.06	0.27
cf2	**0.81**	0.07	0.1
cf3	**0.45**	0.11	0.21
cf5	**0.85**	0.07	0.01
iea3	0.11	**0.75**	-0.2
iea4	0.02	**0.68**	0.27
iea5	0.06	**0.41**	0.18
jr1	-0.08	-0.04	**0.63**
jr2	0.17	0.03	**0.47**

The Job Rotation factor shows divergent validity when only the Cross Functional Teams and Integrative Employee Assessment factors are considered. However, when analysis is conducted using all of the predictor variables included within the full research model, the Job Rotation items do not load clearly onto any one factor. Given the psychometric problems with its measurement, Job Rotation is thereby dropped from further analysis. In addition, item CF1 was dropped as it cross-loads onto other factors.

5.7 Analysis of the Measurement Model

Following the results of the pilot study and the analysis of the human resource management factors detailed in the prior section, the factors and items retained for the research model are listed in Table 5.12.

Table 5.12 Items retained for final analysis

Factor/Item	Text	Mean	Std. Deviation
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			
Centralization			
CEN1	Employees in Purchasing and/or Shipping who do not report to the Plant Manager need to have approval from their boss before making decisions that concern our plant.	3.27	1.052
CEN2R	Employees who do Purchasing and/or Shipping for our plant can proceed without having to check first with their boss.	2.95	1.052
CEN4	Employees who do Purchasing and/or Shipping for this plant rely on their Purchasing/Shipping chains of command to make decisions.	3.39	.869
Communication			
COM1	We have open lines of communication between departments.	4.04	.666
COM2	Employees in the other departments respond promptly when contacted by someone in my department regarding work issues.	3.69	.772
COM3R	We have trouble getting a response from other departments when we contact them regarding work issues.	3.63	.826
COM4	Employees in other departments do not hesitate to contact us to resolve work issues.	4.17	.523
Cross-Functional Teams			
CF2	Our plant has established work teams of employees from different departments to address internal issues.	3.28	1.070
CF3	Members of my department participate in teams with members from other departments.	3.93	.905

Table 5.12 Items retained for final analysis

Factor/Item	Text	Mean	Std. Deviation
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			
CF5	Our plant has established work teams of employees from different departments to address supplier issues.	3.34	.953
Int. Employee Assessment			
IEA3	Employees' merit raises are based at least in part on how well the entire plant meets its goals.	3.76	.856
IEA4	Employees are rewarded for their contribution to the overall performance of the plant.	3.85	.677
IEA5	My contribution to the overall performance of the plant is an important part of my individual performance review.	4.10	.585
Integrative Information Tech.			
IIT1	Our plant uses a computerized system to plan production.	3.91	1.081
IIT2	Our plant uses a commercially available ERP package.	3.56	1.143
IIT4	People in Purchasing, Production/Operations, and Shipping can access data in each other's computer systems.	3.70	.938
IIT5	The computer systems in our plant can communicate with each other.	3.73	.893
Management Support			
MS1	The Plant Manager encourages departments to work together.	4.20	.708
MS2	The Plant Manager has attended meetings intended to promote efforts of departments to work together.	3.80	.846
MS4	The plant manager is willing to clear obstacles to collaboration that are outside our plant.	3.94	.708
MS5	The Plant Manager's staff knows he/she wants them to work together.	4.14	.620

Table 5.12 Items retained for final analysis

Factor/Item	Text	Mean	Std. Deviation
Root: Please select the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.			
MS6	The Plant Manager understands what is needed to support efforts to work with the other departments.	3.96	.661
Strategic Consensus			
SC1	I know my company's competitive strategy.	4.1410	.71466
SC3	I know how my work contributes to my company's plan to set itself apart from the competition.	4.2593	.56517
SC4	I know how my company sets itself apart from its competitors.	4.1095	.75587
SC5	Our long-term performance goals are aligned with our company's competitive strategy.	3.9297	.56245
Collaboration			
COL1	We work together to develop business opportunities.	3.82	.856
COL2	We work together to resolve problems.	4.13	.549
COL3	Short-term projects are accomplished by working together.	3.98	.519
COL4	We accomplish long-term goals by working together.	4.09	.518
Uncertainty			
UNC1	The composition of demand (the product mix) is difficult to predict.	3.5500	1.15845
UNC2	Demand for our products varies unpredictably.	3.5833	1.01736
UNC3	Our production schedule changes unexpectedly.	3.7333	1.06695
UNC4	The volume of demand is difficult to predict.	3.4476	1.03091

5.7.1 Discriminant Validity

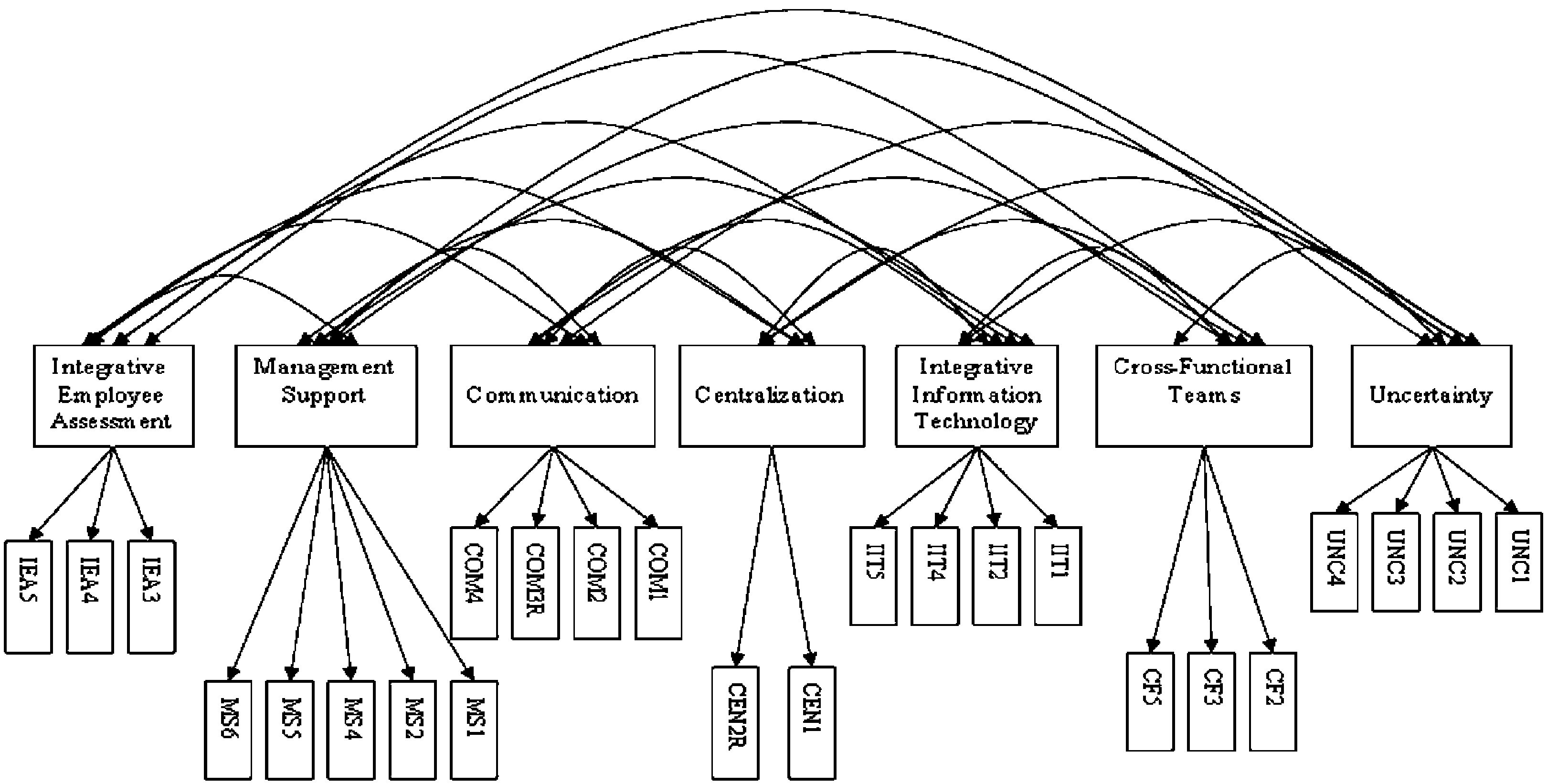
Confirmatory Factor Analysis (CFA) was used to assess discriminant validity. In CFA, items are constrained to load only upon their relevant latent factor. The latent factors are allowed to covary freely. Divergent validity is suggested when the model has good fit and the Modification Indices (MI) do not suggest adding a path from a variable to a factor different from the one it is intended to measure. An MI is a univariate Lagrange Multiplier test that estimates the amount by which the Chi-Sq function would decrease if the parameter was freely estimated instead of constrained to zero (ie—adding a path to the model).

The tests and statistics used to evaluate structural equation models as recommended by Marsh et al. (2004) and Klein (2005) are summarized in Table 5.13. To mitigate the potential impact of nonnormality on parameter estimates and standard errors, if the multivariate kurtosis (i.e.—Mardia's Coefficient) is statistically significant (Critical Ratio > 2), a bootstrapping procedure was used to generate bias-corrected parameters and standard errors. This procedure is implemented using AMOS 16.0.1.

Table 5.13 Guidelines in assessing SEM models

Statistic	Purpose	Guideline
Chi-Square Test	A test of how well the observed correlations fit the implied correlations vs. an Independence model where all relationships are set to equal 0.	Critical value based on model degrees of freedom, from Chi-Sq table.
Comparative Fit Index (CFI)	A test of relative fit—the percentage increase in fit of the model vs. the Independence model	>0.90
Non-normed Fit Index (NNFI) (Reported in AMOS as TLI)	The proportion by which the researcher's model improves fit compared to the null model, penalized for model	>0.90 Not guaranteed to vary between 0 and 1 but is reset to 1 if it goes over. (Bentler

Statistic	Purpose	Guideline
	complexity. Less affected by sample size.	and Bonnett 1980)
Root Mean-Square Error of Approximation (RMSEA)	A test of absolute fit, based on the size of the difference between the observed and implied residuals	≤ 0.10



Chi-Sq. = 344.4, df = 255, B-S p = 0.219 (Mardia = 46.23)
CFI = 0.910, NNFI = 0.894, RMSEA = 0.054

Figure 5.1 Measurement model

Table 5.14 Item loadings for measurement model

Factor/Item	Loading
Communication	
COM1	0.60
COM2	0.48
COM3R	0.59
COM4	0.68
Management Support	
MS1	0.70
MS2	0.50
MS4	0.67
MS5	0.82
MS6	0.64
Uncertainty	
UNC1	0.69
UNC2	0.80
UNC3	0.71
UNC4	0.93
Integrative Employee Assessment	
IEA3	0.54
IEA4	0.75
IEA5	0.59
Integrative Information Technology	
IIT1	0.54
IIT2	0.44
IIT4	0.66
IIT5	0.68
Cross-Functional Teams	
CF2	0.87
CF3	0.61
CF5	0.84
Centralization	
CEN1	0.68
CEN2R	0.69
Note: All loadings are statistically significant at $p<0.01$.	

Initially, the measurement model as did not converge to an admissible solution. The output indicated that there was a problem with the variable CEN4. An offline analysis of the Centralization factor revealed that CEN4 did not have good correlation with the other two Centralization variables. Hence, CEN4 was eliminated. The resulting model, which did converge to an admissible solution, is shown in Figure 5.1. This model did not meet the guidelines set forth in Table 5.13 because the NNFI is lower than 0.90. Additionally, the Modification Indices suggest that there are (i) covariances between two pairs of items and (ii) three items with poor factor loadings. Model modification proceeded stepwise, evaluating the result of each individual change. The modifications are summarized in Table 5.15, and the model is shown in Figure 5.2, with item loadings in Table 5.16..

Table 5.15 Summary of modifications to measurement model

Change	Reason	Chi-Sq	df	Bollen-Stine p	CFI	TLI	RMSEA	Mardia
START	n/a	344.4	255	0.219	0.910	0.894	0.054	46.23
Delete IIT2	Covariance with IIT1 (MI=15.54)	305.3	232	0.247	0.924	0.909	0.052	43.06
Delete COM2	Covariance with COM3 (MI=13.26)	257.3	210	0.352	0.948	0.938	0.043	38.25
Delete IIT1	Poor factor loading (0.44)	223.7	190	0.473	0.962	0.954	0.039	42.47
Delete MS2	Poor factor loading (0.45)	204.2	170	0.404	0.960	0.951	0.041	39.66

Delete IEA3	Poor factor loading (0.50)	183.7	152	0.382	0.962	0.952	0.042	36.67

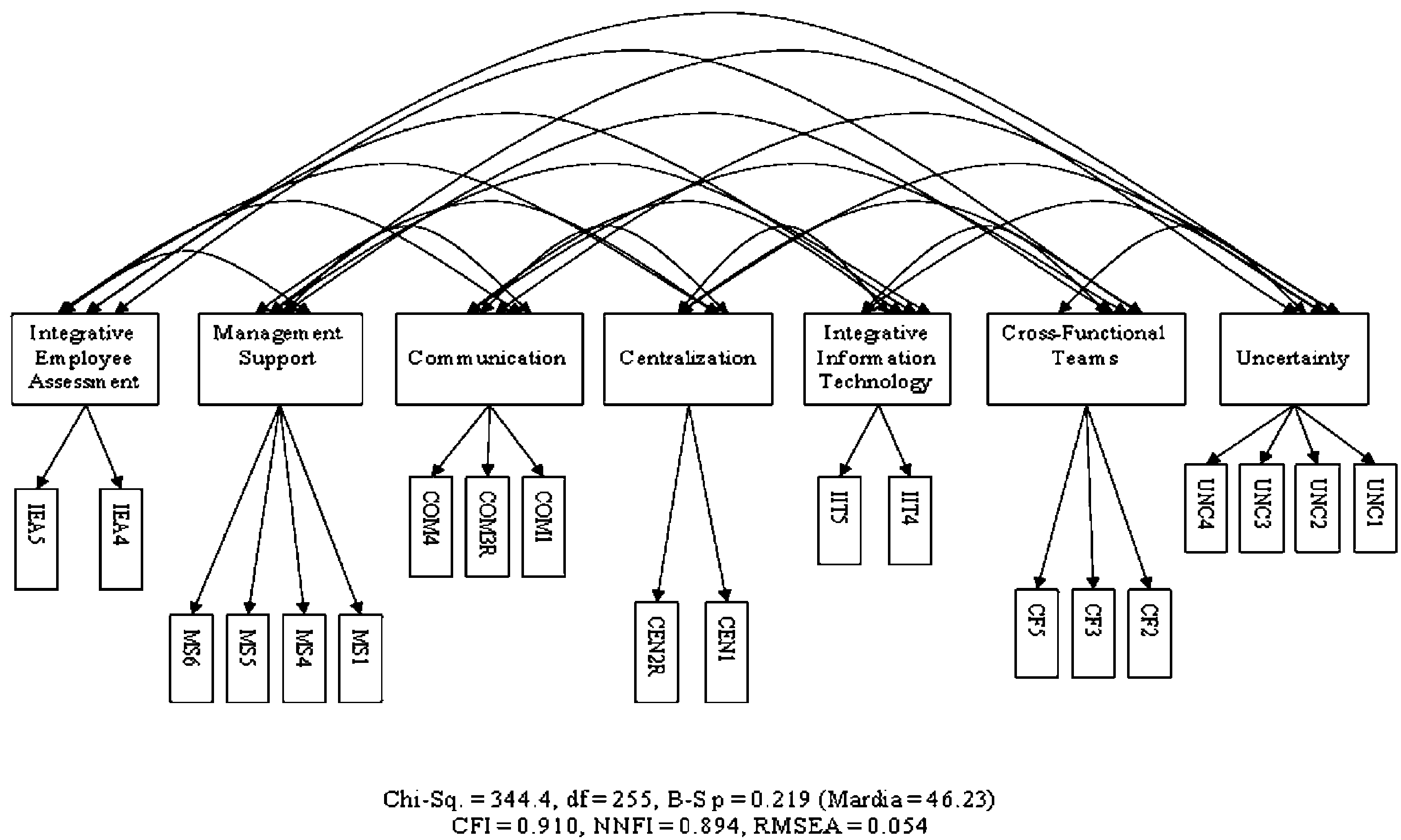


Figure 5.2 Measurement model after modifications

Table 5.16 Item loadings for measurement model after modifications

Factor/Item	Loading
Communication	
COM1	0.60
COM3R	0.64
COM4	0.71
Management Support	
MS1	0.69
MS4	0.66
MS5	0.83
MS6	0.65
Uncertainty	
UNC1	0.68
UNC2	0.80
UNC3	0.71
UNC4	0.93
Integrative Employee Assessment	
IEA4	0.60
IEA5	0.65
Integrative Information Technology	
IIT4	0.69
IIT5	0.72
Cross-Functional Teams	
CF2	0.87
CF3	0.61
CF5	0.84
Centralization	
CEN1	0.67
CEN2R	0.70
Note: All loadings are statistically significant at $p<0.01$.	

The same analysis was conducted for the outcome variables, Strategic Consensus and Collaboration, as suggested by Shah and Ward 2007 and Roth and Menor 2007. The first iteration with all of the retained items did not fit the data well (Chi-Sq. = 51.11, df = 19, Bollen-Stine p = 0.019, CFI = 0.864, NNFI = 0.799, RMSEA = 0.119). The MI's suggested a covariance between the error terms of items SC3 and COL4 (MI = 18.861).

As the latent factors are already allowed to covary freely during CFA, this error covariance is problematic. Item SC3 was dropped from the analysis.

The second iteration fits the data well, with all fit indices within the recommended values (Chi-Sq. = 15.014, df = 13, Bollen-Stine p = 0.602, CFI = 0.988, NNFI = 0.981, RMSEA = 0.036). All items have significant loadings. However, COL1 had a low loading (0.54) and was removed. The resulting model is shown in Figure 5.3.

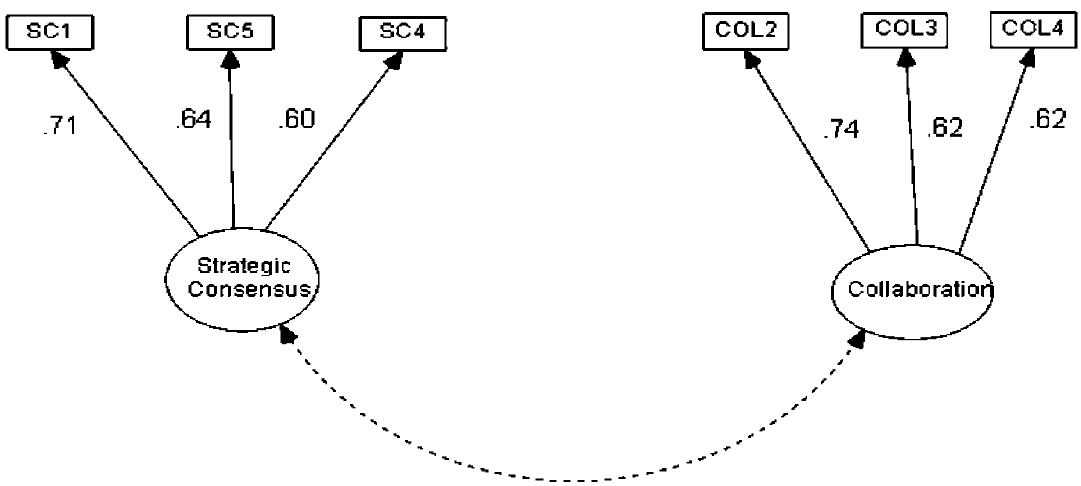


Figure 5.3 Measurement model for the outcome variables (Chi-Sq = 8.09, df = 8, B-S p = 0.652 (Mardia = 15.324), CFI = 0.999, NNFI = 0.999, RMSEA = 0.010). The double-headed arrow represents a freely-estimated covariance between the factors.

As a final test, all the factors and retained items were included in a measurement model. The model has acceptable fit, with Chi-Sq = 335.51, df = 267, B-S p = 0.316 (Mardia = 54.911), CFI = 0.940, NNFI = 0.926, and RMSEA = 0.046. Item loadings were all significantly larger than their standard errors ($p < 0.01$), and modification indices were all below 10 (Shah and Ward 2007). The item loadings are found in Table 5.17.

Table 5.17 Item loadings for full measurement model

Factor/Item	Loading
Communication	
COM1	0.63
COM3R	0.60
COM4	0.69
Management Support	
MS1	0.70
MS4	0.68
MS5	0.81
MS6	0.66
Uncertainty	
UNC1	0.68
UNC2	0.80
UNC3	0.71
UNC4	0.93
Integrative Employee Assessment	
IEA4	0.61
IEA5	0.65
Integrative Information Technology	
IIT4	0.69
IIT5	0.73
Cross-Functional Teams	
CF2	0.91
CF3	0.63
CF5	0.84
Centralization	
CEN1	0.67
CEN2R	0.70
Collaboration	
COL2	0.68
COL3	0.59
COL4	0.73
Strategic Consensus	
SC1	0.64
SC4	0.61
SC5	0.69
Note: All loadings are statistically significant at $p<0.01$.	

5.8 Scale reliability

The reliability of the scale items was analyzed by assessing the internal consistency of each multi-item scale. Results are summarized in Table 5.18.

Table 5.18 Assessment of scale reliability

	Loading (ML)	AVE	CR
Centralization		0.469	0.639
CEN1	0.67		
CEN2R	0.70		
CEN4 (removed)			
Collaboration		0.439	0.699
COL1 (removed)			
COL2	0.74		
COL3	0.62		
COL4	0.62		
Communication		0.423	0.688
COM1	0.60		
COM3R	0.64		
COM4	0.71		
Cross Functional Teams		0.611	0.822
CF2	0.87		
CF3	0.61		
CF5	0.84		
Integrative Employee Assessment		0.391	0.562
IEA3 (removed)			
IEA4	0.60		
IEA5	0.65		
Integrative Information Technology		0.491	0.730
IIT1(removed)			
IIT2 (removed)			
IIT4	0.72		
IIT5	0.69		

Table 5.18 Assessment of scale reliability

	Loading (ML)	AVE	CR
Management support		0.506	0.802
MS1	0.69		
MS2 (removed)			
MS4	0.66		
MS5	0.83		
MS6	0.65		
Strategic consensus		0.425	0.688
SC1	0.71		
SC3(removed)			
SC4	0.60		
SC5	0.64		
Uncertainty		0.618	0.864
UNC1	0.68		
UNC2	0.80		
UNC3	0.71		
UNC4	0.93		

Although reliability is an important consideration with survey scales, striving for a high value of internal reliability may not be appropriate for all research. Little, Lindenberger, and Nesselroade (1999) conducted a simulation study that systematically varied four key dimensions of indicator selection to investigate their effects on the "fidelity of construct representations and the relative ability of exploratory and confirmatory analyses to recover within- and between-construct information" (page 192).

They concluded that confirmatory analyses yielded valid and unbiased estimates of the relations between constructs, even under conditions of very low internal consistency.

The scales used in this study include items adapted from their original application as well as items developed specifically for this study. The instances of low AVE and low CR are associated with the scales developed specifically for this study: Collaboration, Communication, Integrative Employee Assessment, and Strategic Consensus. Some factors, such as Collaboration, have been studied extensively, and so the low AVE and CR are disappointing. However, a sampling of scales used in other research suggests that perhaps one cause is that this study seeks to determine the causes of Collaboration, whereas other scales have assumed that these mechanisms are in place and seek to discover the relationships between collaboration and performance, or between internal and external collaboration. For example, Sanders (2007) uses the following three items to measure Intra-organizational collaboration:

1. Cross-functional collaboration in strategic planning (loading = 0.429)
2. Utilization of integrated database for information sharing (loading = 0.528)
3. Sharing of operations information among departments (loading = 0.531)

These three items in turn would correspond within the current research to the use of cross-functional teams, the implementation of integrative information technology, and the presence of open lines of communication for sharing information. Unfortunately, there is no established definition of Collaboration, and hence there are a variety of interpretations of the construct seen within Operations Management research. For example, Kim, Yamada and Kim (2008, p. 95) define Collaboration as “the extent to which an OEM engages in joint activities with the incumbent supplier, including demand and supply forecasting, end product design, and information exchange. Detert, Schroeder and Cudeck (2003) (cited in Roth, Schroeder, Huang, and Kristal (2008) as a source for a scale to measure Collaboration) do not provide a definition, instead listing "Collaboration is necessary for an effective school" as one of nine "values and beliefs" and measuring it using the following items:

a. There is ongoing collaborative work across subject areas in this school.
b. I frequently have conversations about my teaching practices with teachers from other subject areas/departments.
c. Work time is structured to provide me with opportunities to work with other teachers.

In summary, there is no single accepted definition nor a construct-specific (as opposed to context-specific), accepted scale. We note the limitations of the current scale and propose it as an avenue for further research.

Similarly, the Communication scale attempted to measure the elements involved in the establishment of communication pathways, per the theoretical lens of the Theory of Communicative Action. The Strategic Consensus scale measured both the knowledge of and application of competitive strategy. In the pilot study, most of these scales met the Garver and Mentzer (1999) guidelines. Other scales developed using similar analyses, such as those developed by Shah and Ward (2007), have suffered from comparable issues when the initial survey is expanded into a larger population. Scale development is an iterative process in which scales improve with each replication. Further development of the scales used in this research is recommended.

The Integrative Employee Assessment scale is of particular concern, with an AVE of 0.39 and Composite Reliability of 0.562. This scale was developed specifically for this study, hence there is no prior data for comparison. Future studies should develop this scale or replace it altogether.

5.9 Measurement Invariance

The survey sample contains individuals from three different functional areas within manufacturing firms: Operations, Purchasing, and Logistics. A large majority of the respondents (65 percent) were from the Operations function. Before any of the research hypotheses can be tested, it is important to determine whether respondents from different functions interpret the survey items in the same way. In the pilot study, firms with multiple respondents were used to assess inter-rater agreement by the ratio method (Boyer and Verma 2000). For the individual firms, the average ratio ranged from 0.923 to 0.980. While there is no established standard for this method, Boyer and Verma (2002) suggest that this value should be higher than 0.80. For the individual factors, the averages ranged from 0.875 to 0.976, also meeting the Boyer and Verma (2002) standard.

Rungtusanatham, Ng, Zhao, and Lee (2008) suggest that when research data is pooled from respondents who are transparently different, the measurement models should be tested for measurement invariance across the groups before pooling. Measurement invariance implies that the different groups of respondents interpret the items in the same way. There are seven dimensions of measurement invariance. The first, Configural

Invariance, measures the conceptual interpretation of the items. If a scale has configural invariance, the patterns of factor loadings will be identical across groups, with each item corresponding to the same factor and no others. This hypothesis is tested by fitting measurement models to each group and then comparing the two models. Because of the limited sample size, this analysis was done with subsets of factors. The results are summarized in Table 5.19 and suggest that the threshold for Configural Invariance is met for these factors. The Unconstrained models for all sets of factors show good fit, and the Modification Indices do not suggest cross-loadings within the groups.

Table 5.19 Model fit parameters for the test of Configural Invariance

Factors	Model Chi-Sq	df	p	CFI	NNFI
Uncertainty, Centralization Integrative Employee Assessment	45.734	70	0.656	0.976	0.96
Uncertainty, Centralization Management Support	79.966	84	0.604	0.987	0.97
Uncertainty, Collaboration	39.43	38	0.406	0.995	0.993
Uncertainty, Communication, Integrative Information Technology	107.2	83	0.242	0.936	0.915
Uncertainty, Management Support, Cross-Functional Teams	158.8	96	0.093	0.900	0.895
Uncertainty, Strategic Consensus	43.105	38	0.502	0.984	0.976

The second form of measurement invariance is Metric Invariance. Metric Invariance goes beyond Configural Invariance, imposing a constraint that the factor loadings for each item onto its respective factor should be equal across groups. Metric Invariance is tested by performing a multi-group analysis and constraining all factor loadings to be equal across groups, and examining the statistical significance of the difference in Chi-Sq between this model and the Unconstrained model fitted in the prior step. A nonsignificant Chi-Sq difference indicates support for Metric Invariance. The results are summarized in Table 5.20. The models with constrained factor loadings do not have significantly different Chi-Sq. values from the Unconstrained models, suggesting that these factors meet the threshold for Metric Invariance.

Table 5.20 Model fit parameters for the test of Metric Invariance

Factors	ΔChi-Sq	Δdf	p	CFI	NNFI
Uncertainty, Centralization, Integrative Employee Assessment	4.475	6	0.613	0.964	0.956
Uncertainty, Centralization, Management Support	4.436	8	0.816	0.978	0.979
Uncertainty, Collaboration	2.654	6	0.851	0.988	1
Uncertainty, Communication, Integrative Information Technology	4.475	6	0.613	0.94	0.903
Uncertainty, Management Support, Cross-Functional Teams	2.722	5	0.743	0.896	0.907
Uncertainty, Strategic Consensus	4.508	6	0.608	0.972	0.985

The third form of measurement invariance is Measurement Error Variance Invariance (MEVI). MEVI measures the extent to which the instrument is subject to the same set of unexplained factors between the groups. MEVI is tested by using the Measurement Weights model as the baseline and further constraining the measurement residuals to be equal across groups. The results are summarized in Table 5.21. The Measurement Residuals models do not have significantly different Chi-Sq. values from the Measurement Weights Models, suggesting that these factors meet the threshold for MEVI.

Table 5.21 Model fit parameters for the test of Measurement Error Variance Invariance

Factors	ΔChi-Sq	Δdf	p	CFI	NNFI
Uncertainty, Centralization, Integrative Employee Assessment	10.431	13	0.658	0.935	0.96
Uncertainty, Centralization, Management Support	17.056	16	0.382	0.945	0.973
Uncertainty, Collaboration	15.748	11	0.151	0.945	0.991
Uncertainty, Communication, Integrative Information Technology	10.431	13	0.658	0.911	0.907
Uncertainty, Management Support, Cross-Functional Teams	16.573	12	0.166	0.869	0.913
Uncertainty, Strategic Consensus	15.734	11	0.151	0.929	0.973

The fourth form of measurement invariance assessed is Factor Variance Invariance (FVI), which measures the extent to which the latent factors have the same variance across groups. FVI is assessed by comparing the model constraining the Measurement Weights to be equal across groups to a model additionally constraining the variance of the factors to be equal across groups. The results are summarized in Table 5.22. A significant difference was found for the factor variance in the Strategic Consensus factor. Hence a control variable will be used to account for the effect of respondent’s function on the Strategic Consensus factor, rather than pooling all responses.

Table 5.22 Model fit parameters for the test of Factor Variance Invariance

Factors	ΔChi-Sq	Δdf	p	CFI	NNFI
Uncertainty, Centralization, Integrative Employee Assessment	1.315	3	0.859	0.96	0.965
Uncertainty, Centralization, Management Support	3.091	3	0.686	0.972	0.983
Uncertainty, Collaboration	4.676	2	0.197	0.975	0.995
Uncertainty, Communication, Integrative Information Technology	1.315	3	0.859	0.936	0.912
Uncertainty, Management Support, Cross-Functional Teams	3.822	3	0.575	0.89	0.916
Uncertainty, Strategic Consensus	9.726	2	0.021	0.946	0.960

Three additional forms of measurement invariance are noted by Runtusanatham et al (2008): Factor Covariance Invariance, Scalar Invariance, and Latent Mean Invariance. The sample size is insufficient to address these forms of invariance with the full measurement model. The structural equation modeling program used for this research, AMOS, provides a calculated value of Hoelter's (1983) index, an assessment of the appropriateness of the sample size in estimating the model. Hoelter recommends a value of 200 to ensure that the test has sufficient statistical power to detect differences in the parameters of interest. When attempting to assess these forms of invariance, the value of Hoelter's index is very low, in the range of 40-60.

Although this analysis appears to support the presence of three forms of measurement invariance, specifically Configural, Metric, and Measurement Error Variance, it is important to note that the limited sample size imposes restrictions on the statistical power of the analysis (Ferguson and Ketchen 1999). Hence, the analysis should be considered tentative and requires replication with increased sample size.

5.10 Path Analysis

Path Analysis is a form of Structural Equation Modeling (SEM). SEM is a collection of statistical techniques used to examine the relationships between predictor (exogenous) variables and criterion (endogenous) variables. In addition to estimating path coefficients for relationships between observed variables, SEM allows for the estimation of causal paths between latent or unobserved variables, identified throughout this report as factors. In contrast to stepwise multiple regression, SEM uses an iterative process of matrix manipulation to simultaneously estimate all of the relationships implied by the research model. Hence SEM provides information on both the statistical significance of individual parameters and the overall fit of the observed data to the proposed model. AMOS 16.0.1 (2007) was used to test the research model.

5.11 Factor Scores

The survey instrument was developed to represent measures of latent constructs which cannot be directly observed. The research model hypothesizes relationships between these constructs, and further hypothesizes that the pattern of significant relationships will vary depending on the perceived level of Uncertainty faced by the facility. The scales used to measure these constructs are valuable but they are not perfect representations of the constructs. Moreover, the moderate size of the sample precludes analysis of a full structural equation model. However, the validated scales can be used to calculate factor scores using the factor loadings. The method of extraction was Principal Axis Factoring (PAF) using SPSS. Path analysis assumes that the observed variables are measured without error. The PAF algorithm parcels out each observed variable's uniqueness (random and measurement-specific error) from the factor loadings, so the factor scores represent the proportion of the variance in the items that is directly related to the factor. These scores will be used as observed variables in a path analysis model. Following the recommendation of McDonald and Burr (1967), the Bartlett method of calculating factor scores was used within SPSS. This method is selected as it provides factor scores that are more likely to have:

> " …. high correlations with the corresponding true factor scores, zero correlation with non-corresponding true factor scores, and are conditionally unbiased estimators of the true factor scores …. " (McDonald and Burr 1967)

The Bartlett method uses least squares procedures to minimize the sum of squares of the unique factors over the range of variables. This method leads to high correlations between factor scores and the latent factors and ensures unbiased estimates (Marsh 2001). This method also results in mean-centered variables, which is useful when investigating moderating effects.

The analysis of scale reliability revealed that the Integrative Employee Assessment factor does not have adequate reliability. Instead of calculating a factor score for this scale, the item which was considered the closest to capturing the central theme of this construct was selected to represent the construct. This item is IEA4, which reads as follows: "Employees are rewarded for their contributions to the overall performance of the plant." This was determined to be a more general statement than item IEA5, which referred to an individual's contribution to the overall performance of the plant. Table 5.23 summarizes the variables used for the path analysis.

Table 5.23 Descriptive Statistics for Path Analysis Variables

	Minimum	Maximum	Std. Dev.	Skew	S. E.	Kurtosis	S. E.
Centralization	-2.94	2.62	1.25	-.186	.221	-1.026	.438
Communication	-3.01	2.45	1.18	-.429	.221	.205	.438
Cross Functional Teams	-2.33	2.02	1.07	-.078	.221	-.037	.438
Integrative Employee Assessment	-3.44	2.26	1.17	-.418	.221	.400	.438
Integrative Information Technology	-3.16	1.94	1.15	-.591	.221	.125	.438
Management Support	-4.31	1.99	1.10	-.515	.221	1.963	.438
Collaboration	-3.31	2.57	1.19	.196	.221	.545	.438
Strategic Consensus	-3.41	2.21	1.17	-.075	.221	.191	.438
Uncertainty	-2.43	1.67	1.05	-.421	.221	-.798	.438

The goal of this research is to examine a model of factors that contribute to Collaboration and Strategic Consensus, using Organizational Information Processing Theory (OIPT) as a theoretical lens. OIPT posits that organizations deploy different coordination mechanisms in response to the level of uncertainty in their operating environment. In this study Uncertainty was operationalized as a combination of the predictability of production volumes and product mix, and modeled as a moderator of the relationships between the factors. Marsh, Wen and Hau (2004b), examined four strategies for modeling interactions within structural equation models and suggest that an unconstrained approach, modeling product terms to represent the interaction, is the best technique in terms of ease of use, reliability of results, and relative robustness with regard to deviations from multivariate normality. However, their simulation study also found that sample sizes of 200 or more were better suited for such analysis. Due to the limitations in sample size and the aforementioned situation of multivariate non-normality, the moderation effect will be tested by a multi-group comparison. The sample was split at the median (0.316) for the Uncertainty factor scores, and the model will be tested separately for the low and high groups (Bagozzi and Yi, 1989; Rigdon, Schumacker, & Wothke, 1998). This method is an extension of the multiple regression approach, based on separate groups with observed variables (Hancock and Mueller, 2006). Each group consisted of 60 cases.

Multi-group analysis as a test of moderation has two major limitations. The first is the information loss due to the dichotomization of a latent variable, in this case, the Uncertainty factor. The second is that while the *presence* of a moderation effect can be tested, this method does not allow for determination of the *magnitude* of this effect. These limitations are noted as a future avenue of research.

5.12 Control Variables

5.12.1 Plant Size

Plant size, measured as the number of employees, has been implemented as a control variable for this study. As the number of people within a facility increases, the task of coordination becomes more complex. Hence the effect of size could mask the effect of Uncertainty on the relationships between the factors. Although firm size has also been measured in terms of product sales, this value is not used as the total sales do not necessarily reflect the complexity of the coordination task. The results indicate that Plant Size has a significant effect on three of the predictor variables: Centralization, Communication, and Cross-functional Teams.

5.12.2 Respondent Function

Respondent Function was used as a control variable to confirm that the prior results indicating measurement invariance had not been due to insufficient power to detect a significant effect within the measurement model. Function was utilized as a control variable, first with a hypothesized effect on the predictor variables. These paths were not statistically significant. As the prior analysis had suggested that the Strategic Consensus factor might be influenced by the respondent's function, the control variable was then hypothesized to have an effect on the criterion variables (Collaboration and Strategic Consensus). However, these paths are also not significant.

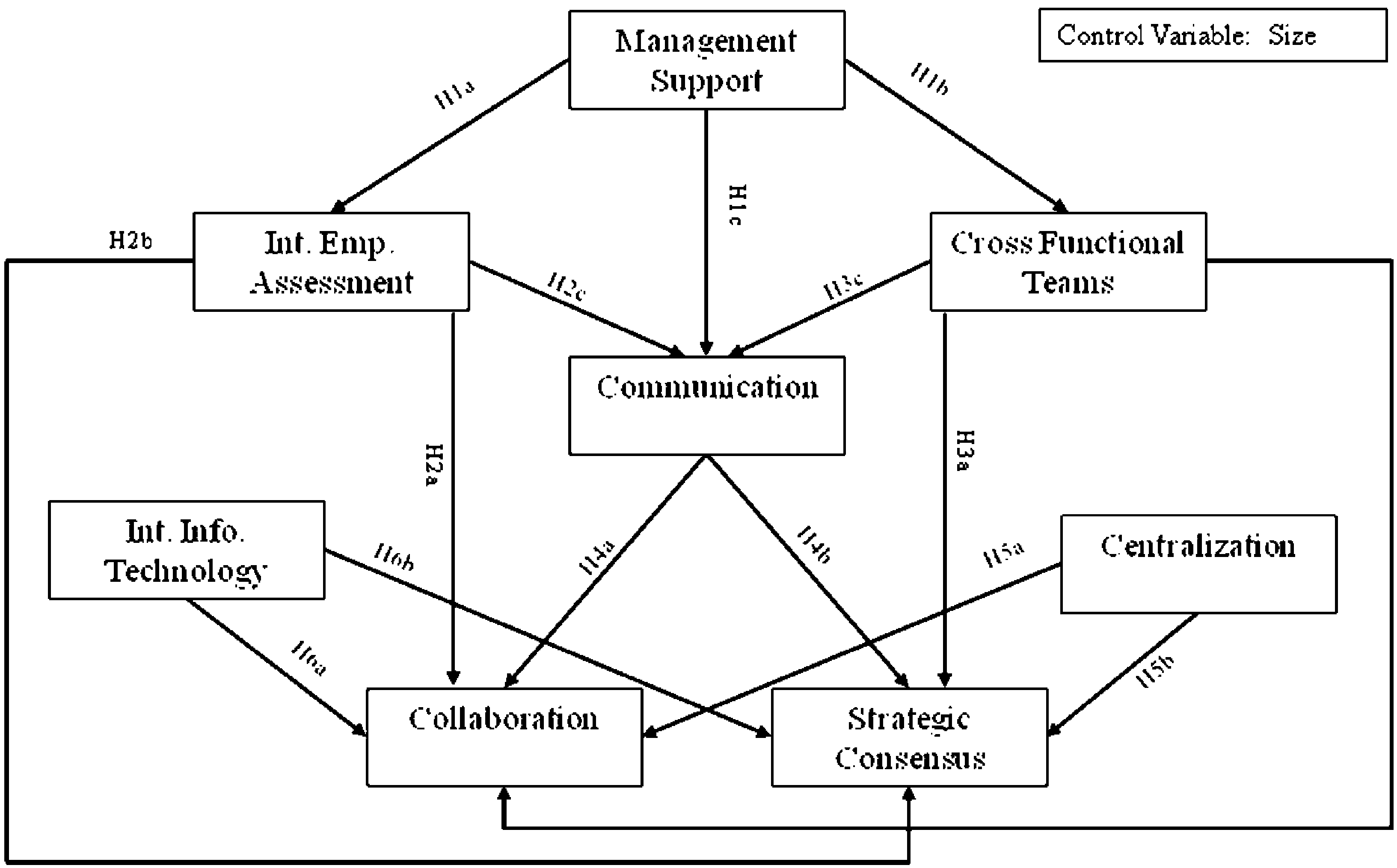


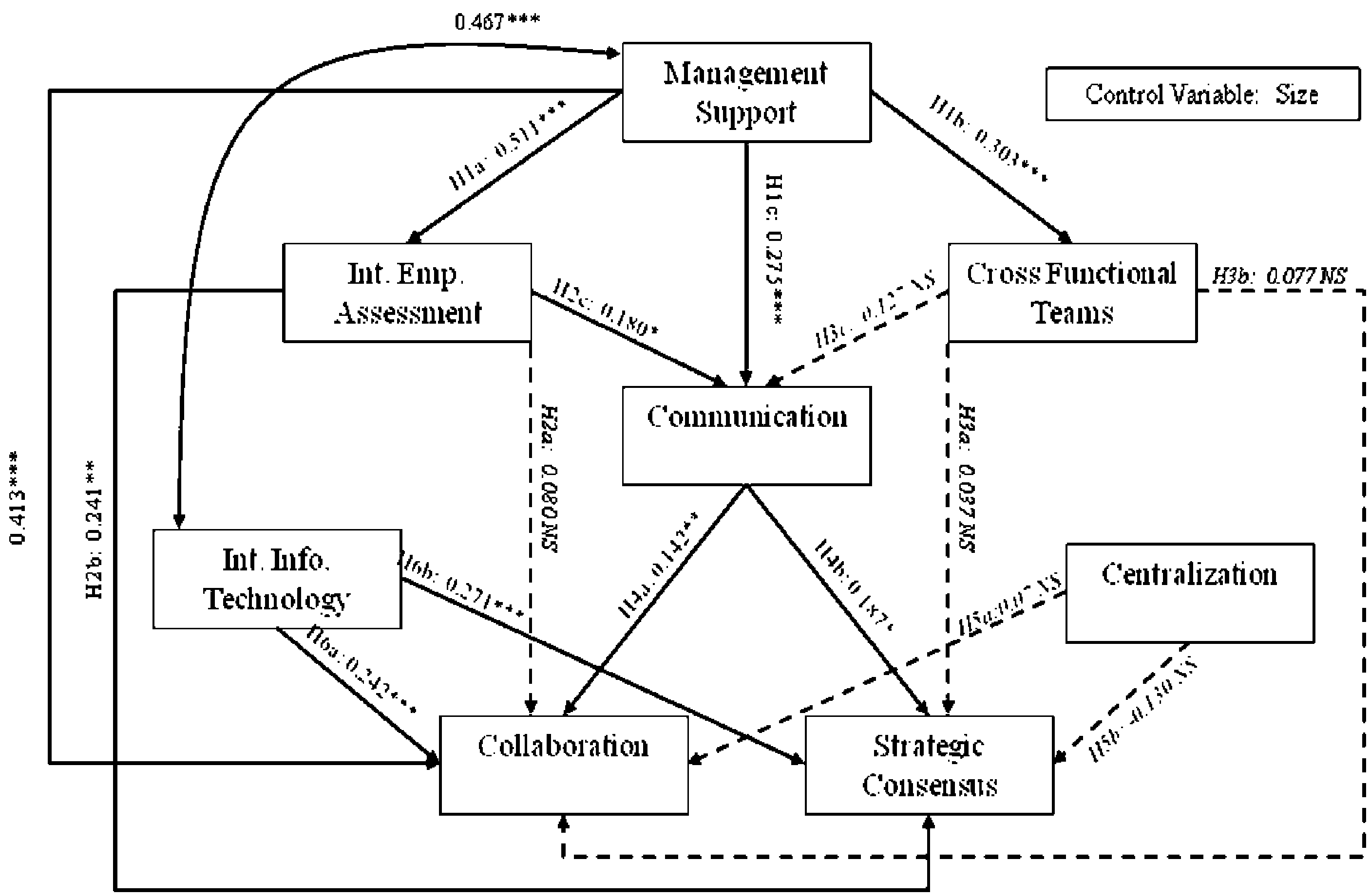
Figure 5.4 Research model

5.13 Analysis of the Path Model

The research model of interest is pictured in Figure 5.4. However, this model does not fit the data (Chi-Sq. = 77.03, df = 16, B-S p = 0.001, Mardia = 13.94, CFI = 0.747, NNFI = 0.430, RMSEA = 0.179). The modification indices suggest a covariance between Management Support and Integrative Information Technology (MI = 25.975). This model modification can be supported theoretically. Although no assumptions were made regarding the ability of the Plant Manager to influence choices in technology, for firms with only one facility, it would make sense that the support of the Plant Manager is required in order to ensure the appropriate resources are allocated, indicating that a direct effect might be present. For those respondents from a facility that is part of a larger corporation, however, this is a tenuous rationale. Large investments in information technology, such as those required to implement ERP or other integrative systems, are often beyond the scope of control of the Plant Manager. As the true nature of this effect is not known, it is added as a covariance between exogenous variables. This covariance represents unanalyzed common causes for these two factors. The model shows marked improvement, with a Chi-Sq. difference of 30.276, which is significant at $p < 0.001$.

However, the fit indices still indicate significant mis-fit (CFI = 0.864, NNFI = 0.674, RMSEA = 0.133). The MI's suggest that there is a significant direct effect of Management Support on Collaboration . It is possible that this effect might be present due to Common Method Variance, therefore an analysis was conducted to determine that this was not the case. While it had been hypothesized that the effect of Management Support was fully mediated through a combination of the communication skills of the

Plant Manager and the human resource management policies that were supported and encouraged, it appears that the Plant Manager might play a direct role in fostering Collaboration within the facility. This additional direct effect, which has an MI of 12.22 is included in the model, now seen in Figure 5.5. This model fits the data well, with CFI = 0.958, NNFI = 0.902, and RMSEA = 0.07. The Chi-Sq. difference for this change was 21.173, significant at $p < 0.001$.



Chi-Sq. = 24.1, df = 14, Bollen-Stine p = 0.094, Mardia = 13.94 (cr = 5.4), CFI = 0.958, NNFI = 0.902, RMSEA = 0.07

Figure 5.5 Research Model after modifications (***: p<0.01, **: p<0.05, *: p<0.10)

174

Once the base research model was established, the sample was split and multi-group analysis performed. The goal of this analysis was to ascertain whether the perceived level of uncertainty in demand moderated the relationships in the research model, as would be suggested by the OIPT theoretical lens. The presence of an interaction is tested by selectively constraining the value of a single parameter to be equal in both groups. A significant Chi-Sq. difference test between the constrained and the unconstrained models determines that an interaction is present. As presented before, this multi-group procedure has two limitations: loss of information through dichotomization of a variable, and the inability to determine the magnitude of the moderating effect. This strategy is pursued in spite of these limitations due to the moderate sample size and the issues with non-normality of the predictors. The analysis was conducted using a bootstrapping procedure with 1000 samples drawn with replacement. The number of bootstrap samples was selected to ensure the stability of the parameter confidence intervals, standard errors, and p-values calculated from them (Efron and Tibshirani 1993, Mooney and Duval 1993). Table 5.24 summarizes the results of the tests for moderation.

Table 5.24 Model comparisons

Parameter	df	ΔChi-Sq.	P
Mgmt Support→Int.Emp.Assessment	1	2.439	0.118
Mgmt Support →Communication	1	0.069	0.793
Int.Emp.Assessment → Communication	1	0.104	0.747
Int. Info. Tech. →Strat. Consensus	1	0.108	0.743
Int. Info. Tech →Collaboration	**1**	**2.562**	**0.099***
Int.Emp.Assessment → Collaboration	1	0.036	0.849
Int.Emp.Assessment → Strat. Consensus	1	0.847	0.357
Communication → Collaboration	1	0.092	0.761
Communication → Strat. Consensus	1	0.27	0.603
Mgmt Support → Collaboration	**1**	**3.162**	**0.075***

Note: * = significant at alpha = 0.10

This analysis is still susceptible to issues of statistical power. One way to increase the power of the analysis is to use a higher level of alpha. According the Ferguson and Ketchen (1999), "relatively high significance levels (e.g., $\alpha = 0.10$) may be appropriate when theory about a phenomenon is not developed enough to permit a precise test". Although some of the individual relationships have been tested in prior studies, this research constitutes the first empirical test of a model based on Pagell's (2004), as viewed through the lens of Organizational Information Processing Theory. Using a critical p-value of 0.10, the results suggest that Uncertainty has a moderating effect on two parameters: the direct effect of Management Support on Collaboration and the direct effect of Integrative Information Technology on Collaboration. Hypothesis testing for these relationships must take this moderation effect into account.

5.14 Hypothesis Testing: Direct Effects

Five factors were hypothesized to have direct effects on both Collaboration and Strategic Consensus. These were Integrative Employee Assessment, Cross Functional Teams, Communication, Centralization, and Integrative Information Technology as identified in Figure 5.5.

5.14.1 Direct effects of Integrative Employee Assessment

The direct effects of Integrative Employee Assessment correspond to the expectation that employees tend to do those activities for which they know they will be rewarded. Uncertainty did not have a significant moderating effect for the effect of Integrative Employee Assessment on Collaboration or Strategic Consensus. The hypotheses associated with a direct effect of Integrative Employee Assessment are as follows:

1. Hypothesis 2a: Integrative Employee Assessment has a direct positive effect on Collaboration.
2. Hypothesis 2b: Integrative Employee Assessment has a direct positive effect on Strategic Consensus.
3. Hypothesis 2c: Integrative Employee Assessment has a direct positive effect on Communication

As shown in Table 5.25, the hypothesis of a direct positive effect of Integrative Employee Assessment on Collaboration (Hypothesis 2a) is not supported. However, the hypotheses of a direct positive effect of Integrative Employee Assessment on Strategic Consensus (Hypothesis 2b) and Communication (Hypotheses 2c) are supported.

Table 5.25 Magnitude and significance of the direct effects of Integrative Employee Assessment on Collaboration, Strategic Consensus, and Communication

Direct Effect of Integrative Employee Assessment on:	Standardized Estimate:	Significance	Unstandardized Estimate:	Significance
Collaboration	0.080	0.368 *NS*	0.142	0.368 *NS*
Strategic Consensus	0.241	0.030**	0.425	0.035**
Communication	0.180	0.078*	0.343	0.068*
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant				

5.14.2 Direct effects of Cross Functional Teams

Cross Functional Teams was hypothesized to have direct positive effects on both Collaboration and Strategic Consensus. These direct effects correspond to the expectation that employees who work in cross functional teams will tend to expend effort (Collaboration) and have knowledge of the team's goals (Strategic Consensus). A significant interaction effect was not found for the effect of Integrative Employee Assessment on Collaboration or Strategic Consensus. The hypotheses associated with a direct effect of Cross Functional Teams are as follows:

1. Hypothesis 3a: Cross Functional Teams has a direct positive effect on Collaboration.
2. Hypothesis 3b: Cross Functional Teams has a direct positive effect on Strategic Consensus.

Table 5.26 Magnitude and significance of the direct effects of Cross Functional Teams on Collaboration and Strategic Consensus

Direct Effect of Cross Functional Teams on:	Standardized Estimate:	Significance	Unstandardized Estimate:	Significance
Collaboration	0.077	0.368 *NS*	0.086	0.241 *NS*
Strategic Consensus	0.037	0.746 *NS*	0.041	0.305 *NS*
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant				

As summarized in Table 5.26, the hypotheses of direct effects of Cross Functional Teams on Collaboration (Hypothesis 3a) and Strategic Consensus (Hypothesis 3b) are not supported.

5.14.3 Direct effects of Communication

Communication was hypothesized to have direct effects on both Collaboration and Strategic Consensus. These effects correspond to the proposition that Communication facilitates both Collaboration and Strategic Consensus. A significant interaction effect was not found for the effect of Communication on Collaboration or Strategic Consensus. The hypotheses associated with the direct effects of Communication are as follows:

1. Hypothesis 4a: Communication has a direct positive effect on Collaboration.
2. Hypothesis 4b: Communication has a direct positive effect on Strategic Consensus.

As summarized in Table 5.27, the hypotheses of direct effects of Communication on Collaboration (Hypothesis 4a) and Strategic Consensus (Hypothesis 4b) are supported.

Table 5.27 Magnitude and significance of the direct effects of Communication on Collaboration and Strategic Consensus

Direct Effect of Communication on:	Standardized Estimate:	Significance	Unstandardized Estimate:	Significance
Collaboration	0.138	0.044**	0.142	0.047**
Strategic Consensus	0.180	0.075*	0.186	0.077*
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant				

5.14.4 Direct effects of Centralization

Centralization was hypothesized to have direct negative effects on Collaboration and Strategic Consensus. Centralization is defined in terms of the locus of authority for decision-making in the Purchasing and Outbound Shipping/Logistics role. Higher levels of Centralization indicate an organization where the Plant Manager has limited or no authority over the employees performing the individual manufacturing plant (i.e—there is centralized Purchasing and/or Outbound Logistics). The direct effect corresponds to the expectation that if the Plant Manager has limited authority, then the employees performing these functions would be less inclined to expend effort (Collaboration) towards the goals of the plant, which may or may not match their own goals (Strategic Consensus). A significant interaction effect was not found for the effect of Centralization on Collaboration or Strategic Consensus. The hypotheses associated with these effects are as follows:

1. Hypothesis 5a: Centralization has a direct negative effect on Collaboration.
2. Hypothesis 5b: Centralization has a direct negative effect on Strategic Consensus.

As summarized in Table 5.28, the hypotheses of direct effects of Centralization on Collaboration and Strategic Consensus are not supported.

Table 5.28 Magnitude and significance of the direct effects of Centralization on Collaboration and Strategic Consensus

Direct Effect of Centralization on:	Standardized Estimate:	Significance	Unstandardized Estimate:	Significance
Collaboration	0.037	0.214 *NS*	0.067	0.241 *NS*
Strategic Consensus	-0.130	0.176*NS*	-0.123	0.183 *NS*
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant				

5.14.5 Direct effects of Integrative Information Technology

Integrative Information Technology was hypothesized to have direct effects on Collaboration and Strategic Consensus. The direct effect corresponds to the proposition that the availability of Integrative Information Technology facilitates Collaboration and Strategic Consensus. A significant interaction effect was found for the effect of Integrative Information Technology on Collaboration, hence the results are presented for each group. There was no significant interaction for the effect of Integrative Information Technology on Strategic Consensus. The hypotheses associated with these effects are as follows:

1. Hypothesis 6a: Integrative Information Technology has a direct positive effect on Collaboration.
2. Hypothesis 6b: Integrative Information Technology has a direct positive effect on Strategic Consensus.

Table 5.29 Magnitude and significance of the direct effects of Integrative Information Technology Factor on Collaboration and Strategic Consensus.

Direct Effect of Integrative Information Technology on:	Standardized Estimate:	Significance	Unstandardized Estimate:	Significance
Collaboration: HIGH Uncertainty	0.320	0.014**	0.310	0.014**
Collaboration: LOW Uncertainty	0.104	0.300 *NS*	0.103	0.321 *NS*
Strategic Consensus	0.323	0.023**	0.309	0.083*
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant				

As summarized in Table 5.29, the hypotheses of direct effect of Integrative Information Technology on Strategic Consensus is supported for both groups. However, the direct effect of Integrative Information Technology is supported only for the group of firms that report HIGH levels of Uncertainty.

5.14.6 Direct Effects of Management Support

Management Support was hypothesized to have indirect effects on the outcome variables, Collaboration and Strategic Consensus. In order to establish mediation, a significant relationship must exist between the initial variable and the mediator variable. The effect of Management Support was hypothesized to be mediated by Integrative Employee Assessment, Cross Functional Teams, and Communication. The direct effects between Management Support and these three potentially mediating factors are summarized in Table 5.30.

Table 5.30 Direct effects of Management Support on potential mediator factors

Direct Effect of Management Support on:	Standardized Estimate	Significance
Integrative Employee Assessment	0.320	0.003***
Cross Functional Teams	0.310	0.034**
Communication	0.323	0.065*
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant		

5.15 Hypothesis Testing: Indirect Effects

According to Kenny (2008), in order for mediation to exist, two conditions must be met: (i) the initial variable must have an effect on the mediator variable and (ii) the mediator must have an effect on the outcome variable. Establishing the significance of these direct effects is necessary before assessment of indirect effects can occur. Mediated (indirect) effects are hypothesized within the model for Management Support, Integrative Employee Assessment, and Cross Functional Teams. In the prior section, significant direct effects were established between the following factors:

1. Management Support and Integrative Employee Assessment
2. Management Support and Cross Functional Teams
3. Management Support and Communication
4. Integrative Employee Assessment and Strategic Consensus
5. Integrative Employee Assessment and Communication
6. Communication and Collaboration
7. Communication and Strategic Consensus

5.15.1 The indirect effects of Management Support

Management Support was hypothesized to affect Collaboration and Strategic Consensus through the actions that the Plant Manager undertook in fulfilling the three functions of the executive: setting goals, eliciting effort from employees, and serving as a communication hub. The original hypotheses proposed that the effects of Management Support on Collaboration and Strategic Consensus were fully mediated by Integrative Employee Assessment, Cross Functional Teams, and Communication. The hypotheses were stated as follows:

1. Hypothesis 1a: Management Support has a positive indirect effect on Collaboration, mediated by Integrative Employee Assessment.
2. Hypothesis 1a': Management Support has a positive indirect effect on Strategic Consensus, mediated by Integrative Employee Assessment.
3. Hypothesis 1b: Management Support has a positive indirect effect on Collaboration, mediated by Cross Functional Teams.
4. Hypothesis 1b': Management Support has a positive indirect effect on Strategic Consensus, mediated by Cross Functional Teams.
5. Hypothesis 1c: Management Support has a positive indirect effect on Collaboration, mediated by Communication.
6. Hypothesis 1c': Management Support has a positive indirect effect on Strategic Consensus, mediated by Communication.

Prior analysis indicated a significant interaction for the effect of Management Support on Collaboration, hence results are presented for each group in Table 5.31. For firms in the HIGH Uncertainty group, the indirect effect of Management Support on Collaboration is supported. In the LOW Uncertainty group, this indirect effect is not supported. For firms in both groups, the indirect effect of Management Support on Strategic Consensus is supported.

Table 5.31 Magnitude and significance of the indirect effects of the Management Support factor on Collaboration and Strategic Consensus.

Effect of Management Support on:	Standardized Estimate	Significance	Unstandardized Estimate	Significance
Collaboration: HIGH Uncertainty	0.107	0.098*	0.100	0.084*
Collaboration: LOW Uncertainty	0.101	0.253^{NS}	0.138	0.234^{NS}
Strategic Consensus	0.204	0.001***	0.221	0.001***
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant				

The results in Table 5.31 do not specify which mediated (indirect) path(s) are significant, reporting instead a composite which includes all of the hypothesized paths. Using the results summarized in Section 5.14.1, we determine that Hypotheses 1b and 1b' are not supported, as the direct effects of Cross Functional Teams on both Collaboration and Strategic Consensus are not significant. Although the direct effect of Integrative Employee Assessment on Collaboration is also not significant, a mediation path still exists from Management Support to Collaboration, through Integrative Employee Assessment and Communication.

5.15.2 The indirect effects of Integrative Employee Assessment

The indirect effects of Integrative Employee Assessment on Collaboration and Strategic Consensus correspond to the proposition that employees who are interested in the overall performance of the plant would tend to cultivate communication with employees outside their department, in order to help ensure that their rewards will occur. Uncertainty did not have a significant moderating effect for the effect of Integrative Employee Assessment on Collaboration or Strategic Consensus.

Table 5.32 Magnitude and significance of the indirect effects of Integrative Employee Assessment on Collaboration and Strategic Consensus

Indirect Effect of Integrative Employee Assessment on:	Standardized Estimate	Significance	Unstandardized Estimate	Significance
Collaboration	0.025	0.072*	0.044	0.067*
Strategic Consensus	0.032	0.103 ^{NS}	0.057	0.110 ^{NS}
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant				

As shown in Table 5.32, the hypothesis of an indirect effect of Integrative Employee Assessment on Collaboration, mediated by Communication, is supported. The hypothesis of an indirect effect of Integrative Employee Assessment on Strategic Consensus, mediated by Communication, is not supported.

5.15.3 The indirect effects of Cross Functional Teams

The indirect effect of Cross Functional Teams on Collaboration and Strategic Consensus corresponds to the proposition that employees who participate in cross functional teams would tend to cultivate communication with employees outside their department, in order to help ensure that the team is successful. A significant interaction effect was not found for the effect of Integrative Employee Assessment on Collaboration or Strategic Consensus. The hypotheses of indirect effects of Cross Functional Teams on Collaboration and Strategic Consensus, mediated by Communication, are not supported .

Table 5.33 Magnitude and significance of the indirect effects of Cross Functional Teams on Collaboration and Strategic Consensus

Effect	Standardized Estimate	Significance	Unstandardized Estimate	Significance
Collaboration	0.017	0.121 *NS*	0.019	0.109 *NS*
Strategic Consensus	0.023	0.106 *NS*	0.025	0.110 *NS*
Note: *** = p<0.01; ** = p < 0.05, * = p < 0.10, *NS* = not significant				

5.16 Significant effects not previously hypothesized

During evaluation of the research model, two additional effects were added: a direct effect of Management Support on Collaboration, and an unanalyzed covariance between Management Support and Integrative Information Technology. The covariance between Management Support and Integrative Information Technology was highly significant (p<0.001) and not moderated by uncertainty.

A direct effect of Management Support on Collaboration had not been hypothesized originally but is clearly supported by the data and its inclusion was justified in a prior section. This direct effect of Management Support is moderated by Uncertainty, and is statistically significant for both the LOW and the HIGH Uncertainty groups. While the true magnitude of the interaction cannot be determined through the multi-group comparison, the results suggest that Management Support has a stronger direct effect on Collaboration in firms with LOW Uncertainty (path coefficient = 0.751, p = 0.001) compared to those with HIGH Uncertainty (path coefficient = 0.374, p = 0.001).

5.17 Variance explained

One measure of the explanatory power of a research model is the proportion of variance in the dependent variable that is explained by the independent variables. With structural equation modeling, this proportion can be obtained from the Squared Multiple Correlation (SMC). The SMC results are summarized in Table 5.34. As the model was estimated using bootstrapping, the table reports the mean value, as well as the range of estimates. On average, the model explains approximately 52% of the variance in Collaboration and 27% of the variance in Strategic Consensus.

Table 5.34 Squared Multiple Correlations

Parameter	Average	Lower	Upper	P
Integrative Employee Assessment	.267	.131	.389	.006
Cross Functional Teams	.143	.068	.232	.003
Communication	.239	.117	.319	.035
Collaboration	.522	.344	.609	.019
Strategic Consensus	.271	.126	.344	.048

5.18 Assessment of Common Method Variance

The use of a cross-sectional survey with a single respondent raises the concern that any relationships between variables may be the result of common method variance. Common method variance (CMV) occurs when the correlations between constructs are inflated because the same respondent (i.e.- "method") has been used to measure both the predictor and criterion variables. The end result of CMV is that the significance of the causal paths may be an artifact of the measurement process rather than a true relationship between the variables. CMV has been a concern in behavioral research for some time (Podsakoff et al, 2003), although the magnitude of its impact is not fully understood. A number of authors have posited that the influence of CMV may be overstated (Crampton and Wagner 1994, Lindell and Whitney 2001, Spector, 2006).

Lindell and Whitney (2001) provide a method to test for CMV in cross-sectional research studies. Their method is based on determining a reasonable approximation of the magnitude of the CMV and then partialling out this effect from the correlations between the variables of interest. If the correlations between the predictors and the criterion variables remain significant after this estimate of CMV has been removed, then there is greater confidence in the research findings.

In the Lindell and Whitney (2001) procedure, the CMV is estimated via a two-step process. In the first step, the researcher attempts to incorporate the suggestions summarized by Podsakoff et al (1993) to minimize the severity of CMV. These include reverse scoring some items, randomizing the presence of scale items throughout the instrument, and using different response scales for the predictor and criterion variables. These recommendations were followed during survey development for this research study. Additionally, a researcher should incorporate a *marker variable* within the instrument. Marker variables are designed to estimate the CMV by being similar to the criterion but not associated theoretically to the predictors (Harrison et al, 1996), or conversely, by being similar in format to the predictors but not theoretically associated to the criterion (Lindell and Whitney 2001). This study did not include a marker variable. Lindell and Whitney (2001) also suggest that the CMV can be estimated by using the smallest correlation among the manifest variables, as proposed by Lindell and Brandt (2000). This smallest correlation can be between two predictors or between a predictor and the criterion. Lindell and Whitney (2001, p. 118) suggest that using the smallest correlation between a predictor and the criterion is a more conservative approach as it is less likely to capitalize on chance variations due to sampling. Table 5.35 provides a summary of the bivariate correlations for the predictors of Collaboration and Strategic Consensus. Table 5.36 summarizes the results of the assessment of Common Method Variance. All significant path coefficients remain significant ($t > 3$) after the minimum correlation has been parceled out. These results suggest that CMV is not a significant issue in this research study.

Table 5.35 Correlations between factors

	IEA	CEN	COL	COM	IIT	MS	SC
Int. Emp. Assessment	1						
Centralization	-.032	1					
Collaboration	.444**	-.023	1				
Communication	.337**	.033	.387**	1			
Int. Info. Tech.	.276**	-.189*	.492**	.133	1		
Mgmt. Support	.516**	-.080	.660**	.385**	.467**	1	
Strategic Consensus	.392**	-.188*	.472**	.303**	.392**	.364**	1
** = p < 0.01 level (2-tailed); * = p< 0.05 (2-tailed).							

Table 5.36 CMV Analysis using minimum inter-factor correlation

Collaboration	$r_{iY.M}$	t
Centralization-Collaboration (MIN)	0.000	0.000
Communication-Collaboration	0.373	4.343
Int. Emp. Assessment-Collaboration	0.431	5.165
Int. Info. Tech.-Collaboration	0.480	5.919
Mgt. Support-Collaboration	0.652	9.301
Min Corr.	-0.023	

Strategic Consensus	$r_{iY.M}$	t
Communication-Strategic Consensus	0	0
Int. Emp. Assessment-Strategic Consensus	0.287	3.236
Int. Info. Tech.-Strategic Consensus	0.378	4.412
Min. Corr.	0.378	4.412

CHAPTER SIX

CONCLUSIONS

This research resulted in several findings regarding the factors that influence Collaboration and Strategic Consensus, in the context of internal supply chain integration. The research model explained significant percentages of the variance in Collaboration and in Strategic Consensus. This provides support for the relationships tested within the model, and for the explanatory value of Pagell's (2004) model of internal supply chain integration as viewed through Organizational Information Processing Theory (OIPT). The research model is presented in Figure 6.1. The hypotheses tested within the research model are summarized in Table 6.1. Figure 6.2 incorporates these results into the research model, while Figure 6.3 highlights the significant relationships between the research factors. The following sections summarize the key findings on this research, describe the limitations, and propose avenues for future research in this area.

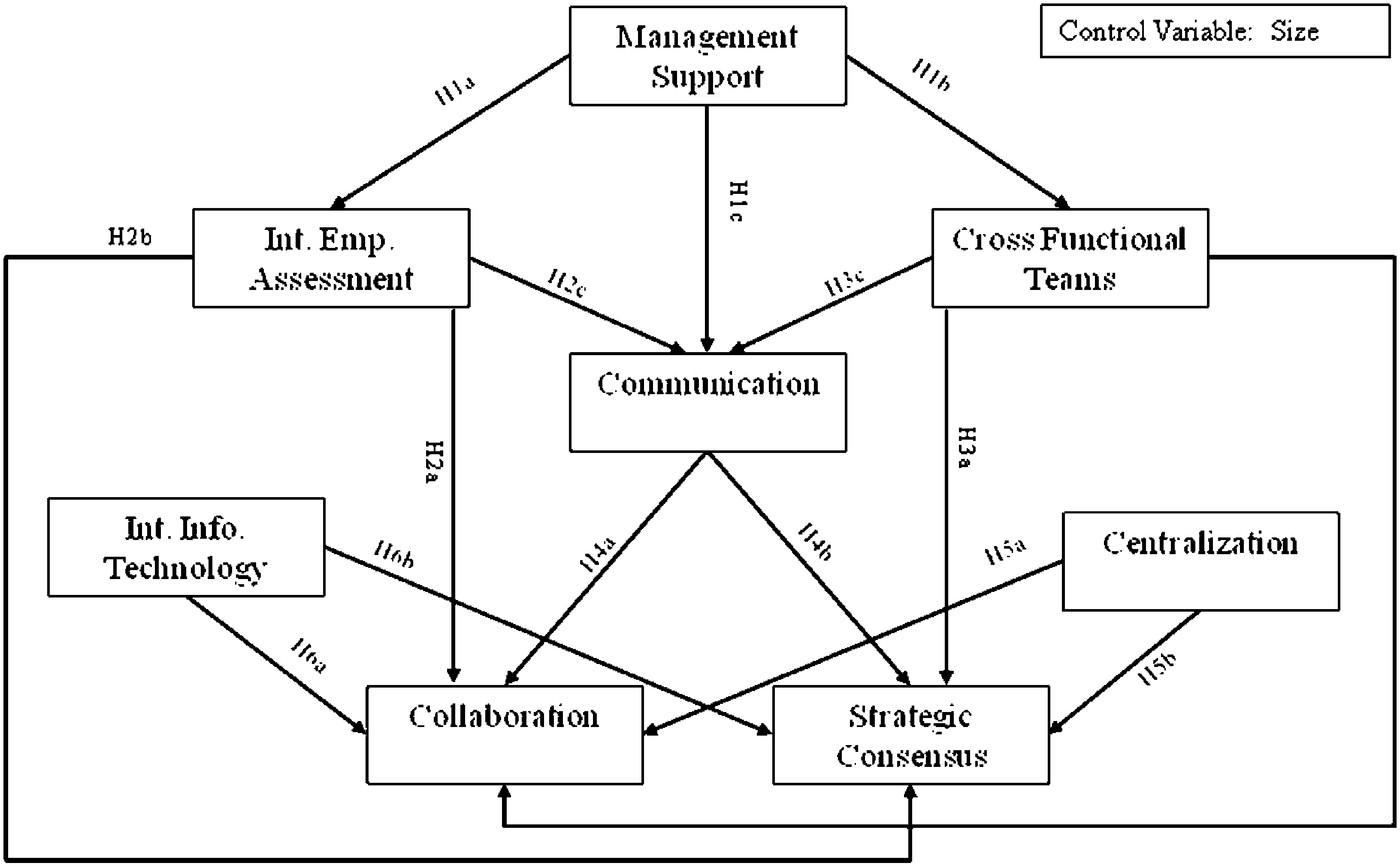
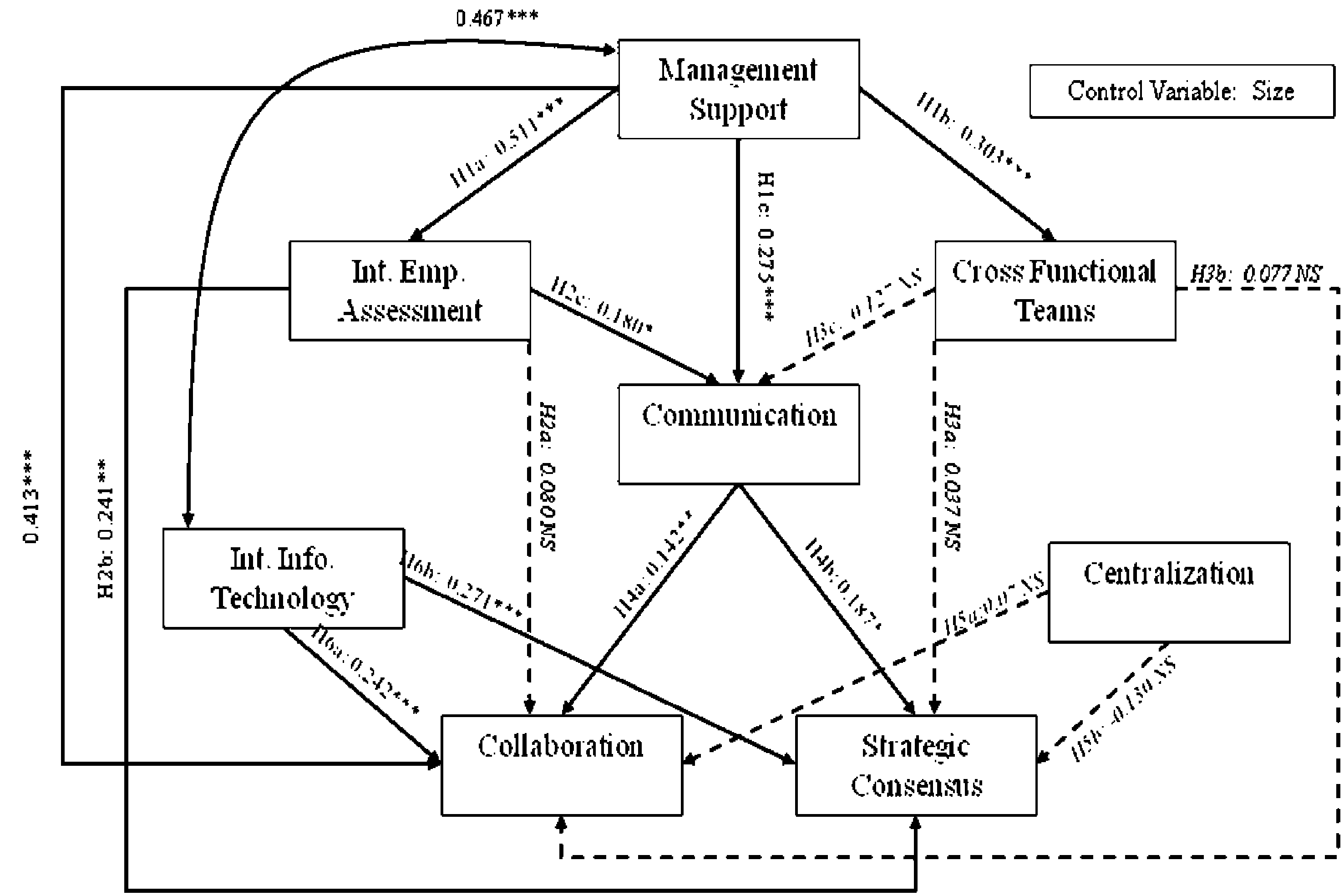


Figure 6.1 Research Model

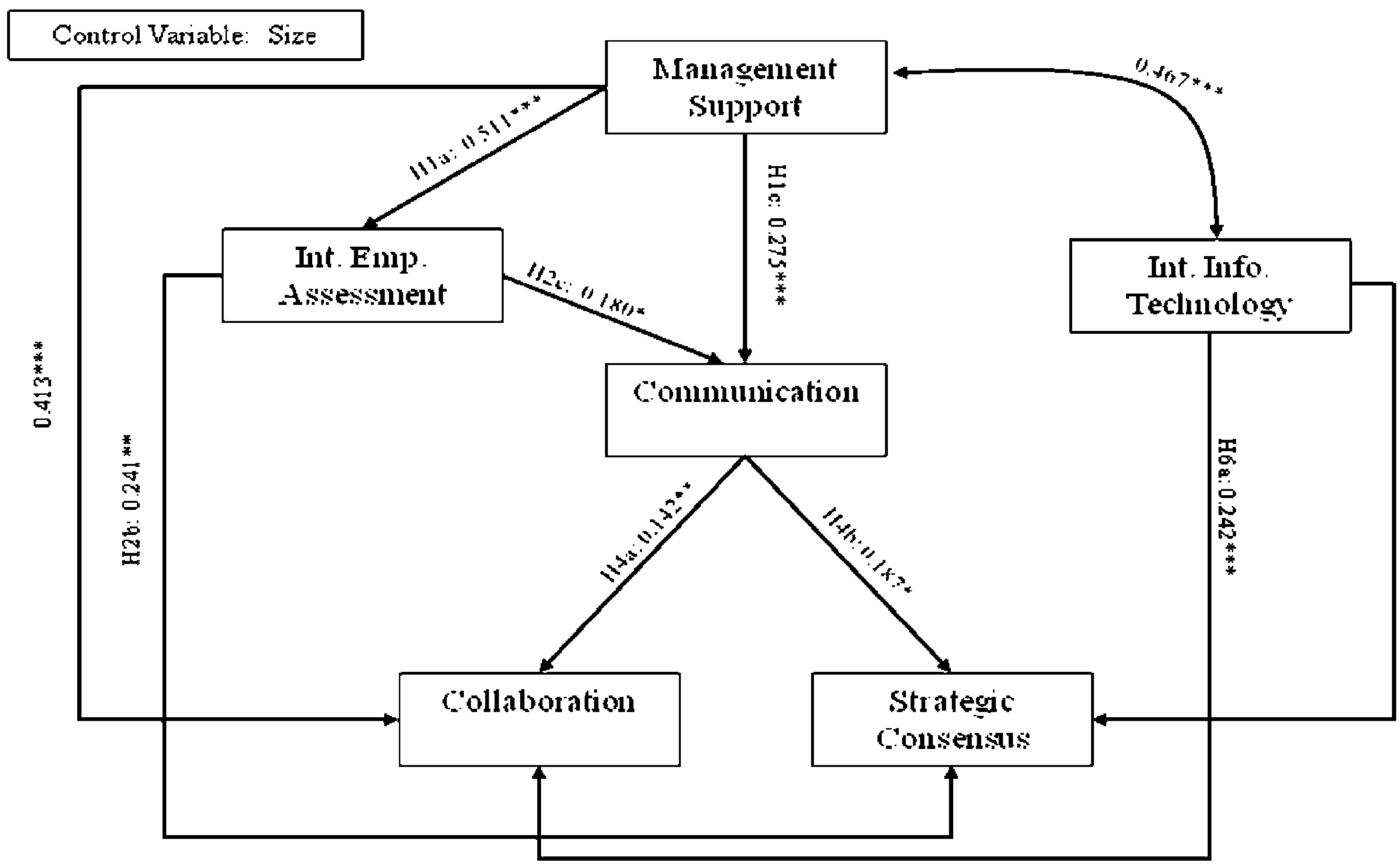


Chi-Sq. = 24.1, df = 14, Bollen-Stine p = 0.094, Mardia = 13.94 (cr = 5.4), CFI = 0.958, NNFI = 0.902, RMSEA = 0.07

Figure 6.2 Research Model with Results (***: $p<0.01$, **: $p<0.05$, *: $p<0.10$)

Table 6.1 Summary of results of hypothesis testing

Hypothesis	Description	Results for Collaboration	Results for Strategic Consensus
1a, 1b, 1c	Management Support has a positive effect on Collaboration and Strategic Consensus, mediated by Integrative Employee Assessment, Cross Functional Teams, and Communication.	Supported, moderated by Uncertainty	Supported
2a, 2b, 2c	Integrative Employee Assessment has a positive effect on Collaboration and Strategic Consensus, partially mediated by Communication	Mediated effect supported. Direct effect not supported.	Mediated effect not supported. Direct effect supported.
3a, 3b, 3c	Cross Functional Teams has a positive effect on Collaboration and Strategic Consensus, partially mediated by Communication.	Mediated effect not supported. Direct effect not supported.	Mediated effect not supported. Direct effect not supported.
4a, 4b	Communication has a positive effect on Collaboration and Strategic Consensus.	Supported	Supported
5a, 5b, 5c	Centralization has a negative effect on Collaboration and Strategic Consensus, partially mediated by Communication.	Mediated effect not supported. Direct effect not supported.	Mediated effect not supported. Direct effect not supported.
6a, 6b	Integrative Information Technology has a positive effect on Collaboration and Strategic Consensus	Supported, moderated by Uncertainty	Supported, moderated by Uncertainty.
Added	Management Support has a positive direct effect on Collaboration.	Supported, moderated by Uncertainty	N/A



Chi-Sq. = 24.1, df = 14, Bollen-Stine p = 0.094, Mardia = 13.94 (cr = 5.4), CFI = 0.958, NNFI = 0.902, RMSEA = 0.07

Figure 6.3 Research Model results, significant relationships only. (***: p<0.01, **: p<0.05, *: p<0.10)

6.1. Research findings regarding Management Support

Management Support was hypothesized to affect Collaboration and Strategic Consensus indirectly, through the actions that the Plant Manager undertook in fulfilling Barnard's (1968) three functions of the executive: serving as a communication hub, setting goals, and eliciting effort from employees. These three functions were represented by the factors Integrative Employee Assessment, Cross Functional Teams and Communication (Hypotheses 1a, 1b, and 1c, respectively). Management Support had a positive effect on all three of these factors, in support of Barnard's conceptualization of the role of the executive. Although Management Support is not explicitly a part of OIPT, it is implicit in that management sets the goals of the organization and controls the resources necessary to develop and implement coordination mechanisms.

Although a direct effect of Management Support was not hypothesized, the analysis clearly indicated the presence of a strong direct effect of Management Support on Collaboration. This effect was present in both groups (High Uncertainty and Low Uncertainty), but it appears to be stronger in the group that contains firms with Low Uncertainty. This result is in line with OIPT. A basic proposition of OIPT is that as the amount of uncertainty involved in completing a task increases, more information must be processed in order to execute the task (Galbraith 1974). Firms faced with low levels of uncertainty would therefore be expected to have lower information requirements, and more dependence on simpler modes of coordination such as rules and programs or hierarchical referral. The Plant Manager is the head of the manufacturing facility's hierarchy. The finding of a strong direct effect of Management Support on Collaboration reflects the personal impact that the Plant Manager can have in enhancing Collaboration between the focal departments in the individual facility. The direct effect appears to be stronger in firms with High uncertainty, further emphasizing the role of the Plant Manager in fostering Collaboration as Uncertainty increases.

The results for Collaboration also indicate that the mediation effect is more consistent in firms reporting high uncertainty. In terms of magnitude, the size of the mediated effect is similar between the two groups. However, there is higher variability in the group reporting low uncertainty, which affects the statistical significance. This finding is also consistent with OIPT. Facilities reporting higher levels of uncertainty might be expected to require more processing of information to complete the required tasks. Rules, programs or hierarchical referral have limited capabilities to process information. Higher levels of uncertainty highlight the need to develop increased capacity to process information. This increased capacity comes in the form or vertical information systems or lateral relations, and manifests as mediated effects through coordination mechanisms that increase information processing capabilities.

According to Kenny (2008), in order for mediation to exist, two conditions must be met. First, the initial variable (in this case, Management Support) must have an effect on the mediator variable. For all three potential mediators, this condition is met. Second, the mediator must have an effect on the outcome variable. In the case of Cross Functional Teams and Integrative Employee Assessment, this condition is not met. Neither of these factors has a significant direct effect on Collaboration. The mediated effect of Management Support on Collaboration occurs through two pathways:

1. Management Support → Communication → Collaboration

2. Mgmt Support → Int. Employee Assessment → Comm. →Collaboration.

These paths highlight the importance of the plant manager's role as both driver and hub of communication throughout the chain of command, as described by Barnard (1968).

This finding contributes to the Operations Management literature in providing empirical evidence supporting Barnard's (1968) framework of the functions of the executive. It also applies Barnard's framework by matching these functions to information-processing mechanisms that enhance Collaboration and Strategic Consensus in manufacturing facilities. Carlsson (1991) found that managers tend to integrate their individual departments by increasing contact through information flows. Kahn and Mentzer (1996) state that interaction and the exchange of information (i.e. communication) between departments is a necessary component of interdepartmental integration. However, they insert the caveat that in certain situations, communication alone will not ensure interdepartmental integration. Other researchers have also highlighted management's use of communication and goal setting to promote integration (Moenaert, Souder, DeMeyer, and Deschoolmeester 1994; Rinehart, Cooper and Wagenheim 1989).

A second contribution comes from the application of the OIPT lens, which allowed for differentiation in the roles of the Plant Manager in environments with varying levels of demand uncertainty. As was expected from the OIPT lens, plants with low uncertainty demonstrated a stronger direct effect of Management Support, indicating higher dependence on hierarchy as an information-processing mechanism. Plants with higher uncertainty had a more consistent use of additional information-processing mechanisms to supplement the information-processing capability provided by the hierarchy, as shown by the significance of the mediated effect. Pagell's (2004) model for internal integration did not include Management Support as a construct, but notes its importance and the need to include this factor when testing the model. The findings of this research study provide support for the proposition formulated by Pagell (2004, p. 479):

> Proposition 1. *Top management support is required to create an internally integrated supply chain.*

With regard to Strategic Consensus, the hypothesis of full mediation is supported, and there was no significant moderating effect of Uncertainty on this relationship. The mediation paths for Strategic Consensus are:

1. Mgmt Support → Communication → Strategic Consensus
2. Mgmt Support → Integrative Employee Assessment → Strategic Consensus
3. Mgmt Support → Int. Employee Assessment → Communication → Strategic Consensus.

The presence of a fully mediated effect suggests that in order for employees to internalize the strategic goals the Plant Manager needs to ensure that there are appropriate information dissemination and reinforcement mechanisms, i.e.—information processing capabilities. The ultimate results of the plant manager's efforts are manifested in the significance of the mediated effects on Strategic Consensus. In accordance with Pagell's (2004) suggestion, Strategic Consensus was modeled in this research as an indicator of integration between departments. The results support Proposition 3 as formulated by Pagell (2004, p. 480):

Proposition 3. *In plants where functional managers do not have consensus on strategy, there will be low levels of integration.*

It is possible to interpret this proposition as suggesting that there is a causal path between Strategic Consensus and Collaboration. To test this, the model as described in Chapter 5 was compared with two models, one with a causal arrow from Strategic Consensus to Collaboration, and one with a causal arrow from Collaboration to Strategic Consensus. The results are summarized in Table 6.2.

Table 6.2 Alternate models

Model	Chi-Sq, ΔChi-Sq	df	p	CFI	NNFI	RMSEA
Research Model	22.631, n/a	14	0.067	0.964	0.908	0.072
Strategic Consensus to Collaboration Path coefficient = 0.193, p = 0.008	15.757, 6.27	13	0.262	0.989	0.968	0.042
Collaboration to Strategic Consensus Path coefficient = 0.254, p = 0.011	16.213, 6.42	13	0.238	0.987	0.963	0.046

Either of these models represents a significant improvement to model fit, but mathematically there is no distinction between them. Model modifications should be undertaken only if there are strong theoretical grounds for the modification. In this case, the argument could be posited that knowledge of the strategic goals of the organization and of the focal departments would be expected to foster collaboration between them. However, the opposite argument can also be made: collaboration with members of other departments enhances the knowledge of each others' strategic goals and how each element of the organization fits into those goals. It is likely that these two constructs are mutually reinforcing, creating a virtuous cycle that manifests as interdepartmental integration. Souder (1977, p. i; cited in Kahn and Mentzer 1996) defined integration as "a state of high degrees of shared values, mutual goal commitments, and collaborative behaviors". With further development and refinement of measurement scales, it may be possible to create a comprehensive model of integration which would incorporate these multiple perspectives (Interaction, Communication, Strategic Consensus, Collaboration, etc.) for further research.

6.2 Research findings regarding Integrative Employee Assessment

Integrative Employee Assessment was hypothesized to have both direct (Hypothesis 2a) and mediated (Hypotheses 2b and 2c) effects on Collaboration and Strategic Consensus. The direct effect corresponds to the expectation that employees tend to do those activities for which they know they will be rewarded. The indirect effect corresponds to the proposition that employees who are interested in the overall performance of the plant would tend to cultivate communication with employees outside their department, in order to help ensure that their rewards will occur. Uncertainty did not have a significant moderating effect for the effect of Integrative Employee Assessment on Collaboration or Strategic Consensus.

Integrative Eployee Assessment did not have a significant direct effect on Collaboration. This finding would indicate that even when a reward mechanism is in place, employees do not spontaneously work with employees from other departments. In OIPT, this factor would represent the transition from managing exceptions through hierarchical referral to management by goals. In the absence of a task that can be performed by rules and procedures, and beyond the ability of the hierarchy to cope with exceptions, some form of coordinating mechanism needs to be implemented.

In this case, the effect of Integrative Employee Assessment on Collaboration was fully mediated by Communication. This finding would indicate that employees who know that they would be rewarded for contributions to the overall goals of the plant seek out ways to find out about and contribute to collaborative action. However, without the Communication mechanism, merely having a reward mechanism does not seem to foster more collaboration. In terms of OIPT the Communication factor serves as a non-technology-based vertical information system, where employees exchange information, and therefore collaboration is hindered when the exchange does not take place.

In contrast, the effect of Integrative Employee Assessment on Strategic Consensus was direct rather than mediated. Linking employee rewards to the goals of the plant appears to create an environment where employees understand what the overarching goals of the plant are, and how their work contributes to them. The findings for Integrative Employee Assessment support Proposition 5 in Pagell (2004, page 480):

> Proposition 5. The more a functional manager's pay is tied to plant level performance the higher the level of integration.

Pagell's case studies focused on interviewing functional managers, as they were available in his small sample. For this research study, the diversity of the personnel arrangements within the manufacturing facilities may have resulted in functional respondents who were not at a management level, particularly for those facilities where

Purchasing and/or Outbound Logistics are centralized in a corporate office rather than distributed to various manufacturing facilities. These non-management personnel would still be considered responsible for coordinating their activities with those of the other functional departments within the manufacturing plant. The nature of the coordination task (i.e.—the movement of material in, through, and out of the manufacturing facility) does not change.

6.3 Research findings regarding Cross Functional Teams

The Cross Functional Teams construct was hypothesized to have both direct and mediated effects on Collaboration and Strategic Consensus. The direct effect corresponds to the expectation that employees who work in cross functional teams will tend to expend effort (Collaboration) to achieve the team's goals (Strategic Consensus). In terms of OIPT, Cross Functional Teams is a form of lateral relations and a mechanism to increase information-processing capacity. A significant interaction effect was not found for the effect of Integrative Employee Assessment on either Collaboration or Strategic Consensus.

The hypotheses of direct effects of Cross Functional Teams on Collaboration (Hypothesis 3a) and Strategic Consensus (Hypothesis 3b) are not supported. The hypotheses of indirect effects of Cross Functional Teams on Collaboration and Strategic Consensus, mediated by Communication, are also not supported. These hypotheses corresponded to Pagell's (2004, page 480) Propositions 4b and 4c:

> Proposition 4b. As a plant increases the use of job rotation and or cross-functional teams the level of communication will increase.

Proposition 4c. As a plant increases the use of job rotation and or cross-functional teams the level of integration will increase.

The lack of significant effect from the Cross Functional Teams factor is troubling. These teams are used extensively in practice, specifically as a way to bring different functions together to work on a common task. There are two possible causes for this finding. The first is that the use of Cross Functional Teams is so pervasive that it is difficult to distinguish a significant differential effect in this moderate sample size. The second is that there are problems with the scale used to measure this construct. In this research, the Job Rotation factor was dropped from analysis due to issues of measurement. It is possible that measurement issues underlie the lack of significant results from Cross Functional Teams as well.

6.4 Research findings regarding Communication

Communication was hypothesized to have direct effects on Collaboration and Strategic Consensus, corresponding to the proposition that Communication facilitates both Collaboration and Strategic Consensus. A significant interaction effect was not found for the effect of Communication on either Collaboration or Strategic Consensus. The hypotheses of direct effects of Communication on Collaboration and Strategic Consensus are supported.

These findings support much prior work regarding the importance of Communication (Wheelwright and Clark 1992; Pagell and LePine 2002) in efforts to coordinate work. The inclusion of this factor within the research model serves to highlight the relationships between the other factors, such as Integrative Employee Assessment, Cross Functional Teams, Job Rotation, and Management Support. Each of these forms of coordination mechanisms was expected to have an impact on the ability of the employees to communicate. Although some relationships, namely Cross Functional Teams and Job Rotation, did not show up as significant, Communication was still a very key driver of Collaboration and Strategic Consensus. It is difficult to envision a facility that can function as a cohesive unit without having high levels of Communication.

In terms of OIPT, Communication leads to information exchange. It is used to transmit information up and down the chain of command, disseminate the goals from the executive suite to the plant floor, and support the creation of lateral relations. It is in fact so central to the mission of coordination that it would be expected to be important regardless of the perceived level of Uncertainty, and the results of this research support that. In terms of Pagell's model, this study provides evidence to support the following proposition (Pagell 2004, p. 480):

> Proposition 4: As the amount of communication between managers in different functions increases, integration across the plant will increase.

6.5 Findings with regard to Centralization

In Hypotheses 5a and 5b Centralization was hypothesized to have negative direct and mediated effects on Collaboration and Strategic Consensus. Centralization is defined in terms of the locus of authority for decision-making in the Purchasing and Outbound Shipping/Logistics role. Higher levels of Centralization indicate an organization where the Plant Manager has limited or no supervisory authority over the employees who perform Purchasing and/or Outbound Logistics. Instead, these employees belong to a chain of command that is outside of the Plant Manager's direct control. In some instances, firms with multiple manufacturing facilities decide to structure their purchasing groups such that their members are located in close proximity to each other. This enhances their ability to learn from each other and can reduce some costs by combining orders from multiple facilities, negotiating quantity discounts, and eliminating duplication of effort. However, these employees tend to be removed from the day-to-day activity of the manufacturing facilities which they serve, and as a result could tend to focus on the goals and needs of their home departments rather than those of the manufacturing plants. The direct effect corresponds to the expectation that if the Plant Manager has limited supervisory authority over them, then the employees performing these functions (Purchasing and/or Outbound Logistics) would be less inclined to expend effort (Collaboration) towards the goals of the plant, which may or may not match their own goals (Strategic Consensus). A significant interaction effect was not found for the effect of Centralization on either Collaboration or Strategic Consensus.

The hypotheses of direct effects of Centralization on Collaboration and Strategic Consensus are not supported. The hypotheses of indirect effects of Centralization on Collaboration and Strategic Consensus, mediated by Communication, are also not supported. In this sample, Centralization does not have significant effects on either Collaboration or Strategic Consensus.

According to Stank et al. (1994), centralized structures can create integration at an organizational (firm) level. However, at the level of the individual plant, and as defined in this research, Centralization of Purchasing and/or Outbound Logistics would be expected to hinder both Collaboration and Strategic Consensus. Pagell (2004) noted that the facilities in his study that had centralized Purchasing had achieved some cost savings for the corporation by leveraging their purchasing power. However, the individuals at the manufacturing facility pointed out difficulties created by the loss of trusted local suppliers and of local control over the quality of inputs. Although the results are not statistically significant, there is an interesting and potentially fruitful avenue for investigation. As seen in Tables 6.3 and 6.4, the coefficients calculated for the effect of Centralization on Collaboration range from weakly negative to moderately positive. In contrast, the coefficients calculated for the effect of Centralization on Strategic Consensus range from weakly positive to moderately negative. It is likely that the moderate sample size of this research study obscures this potential finding.

If these relationships between these factors are indeed real, the implications are that it is possible to overcome the negative effects of Centralization by creating mechanisms for Collaboration. However, there is a barrier to overcome regarding the alignment of goals between the employees who work for the plant manager and those that do not.

Table 6.3 Magnitude and significance of the effects of Centralization on Collaboration

Effect	Standardized Estimate	Significance	Unstandardized Estimate	Significance
Total	0.073 (-0.028 – 0.183)	0.204	0.067 (-0.022 – 0.185)	0.172
Direct	0.037 (-0.027 – 0.178)	0.214	0.067 (-0.018 – 0.178)	0.241
Indirect	0.003 (-0.019 – 0.035)	0.725	0.002 (-0.018 – 0.034)	0.706

Table 6.4 Magnitude and significance of the effects of Centralization on Strategic Consensus

Effect	Standardized Estimate	Significance	Unstandardized Estimate	Significance
Total	-0.126 (-0.278 – 0.037)	0.183	-0.120 (-0.269 – 0.037)	0.199
Direct	-0.130 (-0.275 – 0.038)	0.176	-0.123 (-0.278 – 0.037)	0.183
Indirect	0.003 (-0.025 – 0.044)	0.693	0.003 (-0.023 – 0.044)	0.706

6.6 Research findings regarding Integrative Information Technology

Integrative Information Technology was hypothesized to have direct effects on Collaboration and Strategic Consensus. The direct effect corresponds to the proposition that the availability of Integrative Information Technology facilitates Collaboration and Strategic Consensus. A significant interaction effect was found for the effect of Integrative Information Technology on Collaboration.

In terms of OIPT, Integrative Information Technology systems constitute vertical information systems designed to disseminate data and information throughout the organization. The results of this research with regard to the effect of Integrative Information Technology on Collaboration support the OIPT view. Integrative Information Technology has a direct effect on Collaboration, but only in firms that reported high levels of uncertainty. This finding suggests that the integrative value of information systems manifests when the plant is facing high levels of uncertainty, which would result in a higher need to process information.

One of the modifications made to the model during analysis was the addition of a covariance between Management Support and Integrative Information Technology. Although no assumptions were made regarding the ability of the Plant Manager to influence choices in technology, for firms with only one facility, it would make sense that the support of the Plant Manager is required in order to ensure the appropriate resources are allocated, indicating that a direct effect might be present. For those respondents from a facility that is part of a larger corporation, however, this rationale is tenuous. Large investments in information technology, such as those required to implement ERP or other integrative systems, are often beyond the scope of control of the Plant Manager. As the true nature of this effect is not known, it was added as a covariance between variables. This covariance represents unanalyzed common causes for these two factors. The presence of the information technology is not enough, there is a missing link between Integrative Information Technology and Management Support. These results support Proposition 2 as formulated by Pagell (2004, page 479):

> Proposition 2. Information technology cannot increase the level of integration in a plant on its own.

Integrative Information Technology also had a significant direct effect on Strategic Consensus. As with Collaboration, this effect was moderated by the level of uncertainty, supporting the OIPT view. Although it is not possible to determine the magnitude of the moderation effect, it can be determine that the effect of Integrative Information Technology on Strategic Consensus is stronger in firms with high uncertainty. As the information processing requirements grow, the usefulness of

Integrative Information Technology is highlighted. Integrative Information Technology provides an electronic forum for data transfer. This data can also be transformed into relevant information that disseminates the goals of the organization to all its members, for example thru firm- or plant-wide distribution of financial results, production targets, profit projections, and cost analysis.

6.7 Contributions to the Operations Management Literature

The main contribution of this research to the field of Operations Management concerns the application of the Organizational Information Processing Theory lens to issues of internal supply chain management. This study follows the theory-building framework described by Handfield and Melnyk (1998). Pagell (2004) provided Discovery, Description, Mapping, and Relationship Building for factors influencing the integration between the Purchasing, Operations, and Outbound Logistics departments. This research provided a theoretical lens to place these factors within their environmental context, and thus provide some explanation for their differential effects. Having developed a model incorporating some of Pagell's (2004) findings and informed by OIPT, this research provides an exploratory test of the theoretical model. Theory-building research seeks to describe, explain, and predict phenomena based on observation of causal relationships. Without testing, however, theory cannot be refined or extended.

The results of this study show that Pagell's (2004) model can be applied to the domain of larger manufacturing facilities, beyond the limited sample size of his case study. The results also suggest that the facility's competitive environment has an impact on the magnitude of the relationships between factors, and must be taken into account when attempting to make predictions based on this research model. Within OIPT, Uncertainty is said to shape the firms' coordination mechanisms. In this study, firms were asked about the levels of uncertainty they faced in regards to the demand for their products. The findings confirm that manufacturing firms vary their implementation of coordination mechanisms according to the level of uncertainty in demand that they face.

As an additional contribution to theory-building, this research developed and validated a theoretically-grounded measurement scale for the construct of Management Support. Although the construct is used often in research studies, it lacks a clear conceptual definition as described by Wacker (2004). This research provides a definition and a measurement scale based on organizational theory. Although further refinement is necessary, this scale is a small step toward the development of a standard of measurement grounded in established theory.

Prior research has linked Strategic Consensus to firm performance (Pagell and Krause 2002, Joshi et al 2001). As Pagell (2004) noted, consensus about the overarching goals of the firm is key to the integration of effort. The current study builds on this link by providing some guidance about possible antecedents of Strategic Consensus. If the results of the current study are confirmed, then the outcomes of both studies can be linked, resulting in a more complete picture of the factors contributing to strategic consensus and by extension to firm performance.

Although Collaboration has been studied extensively, Strategic Consensus is relatively unexplored. Moreover, several of these studies focus specifically on consensus, without regard for how this factor may relate to other elements of integration such as

Collaboration. This study seeks to discover mechanisms how different mechanisms can interact when seeking to build both Strategic Consensus and Collaboration. Some mechanisms such as Integrative Employee Assessment have direct effects on Strategic Consensus, while others such as Management Support have direct effects on Collaboration. In combination, these coordination mechanisms result in integration of effort.

6.8 Contributions to Operations Management Practice

Practitioners are often told that integrating the efforts of their various functional departments will result in performance improvements. However, there are few models of how to accomplish this integration. This research contributes to practice by specifically considering the effect of certain coordination mechanisms on Collaboration and Strategic Consensus between the Purchasing, Operations, and Outbound Logistics departments. Even in cases where there are not defined departmental boundaries, employees can tend to stay within their job descriptions and focus on their immediate tasks rather than the performance of the plant as a whole.

This research suggests that it is also important for the Plant Manager to determine and take into account the level of demand uncertainty faced by the facility when selecting which coordination mechanism is appropriate.

It is clear that the Plant Manager plays a key role in ensuring Collaboration and Strategic Consensus within the facility. First, the Plant Manager formulates the overall goals for the facility. Although the performance goals might be dictated by a higher authority, for example the division or business unit management, it is the duty of the

Plant Manager to translate these goals into specific clear guiding statements for his personnel. Second, the Plant Manager must serve as a communication node, both from external parties to the plant employees and also from the employees back up through the chain of command. Finally, it is the duty of the Plant Manager to secure the essential services of the employees. The Plant Manager must be personally involved in the process of establishing these coordination mechanisms, both in words and in action. It is important for the Plant Manager to directly communicate to employees the need for coordination as well as being willing to personally intercede when roadblocks arise, whether within or outside the facility.

6.9 Limitations

This study suffers from several limitations. First, although the research sample appears to be reasonably representative of the target population, the translation issue between SIC and NAICS codes makes it difficult to pinpoint the level of influence that a firm's industry might have on the pattern of relationships. In this survey sample, there is no significant correlation between Industry and any of the factors within the research model. That said, future studies should incorporate the NAICS classification scheme, as this is now the standard for the United States.

Second, the use of a single respondent provides a limitation on the generalizability of the results. Although every effort was made to reduce potential bias, it cannot be completely eliminated. Moreover, when studying the working relationships between multiple departments, it is useful to get the perspective from all sides of the issue. The analysis of Common Method Variance suggests that it is not a problem within this study. However, there was insufficient data to perform multi-trait-multi-method (MTMM) analysis in a way that would systematically reveal any underlying bias between members of the three target departments. A data set with complete responses from all of the relevant departments would allow for the analysis of mean and intercepts between departments in addition to structural relationships.

Third, the scales developed to measure the latent factors need further development and refinement. The Centralization scale was left with only two items, which creates problems of identification during SEM analysis. Several of the scales had Average Variance Extracted that was less than the suggested cutoff of 0.50. While simulation studies have shown that confirmatory factor analysis can reproduce the true sample covariances even under conditions of poor psychometric properties, replication and extension of this research requires further scale development.

Fourth, the sample size limitations precluded testing of the full structural equation model. Path analysis is based on observed variables, and assumes that they are measured without error. The variables used for the path analysis were derived from the factor loadings obtained during latent variable analysis. Although an attempt was made to limit the amount of error included, by using Principal Axis Factoring and Bartlett's method for finding factor scores, it is inevitable that some error was included within the measure. Moreover, the sample had high values of multivariate kurtosis, requiring the use of bootstrapping to approximate the values of the parameters and standard errors. While a general statement can be made that the research model does seem to provide some explanatory power, the results can only be confirmed with confidence after replication.

Finally, this study is a single test of one data sample. Although the results are intriguing, they require confirmation with a separate independent sample. It is also not clear whether the relationships developed within a US-based sample would hold in an international context. Future work should consider cross-validation with a confirmation sample as well as extension to an international domain.

6.10 Directions for future research

The results of the analysis provide several potential avenues for extending this work. Organization Information Processing Theory has not received much attention in empirical research in Operations Management. Given that the research model appears to support the propositions made by OIPT, further study into the applications of this theory is warranted. The use of the OIPT lens encourages the exploration of various forms of coordination, reflecting the rich diversity of experience in manufacturing firms of varying size, industry, and product life cycle stage.

The model developed to describe the antecedents of Collaboration and Strategic Consensus should also be tested in service contexts. The mechanisms for coordination are not limited to manufacturing firms. This research model could be easily adapted to the needs of a service. One promising area for further study is the operation of health care systems, in particular hospitals. Hospitals encompass a number of different departments that must coordinate their activities to serve individual patients. Moreover, the complexity of coordination increases as the diversity of the patient needs increases, making the OIPT lens appropriate. Recent work has focused on the use of OIPT in retail service design and information technology implementation. If OIPT can be shown to be applicable to both manufacturing and service organizations, it will help develop richer theory.

This study does not take into consideration the potential effect, or lack thereof, of internal integration on the operational or financial performance of the firm. A number of prior studies have concluded that integration has a positive effect on performance. A logical extension of this study would be to include measures of performance within the research model to determine whether these mechanisms posited to facilitate collaboration and consensus result in higher levels of performance.

Finally, this study focuses on a very narrow definition of Uncertainty which relates specifically to the predictability of demand patterns. However, manufacturing firms are exposed to many different types of uncertainty, including supply disruptions, personnel availability, and disruptions in the availability of capital. A variety of sources of uncertainty should be explored to determine their individual and collective impact on the operation of the firm.

APPENDICES

APPENDIX A

ITEM SORTING INSTRUMENT

Survey Pre-Test

1. Page 1

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

1. Members of one department can access information in another department's computer system.

2. Purchasing, Operations, and Logistics work together to resolve problems.

3. Our plant uses a computerized system to plan production.

4. The most senior employee doing Purchasing at this plant reports to the Plant Manager.

5. Employees from other departments are encouraged to apply for job openings in my department.

6. Purchasing personnel can access the computerized production system.

Survey Pre-Test

2. Page 2

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

7. My company has a formal training program where employees move through work assignments in different departments.

8. Managers' appraisals include measures of how the entire plant performs against its goals.

9. The plant manager has approved resources to support efforts between departments to work together.

10. Our plant uses a commercial ERP system such as SAP, Oracle or Microsoft Dynamics.

11. Our plant has a high number of unexpected product changeovers.

12. Our plant has established work teams of employees from multiple departments to address customer problems.

Survey Pre-Test

3. Page 3

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

13. The most senior employee doing Logistics at this plant does not report to the Plant Manager in any way.

14. The other departments know which order winners are most important to my department.

15. I am confident that our master production schedule will not change unexpectedly.

16. Purchasing, Operations, and Logistics work together on long-term projects.

17. People from my department are encouraged to apply for job openings in other departments.

18. Managers in our plant have regular performance reviews.

Survey Pre-Test

4. Page 4

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

19. Each department in our plant has its own computer system.

20. The most senior employee doing Purchasing in this plant has an indirect ("dotted-line") reporting relationship to the Plant Manager.

21. The Plant Manager monitors the progress of interdepartmental efforts to work together.

22. Managers' merit raises are based on how well the plant meets its goals.

23. Purchasing, Operations, and Logistics work together to prevent problems.

24. The plant manager has allocated the manpower that I need to support efforts to work with the other departments.

Survey Pre-Test

5. Page 5

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

25. I belong to a work team that has members from different departments.

26. I know my company's competitive strategy.

27. The Plant Manager has verbally told the employees that he/she supports having departments work together.

28. It is easy to predict which of our products will be on the production schedule at any particular time.

29. Managers' appraisals are based on how their department performs against its goals.

30. When we make a decision in my department we consider how it will affect other departments.

Survey Pre-Test

6. Page 6

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

31. I know which order winners Purchasing focuses on.

32. When the other departments make decisions, they consider how it will affect my department.

33. My department seeks out employees with experience in other departments.

34. The Plant Manager has attended meetings intended to promote efforts of departments to work together.

35. Our overall production forecasts are very accurate.

36. Logistics personnel can access the computerized production system.

Survey Pre-Test

7. Page 7

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

37. The computer systems in our plant share a common database.

38. Experience in other departments is highly regarded in my department.

39. Our plant has implemented an Enterprise Resource Planning (ERP) system to manage production activities.

40. My department has goals that support how the company competes in the market.

41. Our plant has established work teams of employees from multiple different departments to address supplier issues.

42. Managers' appraisals are based only on their individual performance.

Survey Pre-Test

8. Page 8

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

43. The most senior employee doing Logistics in this plant has an indirect ("dotted-line") reporting relationship to the Plant Manager.

44. Members of my department participate in ongoing work teams with members from other departments.

45. Operations personnel can access the computerized production system.

46. The plant manager is willing to clear obstacles to collaboration that are within our plant.

47. Forecasting total production volumes at our plant is easy.

48. Purchasing, Operations, and Logistics work together on short-term projects.

Survey Pre-Test

9. Page 9

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

49. The manager of our department has significant experience in another department.

50. The total production volume at our plant can change unexpectedly.

51. The plant manager has allocated the budget that I need to support efforts to work with the other departments.

52. Our plant has a single integrated computer system that is used by Purchasing, Operations and Logistics.

53. Experience in my department is highly regarded in other departments.

54. Members of my department participate in teams with members from other departments to work on specific projects.

Survey Pre-Test

10. Page 10

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

55. The most senior employee doing Logistics at this plant reports directly to the Plant Manager.

56. Our plant has established work teams of employees from multiple different departments to address internal problems.

57. It is easy to forecast demand for each of our plant's products.

58. The plant manager is willing to clear obstacles to collaboration that are outside our plant.

59. The computer systems at our plant can communicate with each other.

60. Purchasing, Operations, and Logistics work together to develop opportunities.

Survey Pre-Test

11. Page 11

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

61. I know which order winners Operations focuses on.

62. Managers at my company move from one department to another.

63. There can be little action taken here until a supervisor approves a decision.

64. Managers receive performance feedback from their internal "customers".

65. I know which order winners are most important for my company.

66. A person who wants to make his own decisions would be quickly discouraged here.

Survey Pre-Test

12. Page 12

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

67. The most senior employee doing Purchasing in this plant does not report to the Plant Manager in any way.

68. Even small matters have to be referred to someone higher up for an answer.

69. The Plant Manager understands what is needed to support efforts to work with the other departments.

70. The sales forecasts for each of our products is very accurate.

71. I have to ask my boss before I do almost anything.

72. Managers of the other departments have significant experience in my department.

Survey Pre-Test

13. Page 13

INSTRUCTIONS: First, read the definitions below. Second, read the items or questions. Third, select the term that corresponds to the definition to which you think the item belongs.

1. Management Support: The ways that a Plant Manager is supportive of a program within his plant.
2. Integrative Information Technology: The implementation of computerized production systems and integrated information systems.
3. Communication: The frequency of transmitting and sharing information between departments.
4. Centralization: The degree to which a department retains authority over its members.
5. Job Rotation: When employees transfer to working in a different department.
6. Cross-functional teams: Teams made of employees from multiple departments who work together on a common problem.
7. Employee Assessment: The criteria used to evaluate and reward work performance.
8. Strategic Consensus: The extent to which members of one department are familiar with the strategic goals of the firm, their department, and the other departments.
9. Collaboration: Working together
10. Demand Uncertainty: The extent to which the product mix is predictable.
11. Volume Uncertainty: The extent to which the production volume is predictable.

73. Managers' merit raises are based on how well they meet their individual goals.

74. The Plant Manager has issued a document supporting the efforts of departments to work together.

75. The plant manager understands what is needed to support efforts to work with the other departments.

76. I know which order winners Logistics focuses on.

77. I know which measures will be the most important in my performance appraisal.

78. Managers' merit rises are based on how well they meet the department goals.

APPENDIX B

SURVEY INSTRUMENT

Information Concerning Participation in a Research Study Sponsored by Clemson University
Project Title: Bridging the Operational Divide: Factors that Affect Internal Supply Chain Integration

Description of the research and your participation
You are invited to participate in a research study conducted by Ms. Ana L. Rosado Feger, Doctoral Candidate in Management, under the direction of Dr. Lawrence D. Fredendall. The purpose of this research is to explore how manufacturing companies can foster integration between three departments: Purchasing, Operations/Production, and Outbound Logistics/Shipping. Your participation will involve completing a survey questionnaire. The amount of time required for your participation will be approximately 15 minutes.
Risks and discomforts
There are no known risks associated with this research.
Potential benefits
This research may help us to understand what manufacturing companies are doing to facilitate collaboration between these three departments. In addition, this research may help us to identify how manufacturing companies respond to uncertainty in their business environment.
Protection of confidentiality
Your responses are completely confidential. Only aggregate data will be used for analysis and discussion. Your personal identity will not be revealed at any time. However, if you choose to receive a copy of an executive summary of the results, you may provide contact information at your discretion. This information will be kept in a separate database established specifically for that purpose. As we require at least two respondents from each facility, a four-digit code will be used to identify the facility and match responses. These codes will remain confidential.
Voluntary participation
Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study.
Contact information
If you have any questions or concerns about this study or if any problems arise, please contact Dr. Lawrence D. Fredendall at Clemson University at 864-656-2016, or Ms. Ana L. Rosado Feger at 864-380-6283. If you have any questions or concerns about your rights as a research participant, please contact the Clemson University Office of Research Compliance at 864-656-6460.

	Please select (X) the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.	Strongly Agree	Agree	Neutral	Disgree	Strongly Disagree
1	Our plant uses a computerized system to plan production.					
2	The composition of demand (the product mix) is difficult to predict.					
3	Employees in Purchasing and/or Shipping who do not report to the Plant Manager need to have approval from their boss before making decisions that concern our plant.					
4	Supervisors/managers review each employee's performance on a regular basis.					
5	My company has a training program where employees rotate through work assignments in different departments.					
6	Our plant has established work teams of employees from multiple departments to address customer problems.					
7	The Plant Manager encourages departments to work together.					
8	Our plant uses a commercially available ERP package.					
9	Demand for our products changes unpredictably.					
10	We have open lines of communication between departments.					
11	Managers at our company move from one department to another.					
12	The Plant Manager has attended meetings intended to promote efforts of departments to work together.					
13	Our plant has established work teams of employees from different departments to address supplier issues.					
14	The plant manager is willing to clear obstacles to collaboration that are within our plant.					
15	The plant manager is willing to clear obstacles to collaboration that are outside our plant.					
16	The Purchasing, Production, and Shipping departments each have their own dedicated computer software.					

	Please select (X) the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.	Strongly Agree	Agree	Neutral	Disgree	Strongly Disagree
17	Members of my department participate in teams with members from other departments.					
18	The Human Resource practices used at our plant encourage cooperation between departments.					
19	Our production schedule changes unexpectedly.					
20	I know my company's strategy for competing in the market.					
21	Employees' individual performance reviews focus exclusively on how they have contributed to the goals of their own department.					
22	Employees who do Purchasing and/or Shipping for our plant and do not report to the Plant Manager can proceed without having to check first with their boss.					
23	Employees in the other departments respond promptly when contacted by someone in my department regarding work issues.					
24	I belong to a work team that has members from different departments.					
25	We work together to develop business opportunities.					
26	Employees in Purchasing and/or Shipping who do not report to the Plant Manager get their instructions only from their boss.					
27	Employees' merit raises are based at least in part on how well the entire plant meets its goals.					
28	We work together to resolve problems.					
29	Employees are encouraged to apply for job openings that are outside their own department.					
30	The other departments know how my department contributes to the company's competitive strategy.					
31	Employees from other departments are encouraged to apply for job openings in my department.					
32	Our plant has established work teams of employees from different departments to address supplier issues.					

	Please select (X) the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.	Strongly Agree	Agree	Neutral	Disgree	Strongly Disagree
33	We have trouble getting a response from other departments when we contact them regarding work issues.					
34	Employees are rewarded for their contribution to the overall performance of the plant.					
35	Employees who do Purchasing and/or Shipping for this plant and do not report to the Plant Manager rely on their chains of command to make decisions.					
36	The volume of demand is difficult to predict.					
37	My contribution to the overall performance of the plant is an important part of my individual performance review.					
38	The Plant Manager's staff knows he/she wants them to work together.					
39	People in Purchasing, Production/Operations, and Shipping can access data in each other's computer systems.					
40	Our human resource policies support each other.					
41	The Plant Manager does not have supervisory authority over the employees who do Purchasing and/or Shipping for our plant.					
42	We consider work experience in more than one area to be valuable.					
43	Short-term projects are accomplished by working together.					
44	The computer systems in our plant can communicate with each other.					
45	I know how my department contributes to our competitive strategy.					
46	Employees in other departments do not hesitate to contact us to resolve work issues.					
47	We accomplish long-term goals by working together.					
48	If I have a question about something done by another department, I know who I could contact for help.					

	Please select (X) the response which most closely reflects the situation at your manufacturing facility. All items refer to the Purchasing, Operations, and Outbound Logistics/Shipping departments.	Strongly Agree	Agree	Neutral	Disgree	Strongly Disagree
49	I know how my company sets itself apart from its competitors in the market.					
50	Our company has Human Resource policies that support collaboration between departments.					
51	Our long-term performance goals are aligned with our company's competitive strategy.					
52	The Plant Manager understand what is needed to support efforts to work with the other departments.					
53	The volume of demand is difficult to predict.					

Title ____________________

Time at current position ____________________

What is your plant's major product? ____________________

How many people work at your plant? ____________________

Please estimate the total sales volume from your plant. ____________________

Which department(s) most closely fit(s) your job duties:

Purchasing ☐

Operations/Production ☐

Outbound Logistics/Shipping ☐

Please write your 4-digit facility code here:

____

*** **This information will only be used to match responses from the same facility.**

APPENDIX C

SURVEY ITEMS

		Mean	Std. Dev.	Loading (ML)	Cronbach's alpha	AVE	CR
Centralization					0.567	0.483	0.651
CEN1	Employees in Purchasing and/or Shipping who do not report to the Plant Manager need to have approval from their boss before making decisions that concern our plant.	3.275	1.05291	0.681			
CEN2R	Employees who do Purchasing and/or Shipping for our plant can proceed without having to check first with their boss.	2.95	1.05201	0.708			
CEN4 (removed)	Employees who do Purchasing and/or Sipping for this plant rely on their Purchasing/Shipping chains of command to make decisions.	*3.3944*	*0.8695*				
Collaboration					0.699	0.389	0.715
COL1	We work together to develop business opportunities.	3.825	0.85664	0.541			
COL2	We work together to resolve problems.	4.1333	0.549	0.728			
COL3	Short-term projects are accomplished by working together.	3.9802	0.51927	0.593			
COL4	We accomplish long-term goals by working together.	4.0927	0.5189	0.618			

		Mean	Std. Dev.	Loading (ML)	Cronbach's alpha	AVE	CR
Communication					0.604	0.382	0.647
COM1 (removed)	We have open lines of communication between departments.						
COM2	Employees in the other departments respond promptly when contacted by someone in my department regarding work issues.	3.6953	0.77252	0.669			
COM3R	We have trouble getting a response from other departments when we contact them regarding work issues.	3.6315	0.8261	0.531			
COM4	Employees in other departments do not hesitate to contact us to resolve work issues.	4.172	0.52387	0.645			
Int. Employee Assessment					0.644	0.41	0.672
IEA3	Employees' merit raises are based at least in part on how well the entire plant meets its goals.	3.7638	0.8569	0.551			
IEA4	Employees are rewarded for their contribution to the overall performance of the plant.	3.855	0.67736	0.601			
IEA5	My contribution to the overall performance of the plant is an important part of my individual performance review.	4.1066	0.58562	0.752			

		Mean	Std. Dev.	Loading (ML)	Cronbach's alpha	AVE	CR
Integrative Information Tech.					0.684	0.491	0.73
IIT1	Our plant uses a computerized system to plan production.	3.9167	1.08142	0.444			
IIT2 (removed)	Our plant uses a commercially available ERP package.	3.5667	1.143				
IIT4	People in Purchasing, Production/Operations, and Shipping can access data in each other's computer systems.	3.7021	0.93839	0.884			
IIT5	The computer systems in our plant can communicate with each other.	3.7372	0.89358	0.703			
Management Support					0.773	0.48	0.819
MS1	The Plant Manager encourages departments to work together.	4.2083	0.70884	0.719			
MS2	The Plant Manager has attended meetings intended to promote efforts of departments to work together.	3.8	0.84615	0.517			
MS4	The plant manager is willing to clear obstacles to collaboration that are outside our plant.	3.9483	0.70841	0.687			
MS5	The Plant Manager's staff knows he/she wants them to work together.	4.1443	0.62057	0.83			
MS6	The Plant Manager understands what is needed to support efforts to work with the other departments.	3.96	0.661	0.673			

		Mean	Std. Dev.	Loading (ML)	Cronbach's alpha	AVE	CR
Strategic consensus					0.692	0.421	0.685
SC1	I know my company's competitive strategy.	4.141	0.71466	0.705			
SC3 (removed)	I know how my work contributes to my company's plan to set itself apart from the competition.	4.2593	0.56517				
SC4	I know how my company sets itself apart from its competitors.	4.1095	0.75587	0.603			
SC5	Our long-term performance goals are aligned with our company's competitive strategy.	3.9297	0.56245	0.634			
Uncertainty					0.855	0.614	0.862
UNC1	The composition of demand (the product mix) is difficult to predict.	3.55	1.15845	0.682			
UNC2	Demand for our products varies unpredictably.	3.5833	1.01736	0.796			
UNC3	Our production schedule changes unexpectedly.	3.7333	1.06695	0.706			
UNC4	The volume of demand is difficult to predict.	3.4476	1.03091	0.927			

APPENDIX D

INTER-RATER RELIABILITY, SURVEY DEVELOPMENT

Undergraduate Students, Section 1

	1	2	3	4	5	6	7	8	9
2	0.797								
3	0.798	0.780							
4	0.890	0.779	0.853						
5	0.890	0.834	0.816	0.890					
6	0.761	0.725	0.724	0.835	0.798				
7	0.816	0.722	0.706	0.798	0.760	0.706			
8	0.853	0.724	0.744	0.798	0.780	0.726	0.726		
9	0.761	0.705	0.670	0.743	0.742	0.653	0.631	0.650	
10	0.872	0.816	0.853	0.890	0.926	0.834	0.779	0.798	0.742

KAPPA	Min	0.631
	Max	0.926

Proportion of Interjudge Agreement	0.809
PRL Reliability per Rust and Cooil (1994)	1.000

Undergraduate Students, Section 2

	1	2	3	4	5	6	7	8	9
2	0.834								
3	0.853	0.871							
4	0.890	0.908	0.963						
5	0.871	0.889	0.945	0.982					
6	0.816	0.871	0.853	0.890	0.908				
7	0.871	0.889	0.908	0.945	0.926	0.871			
8	0.816	0.835	0.853	0.890	0.871	0.816	0.908		
9	0.760	0.724	0.797	0.816	0.834	0.779	0.761	0.761	
10	0.834	0.816	0.835	0.871	0.853	0.890	0.853	0.798	0.743

KAPPA	Min	0.724
	Max	0.982

Proportion of Interjudge Agreement	0.866
PRL Reliability per Rust and Cooil (1994)	1.000

Doctoral Students and Manufacturing Firm Employees

	1	2	3	4
1				
2	0.762			
3	0.670	0.649		
4	0.761	0.705	0.595	
5	0.908	0.762	0.688	0.816

KAPPA	Min	0.595
	Max	0.908

Proportion of Interjudge Agreement	0.698
PRL Reliability per Rust and Cooil (1994)	0.98

MBA Students with Target Respondent Work Titles

	1	2	3
1			
2	0.724		
3	0.668	0.853	
4	0.631	0.743	0.704

KAPPA	Min	0.631
	Max	0.853

Proportion of Interjudge Agreement	0.789
PRL Reliability per Rust and Cooil (1994)	0.99

APPENDIX E

PILOT SAMPLE ANALYSIS

SCALE RELIABILITY

Item	CITC	Cronbach's alpha	Item	CITC	Cronbach's alpha
Centralization		0.695	Int. Human Res. Mgmt.		0.907
CEN1	0.564		*IHRM1*	0.814	
CEN2R	0.498		*IHRM2*	0.809	
CEN4	0.486		*IHRM3*	0.822	
Job Rotation		0.682	Cross functional teams		0.824
JR1	0.482		*CF1*	0.593	
JR2	0.459		*CF2*	0.66	
JR5	0.522		*CF3*	0.619	
Communication		0.836	*CF5*	0.713	
COM1	0.655		Collaboration		0.855
COM2	0.728		*COL1*	0.668	
COM3R	0.669		*COL2*	0.808	
COM5	0.624		*COL3*	0.658	
Int.Info. Tech.		0.798	*COL4*	0.658	
IIT1	0.704		Strategic Consensus		0.87
IIT2	0.549		*SC1*	0.741	
IIT4	0.571		*SC2*	0.583	
IIT5	0.593		*SC3*	0.774	
Mgmt. Support		0.907	*SC4*	0.764	
MS1	0.769		*SC5*	0.606	
MS2	0.627		Uncertainty		0.813
MS3	0.805		*UNC1*	0.546	
MS4	0.78		*UNC2*	0.578	
MS5	0.735		*UNC3*	0.662	
MS6	0.744		*UNC4*	0.733	

Note: The factor Integrated Employee Assessment is not included in this table as it possesses very poor convergent validity and all items were reworded after the pilot.

247

DIVERGENT VALIDITY

This table shows the rotated factor solution using Maximum Likelihood and CF-Varimax oblique rotation. Item loadings with upper bounds higher than 0.4 are highlighted.

	Management Support	Communication	Cross Functional Teams	Int. Info. Technology	Uncertainty	Centralization	Job Rotation
cen1	0.02	0.02	-0.37	0.07	0.06	**0.55**	0.14
cen2r	0.17	-0.12	-0.15	0.06	-0.06	**0.62**	0.02
cen4	-0.04	0.04	0.11	0.1	0.2	**0.68**	0.01
cf1	0.16	0.13	0.33	0.26	-0.02	-0.07	0.4
cf2	0.18	-0.17	**0.77**	-0.02	0.06	0.01	0.14
cf3	0.13	0	**0.49**	0.16	0.08	-0.06	0.11
cf5	-0.01	0.13	**0.68**	0.11	-0.03	0.03	0.19
com1	0.29	**0.57**	0.03	0.07	-0.07	-0.04	0.03
com2	0	**0.86**	-0.05	-0.11	0.04	0	0.22
com3r	0.05	**0.74**	0.07	-0.1	0	0.06	-0.16
com5	0.07	**0.63**	-0.08	0.25	0.06	0.04	-0.12
iit1	0.04	-0.08	-0.02	**0.92**	-0.02	0.04	0.07
iit2	-0.14	-0.04	0.02	**0.64**	0.02	0.01	-0.04
iit4	-0.07	0.14	**0.56**	**0.45**	-0.03	-0.05	-0.17
it5	0.06	0.08	0.27	**0.5**	-0.12	0.21	-0.15
jr1	0.05	0.09	0.17	-0.13	0.07	0.3	**0.44**
jr2	-0.09	0.08	0.21	0.05	-0.04	0.18	**0.58**
jr5	0.04	0.17	0.32	-0.13	-0.08	**0.42**	0.14
ms1	**0.64**	0.25	-0.01	0.04	-0.05	-0.02	0.19
ms2	**0.69**	-0.06	0.01	0.12	0.01	-0.06	0.34
ms3	**0.69**	0.2	0.12	-0.04	-0.01	0.18	-0.16
ms4	**0.84**	-0.02	0.06	-0.05	0.07	0.13	-0.05
ms5	**0.52**	0.31	0.12	0.13	0.02	-0.03	-0.09
ms6	**0.47**	0.4	0.14	0	0.05	0.17	-0.12
unc1	0.07	0.04	-0.21	0.19	**0.63**	-0.1	-0.01
unc2	-0.08	0.08	0.03	0.09	**0.64**	-0.16	0.21
unc3	-0.04	-0.03	-0.06	-0.05	**0.77**	0.19	0.04
unc4	0.05	0	0.13	-0.1	**0.88**	0.04	-0.1

249

CONVERGENT VALIDITY

	Mean	Std. Dev.	Factor Loadings (ML)	Cronbach's alpha	AVE	CR
Centralization						
CEN1	3.15	1.154	0.773	0.695	0.440	0.701
CEN2R	2.99	0.863	0.610			
CEN4	3.39	0.744	0.595			
Cross Functional Teams						
CF1	3.52	1.1	0.638	0.824	0.543	0.824
CF2	3.52	0.978	0.787			
CF3	4.08	0.664	0.653			
CF5	3.46	0.934	0.848			
Collaboration						
COL1	3.77	0.791	0.756	0.855	0.605	0.858
COL2	3.97	0.691	0.923			
COL3	3.9	0.671	0.706			
COL4	4.06	0.685	0.707			
Communication						
COM2	3.72	0.73	0.795	0.787	0.577	0.801
COM3R	3.57	0.686	0.846			
COM5	4.11	0.469	0.62			
Integrative Employee Assessment						
IEA1	4.2	0.838	N/A			
IEA2R	2.85	0.983				
IEA3	3.96	0.562				
IEA4	3.69	0.781				
IEA5	4.12	0.447				
Integrative HRM						
IHRM1	3.51	0.787	0.873	0.907	0.766	0.907
IHRM2	3.55	0.713	0.866			
IHRM3	3.47	0.767	0.886			
Integrative Info. Tech.						
IIT1	3.81	1.202	0.809	0.798	0.505	0.802
IIT2	3.68	1.451	0.630			
IIT4	3.82	0.804	0.688			
IIT5	3.68	0.914	0.703			

CONVERGENT VALIDITY

	Mean	Std. Dev.	Factor Loadings (ML)	Cronbach's alpha	AVE	CR
Job Rotation						
JR1	2.7	1.08	0.646	0.682	0.420	0.683
JR2	2.93	1.039	0.593			
JR5	3.79	0.65	0.7			
Management Support						
MS1	4.18	0.827	0.882	0.852	0.607	0.86
MS2	3.87	0.854	0.726			
MS4	4.01	0.768	0.714			
MS5	4.14	0.583	0.783			
Strategic Consensus						
SC1	4.11	0.722	0.802	0.864	0.64	0.875
SC3	4.09	0.586	0.898			
SC4	3.98	0.7	0.831			
SC5	3.9	0.734	0.649			
Uncertainty						
UNC1	3.65	1.165	0.588	0.807	0.536	0.818
UNC2	3.83	0.949	0.608			
UNC3	3.8	1.005	0.804			
UNC4A	3.51	0.968	0.885			

APPENDIX F

DISCRIMINANT VALIDITY TESTING

	Chi-Sq Free	Chi-Sq const.	Chi-Sq. Difference	Correlation Estimate	Crit Ratio	p-value
Centralization and:						
Collaboration	10.74	83.13	72.39	-0.040	-0.333	0.739
Communication	31.35	85.60	54.25	0.250	2.548	0.011
Int. Emp. Assessment	23.60	103.40	79.80	-0.050	-0.404	0.686
Int. Info. Technology	38.50	104.90	66.40	-0.250	-1.710	0.087
Mgmt. Support	30.20	119.70	89.50	-0.109	-0.879	0.380
Strategic Consensus	27.30	120.60	93.30	-0.250	-1.814	0.070
Collaboration and:						
Communication	50.80	102.90	52.10	0.966	3.956	0.000
Int. Emp. Assessment	30.10	93.70	63.60	0.674	2.935	0.003
Int. Info. Technology	34.60	82.00	47.40	0.673	3.523	0.000
Mgmt. Support	56.20	102.40	46.20	0.805	4.360	0.000
Strategic Consensus	63.80	134.60	70.80	0.670	3.809	0.000
Communication and:						
Int. Emp. Assessment	38.40	113.50	75.10	0.689	3.040	0.002
Int. Info. Technology	51.70	114.70	63.00	0.439	2.611	0.009
Mgmt. Support	60.70	118.90	58.20	0.708	3.606	0.000
Strategic Consensus	59.90	123.00	63.10	0.720	3.879	0.000
Int. Emp. Assessment and:						
Int. Info. Technology	31.50	82.80	51.30	0.463	2.536	0.011
Mgmt. Support	37.10	114.10	77.00	0.660	3.548	0.000
Strategic Consensus	61.80	138.00	76.20	0.706	3.551	0.000
Int. Info. Tech and:						
Mgmt. Support	57.50	131.80	74.30	0.531	3.397	0.000
Strategic Consensus	40.00	82.90	42.90	0.575	3.608	0.000
Mgmt. Support and:						
Strategic Consensus	43.10	114.90	71.80	0.342	2.742	0.006

251

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276

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