OUTSOURCING DIRECT MATERIALS PROCUREMENT IN AN OUTSOURCED MANUFACTURING ARRANGEMENT

by

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ABSTRACT

In the current business environment, outsourcing is a common tool firms use to lower costs, attain access to technology, and to focus on core competencies. Procurement outsourcing is beginning to increase for nonstrategic or indirect purchases. However, outsourcing the procurement of direct materials occurs very infrequently. One exception to limited outsourcing of direct materials is the context of contract manufacturing. When outsourcing the manufacturing of a product or subassembly, original equipment manufacturers (OEM) enter a decision process to retain or outsource the procurement of direct materials for their contracted manufacturing activity. This study examined this phenomenon to determine how decision factors impact the level of procurement outsourcing. To firmly base this study on existing theory the frameworks of transaction cost economics and resource-based view were used to examine how the factors of procurement outsourcing impact the outsourcing decision. An internet survey methodology was implemented to collect data from purchasing managers in the electronics industry for theory building through hypothesis testing.

This research resulted in a greater understanding of procurement outsourcing. The primary contribution better characterized the relationship of drivers to the procurement outsourcing decision in the context of outsourced manufacturing. OEM procurement competence and leverage reduced levels of procurement outsourcing while Contract Manufacturer (CM) manufacturing competence, procurement competence, and leverage increased procurement outsourcing. Additionally, CM procurement competence and competitive advantage were merged to a single latent construct during unidimensionality testing. CM manufacturing capabilities could not be separated from procurement capabilities. Six procurement arrangements were identified through cluster and discriminant analysis. These arrangements indicate three levels of outsourcing with two arrangements at each level based on different decision variables. Discriminant analysis identified three dimensions that identified over 98% of the variance of the six arrangements. The dimensions of CM leverage, CM control of critical direct materials, and OEM leverage had high predictive power for discriminating between the groups.

This research extends current theoretical paradigms of procurement and outsourcing and builds outsourcing knowledge that will enable practitioners and managers to better evaluate the decision to outsource direct materials procurement. Future research should apply the principles supported to other industries and other contexts.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

OVERVIEW OF THE RESEARCH

Introduction

Outsourcing is a prevalent business activity that currently drives heated debate in the United States. This debate ranges from the boardroom, to the affected community, to the highest levels of national political institutions. Outsourcing has been less prevalent in functions that firms perceive to be strategic. Supply management or procurement was often considered to fall in that strategic realm. As a result, "many organizations do not outsource these supply management activities at all (Ellram & Maltz, 1997, pp. 23)." However, this trend is changing. Firms are now shedding activities once considered strategic to focus their efforts and resources on core competencies in their pursuit of sustainable competitive advantage.

Strategic activities like manufacturing and procurement are no longer shielded from outsourcing. The decision to outsource procurement and manufacturing are evolving and changing the way firms do business. A recent survey focusing on strategic outsourcing indicates that that firms are outsourcing up to 20% of transaction processing activities, 13% of supplier management activities, and 15% of procurement strategy activities for purchases of MRO, indirect materials, and services. However, for direct materials purchases the numbers were almost 50% less, coming in at 9%, 4%, and 4% respectively for the same three procurement activities (Monczka, Markham, Carter, Blaskovich, & Slaight, 2005).

Outsourcing the procurement activity for direct material purchases is a phenomenon that occurs infrequently in practice. Firms appear reluctant to release control of their purchases of materials that directly support their manufacturing operations. However, contract manufacturing or manufacturing outsourcing is becoming a common business practice. Firms are more and more willing to outsource their manufacturing to a more efficient contract manufacturer. It seems ironic that firms protect direct materials procurement aggressively to ensure adequate support of manufacturing, yet these same firms are willing to outsource the very manufacturing activities that they protect.

When firms outsource manufacturing, an interesting phenomenon occurs: some firms retain the procurement activities or choose to decouple procurement responsibility from the firm manufacturing the product. The fact that some firms decide to outsource the procurement while others retain these activities for their outsourced manufacturing indicates that there may be situations where assigning manufacturing and procurement responsibility to two distinct firms is preferred. It also presents an opportunity to examine the conditions that would lead to the decoupling of these responsibilities and the outsourcing of direct materials procurement responsibility. The decision to outsource manufacturing appears to be one of the few situations where firms are also engaging in a decision process that approximates outsourcing the procurement of direct materials. Monczka et. al. (2005a) refer to this as a subtle form of outsourcing the procurement of direct materials and indicate that firms outsourcing manufacturing face a decision to retain or outsource purchasing. The decision to outsource direct materials procurement within the context of contract manufacturing appears to be a dynamic decision process.

Motorola recently indicated that it was pulling back in-house the procurement of direct materials and that it would purchase parts for and sell parts to its contract manufacturers (Sullivan, 2003). Firms are making a conscious decision to retain or outsource direct materials procurement. The context of contract manufacturing provides a unique scope within which we can examine the factors driving a decision to outsource direct materials procurement responsibility.

Figure 1: Research Scope

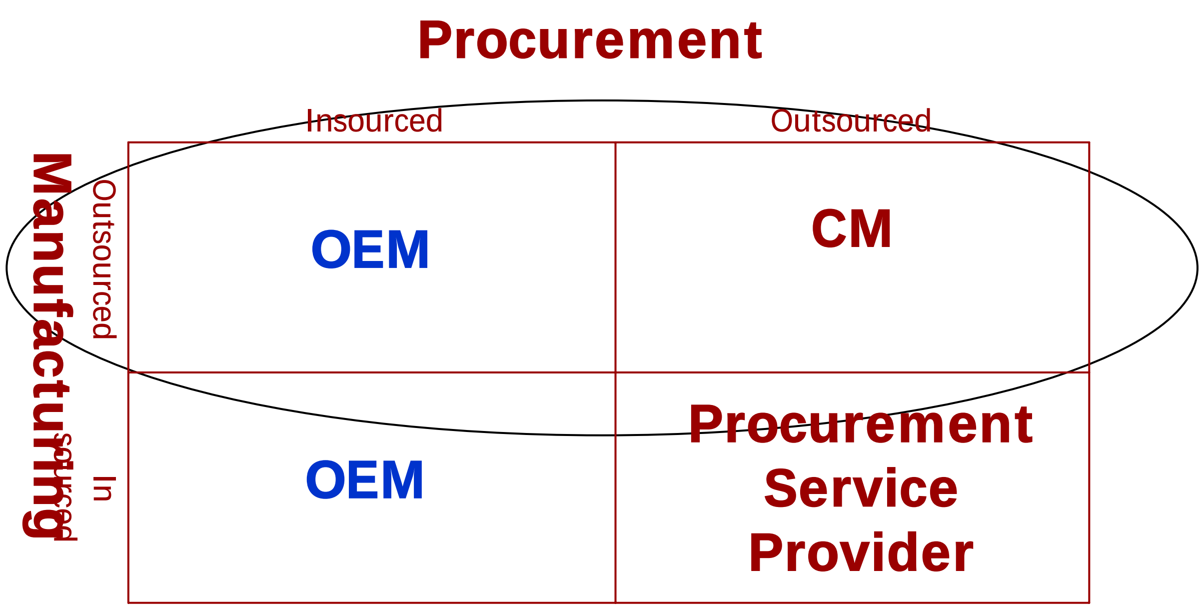


Figure 1 indicates that the research scope will consist of the context where the OEM outsources manufacturing and either outsources or retains procurement responsibility. This research does not address the outsourcing or the retention of the procurement of direct materials when manufacturing is not outsourced. However, the factors affecting this decision within the study context can be theoretically extended to the context where manufacturing is not outsourced. All data collected for this study will be limited to the manufacturing outsourcing context. Examining this phenomenon within this research scope enables the pursuit of the following research objectives and questions.

Research Objectives

- Understand what motivates a firm's decision to outsource or retain direct materials procurement responsibility when product manufacturing is outsourced
- Understand potential determinants or factors for outsourcing the procurement responsibility of direct materials generally when not restricted to the condition of manufacturing being outsourced

Research Questions

- How does the procurement outsourcing decision relate to the manufacturing outsourcing decision?
- What are the important factors in the decision to retain or outsource purchasing?

This research effort obtains data to address and answer these questions and objectives. By doing so, it may be possible to gain insights into the potential to outsource direct materials procurement for manufacturing that is not outsourced by the firm. This research contributes to the body of procurement knowledge by identifying the determinants of outsourcing direct materials procurement when manufacturing has been outsourced and the potential determinants for general direct materials procurement outsourcing.

Theoretical Lens

Answering these research questions requires a thorough examination of the procurement outsourcing decision in the outsourced manufacturing context. The first step is to examine the drivers of the decision to outsource manufacturing. Do these drivers have an effect on the decision to outsource purchasing? Data may indicate an inherent motivation to outsource procurement based on the decision to outsource manufacturing. The second step is to evaluate the drivers of the procurement decision. It is important to examine concepts such as leverage, the level of product standardization, issues surrounding supply base maintenance and other drivers to determine the extent and nature of those drivers that impact the procurement outsourcing decision. In order to build a theoretical framework of research propositions, this study will draw from existing theoretical frameworks.

Concepts and principles of transaction cost economics and resource-based view will be used in conjunction with literature on procurement outsourcing for the outsourced manufacturing context. Each of these theoretical frameworks will form the basis for theory testing that occurs in this research.

Transaction cost economics is a theory that is especially relevant to the outsourcing decision. Coase (1937) initiated this theory by examining how and why firms decide to use the firm or the market for a given activity or product. Manufacturing outsourcing is a decision that firms make to obtain a competitive advantage over or to maintain parity with competitors. Although some of the same factors in the decision to outsource manufacturing are relevant to the procurement responsibility decision, there are other factors that are unique to the procurement outsourcing decision. Transaction cost economics provides an ample theoretical lens through which to view these factors. Inter-firm relationships, product complexity, market maturity, and differentiation are several of the factors that impact outsourcing decision processes. Transaction cost economics is built upon constructs that enable a robust analysis of the outsourcing decision and how these factors influence that decision (Rindfleisch & Heide, 1997).

Resource-based view is another important theoretical framework that enables analysis of the outsourcing decision. Barney (1991) indicated that resources can be acquired and used by a firm to develop a sustainable competitive advantage. The ability of a firm to maintain a lead with respect to other firms in the development and leveraging of a particular resource forms the basis of competing with resources to generate economic rents. Core competence perspective, an outgrowth of resource-based view, encourages not only the pursuit of resources that enable competitive advantage, but also spinning off any resources that do not contribute (Quinn & Hilmer, 1994). A good portion of industry has adopted this approach as a competitive strategy. Resource-based view therefore is a theoretical framework that enables researchers to examine the outsourcing decision.

These theoretical frameworks build on primarily complementary concepts and principles that apply to this untested phenomenon. These frameworks are contextually consistent with an outsourcing decision. For these reasons, it is possible to examine this phenomenon based on previously supported theory that enables new insights into the outsourcing of direct materials procurement.

Contribution of the Research

This research provides a greater understanding of procurement outsourcing. The primary contribution is a better characterization of the relationship of drivers to the decision to outsource procurement in the context of outsourced manufacturing for a product or major subsystem. Additionally, this research extends current theoretical paradigms of procurement and outsourcing. Additionally, it provides an initial framework of potential drivers for outsourcing the procurement of direct materials outside the context of outsourced manufacturing by extending the findings from this research.

This study's survey research benefited the results in two ways. First, this research enabled the examination of drivers affecting the procurement outsourcing decision. Second, the survey data collected enabled the testing of hypotheses developed from existing theory and literature. Furthermore, it tests a proposed theoretical model within the context of this research.

This research also builds outsourcing knowledge that will enable practitioners and managers to better evaluate the decision to outsource direct materials procurement. It appears from the literature that the phenomenon under study is expanding. This expansion presents opportunities for managers to apply principles supported in this study to understand why and when to outsource procurement. Thus, this study enhances the academic and practitioner bodies of knowledge of outsourcing and procurement.

Overview of the Study

Chapter 1 introduces and provides an overview of this dissertation. In chapter 2, the literature is reviewed to establish a general procurement process, to document procurement outsourcing and the evolution of contract manufacturing, and to examine documented procurement outsourcing arrangements used by firms that outsource manufacturing. Chapter 3 examines relevant principles of transaction cost economics (TCE) and resource-based view (RBV) theoretical frameworks and indicates areas were the two theories are relevant to the outsourcing decision under study. Additionally, research hypotheses are presented extending these theoretical frameworks to direct materials procurement outsourcing within the context of outsourced manufacturing. The research design, the study methodology, and data analysis techniques are described in Chapter 4. In Chapter 5, the data analysis results and findings are detailed. A discussion of study findings, implications, limitations, and future research opportunities are included in Chapter 6.

CHAPTER 2

LITERATURE REVIEW

Introduction

To build a necessary framework for procurement and outsourcing, this chapter reviews relevant procurement and outsourcing literature. First, the general procurement process through which firms obtain necessary materials for production operations is examined. Second, literature is reviewed to establish a baseline for manufacturing outsourcing or contract manufacturing. This review helps to establish the primary factors related to contract manufacturing and its evolution. Additionally, it indicates that firms are making a decision to outsource or retain procurement. Third, the review of contract manufacturing is followed by a review of the literature on procurement outsourcing. The limited amount of literature in this area supports the retention of direct materials procurement. Finally, this chapter concludes with a discussion of the procurement arrangements within the context of outsourced manufacturing. These arrangements form a notional continuum of approaches to outsourcing the procurement responsibility for direct materials. This chapter synthesizes the current body of knowledge for procurement outsourcing and contract manufacturing.

Procurement Framework

Procurement is a dynamic process that begins with establishing a procurement strategy for material requirements identified during design or product modification, involves the evaluation and selection of suppliers, enables the procurement of materials, and measures supplier performance. This process is critical in supply chain management as it links suppliers providing components and materials to the manufacturing process and builds the upstream portion of the supply chain.

Based on the requirements for direct materials, firms begin the procurement process. For the purposes of this research study the five phase process illustrated in Table 1 forms the basis for evaluating the extent of procurement outsourcing. This process has been adapted from a number of research studies. Because this research focuses on procuring direct materials for manufacturing operations, this process refers only to materials. However, it could easily be modified to take services into account. Each of the five phases is discussed in greater detail in the following paragraphs.

Table 1: Procurement framework

Phase 1: Establish a Purchasing Strategy	Phase 2: Evaluate Suppliers	Phase 3: Screen and Select Suppliers	Phase 4: Procure Materials	Phase 5: Measure and Manage Supplier Performance
Build a purchasing strategy based on: • Importance of materials/components • Manufacturing requirements • Supply market analysis • Potential customer use and demand.	• Identify a pool of qualified suppliers • Develop a category strategy • Develop selection criteria	• Release request for proposal (RFP) • Analyze bids & past performance • Select supplier • Negotiate and finalize contract • Agree on supply and logistics terms	• Monitor inventory • Order materials • Receive materials • Inspect materials	• Monitor supplier's performance • Identify improvement opportunities • Analyze supplier relationships

(Adapted from Monczka, Trent, & Handfield, 2005b; Ellram & Edis, 1996; Banfield, 1999; Zeng, 2003; Anderson & Katz, 1998; Ellram & Maltz, 1997)

First, firms develop a purchasing strategy for material needs they have identified. In outsourced manufacturing arrangements, requirements are generated through a number of means. The OEM or the CM may jointly or unilaterally design a new product or modify an existing product design. These new designs or changes to existing designs result in new material requirements for the manufacturing operation. Although purchasing activity often starts with design or product modification activities, a decision to exclude these activities from the procurement process was made to establish a process that could be more generally applied to firms. Firms may not include procurement in their design process or product manufacturing may not be outsourced until several years after initiating production. In order to ensure the procurement process could be applied to almost all firms, the process begins after design is completed and material and component requirements have been identified.

Once the material requirements have been identified, the firm then takes action to determine the procurement strategy it will pursue to acquire the needed materials in order to support the firm's competitive strategy with the product. A first step in building a procurement strategy is to determine the strategic nature of the components and materials to be purchased for the product. Category analysis or a portfolio approach is used to assess the importance of the purchase to profitability and the level of risk associated with the purchase (Kraljic, 1983) to determine if the purchase should be managed as strategic, bottleneck, leverage, or commodity. Determining the nature of the purchase through category analysis helps procurement personnel decide how to structure the buyer-supplier relationship to acquire the materials as required for production.

Purchases that are high with respect to both criteria indicate a strategic purchase. Here the supplier will play a critical role in the supply chain. Because of their importance, cooperative long term relationships are constructed to enable a strong relationship to facilitate tacit knowledge sharing, trust, joint problem solving, and participation in new product development (Olsen & Ellram, 1997; Dyer, Cho, & Chu, 1998; Dyer & Nobeoka, 2000; Heide & Miner, 1992; Watsi & Liker, 1999; Petersen, Handfield, Ragatz, 2003). These strategic relationships protect the firm from supply risk and ensure the proper allocation of resources necessary to acquire important materials and components that are essential for production.

Purchases low in importance and risk are classified as a noncritical (Olsen & Ellram, 1997). Arms length relationships (short term and competitive) are common and the supplier will play a less important role in the supply chain. Often, these items are commodities (highly standardized, high number of suppliers, compete on cost).

Outsourcing activities that have mixed levels of importance and risk are classified as leverage (high, low) and bottleneck (low, high) (Olsen & Ellram, 1997). These relationships do not have the level of commitment of strategic purchases and are constructed to mitigate risk, to ensure materials are available to meet the requirements of production, and to enhance procurement efficiency. Procurement personnel attempt to determine the required relationship necessary to perform as desired. It is of critical importance to understand the market factors that will affect the firm's ability to achieve its competitive strategy.

Consistent with category analysis, firms build a procurement strategy based on manufacturing requirements and careful analysis of the supply market. Here strategy development efforts examine the market forces that could affect the firm's ability to compete (Zeng, 2003). Porter (1979) suggests that five factors should be examined. These five factors consist of the threat of new entrants, the level of competition in the industry, the bargaining power of suppliers and buyers, and the threat of substitutes. Evaluation of these factors helps firms determine the viability of their overall competitive strategy and procurement actions that they need to take to support this effort. Buyer and supplier power and the level of competition in the supply market are particularly important for understanding the ability of the firm to execute its procurement strategies. Knowledge of the firm's power or dependence on suppliers as well as the number of competing suppliers are critical elements that underlie any procurement strategy. In addition to examining market forces, it is critical for procurement to understand the potential demand for product and how that demand will impact procurement requirements.

Another element of building a procurement strategy to manufacturing requirements is the need to integrate the acquisition of materials with manufacturing demands. Procurement should examine processes looking specifically at their production requirements, yield rate, scheduling mechanism (JIT vs. MRP), amount of materials required per unit of product produced, inspection requirements, and any other production factors that will place additional requirements on procurement. It is important to integrate purchasing activities with production planning (Rajagopal & Bernard, 1993). Goals are established to support user groups in areas such as total cost of ownership, acquiring new technologies, and acquiring new sources of supply (Anderson & Katz, 1998). Pagell and Krause (2002) found that highly integrated manufacturing and procurement functions in competitive environments outperformed firms with less integration. Not only is it important to respond to manufacturing demands, but also to be aware of the final customers' requirements.

Understanding the customer enables firms to build strategies that support customer needs. Customer analysis based on projected market demand (Zeng, 2003) enable the development of parameters for the length of contracts, potential volume over time, and the potential for requirements of additional capacity or changes in product specifications. Market forecasts enable procurement personnel to meet projected consumer demand (Monczka et. al., 2005b). This analysis helps place bounds on the procurement activity required to support a particular product.

Phase two of the purchasing process focuses on building a pool of competent potential suppliers and establishing the selection criteria necessary to choose the appropriate supplier from this pool. For standard or commodity items, suppliers are readily available. However, for new or complex items, some investigation is required to ensure that only qualified suppliers are considered (Monczka et. al., 2005b). In the process of identifying potential suppliers, procurement personnel should screen suppliers to ensure that they can meet all requirements necessary to provide the desired part or material (Novack & Simco, 1991). Price is only a small portion of the costs affecting the firm's ability to manufacture and compete with a product. Firms should consider the total lifecycle costs of each supplier as they start to build a pool of qualified suppliers. Consideration of cycle time, engineering, maintenance, installation, and other factors are critical in determining the total cost of selecting a specific supplier (Ellram & Edis, 1996). Building the pool of competent suppliers should take into consideration the category strategy established for each material input.

In phase one, category analysis was used to ascertain the ideal relationship for the purchase based on supply risk and the importance of the purchase. The next step is to develop a strategy to build this ideal relationship with each supplier selected in phase three. Qualified suppliers are examined for relationship strength and supplier attractiveness and action plans based on resource allocation are developed to build the desired relationship (Olsen & Ellram, 1997). Past performance is often the best measure of a supplier's ability to perform in potential relationships. Based on past performance, preferred suppliers can be identified. The use of preferred suppliers reduces procurement process time and resource expenditure (Monczka et. al., 2005b).

Finally, procurement personnel and their functional counterparts should establish selection criteria based on the performance criteria necessary to acquire the desired material. Past performance, commitment to quality, technical ability, product design capability, process capability, and cost and delivery performance are some typical criteria that are often used as selection criteria (Monczka et. al., 2005b). These factors are weighted to ensure the firm selects a supplier that performs the best on the most important criteria (Anderson & Katz, 1998). After developing the supplier selection criteria, the procurement process moves into phase three where suppliers are selected.

In the supplier selection phase, formal RFPs are released to potential suppliers, supplier proposals are examined, suppliers are selected, contracts negotiated and finalized, and supply and logistics terms are defined for the purposes of the contract. Potential supplier firms receive requests for proposals or quotes depending on the process selected for acquiring the item (Monczka et. al., 2005b). This decision is based on the category analysis and strategy developed previously. Firms will now build buyer-supplier relationships from short-term, arms-length to long-term, cooperative. Dyer et. al. (1998) refer to this as supplier segmentation, building a relationship based on the strategic importance of the input to the firm. Competitive bidding may occur for commodity-type material, while negotiations are more common for more strategic materials. Based on this activity suppliers are selected and contracts are finalized. Firms come to a common agreement on logistics and supply expectations and terms (Zeng, 2003). Supply relationships now exist to provide the necessary materials for production.

In phase four, materials are procured for manufacturing operations. Ordering materials, receiving, inspection, and monitoring inventory are the nuts and bolts of executing the purchase (Ellram & Maltz, 1997; Anderson & Katz, 1998). In this phase, procurement personnel make the materials physically available for production operations. These activities are often considered inbound logistics (Maltz & Ellram, 2000). Automated ordering processes are often used to lower transaction costs, reduce errors, maintain low inventory levels, and ensure operations are adequately supplied (Krajewski & Wei, 2001; Srinivasan, Kekre, & Mukhopadhyay, 1994; Anderson & Katz, 1998). Failure to provide production operations with the required materials could result in costly delays, but high inventory levels in the supply chain will drive high carrying costs. However, this process must be designed with the product strategy in mind. Some commodity-like products require optimum efficiency, while differentiated products often require higher inventory levels to respond to large fluctuations in demand (Fisher, 1997). Ultimately, the goal is to ensure that suppliers and manufacturing operations jointly support the product strategy designated by the OEM.

The final phase measures and manages supplier performance to ensure that supply management activities provide manufacturing operations the required support. Performance measures in the supply contract that indicate how the supplier should perform are tracked to determine if needs are satisfied (Novack & Simco, 1991). Not only should firms determine that contractual compliance has occurred, but that continuous improvement efforts are implemented to improve upon the limitations inherent in the contract (Williamson; 1971; Monczka et. al.; 2005b). These improvements can occur in cost, quality, process, and supply chain management and form the basis of competitive advantage when suppliers are managed as valuable assets (Anderson & Katz, 1998). It is also critical to evaluate supplier relationships to determine if they should be expanded, dissolved, or reduced (Ellram, 1991). Procurement's role in the management and measurement of suppliers is crucial to maintaining a healthy supply base that can contribute to firm competitive advantage.

This procurement process will be used to determine the level of procurement outsourcing which has occurred as firms have outsourced manufacturing. The phases in this process will be used to capture the level of procurement outsourcing. For example, it may be possible that a firm outsources phase four to the contract manufacturer to ensure an adequate supply for operations, while retaining all other phases of the procurement process. It is important to understand contract manufacturing or manufacturing outsourcing to better envision the potential for procurement outsourcing in this context.

Contract/Outsourced Manufacturing

Contract manufacturing involves firms outsourcing current manufacturing activities or contracting with a firm to produce a product that will carry the OEM brand. McClintock (2002) defined contract manufacturing as mass producing products that another firm developed. Kim (2003) identified it as a supply chain arrangement in which a manufacturing company outsources some of its internal manufacturing processes. These two definitions imply that a contract manufacturer (CM) is limited to producing products developed by the manufacturing firm. Although this was true initially, the role of contract manufacturers has grown significantly. For this study, contract manufacturing is the act of contracting with a firm to produce a product that will carry the OEM brand, regardless of the level of specification development accomplished by the OEM.

Contract/outsourced manufacturing evolved from a safety outlet for OEMs to become a substantial force in today's supply chains. Contract manufacturing was initially a stop-gap arrangement that firms employed to meet demand when internal manufacturing capacity was insufficient (Carbone, 2000b; Kador, 2001; Harrington, 2000; & Gregory, 1995). Using contract manufacturers as buffers for needed manufacturing capacity was typical for much of the 1980s.

In the late 1980s and 1990s a number of factors changed the competitive environment and the role of the CM. An increased pace of technological change coupled with a reluctance to invest in manufacturing equipment (Mason, Cole, Ulrey, & Yan, 2002), a booming economy, and increased global competition (Frolich & Dixon, 2001) drove OEMs to look to CMs as more than capacity relief valves, but also as important supply chain partners (Carbone, 2000b). CM involvement grew from manufacturing to the OEM's specification to include all aspects of manufacturing and distribution, including procurement. This enhanced role consists of cradle to grave involvement in new product development (NPD), parts procurement, assembly, inventory management, distribution, and order fulfillment (Harrington, 2000; Carbone, 1996a; Carbone, 1996b). CMs moved to an integral position within the product supply chain by becoming facilitators of efficient manufacturing through collaborative design and development (Baatz, 1999). Not only was manufacturing improved, but CMs helped streamline the global supply chain, NPD, and engineering teams (Kador, 2001; Gregory, 1995). An example of this enhanced role comes from the electronics industry where two new entities, contract design manufacturers (CDM) and original design manufacturers (ODM), are increasing CM importance in the industry. CDMs specialize in providing design support to ease the transition from prototyping to mass production for higher end, higher value customized product design and manufacturing. ODMs not only assist the customer with design activities, but also design, manufacture, and compete with their own brands (MacLellan, 2003). Because CMs are continually increasing the services they offer OEMs, CM use has increased among OEMs.

In 1999, Baatz reported that 54% of computer, communications, automotive, medical, and industrial control equipment OEMs outsourced part of their manufacturing. In 2001, Mulcahy indicated that an estimated 72% of OEMs used contract manufacturing and that 42% of those currently involved with CMs will increase their use, while 55% will remain the same. The pharmaceutical industry level was 20% in 1988, it increased to between 50-60% in 1998, and is expected to be at 60-70% in 2005 (Plambeck & Taylor, 2005). Outsourcing manufacturing is an increasing trend that will continue to grow.

The prevalence of contract manufacturing within the electronics industry makes it the most meaningful target for collecting data for this dissertation. From World War II to the present, the electronics industry produced approximately 30% of the US economy's GNP (Mason et. al., 2002). Electronics permeate every aspect of society from industrial to residential products and services. Additionally, manufacturing outsourcing has sustained significant and continued growth in this industry. From 1989 to 1998, contract manufacturing within electronics grew at a compounded average growth rate of 25% and the long-term growth rate is projected to continue at 25% per year (Plambeck & Taylor, 2005). The use of CMs is so institutionalized in the electronics industry that the CM name evolved to electronics manufacturing services firms (EMS), reflecting the change from a transactional to a transformational role (Kador, 2001; Mulcachy, 2001). From 1994 to1998, CMs' share of electronics manufacturing grew from an estimated 9% to 17% (Plambeck & Taylor, 2005). EMS firms are taking an active role in procurement and inventory management responsibility (MacLellan, 2003). The outsourced manufacturing context in the electronics industry presents an opportunity to examine direct materials procurement outsourcing.

Contract manufacturing or the outsourced manufacturing context presents an opportunity to examine procurement outsourcing, because of the willingness of OEMs to relinquish direct materials procurement. The section below examines the literature on procurement outsourcing and indicates a general unwillingness to outsource strategic or direct procurement.

Procurement Outsourcing

Outsourcing initially targeted functions secondary to firm competitive strategies, but recently firms have acted to outsource more strategic functions like manufacturing, design, and purchasing (Avery, 2002; Edwards, 1997). Because procurement has traditionally played an important role in supplier selection, contracting, management, and evaluation (Rajagopal & Bernard, 1993), firms have been reluctant to outsource it.

Procurement service providers have improved their ability to achieve economies of scale in the purchase of commodities by pooling the purchases of different firms and obtaining low product and transaction costs (Edwards, 1997). Some outsourcing is initiated to obtain higher levels of efficiency for nonstrategic purchases. Purchasing service providers appear to hold some advantage in the acquisition of nonstrategic items (Maltz & Ellram, 1999; Edwards, 1997; Matthews, 2002). Examples include Harley-Davidson outsourcing all indirect purchases achieving $4 million in savings in the first year and another firm that outsourced indirect spend was able to reduce personnel, control maverick spending, improve core competence focus, and lower overall procurement costs (Carter, Beall, Rossetti, & Leduc, 2003). For some firms, procurement is not considered core and outsourcing presents the opportunity to acquire efficient purchasing services with less management responsibilities (Edwards, 1997). It appears that outsourcing procurement is viable and may be advantageous for nonstrategic purchases.

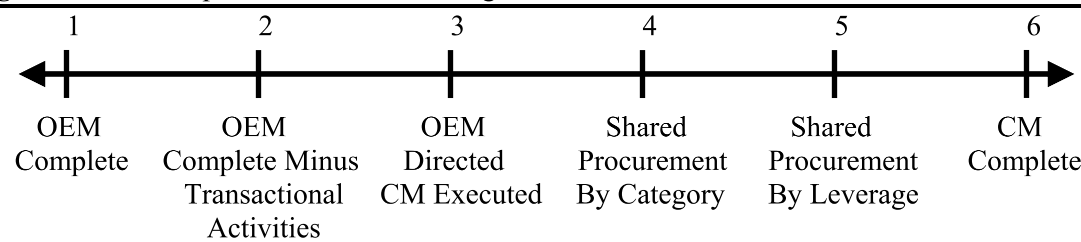
Firms face significant risks with a decision to outsource supply management. Although the number of purchasing personnel may be reduced and supply management is able to focus more on strategic purchasing, competitive advantage may not materialize. At best, purchasing savings are shared in comparison to a direct contribution to firm profits achieved by internal procurement savings (Koskie, 2002). Even more important is the potential to lose direct relationships with suppliers. This loss of contact may negatively impact competitive advantage in industries where suppliers control the technology or where the competitive environment drives a high level of coordination or cooperative relationships (O'Brien, 2002; Edwards, 1997). Some firms terminated outsourcing agreements because service provider competence was questionable. A major concern is the availability of experienced purchasers to service providers necessary for effective performance (O'Brien, 2002). Firms are reluctant to release strategic/direct materials procurement responsibility to another firm. Ellram and Maltz (1997) supported that firms view internal supply management functions superior to third party procurement service providers in their ability to manage the strategic purchase. Their empirical study indicated low levels of outsourcing for these strategic purchases that include direct materials. However, within the contract manufacturing context firms relinquish the core responsibility of manufacturing and also outsource procurement responsibility.

Procurement Arrangements

Initially, CMs had little or no procurement responsibility for outsourced manufacturing operations (Carbone, 1996a). But, over time CM procurement responsibilities grew substantially. In the 1980s, CMs were employed to supplement OEM manufacturing and played a limited role in supply chain management (Kador, 2001). However, Kardor reports that in 2001 82% of EMS firms decided what components to use in final products, 80% recommended suppliers and brands, and 48% held final authority over vendor and brand selection. CMs also have a large role in purchasing and supplier selection during NPD (Mulcahy, 2001). This increased purchasing role for CMs enables a number of purchasing arrangements to be made in the OEM-CM relationship. Outsourcing none, some, or all of purchasing responsibilities are all viable options. For this study, **procurement outsourcing is the OEM assigning any level of responsibility for the procurement of direct materials to the contract manufacturer.**

Six procurement arrangements found in the literature have the potential to describe the various levels of procurement responsibility sharing in outsourced manufacturing relationships. These arrangements can be viewed on a notional continuum as shown in Figure 2. OEM procurement responsibility is highest at the far left and decreases along the continuum with movement to the right. These six arrangements are described below. However, it is important to realize that arrangements two through five are only notionally placed on the continuum. This research may enable the development of a taxonomy of procurement arrangements ordered by empirically measured levels of procurement outsourcing. The six arrangements on this notional continuum are described below.

Figure 2: Notional procurement outsourcing continuum



In arrangement one, OEMs choose to manage all purchasing. This initial arrangement operates with the OEM purchasing parts, building kits, shipping the kits to the CM, and with the CM shipping the finished goods back to the OEM (Kim, 2003; Ellram & Billington, 2001) or the OEM purchases materials and has them shipped directly to the CM. This type of arrangement is appropriate for the CM that is functioning as a capacity safeguard, but may not provide the needed efficiency or flexibility required for other outsourcing arrangements.

In arrangement two, OEMs perform all purchasing responsibility with the exception of ordering, receiving, inspecting incoming materials, and managing preassembly inventory management. At this level of procurement responsibility, CMs order parts and materials from suppliers that have been preapproved by the OEM (Kim, 2003). In the first two arrangements, the OEM considers their purchasing leverage to be greater than the CM's (Ellram & Billington, 2001). IBM pursued this approach by buying items for CMs to save the cost difference between its price and the CM's price (Carbone, 2000b).

In arrangement three, the OEM selects the suppliers the CM must use to ensure the OEM can maintain its leverage, a primary concern for OEMs that Ellram and Billington (2001) highlight in a case where an OEM outsourced procurement responsibility with manufacturing and lost its leverage with suppliers, resulting in higher material costs. In this arrangement, the OEM places all aspects of the buyer-supplier relationship in the CM's hands. The OEM selects suppliers and negotiates prices. The CM identifies to the supplier that the materials are for a product manufactured for the OEM. The CM negotiates a contract with the supplier, procures the materials, and manages the relationship. The supplier credits or pays the OEM any price difference for materials procured above the OEM negotiated price (Ellram & Billington, 2001). This arrangement places the strategic responsibility of supplier selection on the OEM, but enables the OEM to shed contract management and transactional responsibility for the procurement.

The fourth arrangement divides procurement responsibility based on simplified category analysis. Direct materials procurement responsibility is segmented into strategic (OEM) and commodity or noncritical purchases (CM) (Avery, 2002). Berstein (2003) notes that lower level procurement positions are moving overseas, while OEMs retain the sourcing of high-end products. This arrangement is used by Microsoft and Flextronics for the Xbox. Flextronics, the CM, purchases commodities and plans shipping for components. Microsoft took the strategic responsibility of managing 40 key suppliers (Hayes, 2002).

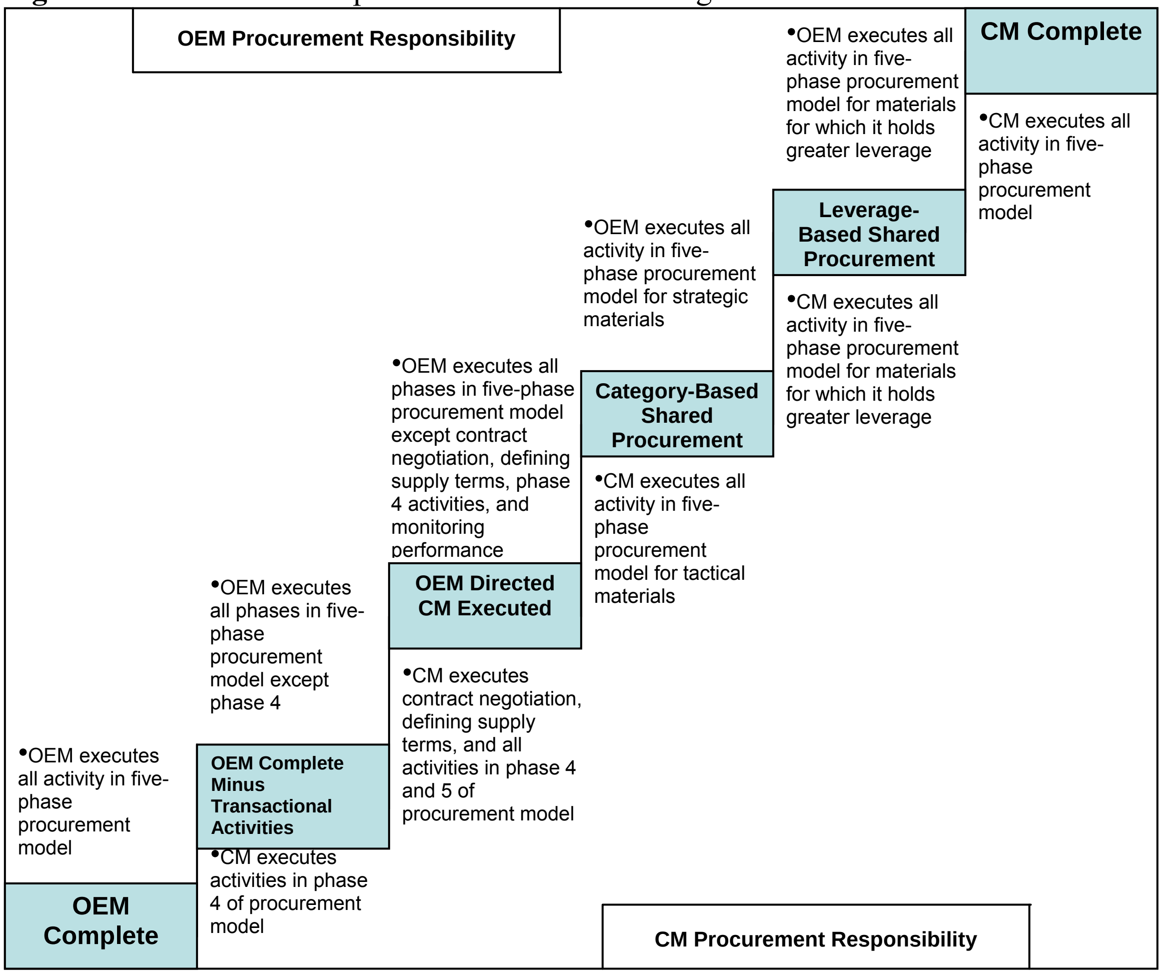
The fifth arrangement divides purchasing responsibility based on OEM or CM leverage advantage. The firm with the greatest leverage for an item procures it. Sometimes, the CM enjoys greater leverage than the OEM due to the use of similar components or materials resulting from similar manufacturing activities pooled from its various customers (Carbone, 1996b; McClintock, 2002; Ellram & Billington; 2001). Other times, CMs will not enjoy the leverage of the OEM as it makes small specialized purchases (McClintock, 2002). Therefore, firms divide responsibility based on leverage.

In the sixth arrangement the OEM gives full purchasing responsibility to CMs. Here the CM takes responsibility for all categories of strategic and tactical purchasing (Carbone, 1996a). The assignment of full procurement responsibility requires CMs to be or become competent in procurement and maintain a lean but adequate supply for production operations (Kador, 2001). In this arrangement, there are situations where CMs may improve procurement and others where CMs may be at a disadvantage.

It is possible that third party procurement service providers receive the purchasing responsibility instead of the CM. In this research, the text will reference the CM as the party accomplishing the procurement of direct materials. However, procurement service provider could be inserted in the place of CM and the two terms used interchangeably when referring to procurement responsibility outsourced by the OEM.

The division of procurement responsibilities is illustrated graphically by figure 3. These arrangements were verified in discussions with supply chain professionals. This notional continuum of purchasing responsibility enables an initial attempt to build a taxonomy that describes the assignment of procurement responsibility in outsourced manufacturing relationships. This research will attempt to empirically verify these arrangements, but may reveal other procurement arrangements.

Figure 3: Procurement responsibilities for each arrangement



CHAPTER 3

RESEARCH MODEL

Introduction

This chapter develops the research model based on existing theory and literature. The level of procurement outsourcing and the procurement arrangement used may be explained by theory. The next section will examine several theories that are relevant to this research. Two theoretical lenses contribute to understanding the decision to outsource procurement in an outsourced manufacturing arrangement. Transaction cost economics (TCE) and resource-based view (RBV) bring relevant constructs, assumptions, and principles that enhance our understanding of this decision. Each of these theoretical lenses is discussed below. Next, seven primary drivers of the direct materials procurement outsourcing decision are discussed and a theoretical model is developed. Theoretically based, testable hypotheses are derived from the model. This chapter takes the theories of TCE and RBV and applies them to procurement outsourcing in the outsourced manufacturing context and develops hypotheses that enable theory testing in this context.

Transaction Cost Economics

Transaction cost economics (TCE) contains a number of theoretically relevant principles and concepts that enable us to examine the procurement outsourcing decision in a manufacturing outsourcing context. Because the dependent construct in transaction cost economics is the governance decision to manage activity through hierarchy (vertical integration) or through the market (outsourcing) (Rindfleish & Heide, 1997), TCE is particularly relevant to the decision to outsource procurement. The decision to outsource is explained by the assumptions and constructs of TCE. The primary consideration is the minimization of transaction costs (Coase, 1937). The decision is found in the boundaries of whether to organize the activity or transaction within the firm and use hierarchy as the governance mechanism or to outsource and use the market (Coase, 1937; Williamson, 1971).

The primary behavioral assumptions related to transaction cost economics are found in the human behavioral aspects of contracting. First, physical and language limits create bounded rationality for those involved in drafting the outsourcing contract (Williamson, 1975; Rindfleish & Heide, 2000; Williamson, 1998). The result is contracts that do not address all firm needs. Second, firms involved in the contract may act opportunistically, in their own self interest (Rindfleish & Heide, 2000; Williamson, 1998). Opportunism can result in buying firms not receiving products or services as desired. Williamson (1998) argues that for contracts where bounded rationality and opportunism are probable and the potential impact is great, the firm will vertically integrate those activities to safeguard against negative impacts. Additionally, the three major TCE constructs of asset specificity, uncertainty, and transaction frequency must be considered.

Asset specificity in procurement is demonstrated by the transferability of the assets of a specific transaction (Rindfleish & Heide, 2000). When considered in the framework of purchasing, asset specificity is mostly human asset specificity. Procurement personnel often build relationships with suppliers that enable trust, cooperation, knowledge sharing, and value creation at an inter-firm level. These firm to firm relationships may not be transferable to a CM. Additionally, specific investments in

EDI or interorganizational systems to manage supply chain operations of purchasing and logistics may be difficult to transfer. Higher asset specificity in the purchasing activity is related to vertical integration or OEMs retaining purchasing responsibility (Williamson, 1985).

Uncertainty is a construct that TCE posits is important in procurement outsourcing. It is the variation in the processes under consideration for the make or buy decision (Maltz, 1994) or unanticipated changes in circumstances surrounding an exchange (Rindfleish & Heide, 2000). Sources of variation can be order quantities, procurement lead time, product demand, transportation requirements, inventory requirements, government regulation, product decisions, and international shipping requirements. Variation in these key elements may affect the ability of CMs or internal procurement functions to provide the level of service required in a competitive market or industry. If change is not predictable, investments in information technology, inventory, and personnel or the ability of a CM to accomplish procurement activities involve significant risk. Uncertainty does not affect nonspecific transactions because standardized transactions are readily available in the market. However, as asset specificity increases, risk increases and firms will act to safeguard investments (Williamson, 1985). Transaction cost economics posits that for higher levels of uncertainty firms, will act to standardize transactions and shift them to the market or organize them internally (Williamson, 1986).

Higher transaction frequency drives more ordering, receiving, inspecting, and inventory monitoring, resulting in higher levels of transaction costs and potential for economy of scale opportunities (Williamson, 1998; Maltz 1994). Williamson (1986) indicates that frequency refers to buyer activity and that the three levels of one-time, occasional, and recurring characterize the frequency construct. In this research, transactions enacted by the purchasing function are recurring. Purchasing direct materials for outsourced manufacturing operations is an ongoing effort required to support production. Therefore, because transaction frequency is a constant, it will not be operationalized as a construct for this research. (However, recurring transactions enable the construct of asset specificity to function and drive the organization of transactions through markets or vertical integration (Williamson, 1986).) Transaction cost economics will be used as one of the theoretical frameworks to build research propositions concerning the level of direct materials procurement outsourcing.

Resource-Based View/Core Competence Perspective

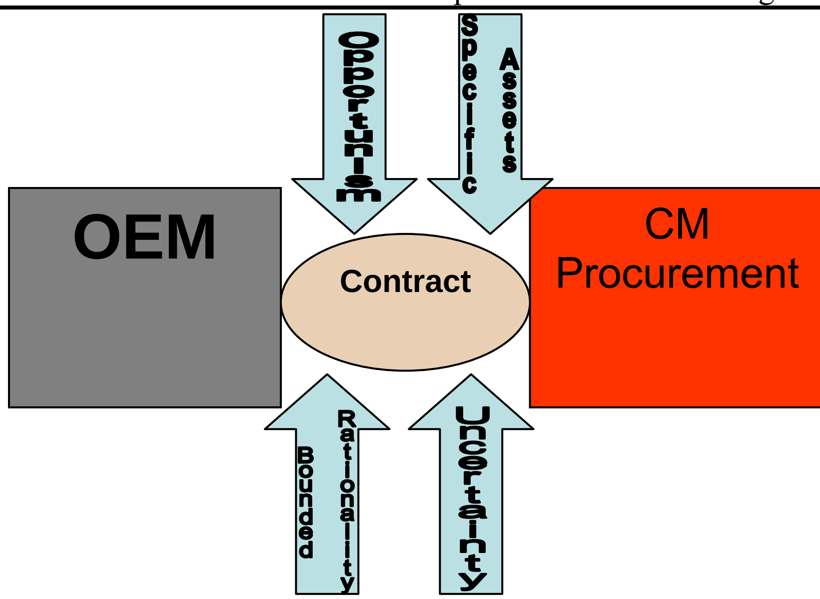
A primary challenge for all businesses is how to obtain a long-term competitive advantage that will ensure profitability and survival as a firm. Porter (1991) calls this a sustainable competitive advantage (SCA). He states that through sustainable competitive advantages firms obtain favorable relative positions. Resourced-based view indicates that firms try to obtain valuable resources to achieve competitive advantages (Wernerfelt 1984). Resources include not only the physical assets of the firm, but also intellectual and technological assets.

Prahalad and Hamel (1990) base their core competence paradigm on resource-based view and suggest that core competencies are the key to long-term competitiveness. Core competence perspective indicates that firms should outsource non-core activities and retain core competencies to achieve maximum gains (Quinn & Hilmer, 1994). The core competence approach focuses firms on the activities it does better than other firms and that contribute to sustainable competitive advantage. The result is competitive strength obtained through the elimination of activities that do not yield a competitive advantage, enabling the firm to focus their efforts, reduce capital investments, and to engage a service provider that enhances the firm's position through providing world-class products or services (Welch & Nayak, 1992).

Prahalad and Hamel (1990) state that three elements distinguish core competencies. First, they provide access to a wide variety of markets. Second, they make a significant contribution to customer perceived benefits of the end product. Third, they are difficult for competitors to imitate. Quinn and Hilmer (1994, p. 45) define core competencies as "skill or knowledge sets." They believe that core competencies form intellectual skills or knowledge that cut across functions or management systems, enabling the organization to perform better than the competition, thus achieving a durable competitive advantage through reducing cycle time, lowering investment, and improving customer responsiveness. The elements of core competence support strategies that integrate the firm as a whole to combine functional contributions in unique ways that prevent imitation or substitution.

These firms are not only dependent on their core activities, but also on other firms as they attempt to build a supply chain that is comprised of firms joined together for a common purpose and acting in their core activities. By linking firms' core competencies through supply chain relationships, competition moves from the firm to the supply chain level. The ultimate core competence is the management of the supply chain as a competitive weapon (Fine, 1998). Although outsourcing supply management presents significant risks to the firm, by using a contract manufacturing approach the firm has demonstrated a willingness to go beyond the traditional manufacturing paradigm. They are seeking to enhance performance by focusing on their core competencies and to leverage the core competencies of other firms. The decision to outsource procurement activities should follow the same considerations as manufacturing or any activity considered for outsourcing. A danger with outsourcing is losing critical skills and cross-functional coordination by mistakenly outsourcing a core competence (Jennings, 2002; Venkatasen, 1992). The identification and protection of core competencies are essential to maintain a SCA. Resource-based view will help explain the procurement outsourcing decision and build hypotheses for this research.

Figure 4: RBV/TCE theoretical framework for procurement outsourcing



Synthesizing TCE and RBV

There are several areas were TCE and RBV intersect to provide a consistent theoretical framework through which the outsourcing decision can be examined. These two theories function together to provide a rich theoretical framework through which to examine the impact of individual factors on the level of the procurement outsourcing of direct materials.

Asset specificity is a concept that is relevant in both paradigms. In TCE, asset specificity indicates a critical resource unique to a transaction or group of transactions that requires safeguarding to prevent opportunism. Similarly, the core competence perspective views these specific assets as valuable resources that should be protected to maintain competitive advantage (Williamson, 1999). Foss (1993) indicates that the competence perspective views these specific assets as the rent enabling mechanisms or resources of the firm. Both theoretical frameworks view specific assets as high value resources that impact performance. High levels of asset specificity are associated with vertical integration as a way to safeguard the resource. Additionally, the competence perspective views tacit knowledge or human asset specificity as one of these critical resources.

Although opportunism is not a major factor in the competence perspective, it plays a major role in the operation of specific assets in TCE and is not inconsistent with the safeguarding of resources that occurs in RBV. In this study, the potential for CMs to act opportunistically creates the need to safeguard specific assets. There are two cases where opportunism could negatively impact an outsourcing relationship. First, a firm could outsource a core competence, an important resource, or proprietary information, losing that competitive weapon (Venkatesan 1992). Second, outsourcing could enable the service provider to enter the market as a competitor (Quinn & Hilmer, 1994). For this reason, opportunism is always a concern with outsourcing.

Like TCE, RBV also contains the concept of bounded rationality. However, its use of bounded rationality indicates the difficulty of transferring tacit knowledge in supply chain relationships. When relating this to procurement outsourcing, human asset specificity in a buyer-supplier relationship is a primary resource developed through procurement activity. The casual ambiguity and social complexity inherent in these relationships form what would be considered bounded rationality, making the transfer of this human asset specificity difficult (Foss, 1993). This inability to transfer information leads to contractual incompleteness for outsourcing, similar to bounded rationality in TCE. Bounded rationality not only explains the inability of a contract to be completely forward looking from a TCE perspective, but also the difficulty of transferring valuable intellectual resources or learning within the contractual arrangement from the RBV perspective.

Uncertainty also plays an important role in TCE by making bounded rationality important for the asset specific transaction. Additionally, uncertainty characterizes the tasks that make up human asset specificity and the specific training and activity required in addition to the classroom to address the nuances of buyer-supplier relations (Williamson, 1985).

The concepts of asset specificity, opportunism, bounded rationality, and uncertainty impact the decision to contract for CM procurement services. See figure 4. TCE and RBV posit that increases in these factors are negatively related to procurement outsourcing. Additionally, it will be important to see if uncertainty impacts the level of outsourcing directly and as a moderator by interacting with asset specificity.

Drivers of Procurement Outsourcing

Seven drivers are hypothesized to influence the procurement outsourcing decision. The theoretical frameworks of RBV and TCE are used to develop hypotheses that indicate the relationship of each driver with the level of procurement outsourcing. Porter's five forces framework (1979) was the basis for six of drivers for this research because it captures major forces impacting competitive strategy. The first two drivers of the procurement outsourcing decision, OEM and CM procurement competence, were derived from the bargaining power of customers to indicate how purchasing activities, strategy, and experience impact the procurement outsourcing decision. OEM and CM procurement competence play a key role in who sources direct materials. The third driver, supply base maintenance was derived from what Porter called the bargaining power of suppliers. Competitive environment, a fourth driver, takes into consideration the OEM's business environment by combining three of Porter's five forces: the threat of substitutes, the threat of new entrants, and the competitive environment. Finally, Porter (1979) indicates that these forces play together to drive the firm's creation of a strategy to gain competitive advantage. OEM competitive advantage and CM competitive advantage are important drivers needed to assess the characteristics of strategy put in place to achieve SCA and how that drives the decision to retain or outsource procurement. These two strategy factors not only drive the procurement outsourcing decision, but the decision to outsource manufacturing. Because these two drivers contain important aspects that drive the contract manufacturing decision, they are used to assess the relationship between the manufacturing outsourcing decision and the procurement outsourcing decision.

The last driver, product commoditization, builds on the concept of product lifecycle (Hayes & Wheelwright, 1979) and asset specificity from TCE (Williamson, 1985). It enables insight into procurement outsourcing from the inherent nature and characteristics of the product in question.

Together, these seven drivers form the basis of the decision framework for outsourcing direct materials procurement, and the independent constructs of the theoretical model.

OEM Competitive Advantage (OEMCA)

Firms must consider the strategic contribution of a product to OEM firm strategy. Firms often rely on a core product to achieve competitive advantage (Prahalad and Hamel 1990). These products may form the central identity of the OEM's brand. As such, it is critical that procurement activities adequately support the production of this product. Core competence perspective indicates that firms should act to protect firm core competencies (Prahalad, 1990; Quinn & Hilmer 1994). At times, manufacturing outsourcing occurs as a result of limited manufacturing capacity (Carbone, 2000b). In this case, a firm still attaches a high level of importance to the product with respect to its competitive strategy. Usually, the manufacturer completed the product specification without any or with little assistance (Gregory, 1995). For a core product, OEMs do not usually release procurement responsibility to CMs because they need to maintain relationships with critical component suppliers to prevent diffusion to competitors. To protect human, technological, or inter-firm specific assets inherent to core products, OEMS will tend to procure materials internally, ensuring a desired level of quality or responsiveness required by a core product. Additionally, high human asset specificity would be present in purchasing activity with procurement personnel already maintaining relationships and knowledge on suppliers and materials.

Based on theory developed from TCE and from resource-based view or core competence perspective, these drivers of OEM competitive advantage are more related to retaining procurement. Firms that have outsourced manufacturing for a product that plays a role in the OEM core competence strategy would be less likely to outsource their procurement responsibility due to the high asset specificity of the procurement relationship (Williamson, 1985). These drivers form our first construct yielding the following hypothesis.

H1: OEM competitive advantage is negatively related to procurement outsourcing.

CM Competitive Advantage (CMCA)

CMs bring a package of resources to the market that drives the OEMs' decision to outsource manufacturing. CM manufacturing and design skills aid OEMs in bringing products to market faster and become a major influence in the decision to outsource manufacturing (Kador, 2001; Mulcahy, 2001; Carbone, 2000b; Blanchette, 2004; Keegan, 2004). Small OEMs frequently work with CMs to complete performance or unfinished product specifications, tapping into CM technical abilities (Blanchette, 2004; Mulcahy, 2001). These firms rely on the ability of the CM to manufacture and often desire expertise in process innovation and design support (Carbone, 1996a). When CMs control the product specification, the propensity is greater for procurement to be accomplished by the CM (Carbone, 2000b; Labowitz & White, 2001). When an OEM contracts manufacturing to gain CM technical expertise, the human asset specificity of CM procurement personnel will be higher than internal procurement personnel. This higher CM asset specificity for inter-firm relationships with critical suppliers and for knowledge of the supply market occur because the CM requires these strengths to support its design competence.

Perhaps CMs' most important competitive weapon is the capability to manufacture products efficiently. CMs have developed core competencies in cost and efficiency (Mason et. al., 2002). OEMs outsource to large CMs that obtain efficiency through economies of scale (Ono & Stango, 2005). This efficiency is a competitive advantage that OEMs exploit to ensure their products are cost competitive in the market (Blanchette, 2004; Keegan, 2004; Kador, 2001; Carbone, 2000a; Mulcahy, 2001). This efficiency also comes with high levels of quality (Kador, 2001; Hayes, 2002). Through outsourcing, OEMs are able to achieve desired levels of quality at lower cost. This low cost/efficiency focus requires efficiency throughout the supply chain and is related to greater purchasing efficiency.

Offshoring or business globalization is another OEM consideration in the decision to outsource manufacturing. By offshoring, firms are able to enter new international markets, gain access to low cost resources, improve supply chain efficiencies by manufacturing near the source of materials, and take advantage of supportive infrastructure (Vestring, Rouse, & Reinert, 2005). Globalization comes with challenges. Companies are hesitant to build internal operations in a country with a culture that is considered very foreign and where resources compatible with their needs are not available (Anderson & Coughlan, 1987). The strength of the CM in the international market, the robustness of their infrastructure, and their access to resources may enable the CM to develop core products and activities that can be integrated into OEM operations.

As CMs develop and acquire specific capabilities or human and physical assets that are difficult to attain in the international market, they build specific assets in their relationship with international suppliers.

When CMs achieve competitive advantages in the areas of technical expertise, specification control, manufacturing efficiency, and business globalization, the probability of outsourcing procurement increases. TCE and RBV support that CM competitive advantage is positively related to outsourcing. Core resources development by the CM drives the OEM to outsource those activities to strengthen its core resources (Quinn & Hilmer, 1994). Additionally, CM efficiency and competitiveness enable the OEM to procure materials with lower transaction costs through the CM. The CM has developed specific assets to support these activities (Williamson, 1985), giving their procurement function a competitive advantage over the OEM's. CMs build procurement human asset specificity in their purchasing functions as their purchasing functions support design expertise, efficient manufacturing, and international manufacturing. The market or CM would be the logical choice for procurement responsibility. CM competitive advantages support increasing procurement outsourcing.

H2: CM competitive advantage is positively related to procurement outsourcing.

OEM Procurement Competence (OEMPC) versus CM Procurement Competence (CMPC)

OEMs should consider how the decision to outsource procurement will impact the firm and the OEM's potential to contribute through procurement activity. When OEMs have world class purchasing organizations, outsourcing may negatively impact the strength of that purchasing function and its ability to provide the current level of service

(Venkatesan, 1992). However, a consideration of equal importance is the ability of the CM procurement function to contribute to supply chain competitive advantage. It is important to consider which organization is more competent in terms of purchasing activity and which procurement function to select for the greatest benefit to competitive advantage (Quinn & Hilmer, 1994). When an OEM's procurement function contributes to firm competitive advantage or core competence, then intra-firm human asset specificity would be high and the potential for procurement outsourcing would be decreased.

An area that must be considered within the realm of OEM procurement concerns is the leverage held by the OEM or the CM. Contract manufacturers can benefit in the area of manufacturing costs by enjoying economies of scope and high capacity utilization by manufacturing similar products for a single or similar industries (Plambert & Taylor, 2005; McClintock, 2002). However, the variety of products produced may drive many small purchases to avoid obsolescence for parts that are uncommon across products, resulting in low CM purchasing leverage. Commonality or similarity of products may allow the CM to experience greater leverage for common materials (McClintock, 2002). The OEM must evaluate procurement decisions by considering leverage in a broader context than the product being outsourced. The OEM may experience a lower cost because of combined leverage across a number of products (Ellram & Billington, 2001). Additionally, a centralized purchasing function will enhance a firm's buying power and increase its leverage (Cavinato, 1992). The leverage of the CM and OEM will influence the procurement outsourcing decision.

Core competence strategies and some product strategies sometimes drive the need for a high degree of cooperation or purchasing support to other firm functions. Developing partnership-like relationships is critical to linking purchasing strategy to corporate strategy (Watts, Kim, & Hahn, 1992). It is essential to establish cross-functional relationships with top management support to achieve a coordinated approach (Rajagopal & Bernard, 1993). For a manufacturing firm, purchasing and manufacturing strategies must be consistent and must support corporate competitive strategy (Watts et. al., 1992, Pagell & Krause, 2002). In the outsourced manufacturing context, it may be in the OEM's interest to outsource procurement to achieve higher levels of integration with manufacturing at the CM. The higher the level of interaction and relationship required between firm functions and procurement, the higher the level of intra-firm human asset specificity required within the firm to maintain competitive advantage. It is important that firms evaluate whether integration is needed in OEM or CM operations.

In some cases, OEMs or CMs may control a source of critical resources or materials with purchasing activities (Barney, 1991). Outsourcing procurement may result in loss of control of that resource and enable other firms to enter the market or compete more efficiently (Venkatesan, 1992) or may enable access to a resource through the CM that was not previously available. The decision to outsource may affect the level of competition in the market and the number of firms competing. Losing control of a critical resource would change the competitive nature of the market and drive changes in the firm' procurement requirements.

The strength of a firm's procurement function should be considered in the procurement outsourcing decision. OEM procurement competence is based on procurement's contribution to core competence, the requirement for procurement to interface with other firm functions, control of critical resources, obtaining procurement leverage, and ultimately how well procurement performs in comparison to the industry or CM procurement functions. Of equal importance in the procurement outsourcing decision is the level of procurement competence developed by the CM. CM procurement functions can contribute to the competence or competitive advantage of the OEM's supply chain by meeting or exceeding OEM procurement competence.

Higher levels of procurement competence in OEM or CM procurement functions result from higher levels of human asset specificity derived from a greater understanding of the supply base (Williamson, 1985), the procurement process, and how to meet material requirements driven by production operations, and ultimately the capability to employ this understanding. Additionally, if OEM or CM procurement functions can contribute directly to firm or supply chain core competence, they attain higher levels of recognition by contributing to the weapon or advantage the firm uses to compete in the market (Prahalad & Hamel, 1990). The presence of high OEM procurement competence supports a decrease in procurement outsourcing while high levels of CM procurement competence support an increase.

H3: OEM procurement competence is negatively related to procurement outsourcing.

H4: CM procurement competence is positively related to procurement outsourcing.

Supply Base Maintenance (SBM)

A main focus of procurement is to build a competent supply base that functions as a competitive weapon (Watts et. al., 1992). Procurement is usually the primary contact with suppliers. As manufacturing operations are outsourced, suppliers must interface with the CM performing manufacturing operations. Nonetheless, suppliers recognize that the ultimate customer is the OEM who puts their brand on the product. OEMs may invest significant amounts of time and resources in suppliers to build lasting and productive relationships or alliances. Purchasing's greatest contribution to the firm is integrating supplier strategies with those of the firm through establishing and managing supplier alliances (Zsidisin & Ellram, 2001). Over time, OEM procurement functions have built trust, goodwill, and strong cooperative relationships to create and maintain a responsive supply base (Monczka, Petersen, Handfield, & Ragatz, 1998).

It is possible that procurement activity is retained to maintain the level of involvement with critical suppliers that are essential for other manufacturing activities or products. Suppliers for the outsourced product may provide materials for products other than those considered for manufacturing outsourcing (Ellram & Billington, 2001). In the case where critical suppliers of other products also produce materials or components for a product under consideration for procurement outsourcing, OEMs will be motivated to maintain close relationships and higher purchase volumes to ensure they retain a level of importance with these suppliers, resulting in beneficial prices, service, or quality (Cox, 2001; Olsen & Ellram, 1996). Supply functions need to ensure that procurement strategies among products are coordinated to prevent outsourcing procurement for one product that negatively impacts a strategic relationship. By increasing their level of attractiveness to the supplier (Olsen & Ellram, 1996) and the volume of items purchased, inter-firm asset specificity can be increased and the critical resource preserved.

Purchasing agreements may prevent the outsourcing of procurement activity.

Agreements may include proprietary information exchange, information safeguarding, or a binding long-term alliance. These agreements are often designed to limit the diffusion of OEM or supplier core information (Oxley, 1999). These agreements can be bidirectional or unidirectional and are often a result of the OEM and/or supplier making an investment for the other party that involves risk and increases asset specificity. Agreements are initiated to safeguard or protect the firm from potential risk (Williamson, 1985).

Maintaining a strong supply base is an important contribution to building firm competitive advantage. Supply base maintenance integrates the resources provided by supplier firms to produce products with characteristics valued by the customer. The supply base maintenance construct consists of maintenance of buyer-supplier relationships, maintenance of influence with critical suppliers of other OEM products, and maintenance of existing supplier agreements. High inter-firm asset specificity is developed as OEMs invest in these relationships (Williamson, 1985). Resource-based view supports the acquisition and retention of valuable resources (Barney, 1991). In building a supply base, a valuable resource is developed, requiring a high degree of inter-firm human asset specificity and procurement expertise to maintain strong and effective relationships. Maintenance of a supply base as a competitive weapon leads to a reduced propensity to outsource procurement.

H5: Supply base maintenance is negatively related to procurement outsourcing.

Product Commoditization (PC)

The product and its inherent nature and specification maturity at the time of outsourcing may be related to the procurement outsourcing decision. One consideration for OEMs is product specification maturity (Hayes & Wheelwright, 1979). OEMs may decide to purchase direct materials for CMs when a product specification is experiencing changes to maintain needed flexibility to meet the changing purchasing requirements. An unstable design specification requires greater interaction between the OEM and CM. Procurement must maintain a closer relationship with suppliers, design engineers, and manufacturing to acquire materials to meet changing requirements. An internal purchasing function would be better able to adjust purchases to specification changes made by the firm than an outside service provider (Hayes & Wheelwright, 1979). However, when the specification matures and changes become infrequent, asset specificity is reduced. Hayes and Wheelwright's (1979) concept of the product lifecycle indicates that mature product specifications require more efficient purchasing. CMs may procure materials more efficiently as it pools purchases for more standard components (Carbone, 1996b; McClintock, 2002; Ellram & Billington, 2001).

Products that are highly standardized do not require specialized materials or components (Williamson, 1985). Procurement activity is focused on the acquisition of commodities or standard materials readily available in the market (Kraljic, 1983; Olsen & Ellram, 1997). However, for differentiated products materials are needed to distinguish the product. The acquisition of these specialized materials requires higher human asset specificity which would be resident in the OEM. Low asset specificity is associated with procurement activities for standardized products

The nature of the product being outsourced to a CM influences the decision to outsource the direct materials procurement. Product commoditization occurs as product specifications mature or as the level of standardization increases in products. As a result, these products are viewed as more common in the market and asset specificity is reduced (Williamson, 1985). Typically, as products or subsystems mature in their lifecycle, specifications become more stable (Hayes & Wheelwright, 1979) and the direct materials more standard. The two drivers, (1) product specification maturity and (2) the level of product standardization, in the product commoditization construct directly impact the complexity of purchasing activity and procurement outsourcing. The lower asset specificity associated with product commoditization supports greater procurement outsourcing.

H6: Product commoditization is positively related to procurement outsourcing.

Competitive Environment

As firms decide about outsourcing purchasing activities they should consider the current business environment and how it affects the firm's competitive position. In highly competitive environments with large numbers of competitors (approaching perfect competition) and with the entry of competing products and the availability of substitute products (Porter, 1979; Porter, 1980), the firm will strive to achieve efficiency and lower capital investments (Porter, 1980). The firm may try to limit overhead expenses by obtaining services through a third party to limit the fixed costs of capital investments or internally maintained functions. Fine (1998) indicates that short lifecycles and rapidly evolving technologies of some industries, like electronics, also increase the level of competition.

Higher competition is associated with reduced asset specificity (Williamson, 1985). The forces of competition make procurement outsourcing more desirable as firms are able to lower overhead and reduce asset specificity. However, in a less competitive market the pressure to reduce cost and improve efficiency are less and the firm is more determined to protect competitive advantage through the resource of an effective procurement function (Fisher, 1997). RBV and TCE support that competition and procurement outsourcing are positively correlated.

Market competition also leads to uncertainty or disruptive forces in the market affecting both supply and demand (Porter, 1979). As such, the potential exists for this construct to moderate the influence of the other drivers on the procurement outsourcing decision. Williamson (1985) indicates that uncertainty moderates the influence of asset specificity on the outsourcing decision and that only in the presence of uncertainty does asset specificity drive the outsourcing decision. TCE theory posits that firm activities with high asset specificity in the presence of high uncertainty are related to activity retention (Williamson, 1985; Williamson, 1986; Williamson, 1999).

An increase in the level of uncertainty amplifies the existing relationship between constructs (for which asset specificity is an important element) and outsourcing. This amplification increases the level of outsourcing for a positive relationship and reduces the level of outsourcing for a negative relationship, when compared to the lower uncertainty condition. For example, in the case of moderate uncertainty, the level of asset specificity required to procure materials for a product is negatively related to the level of procurement outsourcing. If the level of uncertainty increases, the potential for procurement outsourcing in the case of higher uncertainty is reduced beyond the potential found in the negative relationship that existed in the moderate uncertainty condition. Increased uncertainty amplifies the effect of asset specificity by increasing the negative slope that would characterize the relationship between asset specificity and outsourcing in a market condition of lower uncertainty. Therefore, increasing levels of uncertainty moderate by amplifying the negative or positive relationships of asset specific constructs with outsourcing.

Three constructs in this research are characterized as asset specific because of the human or physical specific assets that can exist through supplier relationships or the physical nature of the product. First, product commoditization is a reverse measure of asset specificity for the product or subsystem. As the product becomes more of a commodity, asset specificity is reduced. High levels of uncertainty will amplify the positive relationship of product commoditization with procurement outsourcing.

The second and third constructs of OEM procurement competence and supply base maintenance derive their asset specificity from the building and maintenance of buyer-supplier relationships. Williamson (1985) indicates that human capital investments that are transaction specific evolve during contract execution. The benefits of specialized training, production operations, and learning curves are normally not readily transferable to other suppliers and are only kept through the maintenance of the buyer-supplier relationships. These two constructs are essential to building these transaction specific investments in buyer supplier relationships. The negative relationship of OEM procurement competence and supply base maintenance with procurement outsourcing will be amplified as uncertainty increases.

The competitive environment construct has the potential to directly impact the level of procurement outsourcing and to moderate the relationship between the level of outsourcing and asset specific constructs. In addition to the hypothesis that competitive environment impacts procurement outsourcing directly, three hypotheses have been developed to test for moderation. The results of these tests will indicate if these three drivers vary in their impact on procurement outsourcing in relationship to the variation of the level of competition or uncertainty.

H7: The level of competition in the market environment is positively related to procurement outsourcing.

H7a: The level of competition in the market environment will moderate the relationship between OEM procurement competence and procurement outsourcing by amplifying the negative relationship.

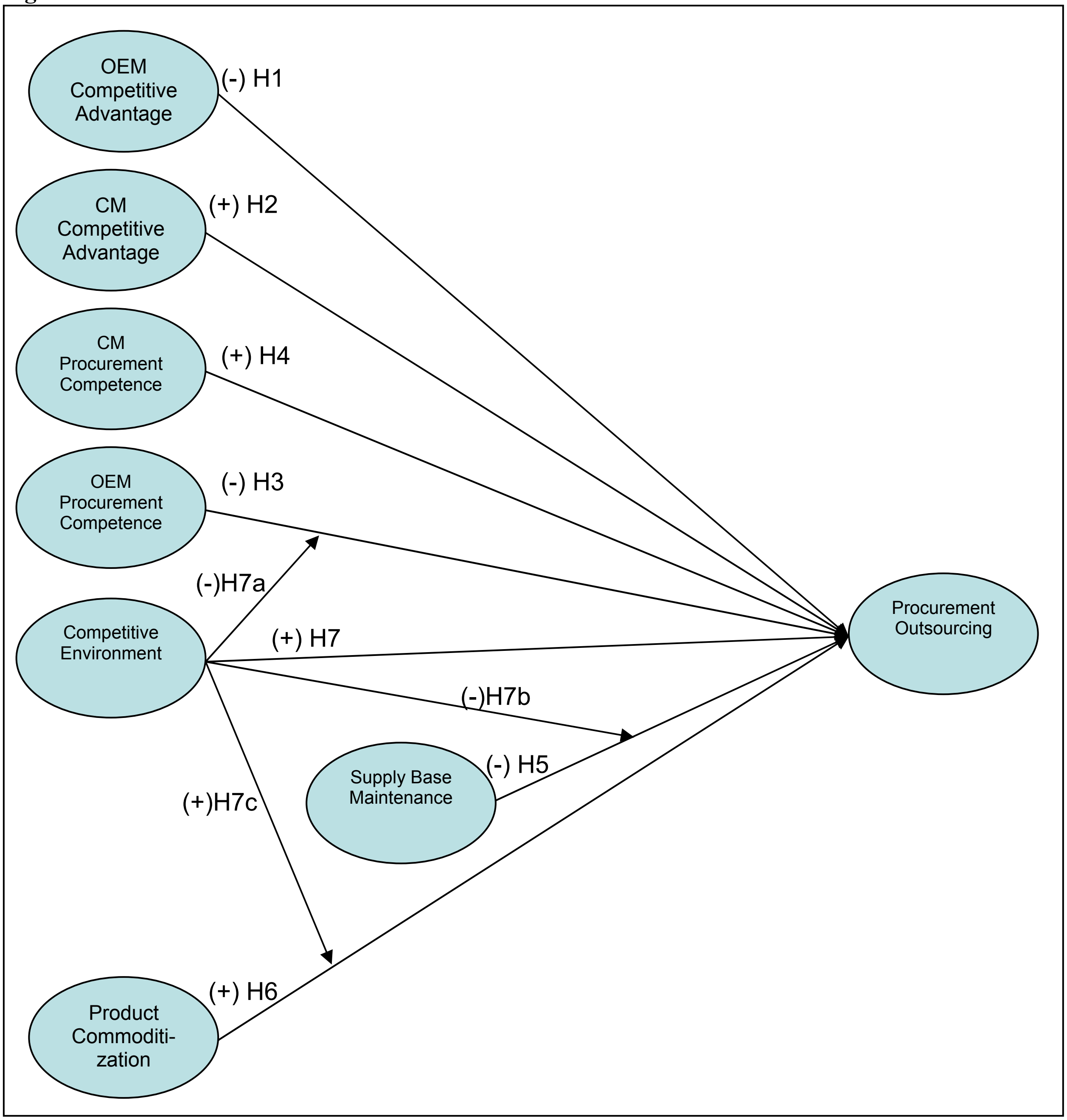
H7b: The level of competition in the market environment will moderate the relationship between supply base maintenance and procurement outsourcing by amplifying the negative relationship.

H7c: The level of competition in the market environment will moderate the relationship between product commoditization and procurement outsourcing by amplifying the positive relationship.

Theoretical Model

The seven hypotheses for the drivers of procurement outsourcing form the theoretical model that helps explain the procurement outsourcing decision. This model presents the opportunity to test for latent constructs that impact the procurement outsourcing decision. The seven constructs of OEM competitive advantage, CM competitive advantage, competitive environment, supply base maintenance, OEM procurement competence, CM procurement competence, and product commoditization are shown in Figure 5 to directly impact procurement outsourcing.

Figure 5: Theoretical Model



Additionally, the competitive environment factor based on TCE theory may moderate the relationships of OEM procurement competence, supply base maintenance, and product commoditization with the level of procurement outsourcing. Hypotheses developed from this model are based on the theoretical frameworks of TCE and RBV.

These seven constructs are hypothesized to impact the procurement outsourcing decision based on principles of RBV and TCE. Direct and indirect relationships have been proposed. Empirical testing will indicate the robustness of theory when applied to the direct materials outsourcing decision in the context of contract manufacturing. This multidimensional decision is complex and requires careful analysis.

CHAPTER 4

RESEARCH METHODOLOGY

Introduction

This chapter describes the methods of data collection and data analysis that were employed to test the hypotheses proposed in the previous chapters. The data collection methodology was an internet survey. The data collection section includes a discussion of the sample, sampling procedures, survey implementation procedures, and scale development information. The section on data analysis indicates how measures were tested for reliability and validity and how the hypotheses were tested.

Data Collection

Data collection is a critical step in theory testing research. Established research methods must be followed to ensure that reliable and valid measures are used. The data collected in this research was used to answer the research questions and to test the associated hypotheses (see Table 2). Research question one was addressed by testing hypotheses one and two. The two competitive advantage constructs addressed the competitive strategy employed by the firm to make the manufacturing outsourcing decision. In the model these two constructs test the relationship of the manufacturing decision and the procurement outsourcing decision. Research question two is addressed through testing the relationships of all the procurement outsourcing drivers and the two competitive advantage factors. Hypotheses were tested by estimating a structural model with the relationships that link these constructs. Finding support or no support for these hypotheses resulted in a greater understanding of procurement outsourcing in the context of outsourced manufacturing and potential implications for procurement outsourcing generally.

Table 2: Hypotheses dealing with procurement outsourcing

Research Question	Constructs	Hypotheses
•How does the procurement outsourcing decision relate to the manufacturing outsourcing decision? (H1-H2)	• OEM Competitive Advantage	H1: OEM competitive advantage is negatively related to procurement outsourcing
•What are the important factors in the decision to retain or outsource purchasing? (H1-H7)	• CM Competitive Advantage	H2: CM competitive advantage is positively related to procurement outsourcing
	• OEM Procurement Competence	H3: OEM procurement competence is negatively related to procurement outsourcing
	• CM Procurement Competence	H4: CM procurement competence is positively related to procurement outsourcing
	• Supply Base Maintenance	H5: Supply base maintenance is negatively related to procurement outsourcing
	• Product Commoditization	H6: Product commoditization is positively related to procurement outsourcing
	• Competitive Environment	H7: The competitive environment for the market is positively related to procurement outsourcing
	• Competitive Environment; OEM Procurement Competence	H7a: The level of competition in the market environment will moderate the relationship between OEM procurement competence and procurement outsourcing by amplifying the negative relationship.
	• Competitive Environment; Supply Base Maintenance	H7b: The level of competition in the market environment will moderate the relationship between supply base maintenance and procurement outsourcing by amplifying the negative relationship.
	• Competitive Environment; Product Commoditization	H7c: The level of competition in the market environment will moderate the relationship between product commoditization and procurement outsourcing by amplifying the positive relationship.

The methodology to collect data for this dissertation was an internet survey. Interviews conducted with industry personnel indicated that the phenomenon of interest is prevalent throughout the electronics industry and that a survey would be an appropriate methodology to collect data. Discussions with a panel of academics concluded that the subject matter addressed in a proposed research questionnaire could be administered in a self-administered survey and that an internet survey would provide the greatest response rate. Internet surveys enable sample members to respond at time convenient to their work schedule and enable the administrator to remotely monitor progress, address questions, and motivate completion. The survey targeted procurement managers.

Data Collection Procedures

The survey data collection protocol followed a modified Tailored Design method (Dillman, 2000). This approach included an electronic mail out of an email invitation to participate in the survey that contained a link to the web-hosted survey. This email was followed by a telephone contact to each potential respondent ensuring receipt of the survey and a verbal invitation for them to participate. If personal contact was not established with the respondent, the researcher left a voice mail communicating that information. Two additional email invitations were sent to nonrespondents at four weeks and five weeks after the initial invitation. The Tailored Design method emphasizes the importance of repeated contact with potential respondents to increase the rate of return (Dillman, 2000). Additionally, Dillman indicates that a special contact that is more personal in nature improves the response rate to the survey. The telephone contact in this research filled that role. Respondents that were contacted by telephone often expressed a view that the survey was originally thought to be spam. The new knowledge gained from the telephone conversation resulted in a commitment to complete the survey. The original email invitation and follow-up emails are located in Appendix B.

Study Population

The study population for this research was purchasing managers and senior management with procurement responsibility in the electronics industry. The sample of respondents for this survey was selected from a professional procurement organization and from a list of subscribers to a nationally distributed procurement publication. Approximately 2,500 purchasing personnel were randomly selected from the electronics industry from the Institute for Supply Management (ISM) database and *Purchasing* magazine subscribers. By selecting respondents from two sources of procurement professionals the external validity or generalizability of study results was enhanced. The electronics industry was targeted specifically because of the prevalence of contract manufacturing in the industry. The sample size was selected to ensure enough responses for proper data analysis. This study used structural equation modeling (SEM) to analyze the data, for which a minimum sample size of 200 is recommended for structural models of modest complexity (Kelloway 1998, Hair et. al. 1998).

The ISM portion of the sample was drawn from the membership database of the Institute of Supply Management. A 2003 survey of members revealed a total membership of 43,168 with 42.8% working in the manufacturing sector. Additionally, 41.1% of members are in positions of manager, director, or VP/executive. ISM provided a list of members working in the electronics industry, SIC codes 35 and 36. This list was then reduced to 1,841 title 1 and title 2 ISM members for which both telephone and email contact information were available. Title 1 and 2 members hold the positions of vice president, director of purchasing, purchasing manager, materials manager, supervisor, and senior buyer. The sample was limited to members of these two levels to ensure a group of respondents that would be involved in the outsourcing decision making process. From this group of members a sample of 1,150 potential respondents were randomly selected. The target sample was 1,000. However, experience with internet surveys indicates that email addresses and phone numbers change frequently. For this reason an additional fifteen percent was added to the original target sample size to target an effective sample size of 1,000.

The sample of subscribers to *Purchasing* magazine (PM) was managed indirectly through DM2 Lists, the firm managing the list of subscribers. A sample of 1,846 was randomly selected by this firm from its list of subscribers in the electronics industry with the titles of purchasing or materials manager or higher. An initial group 2,178 subscribers met these qualifications. The target sample size for this group was 1500. The additional 346 respondents were added to the initial sample to compensate for incorrect email addresses found regularly in the database.

Attrition of sample members occurred throughout the duration of the data collection period for both samples. For the ISM sample, 74 emails bounced or did not reach their intended recipients. Additionally, telephone conversations revealed that 163 respondents did not have knowledge of the phenomenon of interest, three were displaced by hurricane Katrina, seven were on extended absences from their firm, and 92 were no longer employed by their firm. These respondent problems effectively reduced the ISM sample to 811. For the *Purchasing* magazine sample, 515 emails bounced, eight respondents' company or plant closed, 278 did not have knowledge of the phenomenon of interest, 18 respondents were duplicates from the ISM sample, eleven were on extended absences, four were displaced by hurricane Katrina, and 106 were no longer employed by their firm. These reductions created an effective sample size of 906. The final combined sample size after attrition was 1,717. An additional 82 and 116 ISM and PM respondents could not be contacted by phone because of wrong phone numbers, disconnected phone numbers, and other telephone issues. However, these respondents were not dropped from the sample because of the possibility of email contact.

Survey Instrument

The internet survey instrument was designed to collect data about the unit of analysis. In this study, the unit of analysis was the decision to outsource or retain procurement for a product or major subsystem for which manufacturing had been outsourced. This definition focuses the study on the factors, events, and outcomes related to the procurement outsourcing decision. The research instrument was developed based on knowledge gained from discussing this phenomenon with supply chain professionals and reviewing relevant literature on outsourcing, procurement, contract manufacturing, transaction cost economics, and resource-based-view. The survey was built using a 7-point Likert scale for perceptual responses, categorical responses where appropriate, and open-ended questions to obtain additional insight. Each respondent was asked to answer the survey questions based on a current or recent past product or major subsystem for which manufacturing was outsourced and for which the firm went through the procurement outsourcing decision process.

The survey is comprised of three major sections that include procurement outsourcing drivers, procurement outsourcing levels and strategy, and respondent demographics. Each section was designed to tap the appropriate data to represent the research constructs. Preexisting scales were adapted and used where possible. The items adapted from previous studies are identified in the attached survey. No scales were taken in their entirety. For this reason, validity and reliability will be calculated for each scale during the scale purification process.

The first section of the survey collected data on procurement outsourcing drivers for an OEM's recent case of outsourcing manufacturing for a product or major subsystem. Data were collected for seven latent constructs. The three scales, OEM competitive advantage, CM competitive advantage, and product commoditization, were newly developed scales. For the scale of competitive environment four items were adapted from Krause's (1995) competitive environment scale and two new items were added. The supply base maintenance scale adapted one item from Chen and Paulraj (2004) and all other items were newly developed. For the OEM procurement competence scale one item was adapted from Krause (1995) and all other items were newly developed. Finally, the CM procurement competence scale adapted one item from Krause (1995) and all other items were newly developed. Table 3 identifies the sources for each latent construct and the associated items.

The second section seeks to identify the procurement outsourcing approach taken by each responding OEM. To do this respondents are asked to indicate the level of procurement outsourcing for each phase of the procurement process. Additionally, six items that identify strategic or critical decision factors were developed to capture strategy elements employed by each firm in their procurement outsourcing approach. Six procurement outsourcing arrangements were identified in the literature prior to survey development. These arrangements were listed in a question, enabling the respondents to identify the particular procurement arrangement used in the procurement outsourcing decision for their product or major subsystem. Also, an item was included to identify the primary reason manufacturing was outsourced. Three open ended items were used to capture additional information on the procurement outsourcing decision that may not be identified in the literature. A final item seeks to identify if outsourced procurement responsibility was accomplished by the CM or by a procurement service provider. Items for this portion of the scale were developed for this research effort.

Finally, demographic data were collected in the third section to provide a brief description of respondents. The level of annual sales, respondent's position and functional area, and other demographic information were collected to characterize the firms responding to the survey. The demographic section of the survey was adapted from Krause (1995) and Monzca et. al. (2005a).

This survey was pretested by thirteen outsourcing managers and procurement professionals and reviewed by ten academics. This pretest design meets Dillman's (1978) pretest requirement of involving professional researchers, policy makers and respondents with sample characteristics. Outsourcing mangers fill the role of policy makers and purchasing professionals are representative of the sample. This effort was conducted with Dillman's (1978) goal of measuring the intended phenomenon, ensuring accurate understanding and interpretation, motivating participation, eliminating any researcher bias, and ensuring that respondents can correctly answer the questions.

Table 3: Sources for research scale items

Latent Construct	Sources for Scales	Item Numbers
OEM Competitive Advantage (OEMCA)	Developed from Carbone, 2000b; Prahalad, 1990; Quinn & Hilmer 1994; Blanchette, 2004; Mulcahy, 2001	5, 6, 7, 8, 9
CM Competitive Advantage (CMCA)	Developed from Kador, 2001; Mulcahy, 2001; Carbone, 2000b; Blanchette, 2004; Keegan, 2004; Carbone, 1996a; Mulcahy, 2001; Vestring, Rouse, & Reinert, 2005; Anderson & Coughlan, 1987; Ono & Stango, 2005; Cavinato, 1992	10, 11, 12, 13, 14, 15, 16, 17
CM Procurement Competence (CMPC)	Adapted from Krause 1995*; Developed from Plambert & Taylor, 2005; McClintock, 2002; Barney, 1991; Venkatasen, 1992; Watts, Kim, & Hahn, 1992; Rajagopal & Bernard, 1993; Quinn & Hilmer, 1994	18, 19, 20, 21*, 22, 23, 24, 25,
OEM Procurement Competence (OEMPC)	Adapted from Krause 1995*; Developed from Barney, 1991; Venkatasen, 1992; Watts, Kim, & Hahn, 1992; Rajagopal & Bernard, 1993; Ellram & Billington, 2001; Quinn & Hilmer, 1994	31, 32, 33, 34, 35*, 36
Supply Base Maintenance (SBM)	Adapted from Chen & Paulraj, 2004*; Developed from Watts et. al., 1992; Ellram & Billington, 2001; Monczka, Petersen, Handfield, & Ragatz, 1998; Oxley 1999	26, 27, 28, 29, 30*,
Competitive Environment (CE)	Adapted from Krause 1995*; New items developed from Porter, 1980	37*, 38*, 39*, 40*, 41, 42
Product Commoditization (PC)	Developed from Hayes & Wheelwright, 1979; Carbone, 1996b; McClintock, 2002; Ellram & Billington; 2001; Kraljic, 1983; Olsen & Ellram 1997	43, 44, 45, 46, 47
Procurement Outsourcing Level (POSL)	Developed from Monczka, Trent, & Handfield, 2005; Ellram & Edis, 1996; Banfield, 1999; Zeng, 2003; Anderson & Katz, 1998; Ellram & Maltz, 1997	48a, 48b, 48c, 48d, 48e

Data analysis

The data analysis for this research follows a two pronged approach (Anderson & Gerbing, 1988). First, for testing the procurement outsourcing model and research hypotheses, structural equation modeling is employed. Second, cluster analysis and multiple group discriminant analysis were used to examine procurement outsourcing arrangements currently in practice.

The theoretical model was built on the development of seven latent variables that were hypothesized to impact the decision to outsource procurement and the associated level of procurement outsourcing within the manufacturing outsourcing context. For this research, structural equation modeling followed a two step approach to test the relationships among the latent variables. First, in the process of scale purification a measurement model was developed through confirmatory factor analysis (CFA). The measurement model was developed to ensure that constructs were reliable and valid. Construct validity was established through estimating a model that complied with standards for unidimensionality, reliability, convergent, and discriminant validity. Second, hypotheses were tested through the development of a structural model that contained latent variable relationships. This two step process enabled a structured approach to theory testing.

The first step in CFA is to ensure that latent variables are unidimensional. Unidimensionality is demonstrated when a set of indicators load on a single latent variable or underlying factor (Hair, Anderson, Tatham, & Black, 1998). In this research unidimensionality was tested through an iterative process of evaluating latent constructs individually, by pairs, and then finally with the entire measurement model (Garver & Mentzer, 1999). When establishing the unidimensionality of each latent construct, models were examined for overall measurement model fit. The Tucker-Lewis index (TLI $\geq$ .90) or nonnormed fit index (NNFI), the comparative fit index, (CFI$\geq$ .90), and the root mean squared approximation of error (RMSEA) were used because of their independence of sample size, their consistency and accuracy for assessing measurement models, and interpretation ease over a predetermined range (Garver & Mentzer, 1999). Item fit was evaluated through the examination of standardized residuals and modification indices. Small modification indices and residuals indicate unidimensional constructs (Garver and Mentzer, 1999). Items that load weakly or that cross-load and do not jeopardize content validity are eliminated from the scale (Dunn, Seaker, &Waller, 1994). Once latent constructs within the measurement model were judged to be unidimensional, the scales were tested for reliability.

Like unidimensionality, reliability is a necessary but not a sufficient condition for construct validity. Reliability or the internal consistency of measure is often calculated through the use of coefficient alpha (Churchill, 1979). DeVellis (2003) indicates that scale reliability is the proportion of variance attributable to the latent variable's true score. A coefficient alpha of at least 0.70 is considered the standard for scale reliability (Hair et. al., 1998; DeVellis, 2003; Dunn et. al., 1994). For new scales, however, coefficient alphas exceeding 0.50 and 0.60 are considered acceptable (Churchill, 1979; Dunn et. al., 1994).

Because all the scales in this study were completely new or contained some new items, all scales were evaluated for their reliability. Items with low inter-item correlations negatively impact coefficient alphas and were considered candidates to be removed from scales to improve reliability (DeVellis, 2003).

Convergent and discriminant validity were the final requirements for construct validity. Convergent validity was demonstrated when all factor loadings of items on latent variables for the measurement model or CFA were significant (Dunn et. al., 1994). Discriminant validity was tested by fixing all of the latent variable correlations to 1.0 and comparing model fit to the measurement model where the correlations were freely estimated. A significantly lower chi square difference test for the measurement model demonstrated discriminant validity (Garver and Mentzer, 1999; Dunn et. al. 1994). The result was latent factors that were distinct, reliable, and valid. After establishing a valid measurement model, data analysis then turned to theory testing.

Survey data analysis used structural equation modeling (SEM) to determine the relationships between the level of procurement outsourcing and the seven factors and any moderating relationships. Structural models enabled the simultaneous regression of dependent variables on multiple latent factors. Fit indices enabled testing of structural models for appropriate fit (Kelloway 1998). Path analysis was the primary method for testing research hypotheses (Kelloway 1998). Significant paths between latent variables indicated support for research hypotheses. This method of path analysis was used to test for direct effects on the dependent variable. However, TCE indicates that uncertainty (competitive environment) may moderate the impact of latent variables with high asset specificity. To test these moderating relationships with structural equation models the data was split into high and low uncertainty groups (Ping, 1998; Shumaker & Marcoulides 1998). A two group model that fixed the coefficients between dependent and highly asset specific independent variables to be equal for both groups was estimated and a model that allowed these same coefficients to differ between groups was estimated. A chi square difference test was then performed. Evidence for moderation existed if the freed model fit significantly better than the fixed model. Coefficient difference tests would then used to identify the variables moderated by uncertainty (Ping 1998).

The final data analysis for this research involves the use of cluster analysis and multi-group discriminant analysis. In the literature review six procurement outsourcing arrangements were identified from the literature. These arrangements ranged from the OEM performing all procurement activities to the CM performing all procurement activities. Taking the procurement outsourcing data from this study, cluster analysis was used to group procurement outsourcing approaches into clusters that are homogenous with respect to outsourcing characteristics within the group yet distinct from other groups with respect to the same characteristics (Sharma, 1996).

This analysis was performed in a two phase approach. First clusters were formed using Ward's method for hierarchical clustering. This method maximizes within cluster homogeneity by minimizing the within group sums of squares (Sharma, 1996). Stopping rules were used to determine the number of clusters. Miller and Roth (1994) used three rules for determining cluster size. The number of clusters was limited by restricting the quantity of clusters to the range of n/30 to n/60, by stopping at pronounced increases in the R^2 and pseudo F-statistic, and by using ANOVA and the Scheffe criterion for pairwise comparison tests of cluster means to obtain managerial interpretability. The first two rules were implemented to determine the number of clusters for hierarchical clustering. Cluster centroids from the hierarchical procedure were then used as the seeds for nonhierarchical clustering method. For nonhierarchical clustering, the SAS Fastclus algorithm was used to fine tune the hierarchical cluster solution (Hair et. al., 1998; Frolich & Dixon, 2001). The third rule was used to interpret the clusters identified through the nonhierarchical cluster analysis method.

Finally, discriminant analysis was performed to identify the variables that discriminate best between the clusters or procurement outsourcing arrangements (Sharma, 1996). Canonical discriminant functions were calculated. These discriminant functions were evaluated to determine their significance and the importance of individual variables in the discriminating between the individual outsourcing arrangements.

The rigorous application of proven empirical methods and was needed to obtain data necessary to test this study's hypotheses. Careful adherence to the principles of construct validity enabled the development of viable latent constructs and theory testing through appropriate data analysis tools. The next chapter presents the data analysis results that explain how these factors impacted procurement outsourcing.

CHAPTER 5

DATA ANALYSIS AND RESULTS

Introduction

This chapter documents the analysis of data collected from the internet survey of the electronics industry and the results of testing the a priori theoretical model. First, a description of the sample provides respondent characteristics. Next, the sample is tested for nonresponse bias. Third, the measurement model is evaluated using CFA. Fourth, the structural model is estimated, moderation is tested, and significant results are identified. Finally, cluster and discriminant analysis are performed to provide an initial description of unique procurement outsourcing arrangements.

Sample Description

This single industry study of electronics manufacturers surveyed a wide range of procurement professionals from a broad range of firms. Demographic data collected on individual positions, tenure with the firm, firm gross annual sales, and the outsourced procurement service provider provide insight into the capability of the sample to respond to survey questions.

As described in chapter 4 the sample for this study was made up of subscribers to *Purchasing* magazine (PM) and from members of the Institute of Supply Management. In order to treat the two samples as representative of procurement professionals and not as two separate populations, it was important to perform statistical tests to determine if the groups could be combined. For this purpose, twenty survey items and forty responses from ISM and forty from PM were randomly identified. After selecting the questions and respondents, t-tests were performed on each of the twenty items to determine if there were differences between the forty ISM responses and forty PM responses. The t-tests did not find significant differences between ISM and PM samples. Thus, the two samples were considered to be from the same population of purchasing professionals and the two groups were treated as a single sample.

The initial target for sample size was 2,500. This sample size was selected based on current response rates and the need to obtain 200 or more responses, the number of responses frequently deemed sufficient for hypotheses testing using structural equation modeling (Hair et. al., 1998; Kelloway, 1998). Although the phenomenon of interest was readily available in the electronics industry, it was common knowledge that all targeted respondents would not be able to respond to the survey. A sample of 2,996 was randomly selected from higher level procurement professionals. The additional 496 sample members were added to the initial sample size to compensate for incorrect email addresses found regularly in research databases. Over the data collection period these additional sample members were valuable as the sample size was reduced through the attrition of potential respondents.

The attrition of sample members occurred throughout the duration of the data collection period. The first reduction to the sample came as 589 emails bounced or did not reach their intended recipients. Additionally, telephone conversations revealed that 441 potential respondents did not have the necessary knowledge of the phenomenon of interest to respond to the survey or this phenomenon did not occur within their firm. A large number of sample members, 198, were no longer employed by their firm and could not be contacted. Seven potential respondents were displaced by hurricane Katrina and could not respond. Some sample members, 18, were away from their firm for military, medical, or other extended absences during the data collection period. Finally, 18 potential respondents were duplicates between the two samples. These reductions resulted in a final combined sample size of 1,717. An additional 198 sample members could not be contacted by phone because of wrong telephone numbers, disconnected phone numbers, and other telephone issues. However, these respondents were not dropped from the sample because of the possibility of email contact.

From this sample of 1,717, a total of 277 responses were received for a response rate of 16.13%. However, 12 of the responses were unusable because of missing data, reducing the effective responses down to 265 and the effective response rate to 15.43%. Demographic information provides insight into the respondents and their firms.

A person's position in a firm often indicates the role that they have in the decision making process. Table 4 summarizes this position data for survey respondents. Responses from the sample indicated that 70.3% of the respondents held the position of manager or higher in their firm. It is at the level of management where firms make strategic decisions with respect to outsourcing. An examination of the 2.6% of respondents in the other category indicated that for the most part these were individuals that held positions in central procurement offices at the corporate level. These staff level positions are also important in the development of firm procurement policy and many times are involved with strategic decisions made at the corporate level. Another 27.1% were supervisory and nonsupervisory procurement professionals. These procurement professionals also play an important role in the process of working directly with suppliers/contract manufacturers to establish procurement support for supply chain operations. The sample provides an excellent combination of decision makers and decision implementers that are important to the procurement outsourcing decision making process. Additionally, average tenure for respondents with their firms was 10.13 years. This length of tenure indicates a group of people that have gained the trust of the firm and that are relied upon to create and implement firm strategy.

Table 4: Positions Held by Respondents

Position	Frequency	Percentage
President	1	0.4%
Vice President/Executive	18	6.8%
Director	55	20.8%
Manager	112	42.3%
Supervisory	11	4.1%
Professional/Nonsupervisory	61	23.0%
Other	7	2.6%
Total	265	100.0%

Another important piece of demographic information was firm size as expressed by annual sales. Table 5 summarized the gross annual sales for the firms of 255 respondents. A large portion of respondents were from smaller firms with 52.2% of firms below the level of $501 million in gross annual sales. This was not surprising, as the literature indicates that small firms often focused on the design of products as a core competence and relied on CMs to manufacture their products (Blanchette, 2004; Mulcahy, 2001; Carbone, 1996a). The distribution of responding firms with gross sales greater than $501 million followed an almost uniform distribution with each of the higher sales categories containing 7.5% or more of the remaining firms. Because the range of firms responding to the survey represented each gross sales level well, the research results should provide an adequate representation of the electronics industry as a whole.

Table 5: Firms' Gross Annual Sales

Annual Gross Sales in Dollars	Frequency	Percentage
Less than $100 Million	**78**	30.6%
$101 - $500 Million	**55**	21.6%
$501 Million - $1 Billion	**19**	7.5%
$1.1 - $5 Billion	**40**	15.7%
$5.1 - $10 Billion	**20**	7.8%
$10.1 - $20 Billion	**20**	7.8%
Over $20 Billion	**23**	9.0%
	255	100.0%

Nonresponse Bias Testing

Another concern that must be addressed by studies using survey research is nonresponse bias. With any empirical study, the potential exists that the data collected does not accurately represent the population of interest. Nonrespondents may differ from respondents, resulting in survey responses that misrepresent the population of interest and therefore bias the results of the research. The best method to overcome nonresponse bias is to increase the response rate (Lambert & Harrington, 1990). Dillman's Tailored Design (2000) was the method the researcher employed to increase the survey response rate. Although this method was successful in increasing the number of respondents, there was a high number of nonrespondents. For this research, 277 responses were received from the sample of 1,717 for a response rate of 16.13%.

Armstrong and Overton indicate that a method for testing for nonresponse bias is to look for statistical differences between early and late waves of responses. Forty responses from the initial respondents, forty responses from the last wave of respondents, and twenty survey items were randomly selected. T-tests were performed between the late and early groups for each item. No significant differences were found for any of the twenty items. These tests supported that nonresponse bias was not present in the data collected based on the lack of significant differences between early and late respondents.

Confirmatory Factor Analysis/Scale Purification

As explained in Chapter 4, the structural equation modeling data analysis for this research followed a two step process. The first part of this process was estimating the measurement model using CFA. This CFA process was a necessary step in the development of valid constructs. DeVellis (2003) indicates that the cost of a poor measure may be greater than its value and that it is necessary to evaluate individual item performance to identify those that should constitute the scale. Initially, scales were developed for this research by generating a pool of items to exhaustively measure the constructs of interest (Churchill, 1979). In order to purify the scales for this study and ensure construct validity, the measurement model was tested for unidimensionality, reliability, convergent validity, and discriminant validity.

The measurement model was estimated using CFA to determine how well the indicators serve as a scale for each construct (Garver & Mentzer, 1999). The measurement model was constructed by loading the indicators on the constructs that were determined a priori based on the underlying theory (Sharma, 1996; Hair et. al., 1998). Additionally, constructs were allowed to correlate (Garver & Mentzer, 1999). The hypothesis tested with the measurement model was that the constructs were responsible for the covariance within the observed variables or that the observed items were indicators of a latent construct (Hair et. al., 1998; Dunn et. al., 1990). These concepts were the basis for testing the measurement model.

The first test of the measurement model was the test of unidimensionality or that indicators loaded only on a single latent construct (Garver & Mentzer, 1999). The test for unidimensionality for each of the seven latent constructs was accomplished by testing constructs individually, by pairs, and by estimating the entire measurement model. Item fit was demonstrated through significant factor loadings, low standardized residuals, and low modification indices. Item fit and overall model fit were the primary indicators used to assess unidimensionality (Dunn et. al. 1990, Garver & Mentzer, 1999). Items demonstrating poor fit through insignificant factor loadings, high standardized residuals, and high modification indices were dropped from the construct while taking care to maintain content validity. Thirteen items were dropped from the model while assessing unidimensionality. Table 6 shows the items that were dropped from the model.

The unidimensionality assessment indicated a problem with two of the latent constructs. While assessing the unidimensionality of the of the entire measurement model, a high correlation (0.70) and high positive standardized residuals between the latent variables of CM competitive advantage and of CM procurement competence indicated that the 10 remaining items of these two constructs were trying to load on a single construct (Garver & Mentzer, 1999). For this reason, the model was modified to combine CMCA and CMPC into the single latent construct of super CM. This modification resulted in an immediate reduction in the number of high standardized residuals and high modification indices and greatly improved overall model fit. Because of the positive effect of the consolidation on the unidimensionality of the model, the decision was made to change from a model with seven independent latent constructs to six. The theoretical implications of this decision are discussed in chapter 6.

Table 6: Coefficient Alpha, Factor Loadings, and Significance for Survey Items

Items Arranged by Latent Variable	Unstandardized Factor Loading	Standard Error	t-Value	Standardized Factor Loadings
OEMCA: α=.672				
5. How important was the lack of internal manufacturing capacity in the decision to outsource manufacturing?	0.47	0.15	3.10[b]	0.22
6. How important was this product or major subsystem to your firm's core competence strategy?	1.18	0.10	11.79[b]	0.75
7. How important were components of this product or major subsystem to your core competence strategy?	1.20	0.10	11.91[b]	0.76
8. To what extent did the manufacturing of this product or subsystem depend on firm core competencies?	1.03	0.10	10.13[b]	0.65
9. How big was your company (in terms of sales) compared to other companies in your industry? [a]				
Super CM: α=.817				
10. How important was CM design knowledge in the decision to outsource manufacturing?	0.67	0.12	5.56[b]	0.36
11. How important was CM manufacturing knowledge in the decision to outsource manufacturing? [a]				
12. How important were CM manufacturing costs in the decision to outsource manufacturing?	0.40	0.07	5.50[b]	0.36
13. How much control did the CM have over the product specifications (component selection, qualification, etc.)? [a]				
14. How important was entering international markets in your decision to outsource manufacturing?	0.79	0.14	5.79[b]	0.38
15. How important was gaining access to international infrastructure (logistics, marketing, after-sales spprt, etc.)?	0.73	0.13	5.69[b]	0.37
16. How important was gaining access to low cost international resources (labor, materials, etc.)?	0.86	0.14	6.15[b]	0.40
17. How big was the CM in terms of sales compared to other CMs in the industry? [a]				
18. How important was CM leverage with their suppliers in your decision to outsource or retain procurement?	1.39	0.09	14.71[b]	0.82
19. How important was lack of CM leverage with their suppliers in your decision to outsource\retain procurement? [a]				
20. How important was the CM's procurement competence in your decision to outsource or retain procurement?	1.34	0.09	14.99[b]	0.83
21. How centralized was the CM's procurement function? [a]				
22. How competent was the CM's procurement function?	0.64	0.08	8.50[b]	0.53
23. How important was integration between CM manufacturing and procurement?	0.96	0.09	10.58[b]	0.63
24. How important was gaining access to critical resources through the CM?	0.70	0.11	6.54[b]	0.42
25. How was the CM's procurement function performance at the time of the outsourcing decision? [a]				
SBM: α=.848				
26. How important was keeping existing supplier relationships in your decision to outsource or retain procurement?	1.39	0.09	15.13[b]	0.83
27. How important was keeping your product's existing supply base intact?	1.41	0.09	16.12[b]	0.86
28. How important were existing suppliers to other products you manufacture?	1.26	0.10	12.98[b]	0.74
29. How important were existing supplier agreements in your decision to outsource or retain procurement? [a]				
30. What level of computer-enabled transaction processing did you have with existing suppliers? [a]				

[a]Items dropped during scale purification. [b]T-value significant at P<0.01.

Table 6: Coefficient Alpha, Factor Loadings, and Significance for Survey Items (Continued)

Items arranged by latent Variable	Unstandardized Factor Loading	Standard Error	t-Value	Standardized Factor Loadings
OEMCP: α=.623				
31. How much did your procurement function contribute to lasting firm competitive advantages?	0.71	0.09	7.56[b]	0.51
32. How would you describe your procurement function's performance at the time of the outsourcing decision?	0.35	0.08	4.14[b]	0.29
33. How important was the potential loss of control of critical resources?	0.82	0.11	7.21[b]	0.49
34. How important was your firm's existing procurement leverage?	1.30	0.11	11.70[b]	0.77
35. How centralized was your procurement function at the time of the outsourcing decision? [a]				
36. What level of integration between procurement and other company functions was required for this product? [a]				
CE: α=.704				
37. What was the level of market competition for your product or subsystem?				
38. What was the pace of technological change for this type of product or subsystem?	1.47	0.16	9.33[b]	0.88
39. What was the rate of product obsolescence for this type of product or subsystem?	0.85	0.12	7.10[b]	0.54
40. What was the rate of manufacturing obsolescence for this type of product or subsystem?	0.57	0.10	5.47[b]	0.40
41. How would you describe the availability of substitutes for your product or subsystem? [a]				
42. Indicate the threat of new competitors entering the market with similar products or subsystems? [a]				
PC: α=.539				
43. How would you describe the specification maturity of this product or subsystem?	1.04	0.15	7.06[b]	0.81
44. How standardized were the direct materials of the product or subsystem?	0.66	0.13	5.26[b]	0.44
45. For this product, how were the majority of supplier relationships prior to retaining/outsourcing procurement? [a]				
46. For the product, what was the intended length of the majority of supplier? [a]				
47. How differentiated was your product or subsystem from similar products or subsystems?	0.44	0.11	3.84[b]	0.30

[a]Items dropped during scale purification. [b]T-value significant at P<0.01. (Format adapted from Krause et. al., 2001)

Table 7: CFA Model Goodness-of-Fit Indicators

Measure of Fit	Study value	Recommended Values
Normed Chi-Square	1.73	$\leq$ 3.00
Tucker Lewis Index	0.92	$\geq$ 0.90
Bentler's Comparative Fit Index	0.93	$\geq$ 0.90
Root Mean Square Error of Approximation (RMSEA)	0.051	$\leq$ 0.08

Not only was item fit important for assessing unidimensionality with CFA, but good model fit also indicated a measure of factor stability. Garver and Mentzer (1999) indicate that the Tucker-Lewis index (TLI $\geq$ .90) or nonnormed fit index (NNFI), Bentler's comparative fit index, (CFI$\geq$ .90) (Kelloway, 1998), and the root mean squared approximation of error (RMSEA$\leq$ 0.08) are recommended measures of model fit for unidimensionality because of their independence of sample size, their consistency and accuracy for assessing measurement models, and interpretation ease over a predetermined range. Additionally, the normed chi-square measure of fit (ratio of chi-square divided by the degrees of freedom) is an indicator of over all model fit when combined with other goodness-of-fit indicators (Hair et. al. 1998). Hair et. al. (1999) indicate that this measure is useful for models with samples of over 200 responses, where the likelihood-ratio chi-square statistic will indicate poor model fit because of the large sample size. They recommend the ratio fall below the upper threshold of two or three. The CFA model estimated had a chi-square value of 519.32 with 301 degrees of freedom for a ratio of 1.73.

The CFA met all the established thresholds for good model fit (see Appendix D). The study values are found in Table 7. Good model fit confirmed that the individual items loaded well on the latent constructs and that their tendencies to cross-load were minimal.

Reliability or internal consistency is also a necessary condition for construct validity. Coefficient alphas listed in Table 6 represent the reliability of the individual constructs. Three constructs fell below the 0.70 that is recommended as the minimum standard for scale reliability (Hair et. al., 1998; DeVellis, 2003; Dunn et. al., 1994). The three scales with coefficient alphas below 0.70 were OEMCA at 0.672, OEMPC at 0.623, and PC at 0.539. For new scales, however, coefficient alphas exceeding 0.50 & 0.60 are considered acceptable (Churchill, 1979; Dunn et. al., 1994). Nonetheless, the lower reliability impacted the model results. This impact will be discussed in Chapter 6.

Two other important measures of construct validity are convergent and discriminant validity. Convergent validity is demonstrated by significant factor loadings of the individual items on the latent constructs (Dunn et. al., 1990). Table 6 lists all the items, their factor loadings, and standard errors. All of the factor loadings were significant at a p-value of less than 0.01. The significance levels of the factor loadings exceeded Anderson and Gerbing's (1988) requirement of a p-value of 0.05. Thus, the CFA demonstrated that the items converge on the a priori factors and the consolidated super CM factor.

Discriminant validity is the absence of correlation between unrelated constructs' measures (DeVellis, 2003). Discriminant validity was tested by fixing the correlations of the independent latent constructs to 1.0 and estimating the model (Dunn et. al. 1990). A chi-square difference test was used to determine if a significant difference existed between the final CFA and the correlation constrained model. The chi-square difference between the two models was 747.77 with a difference of 15 degrees of freedom. The p-value for the test of difference between the models was less than 0.00000000001. The CFA model that allowed the correlations to vary between the constructs fit significantly better than the correlation constrained model. This test indicated that the latent variables in the model were distinct and unique from the other latent variables in the model. Additionally, discriminant analysis tests were conducted for each possible latent variable pairing to ensure that discriminant analysis testing at the model level did not overlook a problem with discriminant validity at the pair-level (Anderson & Gerbing, 1988; Garver & Mentzer, 1999). These tests were conducted by using the same analysis accomplished at the model level for the pair level. The results for these tests for all construct pairs were significant at an alpha level of 0.000001 or better (see table 8).

Table 8: Chi Square Difference Tests for Discriminant Validity

Constructs Tested		Chi Square Difference	DF	P-value
OEMCA	SuperCM	183.03	1	< 0.000001
OEMCA	OEMPC	79.53	1	< 0.000001
OEMCA	SBM	175.56	1	< 0.000001
OEMCA	PC	50.58	1	< 0.000001
OEMCA	CE	68.8	1	< 0.000001
SuperCM	OEMPC	71.6	1	< 0.000001
SuperCM	SBM	325.74	1	< 0.000001
SuperCM	PC	50.77	1	< 0.000001
SuperCM	CE	393.25	1	< 0.000001
OEMPC	SBM	24.36	1	< 0.000001
OEMPC	PC	51.87	1	< 0.000001
OEMPC	CE	76.27	1	< 0.000001
SBM	PC	56.79	1	< 0.000001
SBM	CE	61	1	< 0.000001
CE	PC	38.1	1	< 0.000001
Complete Model		747.77	15	< 0.00000000001

During the estimation of the measurement model, modification indices showed high correlations between some of the item error terms in the model. In four cases, these error terms were allowed to correlate in the measurement model. These post hoc correlation adjustments were consistent with theory and improved measurement model fit. Additionally, these highly correlated error terms indicated the presence of strong characteristics or facets in three latent variables.

In super CM, these correlations indicated two major characteristics that contributed to CM competitive advantage. First, the error terms of three internationally focused items, (1) access to international markets, (2) access to international infrastructure, and (3) access to low cost resources, and an item representing the importance of manufacturing costs were highly correlated. The error terms were allowed to correlate because theoretically these three items form an offshoring characteristic frequently found in the outsourcing decision. The manufacturing cost item's presence in this group linked manufacturing costs to the offshoring element indicating the importance of cost in the offshoring decision. The correlation was so strong between the three international items that these error terms were allowed to correlate in the structural model as well. Another facet or characteristic of the super CM latent variable was a critical resources element. Items that tapped CM design competence, access to critical resources through the CM, and the integration of CM procurement and manufacturing operations were highly correlated. These high correlations indicated that OEMs view CMs as a source of critical resources especially in design, manufacturing, and procurement. The elements of critical resources, and offshoring are facets of super CM that indicate important aspects that OEMs seek from CMs.

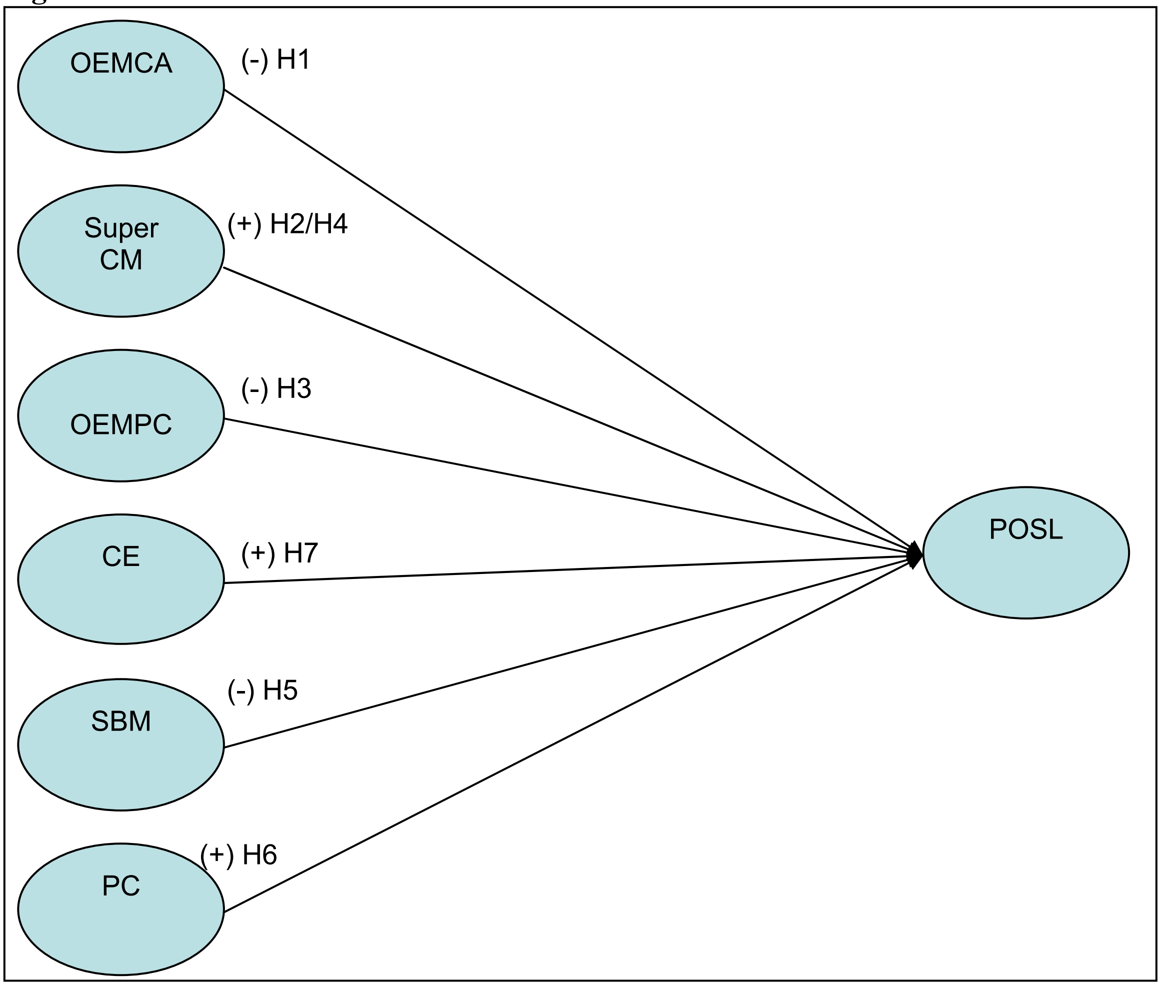
Pairs of correlated error terms in both CE and OEMPC were also important indicators of underlying elements of the competitive environment and OEM procurement competence. In CE, the error terms of product and manufacturing obsolescence were highly correlated. This correlation emphasized the importance of obsolescence in the market and the level of impact on the competitive arena. For OEMPC, procurement's contribution to long term competitive advantage and procurement performance were highly correlated. This correlation indicated the importance of procurement's role in the firm and the need contribute to competitive advantage through high performance. These facets of CE and OEMPC highlighted important underlying elements in the procurement outsourcing decision.

Although these correlated errors indicated important elements of three independent variables, only the errors of the international or offshoring element were moved into the structural model. The offshoring correlations were strong in both models, while the impact of the other correlated errors was reduced in the structural model. After estimation of the measurement model, the focus turned to hypothesis testing in the structural model.

Structural Model Estimation

The estimation of the structural model and the testing of research hypotheses followed a two phase approach. First, a structural model estimating the direct effects of the independent variables OEMCA, super CM, OEMPC, SBM, CE, and PC, was created. The change in the model that occurred while testing unidimensionality drove the consolidation of hypotheses two and four. Second, moderation models were estimated to test hypotheses 7a-7c. The estimation of the direct effect models and the moderation models determined support or non-support for the TCE and RBV based hypotheses.

Figure 6: The Estimated Structural Model



The power of structural equation modeling comes from the ability to estimate a model that incorporates a measurement model that assesses the relationship of measurement items and a structural model that uses path analysis to estimate the structural or causal relationships (Kelloway, 1998). Building on the measurement model, a structural model was developed that linked the latent constructs of this study as hypothesized in Chapter 3 in the theoretical model. Figure 6 shows the changes from the theoretical model to the structural model for the direct paths impacting the level of procurement outsourcing. Specifically, it has replaced CMCA and CMPC with super

CM, a latent construct that combines the scales of the two previously mentioned CM constructs. The level of procurement outsourcing or (POSL) was the dependent variable for this model. Additionally, the moderation paths have been removed from Figure 6. The first structural model estimated only the direct effects from the theoretical model (see Appendix E).

Table 9: Structural Model Goodness-of-Fit Indicators.

Measure of Fit	Study value	Recommended Values
Normed Chi-Square	1.69	$\leq$ 3.00
Tucker Lewis Index (TLI/NNFI)	0.93	$\geq$ 0.90
Bentler's Comparative Fit Index (CFI)	0.93	$\geq$ 0.90
Root Mean Square Error of Approximation (RMSEA)	0.052	$\leq$ 0.08
Goodness-of-Fit Index (GFI)	0.85	$\geq$ 0.90
Adjusted Goodness-of-Fit Index (AGFI)	0.82	$\geq$ 0.90

To determine the validity of the structural model results it is important to assess model and individual item fit. Model fit measures for the estimated structural model are found in Table 9. The structural model fit indicators demonstrated good model fit. The normed chi-square, TLI, CFI, and RMSEA all fell within the recommended values for their respective index. Although the GFI and AGFI are below the desired value of 0.90, Hair et. al. (1998) stated that indicators in that range are marginally acceptable. The AGFI threshold of 0.90 is considered conservative and a rough guideline (Bagozzi & Yi, 1988) and researchers often use a threshold of 0.80 (Sharma, 1996).

Overall the model fits well but individual item fit is also important. Factor loadings, standard errors, and t-values in Table 10 were indicative of good item fit. All factor loadings were positive and highly significant (p-value < 0.01). This table also contains the squared multiple correlations or communalities for the indicators of the latent independent variables. As a rule of thumb these should be greater than 0.50 with the indicator having half of its variance in common with the latent variable. However, this is a rule of thumb and lower values are acceptable (Sharma, 1996). Lower R^2 values revealed less contribution of the item to the latent construct. Each of the latent constructs had one factor loading of one of its indicators fixed at 1.0. This assigned a similar scale of measurement to the latent construct and the indicators (Kelloway, 1998). Table 10 also contains the data for an alternative model discussed later in the chapter. This data for the alternative model follows the initial estimated model unless the values were the same. When the values were the same, a single value was entered in the table.

The coefficients in Table 11 correspond to the direct paths in the estimated model. Table 11 summarizes the support for individual hypotheses. One path, super CM to POSL was statistically significant at an alpha of 0.05. This path combined H2 and H4 to test for a positive effect of CM competitive advantage and CM procurement competence on the level of procurement outsourcing. This coefficient was positive as hypothesized by the theoretical model. Marginally significant coefficients were also estimated for the paths from OEMPC and PC to POSL. In both cases the sign was as hypothesized. Nonetheless, the evidence for support for H3 and H6 was only marginal at an alpha level of 0.10. However, there was evidence to suggest that an alternative model may more accurately test the proposed hypotheses.

Table 10: Structural Model Factor Loadings, and Significance for Latent Variables (Initial Structural Model/Alternative Structural Model)

Items arranged by latent Variable	Unstandardized Factor Loading	Standard Error	t-Value	R^2
OEMCA: α=.672				
5. How important was the lack of internal manufacturing capacity in the decision to outsource manufacturing?	0.40/0.38	0.13	3.08/2.95[b]	0.05/0.04
6. How important was this product or major subsystem to your firm's core competence strategy?	1.00	N/A	N/A	0.56/0.57
7. How important were components of this product or major subsystem to your core competence strategy?	1.02/1.00	0.12/0.11	8.89/8.91[b]	0.58/0.57
8. To what extent did the manufacturing of this product or subsystem depend on firm core competencies?	0.87/0.86	0.10	8.44/8.52[b]	0.42/0.43
Super CM: α=.817				
10. How important was CM design knowledge in the decision to outsource manufacturing?	0.52	0.09	5.76/5.65[b]	0.14/
12. How important were CM manufacturing costs in the decision to outsource manufacturing?	0.30/0.28	0.05/0.06	5.40/5.11[b]	0.13/0.14
14. How important was entering international markets in your decision to outsource manufacturing?	0.60/0.61	0.10/0.11	5.81/5.83[b]	0.15
15. How important was gaining access to international infrastructure (logistics, mkting, after-sales spprt, etc.)?	0.56/0.58	0.10	5.83/5.86[b]	0.15
16. How important was gaining access to low cost international resources (labor, materials, etc.)?	0.65/0.66	0.11	6.04/6.09[b]	0.16/0.17
18. How important was CM leverage with their suppliers in your decision to outsource or retain procurement?	1.00	N/A	N/A	0.63/0.62
20. How important was the CM's procurement competence in your decision to outsource or retain procurement?	0.97	0.08	12.76/12.33[b]	0.66/0.65
22. How competent was the CM's procurement function?	0.48/052	0.06	8.24/8.72[b]	0.29/0.33
23. How important was integration between CM manufacturing and procurement?	0.74/0.73	0.07	10.45/10.05[b]	0.44/0.43
24. How important was gaining access to critical resources through the CM?	0.59/0.57	0.08	7.37/6.95[b]	0.23/0.21
SBM: α=.848				
26. How important was keeping existing supplier relationships?	1.00	N/A	N/A	0.68
27. How important was keeping your product's existing supply base intact?	1.021	0.07	14.22[b]	0.75
28. How important were existing suppliers to other products you manufacture?	0.91	0.07	12.35[b]	0.54
OEMCP: α=.623				
31. How much did your procurement function contribute to lasting firm competitive advantages?	1.00	N/A	N/A	0.30/0.40
32. How would you describe your procurement function's performance at the time of the outsourcing decision?	0.54/0.60	0.12	4.45/5.13[b]	0.12/0.20
33. How important was the potential loss of control of critical resources?	1.08/0.76	0.19/0.16	5.78/4.69[b]	0.24/0.16
34. How important was your firm's existing procurement leverage?	1.64/1.25	0.23/0.20	7.22/6.13[b]	0.56/0.44
CE: α=.704				
38. What was the pace of technological change for this type of product or subsystem?	1.00	N/A	N/A	0.44/0.40
39. What was the rate of product obsolescence for this type of product or subsystem?	1.04/1.11	0.14/0.16	7.47/6.99[b]	0.54/0.57
40. What was the rate of manufacturing obsolescence for this type of product or subsystem?	0.77/0.79	0.11/0.12	7.15/6.77[b]	0.37/0.35
PC: α=.539				
43. How would you describe the specification maturity of this product or subsystem?	1.00	N/A	N/A	0.72/0.75
44. How standardized were the direct materials of the product or subsystem?	0.58/0.54	0.17	3.40/3.19[b]	0.17/0.16
47. How differentiated was your product or subsystem from similar products or subsystems?	0.37/0.33	0.13	2.86/2.63[b]	0.07/0.06

[b]Both t-values significant at a p-value<0.01. A single value means parameters are equal. (Format adapted from Krause et. al., 2001)

Table 11: Direct Effects Coefficients

	OEMCA	Super CM	OEMPC	SBM	PC	CE
Coefficient	0.02	0.57	-1.10	0.57	0.48	0.23
Standard Error	0.19	0.20	0.60	0.27	0.27	0.25
t-value	0.12	2.90[a]	-1.83[b]	1.05	1.77[b]	0.91

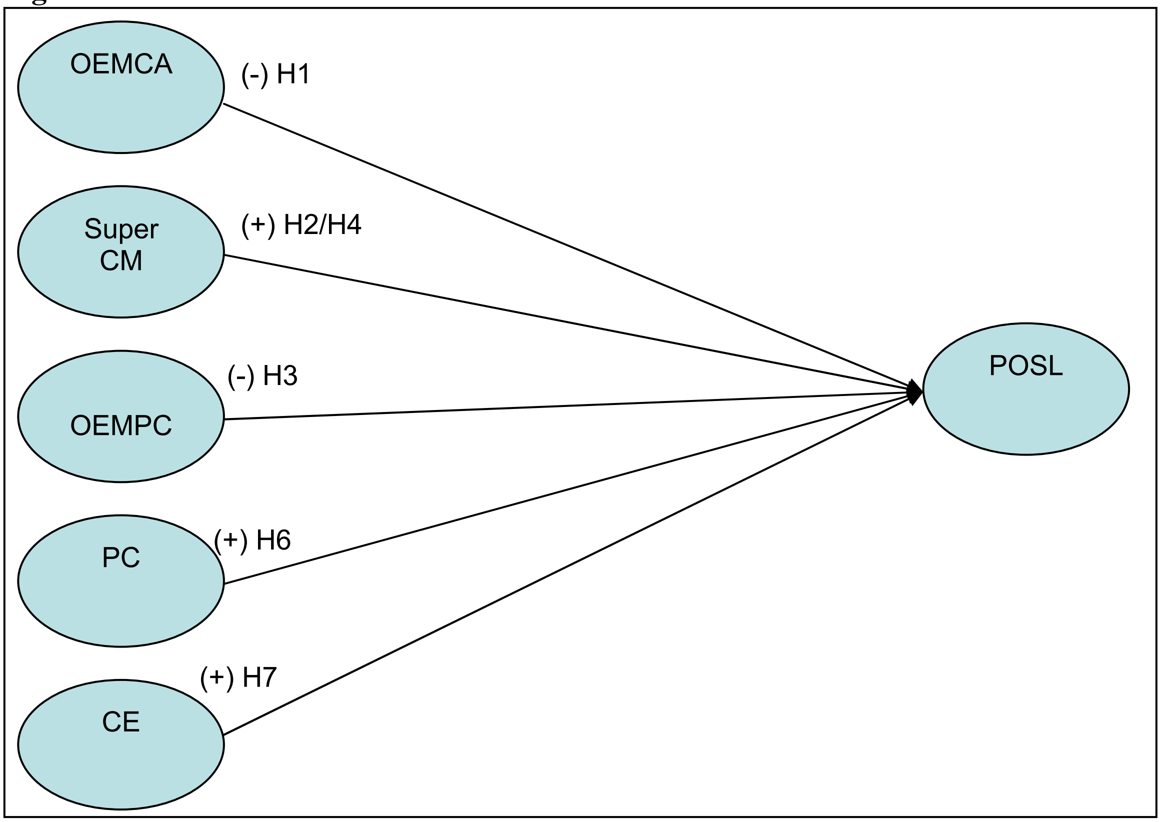
[a]Significant at a p-value of 0.05. [b]Marginally significant at a p-value of 0.10.

An examination of the measurement model indicated a very high correlation between SBM and OEMPC. The correlation between the two constructs was 0.70 and highly significant with a t-value greater than twelve. This level of correlation indicated a possible problem with multicollinearity. Multicollinearity artificially increases the value of the standard errors reducing the usefulness of individual coefficients (Freund & Wilson, 1998). If a high degree of multicollinearity existed between SBM and OEMPC, it was possible that the inclusion of SBM in the structural model was dampening the true value of the OEMPC coefficient or vice versa. For this reason an alternate model, Figure 7, was estimated without SBM.

Table 12: Direct Effect Hypotheses

Research Questions	Hypotheses	Results
•How does the procurement outsourcing decision relate to the manufacturing outsourcing decision? (H1-H2)	H1: OEM competitive advantage is negatively related to procurement outsourcing	Not Supported
•What are the important factors in the decision to retain or outsource purchasing? (H1-H7)	H2/H4: CM competitive advantage and procurement competence is positively related to procurement outsourcing	Supported
	H3: OEM procurement competence is negatively related to procurement outsourcing	Marginally Supported
	H5: Supply base maintenance is negatively related to procurement outsourcing	Not Supported
	H6: Product commoditization is positively related to procurement outsourcing	Marginally Supported
	H7: The competitive environment for the market is positively related to procurement outsourcing	Not Supported

Figure 7: Alternative Model



The alternative model fit almost as well as the initial structural model (see Appendix F). Table 13 contains the goodness of fit indicators for the alternative model. The normed chi square, TLI, and RMSEA all moved in a direction that worsened the model fit. However, none of the thresholds were breached and the fit indices of CFI, GFI, and AGFI remained the same. The alternative model fit indices supported that the model fit well. Table 10 contains the factor loadings, standard errors, t-values, and R^2 of the alternative model. The estimates for SBM are only for the initial model because it was not included in the alternative model. These individual indicators remained almost identical to the initial model estimates. The largest change in these individual parameters occurred in OEMPC, the construct that was the greatest concern for multicollinearity.

Table 14 shows that in the alternative model OEMPC had a significant negative effect on the level of outsourcing.

Table 13: Alternative Structural Model Goodness-of-Fit Indicators

Measure of Fit	Study value	Recommended Values
Normed Chi-Square	1.77	$\leq$ 3.00
Tucker Lewis Index	0.92	$\geq$ 0.90
Bentler's Comparative Fit Index	0.93	$\geq$ 0.90
Root Mean Square Error of Approximation (RMSEA)	0.056	$\leq$ 0.08
Goodness-of-Fit Index (GFI)	0.85	$\geq$ 0.90
Adjusted Goodness-of-Fit Index (AGFI)	0.82	$\geq$ 0.90

The major impact of the alternative model was to increase the level of significance of OEMPC to the 0.05 alpha level as shown in Table 13. Super CM remained significant at the same level and PC remained marginally significant. With the exception of CE's standard error, all of the other standard errors for the direct paths were reduced. These reductions in standard errors effectively provided support for the SBM factor as a source of multicollinearity in the model.

Another model was estimated with OEMPC removed and SBM retained in the model. The result was a model that had no significant coefficients impacting POSL and that model was not considered further for evaluation. The alternative model was found to be superior to the initial model because it appeared to reduce the multicollinearity affecting OEMPC.

Table 14: Direct Effects Coefficients Alternative Model

	OEMCA	Super CM	OEMPC	PC	CE
Coefficient	0.08	0.52	-.68	0.47	0.25
Standard Error	0.19	0.18	0.32	0.26	0.25
t-value	0.40	2.95[a]	-2.11[a]	1.78[b]	1.02

[a]Significant at a p-value of 0.05. [b]Marginally significant at a p-value of 0.10.

Transaction cost economics indicates that varying levels of uncertainty, CE, moderates the affect of asset specificity on the make/buy decision. In accordance with TCE, three constructs, OEMPC, SBM, and PCE, were hypothesized to have high asset specificity. For OEMPC and SBM, this high asset specificity was a result of building human asset specificity through the development of buyer-supplier relationships. PC was an inverse measure of product asset specificity. As such, low levels of PC would indicate high asset specificity for a product or subsystem. According to TCE, high levels of uncertainty will amplify the impact of asset specificity in the make/buy decision (Williamson, 1985). For example, a product that requires a high degree of asset specific processes or equipment in its production would have low probability of being outsourced. When uncertainty increases, this probability of outsourcing would be reduced even more.

To test for a moderating effect of uncertainty as measured by CE, the sample of respondents was divided into high and low uncertainty groups based on their composite CE score. The groups were separated at the median score of twelve. The low uncertainty group consisted of 124 respondents and the high uncertainty group consisted of 134 respondents.

Two models were estimated (see Appendix G) with the high and low groups to test for moderation in the five independent factor model (SBM excluded). The first model fixed all direct effect coefficients to be equal for the two groups. The second, free model allowed the estimation of coefficients for both the high and low uncertainty groups for the direct paths from OEMPC and PC to POSL. If the second model fit significantly better than the first model, the possibility of moderation existed and would be supported through tests to determine if the PC and OEMPC coefficients were significantly different between the two groups. The two models were compared using a chi-square difference test. The chi-square difference between the two models was 0.93 with 2 degrees of freedom. The test was not significant (p-value > 0.5), indicating there was no significant differences between the fit of the models. Table 15 contains the two models' chi-square values, degrees of freedom, and fit indices. Many of the fit indices are lower than previously tested models. This lower result occurred because of the reduced statistical power of dividing the sample into two groups. The most important result is that the fit indices are equal for the two models. This equality supports the conclusion that moderation is not present in the model and that the models fit equally well. As a result, there was no support for uncertainty moderating the relationship of PC and OEMPC on POSL.

Table15: Moderation Models

Measure of Fit	Fixed Model	Free Model	Recommended Values
Minimum Fit Function Chi-Square (Degrees of Freedom)	1127.82 (725)	1126.89 (723)	N/A
Normed Chi-Square	1.56	1.56	$\leq$ 3.00
Tucker Lewis Index	0.88	0.88	$\geq$ 0.90
Bentler's Comparative Fit Index	0.89	0.89	$\geq$ 0.90
Root Mean Square Error of Approximation (RMSEA)	0.061	0.061	$\leq$ 0.08

Moderation was also tested in a model including SBM using the procedures described above. The result was again insignificant with a chi-square difference of 2.19 with 3 degrees of freedom. There was no support for moderation with or without SBM in the model.

Table 16 indicates the final results of hypothesis testing. H2/H4 was supported. CM competitive advantage and CM procurement competence had a positive significant impact on the level of procurement outsourcing. H3 was supported. OEMPC had a significant negative impact on the level of procurement outsourcing. H6 was marginally supported. Product commoditization had a marginal positive impact on the level of procurement outsourcing. All other direct or moderation hypotheses were not supported. The strategy elements of Super CM and OEMCA drive the manufacturing outsourcing decision and were used to answer research question three. The model supported that manufacturing decisions made to take advantage of CM competitive advantages were positively related to procurement outsourcing.

In the structural model, high error correlations were found in the dependent latent variable POSL between the levels of outsourcing of phase four and phase five of the procurement process. The errors were allowed to correlate, resulting in better model fit. This high positive correlation of errors related to CM involvement in the transactional aspects of procurement (ordering, receiving, inspecting, and inventory management) with the management of supplier performance indicated a positive relationship between the amount of CM participation in procurement activities with the suppliers and CM participation in managing the supplier relationship. Thus, it appears that greater CM involvement in order, receiving, inspecting and inventory management results in greater participation in the measurement and management of supplier performance.

The data analysis effort for this research developed and purified a measurement model to examine procurement outsourcing in the manufacturing outsourcing context. The measurement model was connected via paths to the dependent latent construct indicating the level of procurement outsourcing to form a structural model. The structural model was estimated and through path analysis this study's hypotheses were tested.

Table 16: Hypotheses testing results

Research Questions	Hypotheses	Results
•How does the procurement outsourcing decision relate to the manufacturing outsourcing decision? (H1-H2)	H1: OEM competitive advantage is negatively related to procurement outsourcing	Not Supported
•What are the important factors in the decision to retain or outsource purchasing? (H1-H7)	H2/H4: CM competitive advantage and procurement competence is positively related to procurement outsourcing	Supported
	H3: OEM procurement competence is negatively related to procurement outsourcing	Supported
	H5: Supply base maintenance is negatively related to procurement outsourcing	Not Supported
	H6: Product commoditization is positively related to procurement outsourcing	Marginally Supported
	H7: The competitive environment for the market is positively related to procurement outsourcing	Not Supported
	H7a: The level of competition in the market environment will moderate the relationship between OEM procurement competence and procurement outsourcing by amplifying the negative relationship.	Not Supported
	H7b: The level of competition in the market environment will moderate the relationship between supply base maintenance and procurement outsourcing by amplifying the negative relationship.	Not Supported
	H7c: The level of competition in the market environment will moderate the relationship between product commoditization and procurement outsourcing by amplifying the positive relationship.	Not Supported

Procurement Arrangements Analysis

The final data analysis for this research involves the use of cluster analysis and multi-group discriminant analysis to determine if predominant procurement outsourcing arrangements or a taxonomy of arrangements exist in practice for the contract manufacturing context. In the literature review, six procurement outsourcing arrangements were identified. These arrangements ranged from the OEM performing all procurement activities to the CM performing all procurement activities. The following analysis seeks to determine what procurement arrangements are supported by data.

Cluster Analysis

Cluster analysis was used to group procurement outsourcing approaches into clusters that are homogenous with respect to outsourcing characteristics within the group yet distinct from other groups with respect to the same characteristics (Sharma, 1996). This analysis was performed in a three phase approach. First, data were checked for multivariate normality and outliers removed from the data set. Second, cluster analysis was performed using a hierarchical clustering method. Last, cluster centroids from the first cluster analysis were used for seeds in nonhierarchical cluster analysis.

The overriding assumption of cluster analysis and multiple discriminant analysis is multivariate normality (Hair et. al, 1998; Sharma, 1996). In order to ensure that the results of the cluster analysis could be effectively analyzed during the subsequent discriminant analysis, data were examined for multivariate normality and outliers causing the data to deviate from multivariate normality based the calculation of Mahalanobis distance sum of squares were eliminated. A SAS macro created by Michael Friendly (1991) was implemented to identify outliers that prevented multivariate normality (see Appendix C). As a result, the number of responses used in cluster analysis was reduced from 265 to 208. These 208 responses were then analyzed using cluster analysis.

Clusters were formed using Ward's method for hierarchical clustering. This method maximizes within cluster homogeneity by minimizing the within group sums of squares (Sharma, 1996). Next, stopping rules were used to determine the number of clusters. Three rules from Miller and Roth (1994) were applied to determine cluster size. The number of clusters was limited by restricting the quantity of clusters to the range of n/30 to n/60 (n = 208), by stopping at pronounced increases in the R^2 and pseudo F-statistic, and by using ANOVA and the Scheffe criterion for pairwise comparison tests of cluster means to obtain managerial interpretability.

The first two rules were implemented to determine that six was the appropriate number of clusters for hierarchical clustering. With a sample size of 208, rule one drove a lower limit of 3 clusters and an upper limit of 7 clusters. The second stopping rule supported a six cluster solution. The pseudo F-statistic showed a large jump in the percentage change of 7.8% in moving from the 7 to the 6 cluster solution. The R^2 for the six cluster solution was 0.562 explaining 56.2% of the variance in the data. A 4.8% change from a seven cluster solution to six cluster solution demonstrated a marked increase for over previous changes around two percent or less. Additionally, the root-mean-square total-sample-standard deviation (RMSSTD) fell from 2.34 to 2.20 when moving from the seven to the six cluster solution, demonstrating a more homogenous cluster solution (Sharma, 1996). Solutions with less than six clusters resulted in higher values of RMSSTD indicating less homogenous solutions occurred with few clusters.

Cluster centroids from the hierarchical procedure were then used as the seeds for nonhierarchical clustering method. For nonhierarchical clustering, the SAS Fastclus algorithm was used to fine tune the hierarchical cluster solution (Hair et. al., 1998; Frohlich & Dixon, 2001). The third rule was used to interpret the clusters identified through the nonhierarchical cluster analysis method. The results from the one-way ANOVA and pairwise comparisons using the Scheffe criterion are found in Table 17.

The data indicate that for all 11 variables tested the null hypothesis, all means are equal, was rejected with a p-value less than 0.0001. Significant differences among the means existed for each variable.

Pairwise comparisons using the Scheffe criterion were evaluated for each variable. Because there were there were more significant differences between the variables than not, Table 17 indicates pairs that were not significantly different. The heading row in Table 17 indicates the title applied to distinguish each group. Moving from left to right on Table 17 indicates an increasing procurement responsibility as demonstrated by the mean level of outsourcing by phase for each group.

OEM complete (Group One) and CM Complete (Group Six), the two clusters at each end of the outsourcing spectrum, remained the same with OEM leverage being the most important variable in the former and the least important variable in the latter. The OEM appeared to procure materials autonomously in OEM complete while the CM was autonomous in CM complete.

Group two (OEM principal/CM limited partner) differed significantly from Group One (OEM complete) on OEM leverage and on the CM executing all phases of the procurement process for some materials. The CM did not have significantly more purchasing responsibility in Group One than Group Two. However, OEM leverage was of low importance in the outsourcing decision and the increased level of the CM accomplishing all phases of the procurement process for certain materials indicated that the CM controlled a critical resource or component for which the OEM gave the CM full control of the acquisition process.

Table 17: Six Group One-way ANOVA with Scheffe Pairwise Comparisons

Taxons	OEM Complete (n=25) Group 1	OEM Principal CM Limited Partner (n=40) Group 2	Noncritical Transactional CM (n=30) Group 3	CM Leverage OEM Control (n=37) Group 4	OEM Directed/ CM Executed (n=48) Group 5	CM Complete (n=28) Group 6	F Value P-Value (from one-way ANOVA)
Phase 1							
Group Cluster Mean	1.08 (2,3)	1.13 (1,2)	1.30 (1,2,4)	2.57 (3)	7.00 (6)	8.04 (5)	118.73
Group Rank	5	11	11	11	5	5	<.0001
Group Standard Error by Item	1.47	1.60	1.29	1.94	1.96	1.57	
Phase 2							
Group Cluster Mean	0.84 (2)	1.28 (1,3)	2.33 (2,4))	3.41 (3)	7.83 (6)	8.18 (5)	160.76
Group Rank	8	10	10	10	3	3	<.0001
Group Standard Error by Item	1.21	1.32	1.56	1.88	1.48	1.44	
Phase 3							
Group Cluster Mean	0.96 (2)	1.35 (1)	2.67 (4)	3.86 (3)	8.10 (6)	8.25 (5)	152.26
Group Rank	6	9	7	8	1	2	<.0001
Group Standard Error by Item	1.14	1.33	1.74	2.22	1.30	1.27	
Phase 4							
Group Cluster Mean	0.96 (2)	2.60 (1)	5.10 (4)	5.65 (3)	7.31 (6)	8.32 (5)	56.51
Group Rank	6	3	3	5	4	1	<.0001
Group Standard Error by Item	1.17	1.97	2.88	2.38	1.98	1.42	
Phase 5							
Group Cluster Mean	0.88 (2)	1.73 (1)	4.03 (4)	5.32 (3)	7.85 (6)	7.36 (5)	75.92
Group Rank	7	8	4	6	2	7	<.0001
Group Standard Error by Item	1.30	1.84	2.65	2.21	1.70	1.59	

Numbers in parentheses not significantly different at 0.05 level

Table 17: Six Group One-way ANOVA with Scheffe Pairwise Comparisons (Continued)

Procurement Phase	OEM Complete (n=25) Group 1	OEM Principal CM Limited Partner (n=40) Group 2	Noncritical Transactional CM (n=30) Group 3	CM Leverage OEM Control (n=37) Group 4	OEM Directed CM Executed (n=48) Group 5	CM Complete (n=28) Group 6	F Value P-Value (from one-way ANOVA)
CM Leverage							
Group Cluster Mean	1.16 (2)	2.13 (1,3)	3.23 (2,5)	6.86 (6)	4.29 (3)	8.07 (4)	65.53
Group Rank	4	7	6	2	9	4	<.0001
Group Standard Error by Item	1.46	1.67	1.56	2.08	2.24	1.51	
OEM Leverage							
Group Cluster Mean	8.36 (3)	2.28 (5)	6.47 (1,5,6)	3.65 (2,5,6)	5.94 (4,6)	5.25 (3,4,5)	26.75
Group Rank	1	5	2	9	7	10	<.0001
Group Standard Error by Item	1.63	2.16	1.92	2.31	2.55	3.25	
Critical Direct Materials							
Group Cluster Mean	0.60 (2,3)	2.15 (1,3)	2.40 (1,2)	6.89 (6)	4.17	7.61 (4)	57.23
Group Rank	9	6	9	1	10	6	<.0001
Group Standard Error by Item	0.87	2.11	1.94	2.04	2.38	2.06	
Noncritical Direct Materials							
Group Cluster Mean	1.52 (2)	2.53 (1)	6.57 (4,6)	6.65 (3,6)	4.65 (6)	6.50 (3,4,5)	26.22
Group Rank	2	4	1	4	8	9	<.0001
Group Standard Error by Item	2.18	1.88	2.36	2.70	2.57	2.80	
CM All Phases							
Group Cluster Mean	1.24	5.03 (3,4,5)	3.77 (2)	6.70 (2,5,6)	6.54 (2,4,6)	8.25 (4,5)	32.92
Group Rank	3	1	5	3	6	2	<.0001
Group Standard Error by Item	1.48	3.28	2.27	1.65	2.58	1.11	
CM Supplier Selection							
Group Cluster Mean	1.24 (2,3)	3.05 (1,3,4,5)	2.53 (1,2,5)	4.62 (2,5)	3.44 (2,3,4)	7.04	18.56
Group Rank	3	2	8	7	11	8	<.0001
Group Standard Error by Item	1.94	2.94	2.44	2.44	2.54	1.93	

Numbers in parentheses not significantly different at 0.05 level

Group Three significantly increased the level of outsourcing over Groups One and Two. Although the noncritical transactional CM procurement arrangement not significantly different in phases one and two than the first two groups, CM procurement responsibility was significantly greater in the last three phases. This increased responsibility for these three phases supported that the CM for this group was much more involved in the transactional elements of contracting with suppliers, procuring materials and managing suppliers. Additionally, this arrangement was very dependent on OEM leverage and the CM acquiring noncritical direct materials. The OEM wielded its leverage and the CM focused on transactions and noncritical acquisitions.

The levels of outsourcing for Group Four, CM leverage/OEM control, did not differ significantly from Group Three in any phase. However, the OEM approach differed significantly on all six of the remaining variables except noncritical direct acquisitions. CM leverage, critical direct materials acquisitions, CM execution of all procurement phases, and CM supplier selection were all higher while OEM leverage importance was lower. This arrangement appeared to leverage the CM's buying power under the active control of the OEM. Although higher, the level of CM supplier selection still indicated that the OEM retained the majority of this responsibility.

The procurement outsourcing levels for Groups Five and Six were significantly higher than the other arrangements for all phases of the procurement process. However, they did not significantly differ from each other although outsourcing means for Group Six were higher. Group Six, CM complete, was all about the CM being the primary actor in procurement. Its main differences from Group Five, OEM directed/CM executed, were higher levels of CM leverage, critical direct materials acquisitions, and CM supplier selection. Group Five was significantly lower on these three variables indicating a tendency for OEMs to select the majority of suppliers, acquire critical direct materials, and rely on their own leverage. The high levels of procurement outsourcing for Group Five were accompanied by high levels of OEM control.

Multiple Discriminant Analysis

Discriminant analysis was performed to identify the variables that best discriminate between the clusters or procurement outsourcing arrangements (Sharma, 1996). Canonical discriminant functions were calculated. These discriminant functions were evaluated to determine their significance and the importance of individual variables in discriminating between the individual outsourcing arrangements. Discriminant analysis reduces the dimensions that discriminate between groups.

Discriminant analysis was performed with the cluster serving as the categorical dependent variable and eleven independent variables. The independent variables consisted of five items that indicated the level of outsourcing for each phase of the procurement process and six variables that represented decisions made to structure the outsourcing arrangement. The model generated five significant canonical discriminant functions, all significant at an alpha level of 0.01. The first three equations accounted for 98.27% of the variation in the dependent variable (Hair et. al., 1998). For this reason, although the other two equations were significant, they were not analyzed further because of their minimal contribution to explaining the difference between the clusters or procurement arrangements.

Evaluation of the discriminant model reveals that it discriminates well between the six procurement arrangements. First, the likelihood ratio test for the model (Wilk's

Lambda) is significant at a p-value of less than 0.0001. This test result indicates that at least one of the groups differs significantly across the model (Sharma, 1996). Next, pairs of cluster centroids were tested for pairwise differences between the six groups. The result of difference testing yielded a p-value of less than 0.001 for all tests of differences between the six groups. This indicated that not only did the equations create overall separation, but they also separated each group (Hair et. al., 1998). Additionally, group membership prediction accuracy indicated that the model fit well. Hair et. al. (1998) indicate the hit rate of assigning observations to the correct group serves the purpose of R^2 in regression analysis. The model demonstrated an overall hit rate of 97.5% by classifying correctly 202 of the 208 observations. Analysis comparing proportional chance criterion and maximum chance criterion demonstrated that the model greatly exceeded the more stringent maximum chance criterion with a twenty-five percent threshold of 28.8 percent with its 97.75% correct classification rate. This indicated that the discriminant functions achieved a high level of predictive accuracy (Hair et. al., 1998). These tests of the three discriminant functions indicated that the functions represented the data well and explained the variation in the data.

The raw canonical coefficients of the first three discriminant functions were used to define three dimensions affecting procurement outsourcing. These coefficients are found in Table 18 and are read in a similar manner to factor scores in exploratory factor analysis with high positive or negative scores indicating the variable has importance in the function. The three functions enabled the concentration of variables into three dimensions impacting procurement outsourcing and its associated arrangements.

Function 1 was centered on CM leverage. High CM leverage drove higher levels of critical direct materials sourcing and was related to increased CM involvement in the first three phases of procurement. Leverage increased the importance of the CM in the process and the importance of CM acquisitions.

Function 2 focused on CM control of critical direct materials. CMs with control or access to critical direct materials and a moderate amount of leverage became more involved in supplier selection and phase four of the procurement process. However, OEMs planned the procurement strategy, created supplier selection criteria, and had greater involvement in managing suppliers. Even though it appeared the CM had access to or control of critical direct materials, the OEM planned and controlled the majority of the procurement process in a manner that limited CM procurement responsibilities to acquiring those critical direct materials. OEM strategies to increase participation in the management of suppliers enabled OEMs to develop relationships directly with critical suppliers.

Table 18: Raw Canonical Coefficients for Discriminant Functions.

Taxons	Canonical Coefficients Function 1	Canonical Coefficients Function 2	Canonical Coefficients Function 3
Phase 1	0.150	-0.168	-0.169
Phase 2	0.166	-0.149	-0.081
Phase 3	0.183	-0.046	-0.045
Phase 4	0.0986	0.119	0.123
Phase 5	0.083	-0.128	-0.007
CM Leverage	0.149	0.106	0.150
OEM Leverage	-0.032	-0.205	0.300
Critical Direct Materials	0.149	0.236	0.056
Noncritical direct Materials	0.044	0.046	0.173
CM All Phases	0.088	0.043	-0.200
CM Supplier Selection	0.052	0.148	0.025

Function 3 centered on OEM leverage. This leverage resulted in OEMs controlling phases one and two of the procurement process and CMs being less involved in accomplishing the procurement process for all phases of specific materials. However, CMs experienced increased involvement in phase four (procuring material) and in the acquisition of noncritical materials with their own leverage. The means for each procurement arrangement on these three procurement outsourcing dimensions will be illustrated graphically and discussed in the next chapter.

Data analysis was focused on the relationships of factors and procurement outsourcing and building a taxonomy of procurement outsourcing arrangements. First, it tested the hypothesized relationships in the theoretical model. This was accomplished through estimation of a measurement model and a structural model. An alternative model was estimated to account for multicollinearity between SBM and OEMPC. Second, cluster analysis and multiple discriminant analysis were performed as exploratory procedures to build a taxonomy of procurement outsourcing arrangements and to understand their underlying dimensions.

CHAPTER 6

CONCLUSIONS AND RECOMENDATIONS

Introduction

This chapter draws conclusions from the results of the previous chapter. The discussion of the results for the factors impacting procurement outsourcing is followed by the discussion of the procurement outsourcing arrangement results. Theoretical and managerial implications will be discussed. Finally, research limitations and future research will conclude the chapter.

Research Overview

The context of contract manufacturing provides a unique scope within which it is possible to examine the factors driving a decision to outsource direct materials procurement responsibility. This research was designed to answer the two research questions in Table 19. Answering these research questions would extend the purchasing body of knowledge by helping to understand what motivates firms to outsource the procurement of direct materials in this context and the potential to extend this motivation or underlying factors to outsourcing the procurement of direct materials generally.

The methodology to collect data for this dissertation was an internet survey. Interviews conducted with industry personnel indicated that the phenomenon of interest is prevalent throughout the electronics industry and that a survey would be an appropriate methodology to collect data. Discussions with a panel of academics concluded that the subject matter addressed in a proposed research questionnaire could be captured in a self-administered survey and that an internet survey would provide the greatest response rate.

The survey targeted procurement managers. Data were collected over a two month period for use in testing research hypotheses.

Survey data were analyzed using a two step structural equation modeling approach of estimating a measurement model using CFA and then a structural model. Path analysis was employed to determine significant links driving the procurement outsourcing decision. High correlation between OEM procurement competence and supply base maintenance constructs drove the testing of an alternative model. The reduction of multicollinearity in the alternative model enabled the estimation of a significant relationship between OEM procurement competence and the level of outsourcing. Additionally, moderation was tested for the initial and alternative structural models using a high and low uncertainty two group model.

Another focus of the research effort was to examine procurement outsourcing arrangements based on a five-step procurement process. Cluster analysis and multi-group discriminate analysis were used to analyze outsourcing data. The result was six procurement outsourcing arrangements that describe a procurement outsourcing taxonomy.

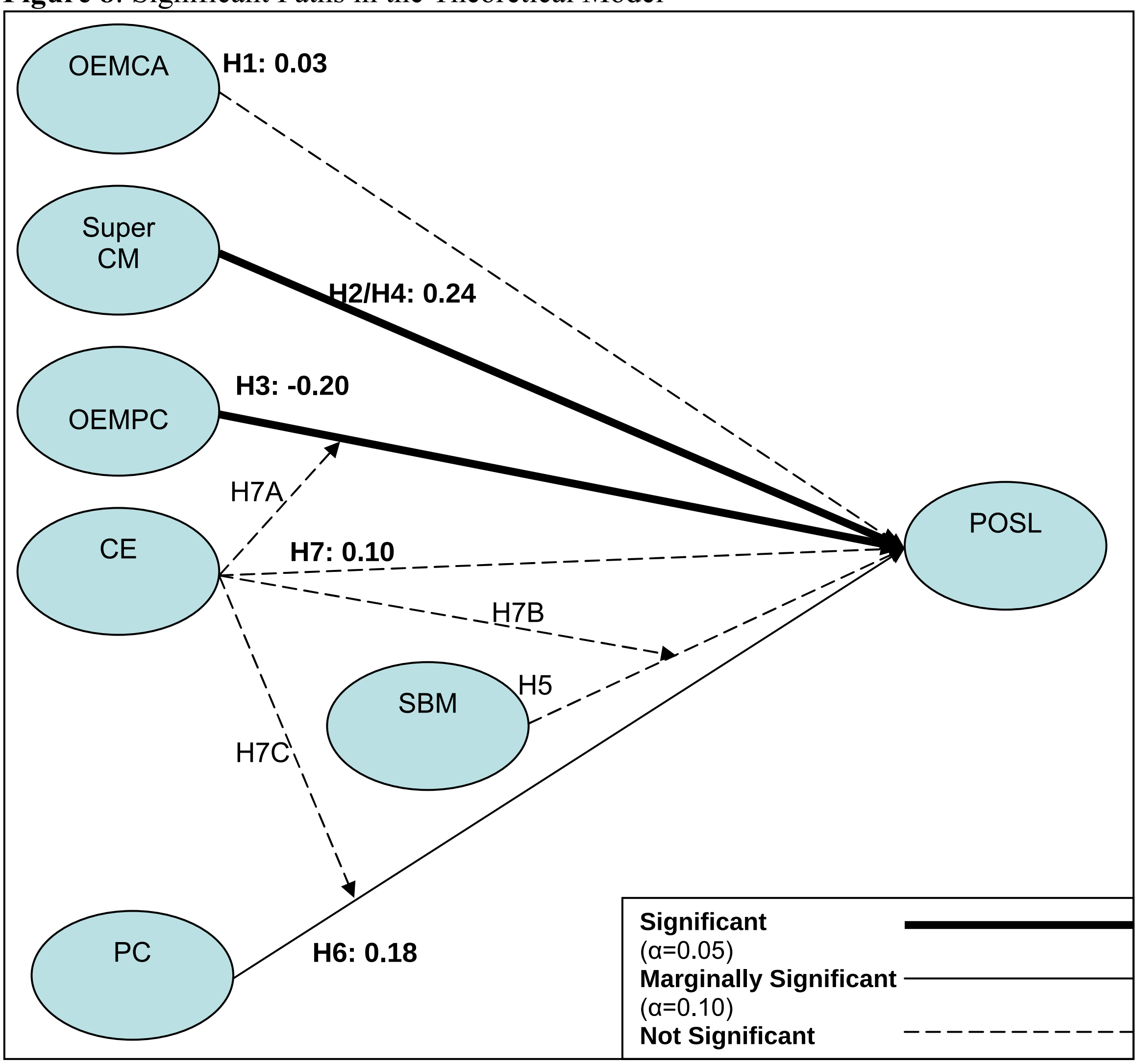
Table 19: Research Questions

•How does the procurement outsourcing decision relate to the manufacturing outsourcing decision? (H1-H2)
•What are the important factors in the decision to retain or outsource purchasing? (H1-H7)

Discussion of Procurement Outsourcing Factors

This section discusses the results of hypothesis testing and links it with the current literature where appropriate. Table 20 lists all tested hypotheses, the results, and an explanation of the results. Hypotheses one through seven tested the direct effects of seven factors identified in an a priori theoretical model. Hypotheses 7a-7c tested for the moderating effects of uncertainty on high asset specific constructs within the model. The significance of paths with their standardized coefficients in the theoretical model is illustrated in Figure 8. Coefficients are not provided for moderation hypotheses or for SBM because moderation was not supported and SBM was not included in the alternative model. The results of each hypothesis test are discussed below.

Figure 8: Significant Paths in the Theoretical Model



In hypothesis one, the OEM competitive advantage (OEMCA) construct's relationship with the level of procurement outsourcing was tested. OEMCA was formed from drivers of OEM competitive strategy related to core competence. These drivers impact the manufacturing outsourcing decision and were hypothesized to negatively impact the level of procurement outsourcing. This hypothesis was not supported. Therefore, indicators of OEM competitive advantage did not impact the procurement outsourcing decision and did not demonstrate a link between the outsourcing manufacturing decision and procurement outsourcing. These results indicate that once the decision is made to outsource manufacturing, the resulting procurement retention or outsourcing decision is not driven by a core product strategy. This opposes the principles of resource-based view which predict that the firm will act to protect valuable assets. Support for H4 and H3 indicates that firms place procurement responsibility based on organizational procurement capability and leverage. The results conform more to Quinn and Hlimers (1994) core competence view that firms will seek competitive advantage through assigning process responsibility based on who holds a competence in the process. Reliability for this scale, 0.672, fell below the desired coefficient alpha of 0.70. Additional items that capture the OEM's considerations in the manufacturing outsourcing decision may improve the scale and the ability to test this construct.

For H2 and H4, hypothesis testing did not occur individually. The CFA revealed that indicators for CM competitive advantage and CM procurement competence loaded on a single construct, super CM. CM competitive advantage consisted of items in the areas of technical expertise, specification control, manufacturing efficiency, and business globalization. It was a factor that focused on CM capalities that drive OEMs' manufacturing outsourcing decision. CM procurement competence was based on CM procurement performance, procurement integration with manufacturing, control of critical resources, and procurement leverage. The measurement items of the two factors loaded on a single factor, super CM, combining hypothesis H2 and H4 into a single hypothesis. The positive relationship of CM procurement competence and competitive advantage were strongly supported by the structural model. The literature on contract manufacturing supports the idea that CMs are recognized not only for low cost manufacturing, but also for breadth of supply chain service they support (Harrington, 2000; Carbone, 1996a; Carbone, 1996b). A number of purchasing professionals contacted during the study mentioned the vertically integrated nature of CMs in the electronics industry. This total package approach taken by CMs may explain why all these dimensions of their service loaded on a single factor. Additionally, this indicated that the elements of CM competitive advantage impacting the manufacturing outsourcing decision (manufacturing efficiency and knowledge, design capability and control, and offshoring resources) positively impact the procurement outsourcing decision.

OEM procurement competence (OEMPC), as tested in H3, was marginally supported in the initial model but demonstrated a significant negative relationship in the alternative model. High correlation in the initial model between OEMPC and supply base maintenance (SBM) indicated that procurement competence was very much correlated with supply base maintenance. The multicollinearity that occurred in the initial model was eliminated by dropping SBM to create the alternative model in which OEMPC was supported. The OEM's leverage and procurement's contribution to lasting competitive advantage were items that had the greatest variance in common with the latent construct. This indicates that firms are tentative to outsource when they enjoy an advantage in leverage and when procurement functions contribute to firm competitive advantage (Venkatesan, 1992; Quinn & Hilmer, 1994). Thus, the only factor limiting procurement outsourcing in this research was the procurement competence of the OEM.

In testing H5, no support was found for a negative relationship between the need to maintain an established supply base and the level of procurement outsourcing. It is possible that in many cases products or major subsystems did not have an established supply base before manufacturing was outsourced. This may have limited the variance and the importance of the supply base in the procurement outsourcing decision. Additionally, it is possible that the level of procurement competence exhibited by the contract manufacturer was so great that the OEM did not fear handing the CM an established supply base. Finally, over half of respondents were below $501 million in gross annual sales. This large percentage of smaller firm may have increased the number of design firms in the sample. Design firms would be firms that have a tendency to outsource manufacturing without manufacturing the product or subsystem internally (Blanchette, 2004; Mulcahy, 2001). In the case of design firms, there would be less focus on building a supply base for a product. These smaller firms would have less leverage and would be more willing to seek procurement support from the CM.

Product commoditization's (PC) positive relationship with the level of outsourcing was marginally supported in testing H6. It appeared that the main driver in product commoditization was specification maturity or stability which shared 75% of its variance in common with the latent construct. This does show some support for the product lifecycle concepts proposed by Hayes and Wheelwright (1979) that as a product matures the focus shifts to efficiency and away from flexibility. Outsourcing to a CM may achieve the efficiency demanded of procurement by a more mature product. However, a limiting factor for PC may have been the low reliability exhibited by the scale, 0.539. This was the lowest reliability of any scale in the research and it only minimally fell into what is considered acceptable for new scales (Churchill, 1979). Improving the scale reliability may improve PC's performance in future research.

Hypothesis seven was the last test of direct effects in the model. Competitive environment (CE) did not exhibit a significant positive relationship with the level of procurement outsourcing. In this study, CE was also used as a measure of environmental uncertainty. The lack of a significant relationship may be due to the fact that the measure concentrated on technological change and product and process obsolescence. The electronics industry has always been one of the more volatile industries in these areas. High obsolescence or technological change may be considered a normal environment for the industry. Competitive environment as captured by the measures used in the study may not have provided an accurate view of uncertainty in the electronics industry. However, this is not the first study to find its measure of uncertainty did not support TCE principles. Rindfleisch and Heide's (1997) literature review of empirical studies implementing TCE found only mixed support for uncertainty. Many studies using uncertainty did not find support for uncertainty to drive vertical integration and others actually found uncertainty supported outsourcing. Uncertainty as currently expressed in TCE was not supported in this study. Consistent with the test for the direct impact of CE or uncertainty on outsourcing, CE did not function as a moderating factor in the study. The three moderation hypotheses of 7a-7c did not prove statistically significant. In fact, the tests for moderation provided no indication that CE or uncertainty moderated the impact of SBM, OEMPC, or PC. Model improvement from the fixed and free estimated models was almost nonexistent. CE did not function in the model as hypothesized.

Table 20: Explanation of results for hypothesis testing

Hypotheses	Results	Explanation
H1: OEM competitive advantage is negatively related to procurement outsourcing	Not Supported	Protection of core products do not hold for procurement outsourcing.
H2/H4: CM competitive advantage and procurement competence is positively related to procurement outsourcing	Supported	CM procurement competence and manufacturing competitive advantage positively impacted procurement outsourcing.
H3: OEM procurement competence is negatively related to procurement outsourcing	Supported	OEM procurement competence limited the level of procurement outsourcing.
H5: Supply base maintenance is negatively related to procurement outsourcing	Not Supported	Variance may have been limited by firms that design and outsource manufacturing without manufacturing internally.
H6: Product commoditization is positively related to procurement outsourcing	Marginally Supported	Product specification maturity encourages procurement outsourcing
H7: The competitive environment for the market is positively related to procurement outsourcing	Not Supported	CE or uncertainty has shown mixed results in TCE studies.
H7a: The level of competition in the market environment will moderate the relationship between OEM procurement competence and procurement outsourcing by amplifying the negative relationship.	Not Supported	No evidence of moderation tendencies.
H7b: The level of competition in the market environment will moderate the relationship between supply base maintenance and procurement outsourcing by amplifying the negative relationship.	Not Supported	No evidence of moderation tendencies.
H7c: The level of competition in the market environment will moderate the relationship between product commoditization and procurement outsourcing by amplifying the positive relationship.	Not Supported	No evidence of moderation tendencies.

The results of the structural model were used to address research question one: How does the procurement outsourcing decision relate to the manufacturing outsourcing decision? A relationship between OEM drivers of the manufacturing decision, as indicated by OEMCA, and the procurement outsourcing decision was not found. OEM core product strategy driving the manufacturing outsourcing did not impact the procurement outsourcing decision. However, the drivers of CM competitive advantage (design competence, manufacturing competence, and offshoring), items associated with the manufacturing outsourcing decision, were positively linked to procurement outsourcing. These elements of CM competitive advantage are the factors related to the manufacturing outsourcing decision. OEM responses supported a positive relationship between CM competitive capabilities and outsourcing the procurement of direct materials. When assessing how drivers of the manufacturing outsourcing decision impact procurement outsourcing, it appears that CM capabilities are positively related to procurement outsourcing while OEM core competence strategy elements are not.

Three factors were found that answer research question two: What are the important factors in the decision to retain or outsource purchasing? The important factors in the decision to outsource or retain direct materials procurement are CM procurement and competitive capabilities (positively related) and OEM procurement competence (negatively related). The primary components of these factors influencing the outsourcing decision are leverage, procurement competence, and integration between manufacturing and procurement functions. Product commoditization (positively related) marginally impacts the procurement outsourcing decision. Specification maturity was the strongest indicator of procurement outsourcing for this construct. These elements were the most important factors in the direct materials procurement outsourcing decision.

Conclusions from Cluster Analysis

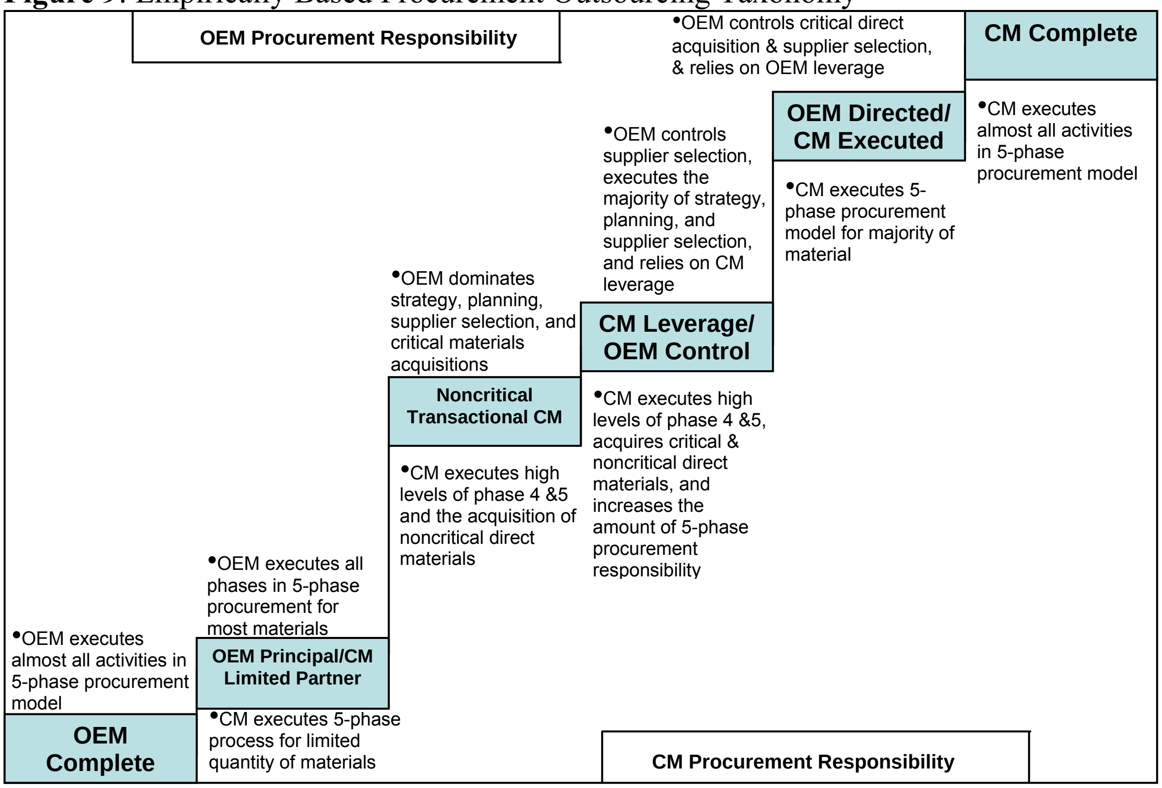
Cluster analysis of the procurement outsourcing levels and decision variables resulted in six groups or clusters that describe procurement outsourcing arrangements used in the contract manufacturing context. These groups can be categorized by the level of outsourcing and the decisions driving these levels.

The six groups seem to form three distinct levels of outsourcing with groups one and two (level 1), groups three and four (level 2), and groups five and six (level 3) not differing significantly on any phase of procurement. The real difference between the approaches is the emphasis of the OEM on the CM's role or capability in the procurement process. For groups one, three, and five OEMs were more controlling of supplier selection and critical direct materials and emphasized their leverage as a main component of their relationship of the CM.

Groups two, four, and six emphasized some level of CM responsibility in the process whether in accomplishing all phases of procurement, selecting suppliers, or acquiring critical direct materials. Additionally in groups four and six OEMs capitalized on the CM's leverage. These three groups appeared to emphasize CM strengths, while the odd groups emphasized OEM strengths.

These groups and the salient characteristics of the relationship for the OEM and CM are indicated below in Figure 11. Unlike the notional continuum based on the literature that was presented in chapter 2, this is a three level empirically based continuum. As stated previously, although there are six distinct procurement arrangements in the continuum, the consecutive pairs made up by the first and second, third and fourth, and fifth and sixth arrangements are not statistically different on the phases of procurement. Therefore, there are three levels with a two distinct approaches on each level.

Figure 9: Empirically Based Procurement Outsourcing Taxonomy



Discussion of Discriminant Analysis Results

Multiple discriminant analysis generated three discriminant functions that account for over 98 percent of the variance for the categorical dependent variable of group identified in Figure 9. These three functions form the dimensions of CM leverage, CM control of critical direct materials, and OEM leverage. These dimensions are represented graphically in Figures 10, 11, and 12. Group means or centroids are plotted on these graphs that indicate how the dimensions characterize each group.

Figure 10: Plot of Group Centroids on Canonical Leverage Functions

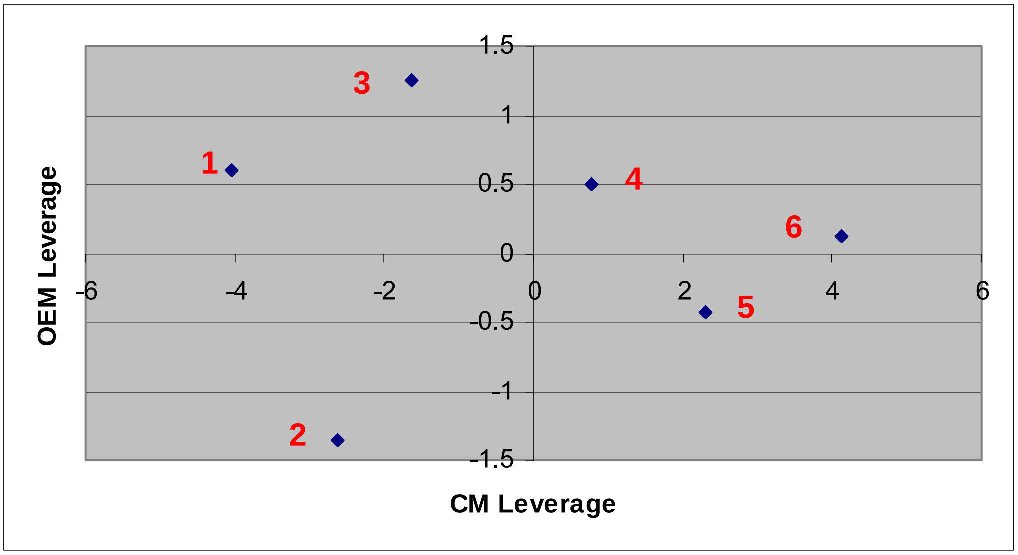


Figure 11: Plot of Group Centroids on CM Canonical Functions

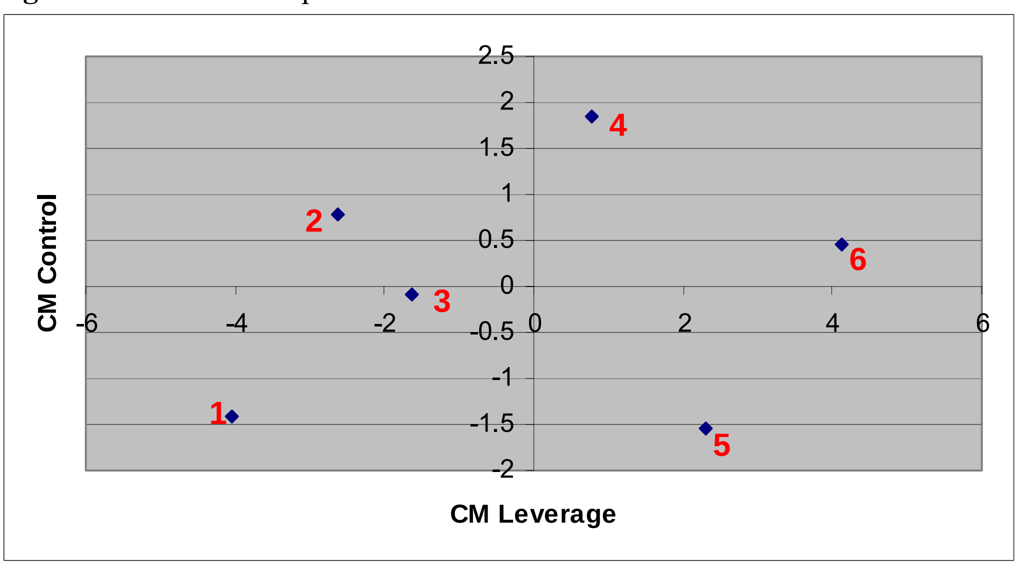
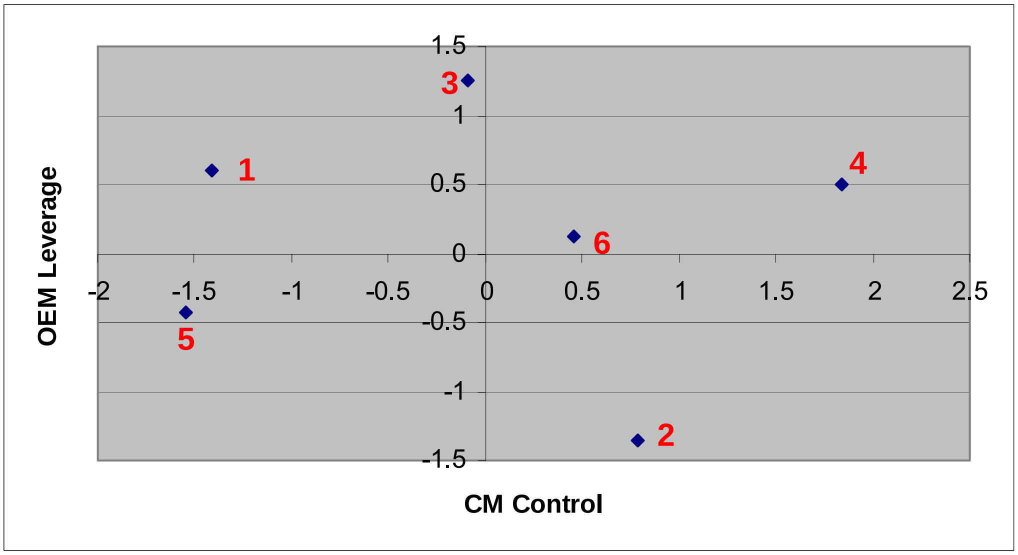


Figure 12: Plot of Group Centroids on CM Control and OEM Leverage Functions



OEM complete, Group One, is characterized by the OEM relying on its leverage to procure the direct materials for the CM's manufacturing operations. In three plots above, this arrangement occupies the lowest position on the dimension of CM leverage, the second lowest position on CM control and the second highest level on OEM leverage. OEM complete is characterized by little CM involvement. The OEM leverage dimension places responsibility on the CM to procure noncritical direct materials. Because OEM complete does basically all procurement activity to include noncritical acquisitions it only achieves the second highest position on the OEM leverage dimension. This arrangement validates the OEM complete arrangement found in the literature (Kim, 2003; Ellram & Billington, 2001).

The OEM principal/CM limited partner arrangement or Group Two is characterized by activity similar to Group One with the OEM dominating the five-phase process and most decision variables. However, the arrangement differs from group one in that the arrangement does not rely on OEM leverage and the CM increases acquisitions where it controls all phases of the procurement process. This drives some interesting positions on the outsourcing dimensions. First, its positions on CM (second lowest) and OEM (lowest) leverage place this arrangement in the worst leverage position of all arrangements. Second, it holds the second highest position on CM control. This arrangement is similar to OEM complete in that almost all procurement activity is accomplished by the OEM. In fact there are not significant statistical outsourcing differences, when comparing procurement phases. However, the high level of CM control is puzzling. It is possible that several scenarios exist to explain this dichotomy. It is possible that the OEM has offshored its manufacturing to a location where culture, politics, language, or other barriers prevent OEM procurement from performing some level of procurement responsibility (Anderson and Coughlan, 1987). A second explanation may be that the CM controls a resource so critical that it becomes the centerpiece of the procurement strategy even though the volume is relatively small when compared to the remaining purchasing responsibility (Barney, 1991). This resource may become the competitive advantage for the OEM that drives its competitive strategy. This is a new procurement outsourcing arrangement not documented in the literature.

Noncritical transactional CM, Group Three, is the third outsourcing arrangement resulting from the cluster analysis. It is characterized by high OEM leverage and employment of the CM to acquire noncritical direct materials and to accomplish transactional type procurement responsibilities mainly located in phase 4 of the procurement process. CM procurement activity is significantly higher in this arrangement for procurement phases three through five than the previous two arrangements. This arrangement dominates the OEM leverage dimension, taking its highest position. The plots demonstrate that the OEM directs the efforts of the CM with a negative position on the CM control dimension. Additionally, it appears that the CM brings no purchasing power to the table as it also holds a negative position with respect to CM leverage. This group appears to be the second arrangement found on the notional continuum, OEM complete minus transactional activities. The high OEM leverage (Ellram & Billington, 2001) and the focus on CM transactional responsibility (Kim, 2003) drive the OEM to use its purchasing power to save money over the CM's procurement possibilities (Carbone, 2000b) and to have the CM handle transactional responsibilities to supply manufacturing operations.

CM leverage/OEM control, Group Four, although not significantly different in CM procurement responsibility on the five-phase procurement process than Group Three, differs on outsourcing decision variables. In this arrangement the CM enjoys greater leverage than the OEM resulting in greater levels of acquisition of both critical and noncritical direct materials and the amount of materials where the CM accomplishes all phases of the procurement process. However, the OEM still selects the majority of suppliers in this arrangement. Group Four holds the highest position on the dimension of CM control of critical direct materials and lower but positive positions on CM and OEM leverage. It and Group Six, CM complete, are the only arrangements that are positive on all three dimensions. OEM and CM leverage are both important for the acquisition of direct materials, driving the positive positions on both of these dimensions. This arrangement supports a CM with great procurement competence that takes its direction from the OEM.

OEM directed/CM executed, Group Five, is characterized by higher OEM leverage, moderate CM leverage, and significantly higher levels of CM responsibility for all phases of procurement than groups 1-4. Moderate levels of CM critical direct materials acquisition and low levels of CM supplier selection demonstrate the control exercised by the OEM. This arrangement was the third on the notional continuum. However, on the notional continuum, the perceived level of CM procurement responsibility was lower with OEMs performing more activity in phase one and two. In practice, the conditions generally hold with the OEM enjoying more leverage, selecting suppliers for the CM to maintain OEM leverage, and allowing the CM to execute most procurement activities (Ellram & Billington, 2001). As anticipated, this arrangement holds a negative position on the CM control of critical resources dimension. However, contrary to the OEM-CM relationship implied in the literature, Group Five holds a negative position on the OEM leverage dimension and a positive position on the CM leverage dimension. The high CM leverage position is mainly due to the high level of responsibility carried in the first three phases of the procurement process. The negative OEM leverage position results from high levels of CM responsibility across all phases of the procurement process not typical of a high OEM leverage position.

CM complete, Group Six, is represented by the highest levels of procurement outsourcing on the five phase procurement process (not significantly different than Group Five), and high levels on all outsourcing decision variables with the exception of OEM leverage which is moderate. The CM in this arrangement holds almost exclusive procurement responsibility (Carbone, 1996a; Kador, 2001). Although the CM controls the highest position on the dimension of CM leverage, it holds a minimally positive position for CM control of critical resources and for OEM leverage. The relatively low position for CM control stems from high levels of CM procurement activity in phases one through three not normally associated with the acquisition of critical direct materials. The CM control of critical direct materials dimension is characterized by a high level of OEM control not exhibited by CM complete. The positive OEM leverage dimension results from moderate OEM leverage not expected in the OEM complete arrangement. It appears there may be a minimal level of OEM procurement activity associated with this arrangement. Nonetheless, this arrangement supports the CM complete arrangement from the literature with the CM acting as the primary procurement agent (Carbone, 1996a).

These six arrangements form a taxonomy that help describe the procurement approach firms take within the contract manufacturing context to procure direct materials. The indicate the levels of outsourcing and the importance of other decisions variables that structure the outsourcing arrangement.

Theoretical Implications

This research has resulted in a greater understanding of procurement outsourcing. The primary contribution was the ability to better characterize the relationship of drivers to the decision to outsource procurement in the context of outsourced manufacturing. Additionally, this research extended current theoretical paradigms of procurement and outsourcing through the identification of potential drivers for outsourcing the procurement of direct materials outside the context of outsourced manufacturing. Finally, the research supports a six-group taxonomy of procurement outsourcing arrangements.

This survey research contributed to a greater understanding of the drivers of the direct materials procurement decision. A theoretical model was established based on the outsourcing and contract manufacturing literature and the theories of transaction cost economics and resource-based-view. The hypotheses from the theoretical model were empirically tested and support was found for some of the hypothesized factors impacting the level of procurement outsourcing. CM competitive advantage and procurement competence, OEM procurement competence, and to a lesser degree product commoditization impacted the level of direct materials procurement outsourcing.

The role and capability of the CM played a major role in increasing the level of procurement outsourcing. First, it appears that CMs are viewed as a bundle of capabilities and not by their distinct capabilities. The original theoretical model separated CM procurement competence and manufacturing competitive advantage. However, during the estimation of the measurement model, standardized residuals and modification indices indicated that the items designed for the two constructs load on a single construct. During data collection several procurement professionals indicated the vertically integrated nature of electronics CMs. This tight integration may drive OEMs to view CMs as a supply chain capability or component that can be added to their supply chain and not just a manufacturing capability that plays a limited role in the supply chain. Additionally the correlation of item error terms in the measurement model within the large CM construct identified some underlying elements present in the construct.

First, an element of highly correlated offshoring items and manufacturing cost was identified. The access to international markets, infrastructure, low cost resources, and low cost manufacturing formed an offshoring facet to the CM construct. This emergent element highlighted the strong trend for manufacturing and other supply chain activities to be offshored. This offshoring facet of contract manufacturing is a strong reminder that contract manufacturing and the associated cost savings are often associated with offshore activity.

Second, the correlation of items related to gaining access to critical resources through the CM was present in the measurement model. Integrated manufacturing and purchasing activities, design competence, and the general access to critical resources indicated the contract manufacturing is used very much in accordance with the principles of resource-based-view. CMs are seen as a resource that can be added to strengthen the supply chain and the competitive advantage of the OEM (Barney, 1991; Quinn & Hilmer, 1994).

The items that had the highest factor loadings and the greatest shared variance with the CM construct were CM leverage, CM procurement competence, and the integration of the CM procurement function with manufacturing. This indicates that OEMs outsource procurement to CMs that perform procurement activities at a high level of competence and supports that CMs with greater integration between procurement and manufacturing perform better (Pagell & Krause, 2001) and are more likely to receive procurement responsibility in addition to manufacturing. Additionally, the importance of leverage in the super CM factor identifies cost as a primary reason for outsourcing procurement. This is also consistent with the reason for outsourcing manufacturing, where over forty percent of firms outsourced to achieve lower costs.

OEM procurement competence was the only construct related to decreased levels of procurement outsourcing in the model. Again competence and leverage were the two items with the highest factor loadings and shared the greatest common variance with the latent factor. It appears that a firm's procurement competence is often measured through leverage for the OEM and the CM. A major determinant of who holds the responsibility for procurement is cost as a function of leverage. This result is consistent with recent results of another empirical study of outsourcing. Monczka et. al. (2005a) indicate that over 80 percent of respondents outsourced with the goal of reducing costs. It appears that the main driver of procurement responsibility in the outsourced manufacturing context is which firm has the greatest leverage.

A final factor that was marginally related to increased procurement outsourcing was product commoditization. The item that shared the majority of shared common variance with the latent variable and that had the highest factor loading was product specification maturity. It appears that as products mature in their lifecycle there is a greater need for efficiency (Hayes and Wheelwright, 1979) and that this efficiency is achieved through outsourcing procurement responsibility. More mature or stable products present an opportunity to outsource manufacturing, while more innovative and less stable products appear to require internal procurement responsibility.

Through the use of cluster and discriminant analysis a taxonomy of procurement outsourcing arrangements was developed. This taxonomy added empirical support for four procurement outsourcing arrangements found in the literature. OEM complete, CM complete, OEM complete minus transactional activities, and OEM directed/CM executed exhibited most of the expected characteristics described in the literature. Although there are six unique arrangements in the taxonomy, there are only three significantly distinguishable levels of outsourcing on the five-phase procurement process. Groups 1 and 2, groups 3 and 4, and groups 5 and 6 share the levels of low, moderate, and high procurement outsourcing respectively. It seems somewhat contradictory that there are two arrangements for each of the three significantly different levels of procurement outsourcing. Of the two arrangements sharing the same level, one appears to rely on CM strengths and one appears to rely on OEM strengths. OEM procurement competence does not fade with higher levels of outsourcing and CMs appear to hold valuable procurement positions at low levels of outsourcing. Resource-based-view best explains this result that resources held by different firms can be linked together to create a strong supply chain (Quinn & Hilmer, 1994).

Additionally, cluster and discriminant analysis supported the main results of hypothesis testing. Leverage on the part of the CM and OEM were found to be primary dimensions on which the six procurement arrangements were separated. Additionally, procurement competence at all levels of procurement outsourcing would enable participation by the OEM or CM in the process. OEM and CM procurement functions can participate effectively at any level of the outsourcing taxonomy if they exhibit competence and leverage.

Open ended responses in the internet survey enabled respondents to identify issues or procurement outsourcing drivers not addressed in the research. Some of these open ended responses indicated that future models may need to include a procurement cost reduction driver. One factor in outsourcing is management goals to reduce head count in the procurement department. Additionally, procurement costs are reduced through reduced inventories and reduced purchasing activity. One firm stated that by breaking a product down into two major subsystems, it had reduced procurement activity to releasing two purchase orders. Additionally, these actions can improve cash flow and allow capital to be placed in more core areas of the firm such as design or marketing. Although the merits of these courses of action can be debated, they are real concerns for firms and play an important role in the procurement outsourcing decision. The addition of a procurement cost reduction factor may provide additional insight into the procurement outsourcing decision.

The final objective of this research is to determine if the insight gained through the decision process of procurement outsourcing in an outsourced manufacturing scenario can be applied to outsourcing the procurement of direct materials generally. Would the same decision factors be applicable for outsourcing the procurement of direct materials when manufacturing is retained in house?

Two main elements of this research appear to indicate a potential for a general direct materials procurement outsourcing frame work. First, the leverage and competence possessed by OEM internal procurement functions and that possessed by potential service providers should be the two main drivers of the outsourcing decision. The main driver that impacted procurement outsourcing in this research was who held the leverage and competence to procure at the lowest cost. The availability of procurement service providers that can compete with internal procurement functions on these two characteristics creates an opportunity for direct materials procurement outsourcing. Second, product lifecycle or product specification maturity may provide an opportunity for firms to focus the flexibility of internal procurement functions on more innovative products, while efficient service providers procure materials for more stable, mature products. The constructs of OEM procurement competence, procurement service provider competence, and product commoditization provide an initial departure point for a general direct materials procurement outsourcing framework. Additional constructs such as procurement cost reduction could be added on an exploratory basis. These three constructs create the possibility for empirically testing the basic theoretical framework used in this research for a general case of direct materials procurement outsourcing.

Managerial Implications

It appears from the literature that the phenomenon of interest is expanding. This expansion presents opportunities for managers to apply principles supported in this study to understand when and why to outsource procurement. Four major implications for managers emerge from this study.

First, procurement outsourcing is mostly about cost. The primary reasons for retaining or outsourcing procurement were to take advantage of cost saving procurement competence in the OEM or in the CM. Who held the leverage was a major factor in the decision of who would be responsible to procure the direct materials. Some exceptions to this were reported by OEMs that acquired strategic materials internally and allowed CMs to acquire more commodity type direct materials. Some care should be exercised on the part of OEMs to ensure their decision process considers the supply chain requirements for the product or subsystem in question. Some innovative products require more flexible supply chains, while commodity products demand efficiency in the supply chain (Fisher, 1997). Internal and CM procurement functions should be evaluated for their ability to fill these product supply chain requirements. Although cost may appear to drive the majority of decisions with respect to procurement outsourcing, managers need to ensure that they apply long term strategy lenses to their decision process to meet the overall product or firm strategy.

Second, products with stable or mature specifications appear to be the most plausible target for procurement outsourcing. Because the purchasing activities for these products are more defined, the ability to transfer responsibility is enhanced. A CM procurement function can add these procurement activities to their procurement responsibilities more readily than a product with changing procurement requirements. Additionally, the OEM can determine if the CM procurement function has sufficient ability to acquire materials if these material requirements are stable, better than in the case of the changing requirements of a product with a changing specification and changing procurement requirements.

Third, although offshoring is typically associated with low cost labor, firms need to look beyond this resource and consider the potential markets and resources that are available through business globalization. A number of firms in the survey indicated they outsourced manufacturing and procurement to put these activities close to the customer. Offshoring may provide greater opportunities to a firm that examines additional aspects of offshoring beyond the obvious availability of inexpensive labor.

Last, direct materials procurement outsourcing arrangements identified and empirically supported in this research may enable firms to consider different procurement outsourcing approaches than have previously been considered. The role of the CM or OEM procurement function at both ends of the outsourcing spectrum appears to be viable and have the potential to make some level of contribution to the procurement activity required for direct materials acquisition.

Research Limitations

This study has some limitations that may restrict the application of results. First, the focus on a single industry, the electronics industry, may limit generalizability to that industry. However, the principles under study appear universal in nature and may be applicably generally, but perhaps not with the same emphasis to which they occur in the electronics industry. Second, this cross-sectional survey research will not be able capture a longitudinal view of this phenomenon. In order to understand how this phenomenon changes with respect to time, future research should engage in a longitudinal study of the procurement outsourcing phenomenon. Third, the OEM procurement competence scales, OEM competitive advantage, and product commoditization scales suffer from low reliability. Future research should consider the inclusion of additional items or item refinement for these scales to improve construct validity. Finally, because the focus on procurement outsourcing occurs only in the context of contract manufacturing, findings may be limited to that context. Implications that may appear relevant in other procurement outsourcing contexts should be carefully considered and, where possible, findings and conclusions should be tested within those contexts to support their applicability.

Future Research

The research limitations of this study may be addressed through future research that examines the results, findings, and conclusions of this study within other contexts to determine the level of generalizability of this study. This should include improving construct validity of scales were possible. Future research should test these principles in a study that includes multiple industries. Thus, researchers will understand how these concepts and constructs function in other industries.

Additional future research should examine outsourcing the procurement of direct materials outside the framework of contract manufacturing. An initial theoretical framework was proposed by this research for general direct materials procurement outsourcing. Some case study research may be performed at this time with the few firms that have initiated direct materials procurement outsourcing. However, research that examines a larger sample will be delayed until direct materials procurement outsourcing becomes more common.

Another future research study could address the impact of procurement outsourcing on contract manufacturers. It would be interesting to examine how their integration into greater supply chain activities impacts their performance that was initially based on manufacturing efficiency.

CM opportunism is another area of future research that could yield valuable information. A number of OEMs believe that CMs are increasing their margins by hiding the true procurement costs of materials. Some firms have retaken responsibility that had previously been outsourced to enable them to maintain control of the suppliers and materials procurement prices (Sullivan, 2003).

An empirical test of purchasing performance by procurement outsourcing arrangement would yield valuable knowledge about the relative value of each of the arrangements. Furthermore, performance research could inform practitioners regarding the risks and benefits of each procurement arrangement and the conditions that would drive a particular arrangement.

A final future research topic could be the change that procurement outsourcing makes on OEM or internal procurement organizations. The function performed by OEM procurement personnel changes as procurement responsibility is outsourced. A change from standard procurement activity would be replaced by management of the procurement service provider or CM. Additionally, this research should address whether the change in function limits the flexibility of procurement personnel to meet changing requirements levied by the firm.

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APPENDIX A

Internet Survey Instrument

Procurement Outsourcing within the CM Context
Survey
(adapted from Krause, 1995*; Chen & Paulraj, 2004†; Pagell & Krause, 2002‡; Monczka et. al., 2005aΩ; and Carr & Smeltzer 2000§)

Welcome to the procurement outsourcing survey.

The purpose of this survey is to determine what factors drive firms to outsource the procurement of direct materials.

We estimate this survey will take about 15 to 20 minutes to complete.

You will be able to return to your original responses if you have not clicked on the final submit button. Your responses will be saved for those pages you have submitted.

Please enter your contact information below. We will hold this information with the highest degree of confidentiality. None of your responses will be attributed to you or to your firm. We will only contact you if we need clarification about your responses.

1. Name ___________________________
2. Title_____________________________________
3. Company_____________________________
4. Telephone Number______________________

Instructions:

To answer questions in this survey, identify a current or recent past product or major subsystem (made up of multiple components) that meets the following criteria:

1. Your company outsourced manufacturing to a contract manufacturer (CM)
2. Your firm decided between retaining or outsourcing direct materials procurement responsibility to the CM (contract manufacturer)

For example, an OEM decides to outsource the manufacturing of a radio. As a result of this decision, now the OEM must decide whether to retain direct materials procurement responsibility for radio components or to outsource it to the CM.

Use the product or major subsystem you selected as the source of information to answer questions then click on the most correct answer.

<u>Internal Competitive Advantage</u>

5. How important was the lack of internal manufacturing capacity in the decision to outsource manufacturing?

1 2 3 4 5 6 7

Not Important *Important* *Very Important*

6. How important was this product or major subsystem to your firm's core competence strategy?

1 2 3 4 5 6 7

Not Important *Important* *Very Important*

7. How important were <u>components</u> of this product or major subsystem to your core competence strategy?

1 2 3 4 5 6 7

Not Important *Important* *Very Important*

8. To what extent did the manufacturing of this product or subsystem depend on firm core competencies?

1 2 3 4 5 6 7

Very Little *Moderately* *Very Much*

9. How big was your company (in terms of sales) compared to other companies in your industry?

1 2 3 4 5 6 7

Very Small Very Large

<u>Contract Manufacturer (CM) Competitive Advantage</u>

10. How important was CM <u>design</u> knowledge in the decision to outsource manufacturing?

1 2 3 4 5 6 7

Not Important *Important* *Very Important*

11. How important was CM <u>manufacturing</u> knowledge in the decision to outsource manufacturing?

1 2 3 4 5 6 7

Not Important *Important* *Very Important*

12. How important were CM manufacturing costs in the decision to outsource manufacturing?

1 2 3 4 5 6 7

Not Important *Important* *Very Important*

13. How much control did the CM have over the product specifications (component selection, qualification, etc.)?	1	2	3	4	5	6	7
	Very little			*Moderate*			*Substantial*
14. How important was entering international markets in your decision to outsource manufacturing?	1	2	3	4	5	6	7
	Not Important			*Important*			*Very Important*
15. How important was gaining access to international infrastructure (logistics, marketing channels, after-sales support, etc.) in the decision to outsource manufacturing?	1	2	3	4	5	6	7
	Not Important			*Important*			*Very Important*
16. How important was gaining access to low cost international resources (labor, materials, etc.) in your decision to outsource manufacturing?	1	2	3	4	5	6	7
	Not Important			*Important*			*Very Important*
17. How big was the CM in terms of sales compared to other CMs in the industry?	1	2	3	4	5	6	7
	Small						*Large*

Contract Manufacturer (CM) Procurement Competence

18. How important was CM leverage with their suppliers in your decision to outsource or retain procurement?	1	2	3	4	5	6	7
	Not Important			*Important*			*Very Important*

19. How important was the lack of CM leverage with their suppliers in your decision to outsource or retain procurement?

1	2	3	4	5	6	7

Not Important — *Important* — *Very Important*

20. How important was the CM's procurement competence in your decision to outsource or retain procurement?

1	2	3	4	5	6	7

Not Important — *Important* — *Very Important*

21. How centralized was the CM's procurement function?

1	2	3	4	5	6	7

Decentralized — *Centralized*

22. How competent was the CM's procurement function?

1	2	3	4	5	6	7

Not Competent — *Moderately Competent* — *Very Competent*

23. How important was integration between the CM's manufacturing and procurement functions in your decision to outsource or retain procurement?

1	2	3	4	5	6	7

Not Important — *Important* — *Very Important*

24. How important was gaining access to critical resources through the CM in your decision to outsource or retain procurement?

1	2	3	4	5	6	7

Not Important — *Important* — *Very Important*

25. How was the CM's procurement function performance at the time of the outsourcing decision?

1	2	3	4	5	6	7

Poor — *Excellent*

<u>**Supply Base Maintenance**</u>

26. How important was keeping existing supplier relationships in your decision to outsource or retain procurement?

1 2 3 4 5 6 7

Not Important — *Important* — *Very Important*

27. How important was keeping your product's existing supply base intact in your decision to outsource or retain procurement?

1 2 3 4 5 6 7

Not Important — *Important* — *Very Important*

28. How important were existing suppliers to other products you manufacture in your decision to outsource or retain procurement?

1 2 3 4 5 6 7

Not Important — *Important* — *Very Important*

29. How important were existing supplier agreements in your decision to outsource or retain procurement?

1 2 3 4 5 6 7

Not Important — *Important* — *Very Important*

30. What level of computer-enabled transaction processing did you have with existing suppliers? †

1 2 3 4 5 6 7

Very Low — *Moderate* — *Very High*

<u>**OEM Procurement Competence**</u>

31. How much did your procurement function contribute to lasting firm competitive advantages at the time of the outsourcing decision?

1 2 3 4 5 6 7

Very Little — *Moderately* — *Substantially*

32. How would you describe your procurement function's performance at the time of the outsourcing decision?

1	2	3	4	5	6	7
Poor						*Excellent*

33. How important was the potential loss of control of critical resources to your decision to outsource or retain procurement?

1	2	3	4	5	6	7
Not Important			*Important*			*Very Important*

34. How important was your firm's existing procurement leverage in the decision to outsource or retain procurement?

1	2	3	4	5	6	7
Not Important			*Important*			*Very Important*

35. How centralized was your procurement function at the time of the outsourcing decision?*

1	2	3	4	5	6	7
Very Decentralized						*Very Centralized*

36. What level of integration between procurement and other company functions was required for this product?

1	2	3	4	5	6	7
Little Integration			*Moderate*			*High Integration*

<u>Competitive Environment</u>

37. What was the level of market competition for your product or subsystem?*

1	2	3	4	5	6	7
Very Low			*Moderate*			*Very High*

38. What was the pace of technological change for this type of product or subsystem?*

1	2	3	4	5	6	7
Slow			*Moderate*			*Fast*

39. What was the rate of product obsolescence for this type of product or subsystem?*	1 2 3 4 5 6 7 *Very Low* *Moderate* *Very High*
40. What was the rate of <u>manufacturing</u> obsolescence for this type of product or subsystem?*	1 2 3 4 5 6 7 *Very Low* *Moderate* *Very High*
41. How would you describe the availability of substitutes for your product or subsystem?	1 2 3 4 5 6 7 *Very Low* *Moderate* *Very High*
42. Indicate the threat of new competitors entering the market with similar products or subsystems?	1 2 3 4 5 6 7 *Very Low* *Moderate* *Very High*

<u>Product Commoditization</u>

43. How would you describe the specification maturity of this product or subsystem?	1 2 3 4 5 6 7 *Very Unsi* *Very Stable*
44. How standardized were the direct materials of the product or subsystem?	1 2 3 4 5 6 7 *Unique* *Somewhat Standardized* *Very Standardized*
45. For this product, how would you describe the majority of supplier relationships prior to the decision to retain or outsource procurement?	1 2 3 4 5 6 7 *Close/Cooperative* *Arms length*

46. For the product, what was the intended length of the majority of supplier relationships prior to the decision to retain or outsource procurement?*

1 2 3 4 5 6 7

Long Term ... *Short Term*

47. How differentiated was your product or subsystem from similar products or subsystems?

1 2 3 4 5 6 7

Highly ... Moderately ... Very Little

Use the procurement process shown below as a guide to answer question 48

Procurement Process

Phase 1: Establish a Purchasing Strategy	Phase 2: Evaluate Suppliers	Phase 3: Screen and Select Suppliers	Phase 4: Procure Materials	Phase 5: Measure and Manage Supplier Performance
Build a purchasing strategy based on: • Importance of materials/components • Manufacturing requirements • Supply market analysis • Potential customer use and demand.	• Identify a pool of qualified suppliers • Develop a category strategy • Develop selection criteria	• Release request for proposal (RFP) • Analyze bids & past performance • Select supplier • Negotiate and finalize contract • Agree on supply and logistics terms	• Monitor inventory • Order materials • Receive materials • Inspect materials	• Monitor supplier's performance • Identify improvement opportunities • Analyze supplier relationships

48. Estimate the percentage of procurement activities outsourced based on the cost of direct materials for each phase.

Phase 1: Establish a Purchasing Strategy

0 10 20 30 40 50 60 70 80 90 100

Phase 2: Evaluate Suppliers

0 10 20 30 40 50 60 70 80 90 100

Phase 3: Screen and Select Suppliers

0 10 20 30 40 50 60 70 80 90 100

Phase 4: Procure Material	0 10 20 30 40 50 60 70 80 90 100
Phase 5: Measure and Manage Supplier Performance	0 10 20 30 40 50 60 70 80 90 100

49. Indicate the cost percentage of

direct materials or components where procurement is outsourced because the CM has more leverage.	0 10 20 30 40 50 60 70 80 90 100
direct materials or components where procurement is retained because your firm has more leverage.	0 10 20 30 40 50 60 70 80 90 100
critical direct materials for which you outsource procurement.	0 10 20 30 40 50 60 70 80 90 100
noncritical direct materials for which you outsource procurement.	0 10 20 30 40 50 60 70 80 90 100

50. Indicate the percentage of

supplier relationships for this product or subsystem where your CM manages all phases of the procurement process.	0 10 20 30 40 50 60 70 80 90 100
suppliers the CM independently selects for your product or subsystem.	0 10 20 30 40 50 60 70 80 90 100

51. Indicate the level of procurement outsourcing for your product or major subsystem. Select the procurement arrangement that most closely resembles procurement responsibility for your product.

☐ Your firm completes all procurement activities (phases 1-5).
☐ Your firm outsources ordering, receiving, inspections and inventory management (phase 4) to the CM, while your firm executes phases 1, 2, 3, & 5..
☐ Your firm executes phases 1 and 2 and selects suppliers, while the CM executes contract negotiation and phases 4 and 5.
☐ Your firm manages the procurement of strategic direct materials (phases 1-5) and the CM manages the procurement of noncritical direct materials (phases 1-5).
☐ Procurement activity is divided between your firm and the CM based on which organization has the best leverage.
☐ The CM manages all procurement activities (phases 1-5.)
☐ other___________________

52. **The product's or subsystem's manufacturing was outsourced primarily because of**

☐ a lack of manufacturing capacity
☐ a core competence strategy
☐ low CM manufacturing cost
☐ CM design expertise
☐ CM manufacturing expertise
☐ product specification stability
☐ the level of competition
☐ business globalization
☐ other___________________.

Procurement Performance

Please indicate the level of procurement performance for your product or major subsystem as a result of your decision to retain or outsource procurement in comparison to similar products where procurement responsibility was completely retained.

53. Volume flexibility to meet changing demand or production requirements†

1	2	3	4	5	6	7
Far Worse			*Same*			*Far Better*

54. Delivery dependability of direct materials to manufacturing‡

1	2	3	4	5	6	7
Far Worse			*Same*			*Far Better*

55. Conformance quality of purchased direct material inputs§

1 2 3 4 5 6 7

Far Worse *Same* *Far Better*

56. Inventory reduction of direct materials

1 2 3 4 5 6 7

Far Worse *Same* *Far Better*

57. Purchase price savings for direct material inputs§

1 2 3 4 5 6 7

Far Worse *Same* *Far Better*

58. Are there additional reasons you would outsource procurement not mentioned in the study?

____

59. If you outsourced any direct materials procurement responsibility, did you outsource to a CM or a procurement services provider?

☐ CM ☐ Procurement services provider ☐ Both

60. What conditions would change the procurement outsourcing strategies you employed? ____

61. Is there anything concerning outsourcing direct materials procurement this survey did not address, but that you would like to comment on?

____

Demographics:

62. What is your function in the firm? _________________________

63. What level represents your position within the firm?*

1. VP/Executive
2. Director
3. Manager
4. Supervisory
5. Professional/Nonsupervisory
6. Other (Please Specify)___________________________

64. Number of years with this organization?* _______

65. What are your firm's annual gross sales in dollars?Ω

1. Less than $100 Million
2. $101 – $500 Million
3. $501 Million to $1 Billion
4. $1.1 – $5 Billion
5. $5.1 - $10 Billion
6. $10.1 - $20 Billion
7. Over $20 Billion

66. Do you want a copy of research results? Yes No

67. Please provide your email address so that we may send you the research results.

____

Thank you for completing the direct materials procurement outsourcing survey!

APPENDIX B

Email Survey Invitations

Initial Email Invitation

Subject: Direct materials procurement outsourcing study

As an active-duty member of the U.S. Air Force and a doctoral student at Arizona State University, I request your assistance in conducting a survey of procurement professionals for a research study examining outsourcing decisions. In this study, we are interested in determining what influences decision makers to outsource or retain direct materials purchasing responsibility when manufacturing of that product or major subsystem has been outsourced to a contract manufacturer (CM).

The questionnaire can be completed in about fifteen minutes. Your responses and the identity of you and your firm will be kept confidential. At the completion of the project, I will be happy to provide you with the results of the study and any managerial implications. Your participation is completely voluntary, but we encourage your input to obtain valid research results.

Please contact me at (480) 529-5398 or via email at barry.brewer@asu.edu for any concerns or questions with respect to the survey. I will be calling survey participants within the next several weeks to discuss any survey issues. Your assistance with this research is essential to improving our knowledge of procurement outsourcing.

Please click in the following link to participate.
http://www.zoomerang.com/survey.zgi?p=WEB224KWPQQXRB

Your PIN is _____.

Thank you for participating.

Barry Brewer
Graduate Student
Arizona State University
Department of Supply Chain Management
W. P. Carey School of Business
P.O. Box 874706
Tempe, AZ 85287-4706

Second Email Invitation

Subject: ASU/Barry Brewer procurement outsourcing research

As an active-duty Air Force member and a doctoral student at Arizona State University, I request your assistance in completing a survey examining outsourcing decisions. Although response rates to the survey have been good, we need your response to improve the quality of this research! This research will identify what influences decision makers to outsource or retain direct materials purchasing responsibility when manufacturing of a product or major subsystem has been outsourced to a contract manufacturer (CM).

The survey can be completed in about fifteen to twenty minutes. Your responses and identity will be kept confidential. If desired, I will provide you with the research results and the managerial implications. Your participation is voluntary, but I encourage your input to increase research validity.

Please contact me at (480) 529-5398 or at barry.brewer@asu.edu for any concerns or questions you have. I will call survey participants within the next several weeks to discuss any issues. Your procurement experience is essential to improving our knowledge of procurement outsourcing through this research.

Please click in the following link to participate.
http://www.zoomerang.com/survey.zgi?p=WEB224NGG6AV9H

Thank you for participating!

Barry Brewer
Graduate Student
Arizona State University
Department of Supply Chain Management
W. P. Carey School of Business
P.O. Box 874706
Tempe, AZ 85287-4706

Third Email Invitation

Subject: Update on direct materials procurement outsourcing research

Over 200 procurement professionals have completed procurement outsourcing surveys.

Their responses have built a valuable database of knowledge.

I encourage you to invest 15-20 minutes to complete a survey to improve the value of this research.

Those who complete the survey can receive an electronic copy of the findings.

Please click on the link at the end of the email to enter and complete the web survey.

If this survey does not apply to you or your company, please reply with an email stating the research doesn't apply to you.

See the following paragraphs for more detailed information on the survey.

Thank you for contributing to this research,

Barry Brewer
Graduate Student
Arizona State University
Department of Supply Chain Management
W. P. Carey School of Business
P.O. Box 874706
Tempe, AZ 85287-4706

I am an active-duty Air Force member and a doctoral student at Arizona State University working to finish a dissertation. This research will identify what influences decision makers to outsource or retain direct materials purchasing responsibility when manufacturing of a product or major subsystem has been outsourced to a contract manufacturer (CM).

The survey can be completed in about fifteen to twenty minutes. Your responses and identity will be kept confidential. Your participation is voluntary, but I encourage your input to increase the research validity.

Please contact me at (480) 529-5398 or at barry.brewer@asu.edu for any concerns or questions you have. Your procurement experience is essential to improving our knowledge of procurement outsourcing through this research.

http://www.zoomerang.com/survey.zgi?p=WEB224NGG6AV9H

APPENDIX C

OUTLIER SAS   Robust multivariate outlier detection

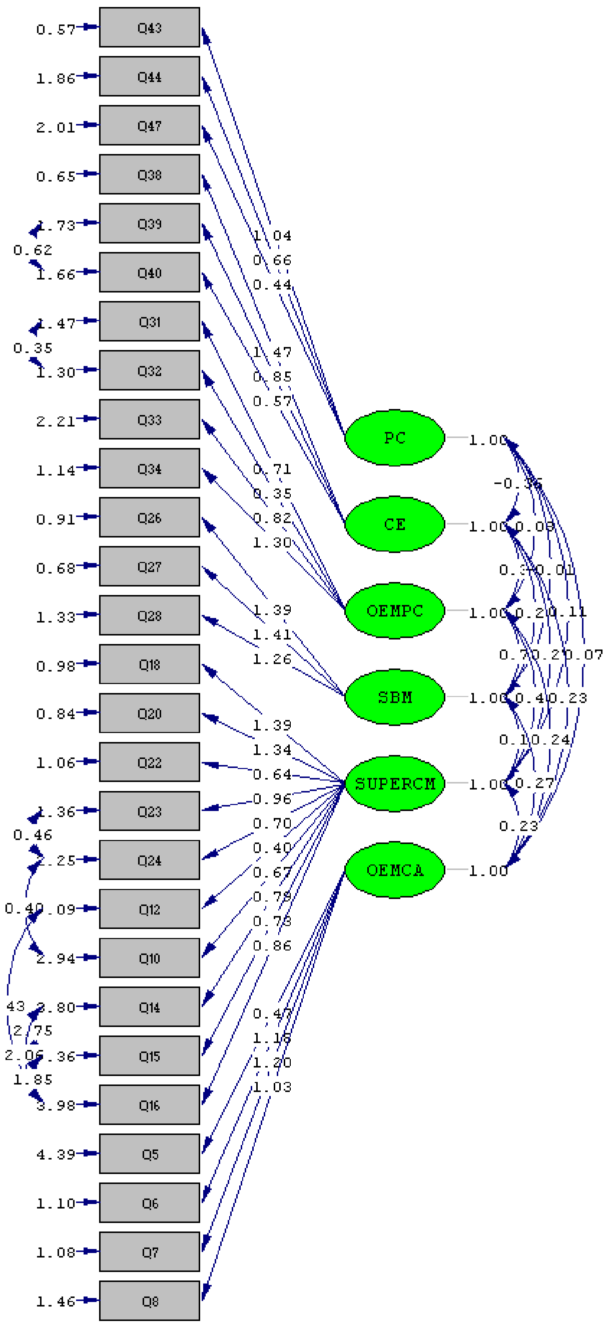
```
/*-------------------------------------------------------------------*
* OUTLIER SAS    Robust multivariate outlier detection             *
*                                                                   *
* Macro to calculate robust Mahalanobis distances for each          *
* observation in a dataset. The results are robust in that          *
* potential outliers do not contribute to the distance of any       *
* other observations.                                               *
*                                                                   *
* The macro makes one or more passes through the data. Each         *
* pass assigns 0 weight to observations whose DSQ value             *
* has prob < PVALUE. The number of passes should be determined      *
* empirically so that no new observations are trimmed on the        *
* last pass.                                                        *
*-------------------------------------------------------------------*
*  Author:  Michael Friendly            <FRIENDLY@YORKVM1>          *
* Created:  16 Jan 1989 18:38:18                                    *
* Revised:  11 Jun 1991 12:16:31                                    *
* Version:  1.0                                                     *
*      From ``SAS System for Statistical Graphics, First Edition''  *
*      Copyright(c) 1991 by SAS Institute Inc., Cary, NC, USA       *
*                                                                   *
*-------------------------------------------------------------------*/
         %macro OUTLIER(
data=_LAST_,      /* Data set to analyze             */
var=_NUMERIC_,    /* input variables                 */
id=,              /* ID variable for observations    */
out=CHIPLOT,      /* Output dataset for plotting     */
pvalue=.1,        /* Prob < pvalue -> weight=0       */
passes=2,         /* Number of passes                */
print=YES);       /* Print OUT= data set?            */

          /*-----------------------------------------------------*
           | Add WEIGHT variable. Determine number of observations |
           | and variables, and create macro variables.            |
           *-----------------------------------------------------*/
         data in;
            set &data end=lastobs;
            array invar{*} &var;
            _weight_ = 1;               /* Add weight variable */
            if ( lastobs ) then do;
               call symput('NOBS', _n_);
               call symput('NVAR', left(put(dim(invar),3.)) );
               end;

         %do pass = 1 %to &PASSES;
            %if &pass=1 %then %let in=in;
                        %else %let in=trimmed;
/*--------------------------------------------------------------*
| Transform variables to scores on principal components.       |
| Observations with _WEIGHT_=0 are not used in the calculation,|
| but get component scores based on the remaining observations.|
*--------------------------------------------------------------*/
            proc princomp std noprint data=&in out=prin;
               var &var;
               freq _weight_;
```

```
/*------------------------------------------------------------*
| Calculate Mahalanobis D**2 and its probability value. For |
| standardized principal components, D**2 is just the sum   |
| of squares. Output potential outliers to separate dataset.|
*------------------------------------------------------------*/
            data out1    (keep=pass case &id dsq prob)
                 trimmed (drop=pass case );
               set prin ;
               pass = &pass;
               case = _n_;

               dsq = uss(of prin1-prin&nvar);    /* Mahalanobis D**2 */
               prob = 1 - probchi(dsq, &nvar);
               _weight_ = (prob > &pvalue);
               output trimmed;
               if _weight_ = 0 then do;
                  output out1   ;
                  end;
            run;
            proc append base=outlier data=out1;
         %end;
            proc print data=outlier;
            title2 'Observations trimmed in calculating Mahalanobis
distance';
          /*------------------------------------------*
           | Prepare for Chi-Square probability plot. |
           *------------------------------------------*/
         proc sort data=trimmed;
            by dsq;
         data &out;
            set trimmed;
            drop prin1 - prin&nvar;
            _weight_ = prob > &pvalue;
            expected = 2 * gaminv(_n_/(&nobs+1), (&nvar/2));

         %if &print=yes %then %do;
         proc print data=&out;
            %if &id ^=%str() %then
            %str(id &id;);
            title2 'Possible multivariate outliers have _WEIGHT_=0';
         %end;

         %if &ID = %str() %then %let SYMBOL='*';
                          %else %let SYMBOL=&ID;
         proc plot data=&out;
            plot dsq      * expected = &symbol
                 expected * expected = '.'   /overlay hzero vzero;
         title2 'Chi-Squared probability plot for multivariate
outliers';
         run;
         %done:
         proc datasets nofs nolist;
            delete outlier out1;
```

```
          %mend outlier;

          %outlier(data=taxons, var= Phase1 Phase2 Phase3 Phase4 Phase5
Q49a Q49b Q49c Q49d Q50a Q50b, id=respondent,, out=chiplot);

          data labels;
            set chiplot;
            if prob < 0.05;
            xsys='2'; ysys='2';
            y = dsq;
            n+1;
            if mod( n ,2) = 0 then do;   * alternate label position;
              x = 0.98*expected; position = '4';
              end;
            else do;
              x = 1.02*expected; position = '6';
              end;
            function = 'LABEL';
           text = respondent; * modify as needed to identifier variable;
            size = 1.4;
          proc gplot data=chiplot ;
            plot dsq   * expected = 1
              expected * expected = 2
          / overlay anno=labels
            vaxis=axis1 haxis=axis2
            vminor=1 hminor=4
                 name='GB0904' ;
          symbol1 f=special v=K h=1.5 i=none c=black;
          symbol2 v=none i=join c=black;
          label dsq    = 'Squared Distance'
               expected='Chi-square quantile';
          axis1 label=(a=90 r=0 h=1.5 f=duplex) ;
          axis2 order=(0 to 20 by 5) label=(h=1.5 f=duplex);

title h=1.5 'Outlier plot for POSL data';     * modify as needed;
               run;
```

APPENDIX D

Final Confirmatory Factor Analysis


Q43
Q44
Q47
Q38
Q39
Q40
Q31
Q32
Q33
Q34
Q26
Q27
Q28
Q18
Q20
Q22
Q23
Q24
Q12
Q10
Q14
Q15
Q16
Q5
Q6
Q7
Q8
PC
CE
OEMPC
SBM
SUPERCM
OEMCA

L I S R E L 8.72

BY

Karl G. Jöreskog & Dag Sörbom

The following lines were read from file C:\DISS\lisrel data files\Dissertation CFA EVERYTHING SUPERCM PLUS 3.LS8:

```
TI Dissertation CFA ALL
DA NI=48 NO=258

RA FI='C:\DISS\Dissertation 258.psf'
SE
39 40 43 34 35 36 27 28 29 30 22 23 24 14 16 18 19 20 8 6 10 11 12 1 2 3 4 44 45 46 47 48 7 9 41 42 33
37 15 17 5 21 26 13 25 38  31 32
MO NX=27 NK=6  LX=FU,FI TD=FU,FI PH=ST
LK
PC CE OEMPC SBM SUPERCM OEMCA

FR LX(1,1) LX(2,1) LX(3,1) LX(4,2) LX(5,2) LX(6,2) LX(7,3) LX(8,3) LX(9,3) LX(10,3) LX(11,4)
LX(12,4) LX(13,4) LX(14,5) LX(15,5) LX(16,5) LX(17,5) LX(18,5) LX(19,5) LX(20,5) LX(21,5)
LX(22,5) LX(23,5) LX(24,6) LX(25,6) LX(26,6) LX(27,6) TD(1,1) TD(2,2) TD(3,3) TD(4,4) TD(5,5)
TD(6,6) TD(7,7) TD(8,8) TD(9,9) TD(10,10) TD(11,11) TD(12,12) TD(13,13) TD(14,14) TD(15,15)
TD(16,16) TD(17,17) TD(18,18) TD(19,19) TD(20,20) TD(21,21) TD(22,22) TD(23,23) TD(24,24)
TD(25,25) TD(26,26) TD(27,27) TD(22,21) TD(23,21) TD(23,22) TD(23,21) TD(20,18) TD(18,17)
TD(6,5) TD(8,7) TD(23,19)

PD
OU SE SC TV RS MI
```

TI Dissertation CFA ALL

Number of Input Variables 48
Number of Y - Variables 0
Number of X - Variables 27
Number of ETA - Variables 0
Number of KSI - Variables 6
Number of Observations 258

Number of Iterations = 20

LISREL Estimates (Maximum Likelihood)

LAMBDA-X

	PC	CE	OEMPC	SBM	SUPER CM	OEMCA
	--------	--------	--------	--------	--------	--------
Q43	1.04	- -	- -	- -	- -	- -
	(0.15)					
	7.06					
Q44	0.66	- -	- -	- -	- -	- -
	(0.13)					
	5.26					
Q47	0.44	- -	- -	- -	- -	- -
	(0.11)					
	3.84					
Q38	- -	1.47	- -	- -	- -	- -
		(0.16)				
		9.33				
Q39	-	0.85	- -	- -	- -	- -
		(0.12)				
		7.10				
Q40	- -	0.57	- -	- -	- -	- -
		(0.10)				
		5.47				
Q31	- -	- -	0.71	- -	- -	- -
			(0.09)			
			7.56			
Q32	- -	- -	0.35	- -	- -	- -
			(0.08)			
			4.14			
Q33	- -	- -	0.82	- -	- -	- -
			(0.11)			
			7.21			
Q34	- -	- -	1.30	- -	- -	- -
			(0.11)			
			11.70			
Q26	- -	- -	- -	1.39	- -	- -
				(0.09)		
				15.13		

Q27	- -	- -	- -	1.41 (0.09) 16.12	- -	- -
Q28	- -	- -	- -	1.26 (0.10) 12.98	- -	- -
Q18	- -	- -	- -	- -	1.39 (0.09) 14.71	- -
Q20	- -	- -	- -	- -	1.34 (0.09) 14.99	- -
Q22	- -	- -	- -	- -	0.64 (0.08) 8.50	- -
Q23	- -	- -	- -	- -	0.96 (0.09) 10.58	- -
Q24	- -	- -	- -	- -	0.70 (0.11) 6.54	- -
Q12	- -	- -	- -	- -	0.40 (0.07) 5.50	- -
Q10	- -	- -	- -	- -	0.67 (0.12) 5.56	- -
Q14	- -	- -	- -	- -	0.79 (0.14) 5.79	- -
Q15	- -	- -	- -	- -	0.73 (0.13) 5.69	- -
Q16	- -	- -	- -	- -	0.86 (0.14) 6.15	- -
Q5	- -	- -	- -	- -	- -	0.47 (0.15) 3.10

Q6	- -	- -	- -	- -	- -	1.18
						(0.10)
						11.79
Q7	- -	- -	- -	- -	- -	1.20
						(0.10)
						11.91
Q8	- -	- -	- -	- -	- -	1.03
						(0.10)
						10.13

PHI

	PC	CE	OEMPC	SBM	SUPER CM	OEMCA
	--------	--------	--------	--------	--------	--------
PC	1.00					
CE	-0.36	1.00				
	(0.09)					
	-4.16					
OEMPC	0.08	0.30	1.00			
	(0.09)	(0.08)				
	0.92	3.66				
SBM	-0.01	0.26	0.70	1.00		
	(0.08)	(0.07)	(0.06)			
	-0.09	3.55	12.44			
SUPER CM	0.11	0.27	0.43	0.16	1.00	
	(0.08)	(0.07)	(0.07)	(0.07)		
	1.31	3.65	5.93	2.19		
OEMCA	0.07	0.23	0.24	0.27	0.23	1.00
	(0.09)	(0.08)	(0.08)	(0.07)	(0.07)	
	0.81	2.91	2.92	3.79	3.11	

Goodness of Fit Statistics

Degrees of Freedom = 301
Minimum Fit Function Chi-Square = 519.32 (P = 0.00)
Normal Theory Weighted Least Squares Chi-Square = 505.20 (P = 0.00)
Estimated Non-centrality Parameter (NCP) = 204.20
90 Percent Confidence Interval for NCP = (146.15 ; 270.13)

Minimum Fit Function Value = 2.02
Population Discrepancy Function Value (F0) = 0.79
90 Percent Confidence Interval for F0 = (0.57 ; 1.05)
Root Mean Square Error of Approximation (RMSEA) = 0.051
90 Percent Confidence Interval for RMSEA = (0.043 ; 0.059)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.38

Expected Cross-Validation Index (ECVI) = 2.56
90 Percent Confidence Interval for ECVI = (2.34 ; 2.82)
ECVI for Saturated Model = 2.94
ECVI for Independence Model = 13.99

Chi-Square for Independence Model with 351 Degrees of Freedom = 3540.54
Independence AIC = 3594.54
Model AIC = 659.20
Saturated AIC = 756.00
Independence CAIC = 3717.47
Model CAIC = 1009.78
Saturated CAIC = 2477.02

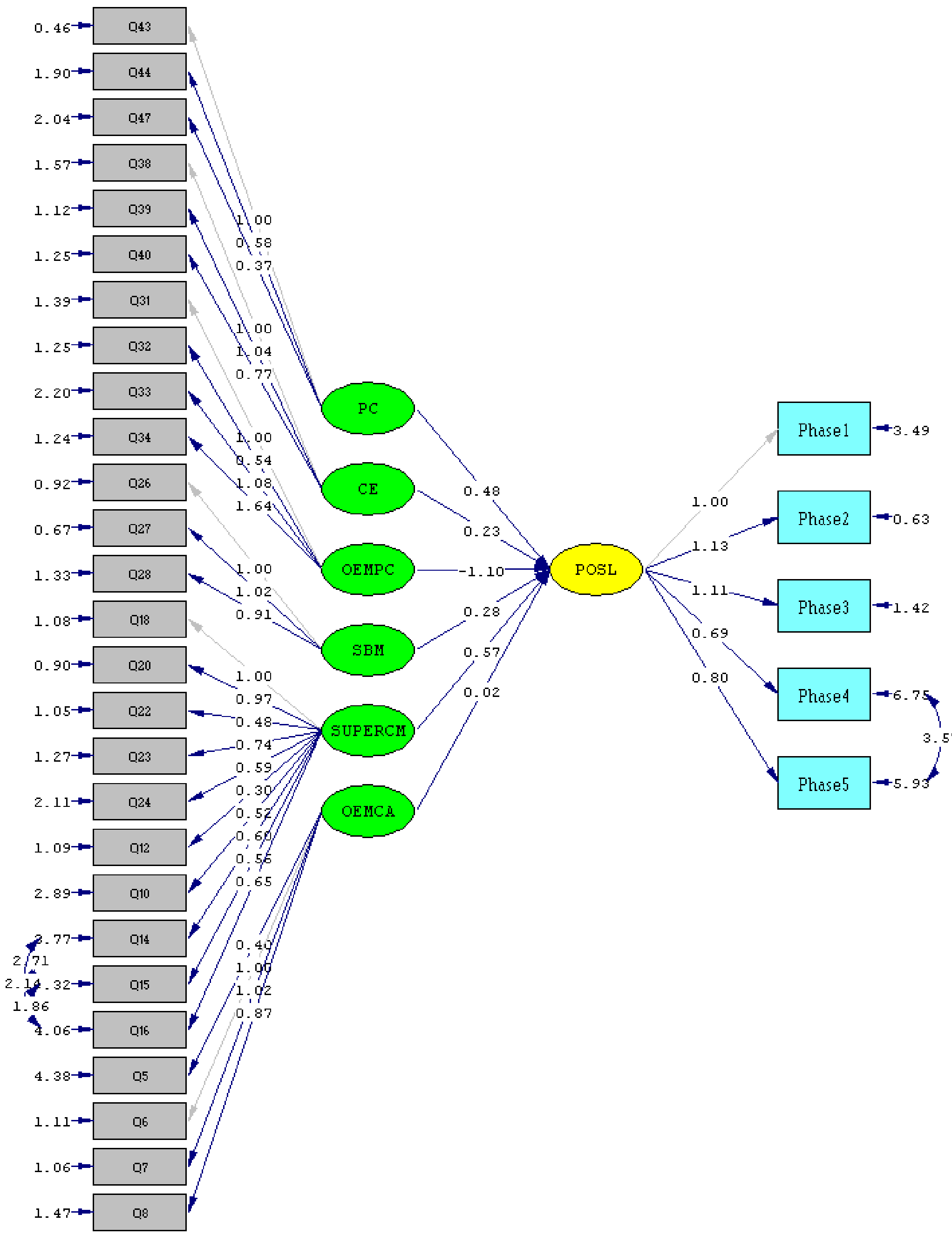
Normed Fit Index (NFI) = 0.85
Non-Normed Fit Index (NNFI) = 0.92
Parsimony Normed Fit Index (PNFI) = 0.73
Comparative Fit Index (CFI) = 0.93
Incremental Fit Index (IFI) = 0.93
Relative Fit Index (RFI) = 0.83

Critical N (CN) = 179.65

Root Mean Square Residual (RMR) = 0.18
Standardized RMR = 0.065
Goodness of Fit Index (GFI) = 0.87
Adjusted Goodness of Fit Index (AGFI) = 0.84
Parsimony Goodness of Fit Index (PGFI) = 0.70

APPENDIX E

Initial Structural Model


Q43
Q44
Q47
Q38
Q39
Q40
Q31
Q32
Q33
Q34
Q26
Q27
Q28
Q18
Q20
Q22
Q23
Q24
Q12
Q10
Q14
Q15
Q16
Q5
Q6
Q7
Q8
PC
CE
OEMPC
SBM
SUPERCM
OEMCA
POSL
Phase1
Phase2
Phase3
Phase4
Phase5
0.48
0.23
-1.10
0.28
0.57
0.02
1.00
1.13
1.11
0.69
0.80
3.49
0.63
1.42
6.75
5.93
3.57

L I S R E L 8.72

BY

Karl G. Jöreskog & Dag Sörbom

The following lines were read from file C:\DISS\lisrel data files\Dissertation SEM EVERYTHING SUPERCM 10 REV1 W PARTIALS rev1 PLUS 3.LS8:

```
TI Dissertation SEM ALL
DA NI=48 NO=258

RA FI='C:\DISS\Dissertation 258.psf'
SE
44 45 46 47 48 39 40 43 34 35 36 27 28 29 30 22 23 24 14 16 18 19 20 8 6 10 11 12 1 2 3 4 7 9 41 42 33
37 15 17 5 21 26 13 25 38  31 32
MO NY=5 NE=1 NX=27 NK=6 LY=FU,FI LX=FU,FI TD=FU,FI TE=FU,FI
LE
POSL
LK
PC CE OEMPC SBM SUPERCM OEMCA

FR LY(2,1) LY(3,1) LY(4,1) LY(5,1) LX(2,1) LX(3,1) LX(5,2) LX(6,2) LX(8,3) LX(9,3) LX(10,3)
LX(12,4) LX(13,4) LX(15,5) LX(16,5) LX(17,5) LX(18,5) LX(19,5) LX(20,5) LX(21,5) LX(22,5)
LX(23,5) LX(24,6) LX(26,6) LX(27,6) TD(1,1) TD(2,2) TD(3,3) TD(4,4) TD(5,5) TD(6,6) TD(7,7)
TD(8,8) TD(9,9) TD(10,10) TD(11,11) TD(12,12) TD(13,13) TD(14,14) TD(15,15) TD(16,16) TD(17,17)
TD(18,18) TD(19,19) TD(20,20) TD(21,21) TD(22,22) TD(23,23) TD(24,24) TD(25,25) TD(26,26)
TD(27,27) TD(22,21)  TD(23,22) TD(23,21) TE(1,1) TE(2,2) TE(3,3) TE(4,4) TE(5,5) TE(5,4)

VA 1.0 LY(1,1)  LX(1,1) LX(4,2) LX(7,3) LX(11,4) LX(14,5) LX(25,6)
PD
OU SE SC TV RS MI

TI Dissertation SEM ALL

        Number of Input Variables 48
        Number of Y - Variables    5
        Number of X - Variables   27
        Number of ETA - Variables  1
        Number of KSI - Variables  6
```

Number of Observations 258

Number of Iterations = 18

LISREL Estimates (Maximum Likelihood)

LAMBDA-Y

	POSL
Phase1	1.00
Phase2	1.13 (0.05) 22.31
Phase3	1.11 (0.05) 21.15
Phase4	0.69 (0.06) 10.86
Phase5	0.80 (0.06) 12.88

LAMBDA-X

	PC	CE	OEMPC	SBM	SUPER CM	OEMCA
Q43	1.00	- -	- -	- -	- -	- -
Q44	0.58 (0.17) 3.40	- -	- -	- -	- -	- -
Q47	0.37 (0.13) 2.86	- -	- -	- -	- -	- -
Q38	- -	1.00	- -	- -	- -	- -
Q39	- -	1.04 (0.14) 7.47	- -	- -	- -	- -
Q40	- -	0.77 (0.11)	- -	- -	- -	- -

		7.15				
Q31	- -	- -	1.00	- -	- -	- -
Q32	- -	- -	0.54 (0.12) 4.45	- -	- -	- -
Q33	- -	- -	1.08 (0.19) 5.78	- -	- -	- -
Q34	- -	- -	1.64 (0.23) 7.22	- -	- -	- -
Q26	- -	- -	- -	1.00	- -	- -
Q27	- -	- -	- -	1.02 (0.07) 14.22	- -	- -
Q28	- -	- -	- -	0.91 (0.07) 12.35	- -	- -
Q18	- -	- -	- -	- -	1.00	- -
Q20	- -	- -	- -	- -	0.97 (0.08) 12.76	- -
Q22	- -	- -	- -	- -	0.48 (0.06) 8.24	- -
Q23	- -	- -	- -	- -	0.74 (0.07) 10.45	- -
Q24	- -	- -	- -	- -	0.59 (0.08) 7.37	- -
Q12	- -	- -	- -	- -	0.30 (0.05) 5.40	- -
Q10	- -	- -	- -	- -	0.52 (0.09)	- -

					5.76	
Q14	- -	- -	- -	- -	0.60 (0.10) 5.81	- -
Q15	- -	- -	- -	- -	0.56 (0.10) 5.83	- -
Q16	- -	- -	- -	- -	0.65 (0.11) 6.04	- -
Q5	- -	- -	- -	- -	- -	0.40 (0.13) 3.08
Q6	- -	- -	- -	- -	- -	1.00
Q7	- -	- -	- -	- -	- -	1.02 (0.12) 8.89
Q8	- -	- -	- -	- -	- -	0.87 (0.10) 8.44

GAMMA

	PC	CE	OEMPC	SBM	SUPER CM	OEMCA
	--------	--------	--------	--------	--------	--------
POSL	0.48 (0.27) 1.77	0.23 (0.25) 0.91	-1.10 (0.60) -1.83	0.28 (0.27) 1.05	0.57 (0.20) 2.90	0.02 (0.19) 0.12

Standardized Solution

GAMMA

	PC	CE	OEMPC	SBM	SUPER CM	OEMCA
	--------	--------	--------	--------	--------	--------
POSL	0.18	0.09	-0.29	0.14	0.27	0.01

Goodness of Fit Statistics

Degrees of Freedom = 439
Minimum Fit Function Chi-Square = 743.42 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 741.99 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 302.99
90 Percent Confidence Interval for NCP = (231.70 ; 382.15)

Minimum Fit Function Value = 2.89
Population Discrepancy Function Value (F0) = 1.18
90 Percent Confidence Interval for F0 = (0.90 ; 1.49)
Root Mean Square Error of Approximation (RMSEA) = 0.052
90 Percent Confidence Interval for RMSEA = (0.045 ; 0.058)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.31

Expected Cross-Validation Index (ECVI) = 3.58
90 Percent Confidence Interval for ECVI = (3.30 ; 3.89)
ECVI for Saturated Model = 4.11
ECVI for Independence Model = 20.34

Chi-Square for Independence Model with 496 Degrees of Freedom = 5164.11
Independence AIC = 5228.11
Model AIC = 919.99
Saturated AIC = 1056.00
Independence CAIC = 5373.80
Model CAIC = 1325.20
Saturated CAIC = 3459.96

Normed Fit Index (NFI) = 0.86
Non-Normed Fit Index (NNFI) = 0.93
Parsimony Normed Fit Index (PNFI) = 0.76
Comparative Fit Index (CFI) = 0.93
Incremental Fit Index (IFI) = 0.94
Relative Fit Index (RFI) = 0.84

Critical N (CN) = 177.60

Root Mean Square Residual (RMR) = 0.24
Standardized RMR = 0.067
Goodness of Fit Index (GFI) = 0.85
Adjusted Goodness of Fit Index (AGFI) = 0.82
Parsimony Goodness of Fit Index (PGFI) = 0.70

APPENDIX F

Alternative Structural Model

```
                                DATE: 11/24/2005
                                  TIME:  1:41


                                L I S R E L  8.72

                                       BY

                         Karl G. Jöreskog & Dag Sörbom



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 The following lines were read from file C:\DISS\lisrel data
files\Dissertation SEM EVERYTHING SUPERCM 10 REV1 W PARTIALS rev1 wo
sbm.LS8:

 TI Dissertation SEM ALL
 DA NI=48 NO=258

 RA FI='C:\DISS\Dissertation 258.psf'
 SE
 44 45 46 47 48 39 40 43 34 35 36 27 28 29 30 14 16 18 19 20 8 6 10 11
12 1 2 3 4 7 9 41 42 33 37 15 17 5 21 26 13 25 38  31 32 22 23 24
 MO NY=5 NE=1 NX=24 NK=5 LY=FU,FI LX=FU,FI TD=FU,FI TE=FU,FI
 LE
 POSL
 LK
 PC CE OEMPC SUPERCM OEMCA

 FR LY(2,1) LY(3,1) LY(4,1) LY(5,1) LX(2,1) LX(3,1) LX(5,2) LX(6,2)
LX(8,3) LX(9,3) LX(10,3) LX(12,4) LX(13,4) LX(14,4) LX(15,4) LX(16,4)
LX(17,4) LX(18,4) LX(19,4) LX(20,4) LX(21,5) LX(23,5) LX(24,5) TD(1,1)
TD(2,2) TD(3,3) TD(4,4) TD(5,5) TD(6,6) TD(7,7) TD(8,8) TD(9,9)
TD(10,10) TD(11,11) TD(12,12) TD(13,13) TD(14,14) TD(15,15) TD(16,16)
TD(17,17) TD(18,18) TD(19,19) TD(20,20) TD(21,21) TD(22,22) TD(23,23)
TD(24,24) TD(19,18)  TD(20,19) TD(20,18) TE(1,1) TE(2,2) TE(3,3)
TE(4,4) TE(5,5) TE(5,4)

 VA 1.0 LY(1,1)  LX(1,1) LX(4,2) LX(7,3) LX(11,4)  LX(22,5)
 PD
 OU SE SC TV RS MI

 TI Dissertation SEM ALL
```

```
                           Number of Input Variables 48
                           Number of Y - Variables    5
                           Number of X - Variables   24
                           Number of ETA - Variables  1
                           Number of KSI - Variables  5
                           Number of Observations   258

Number of Iterations = 17

 LISREL Estimates (Maximum Likelihood)

         LAMBDA-Y

                POSL
            --------
   Phase1       1.00

   Phase2       1.13
              (0.05)
               22.31

   Phase3       1.11
              (0.05)
               21.14

   Phase4       0.69
              (0.06)
               10.86

   Phase5       0.80
              (0.06)
               12.88


         LAMBDA-X

                  PC         CE      OEMPC    SUPERCM      OEMCA
            --------   --------   --------   --------   --------
      Q43       1.00       - -        - -        - -        - -

      Q44       0.56       - -        - -        - -        - -
              (0.17)
                3.33

      Q47       0.36       - -        - -        - -        - -
              (0.13)
                2.81

      Q38        - -       1.00       - -        - -        - -

      Q39        - -       1.08       - -        - -        - -
                         (0.15)
```

		7.41			
Q40	- -	0.78 (0.11) 7.12	- -	- -	- -
Q31	- -	- -	1.00	- -	- -
Q32	- -	- -	0.55 (0.11) 4.77	- -	- -
Q33	- -	- -	0.85 (0.17) 5.09	- -	- -
Q34	- -	- -	1.39 (0.22) 6.36	- -	- -
Q18	- -	- -	- -	1.00	- -
Q20	- -	- -	- -	0.98 (0.08) 12.76	- -
Q22	- -	- -	- -	0.48 (0.06) 8.25	- -
Q23	- -	- -	- -	0.74 (0.07) 10.42	- -
Q24	- -	- -	- -	0.59 (0.08) 7.32	- -
Q12	- -	- -	- -	0.30 (0.05) 5.44	- -
Q10	- -	- -	- -	0.51 (0.09) 5.72	- -
Q14	- -	- -	- -	0.60 (0.10) 5.81	- -
Q15	- -	- -	- -	0.56 (0.10)	- -

				5.82	
Q16	- -	- -	- -	0.65 (0.11) 6.06	- -
Q5	- -	- -	- -	- -	0.39 (0.13) 3.01
Q6	- -	- -	- -	- -	1.00
Q7	- -	- -	- -	- -	1.01 (0.11) 8.82
Q8	- -	- -	- -	- -	0.85 (0.10) 8.38

GAMMA

	PC	CE	OEMPC	SUPERCM	OEMCA
POSL	0.47 (0.26) 1.78	0.25 (0.25) 1.02	-0.68 (0.32) -2.11	0.52 (0.18) 2.95	0.08 (0.19) 0.40

Standardized Solution

GAMMA

	PC	CE	OEMPC	SUPERCM	OEMCA
POSL	0.18	0.10	-0.20	0.24	0.03

Goodness of Fit Statistics

Degrees of Freedom = 358
Minimum Fit Function Chi-Square = 635.40 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 641.76 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 283.76
90 Percent Confidence Interval for NCP = (216.88 ; 358.48)

Minimum Fit Function Value = 2.47
Population Discrepancy Function Value (F0) = 1.10
90 Percent Confidence Interval for F0 = (0.84 ; 1.39)
Root Mean Square Error of Approximation (RMSEA) = 0.056
90 Percent Confidence Interval for RMSEA = (0.049 ; 0.062)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.094

Expected Cross-Validation Index (ECVI) = 3.10
90 Percent Confidence Interval for ECVI = (2.84 ; 3.39)
ECVI for Saturated Model = 3.39
ECVI for Independence Model = 17.00

Chi-Square for Independence Model with 406 Degrees of Freedom = 4310.86
Independence AIC = 4368.86
Model AIC = 795.76
Saturated AIC = 870.00
Independence CAIC = 4500.89
Model CAIC = 1146.34
Saturated CAIC = 2850.54

Normed Fit Index (NFI) = 0.85
Non-Normed Fit Index (NNFI) = 0.92
Parsimony Normed Fit Index (PNFI) = 0.75
Comparative Fit Index (CFI) = 0.93
Incremental Fit Index (IFI) = 0.93
Relative Fit Index (RFI) = 0.83

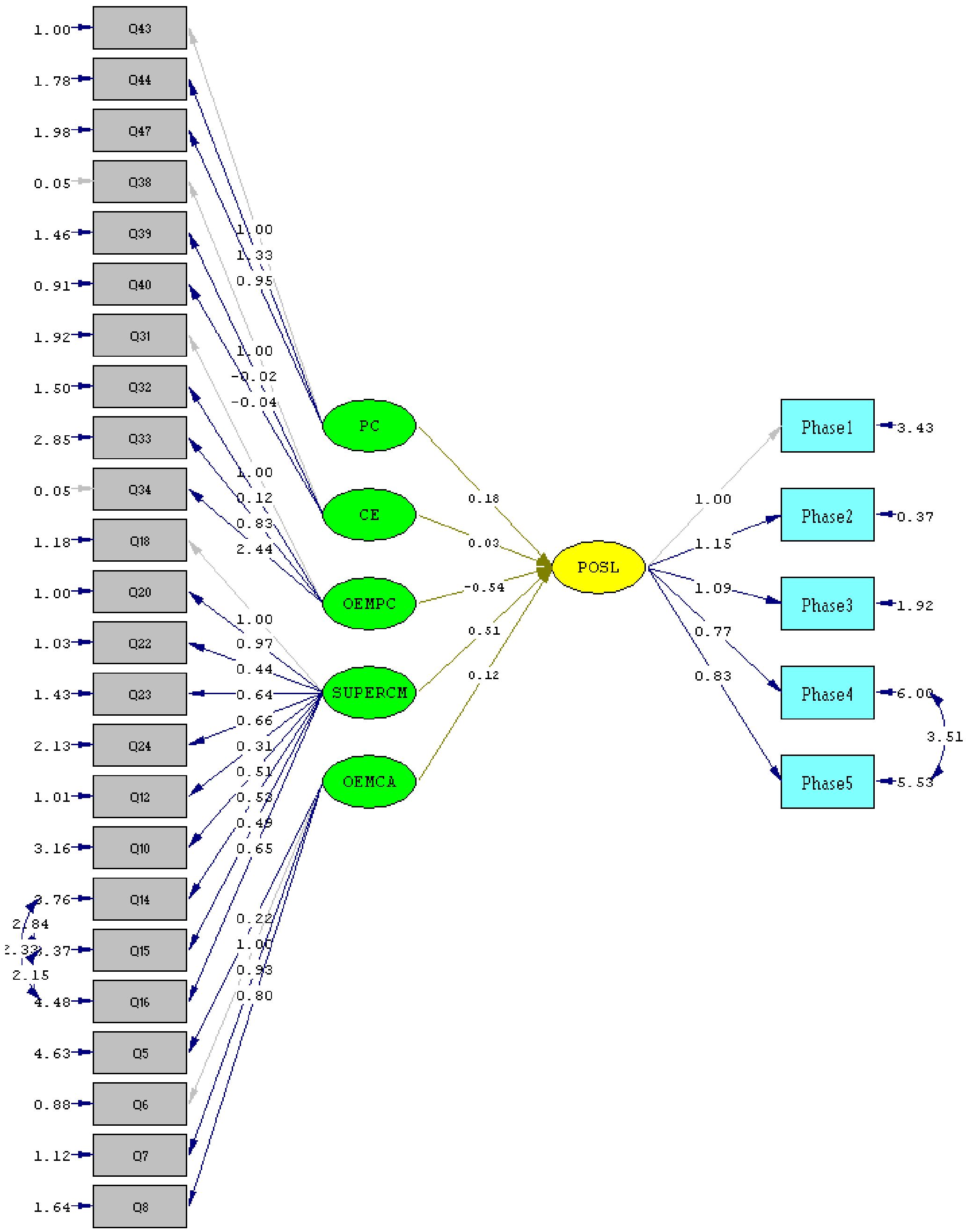
Critical N (CN) = 172.16

Root Mean Square Residual (RMR) = 0.26
Standardized RMR = 0.069
Goodness of Fit Index (GFI) = 0.85
Adjusted Goodness of Fit Index (AGFI) = 0.82
Parsimony Goodness of Fit Index (PGFI) = 0.70

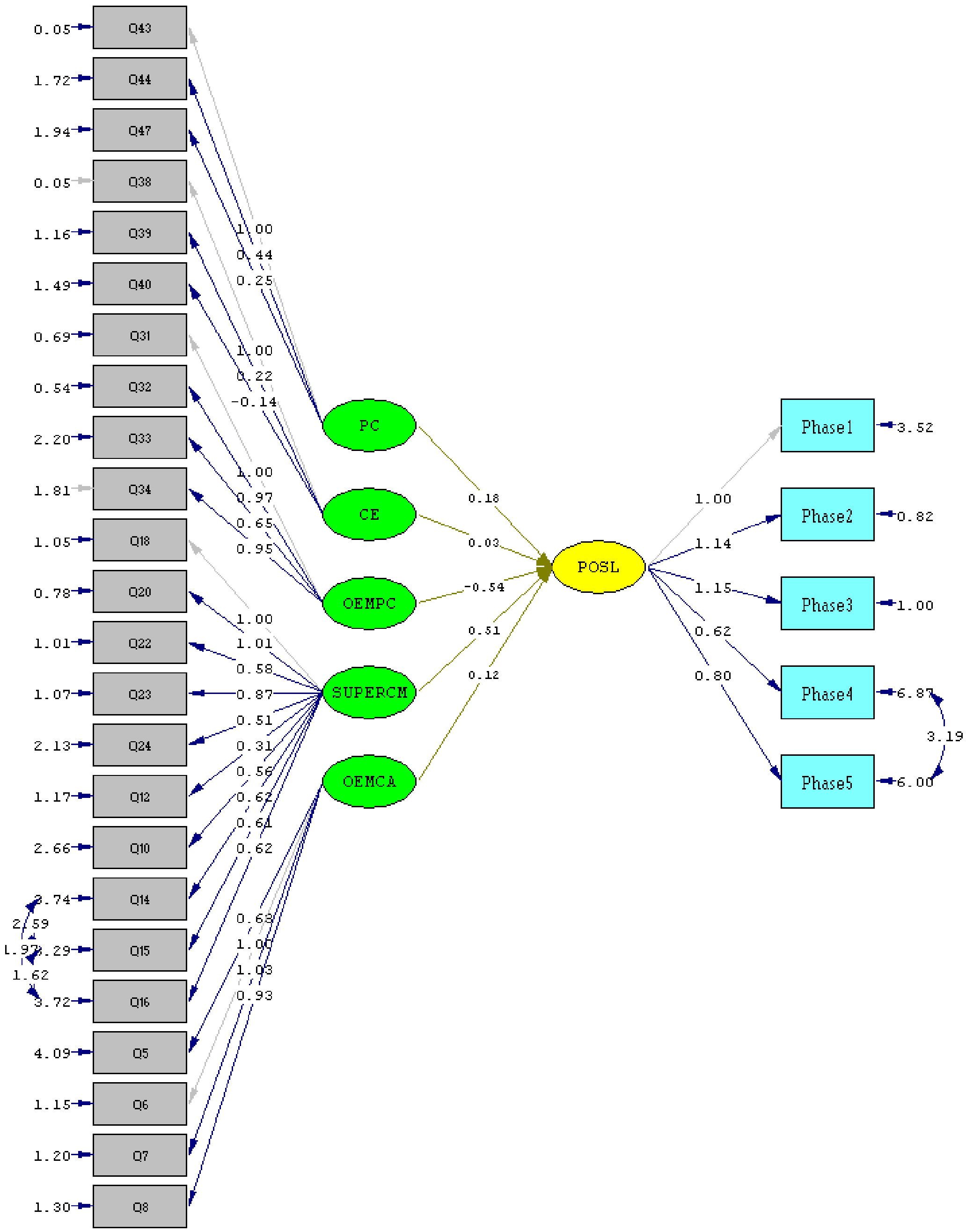
APPENDIX G

Moderation Structural Models

Free Model
Low Group



High Group


Q43
Q44
Q47
Q38
Q39
Q40
Q31
Q32
Q33
Q34
Q18
Q20
Q22
Q23
Q24
Q12
Q10
Q14
Q15
Q16
Q5
Q6
Q7
Q8
PC
CE
OEMPC
SUPERCM
OEMCA
POSL
Phase1
Phase2
Phase3
Phase4
Phase5

```
                         L I S R E L  8.72

                               BY

                   Karl G. Jöreskog & Dag Sörbom

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 The following lines were read from file C:\DISS\lisrel data
files\Dissertation SEM EVERYTHING SUPERCM 10 REV1 W PARTIALS
Interaction fixed PLUS 3 wo SBM.LS8:
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Group: Low

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 DA NG=2 NI=48 NO=124

 RA FI='C:\DISS\ILDissertation 124.psf'
 SE
 44 45 46 47 48 39 40 43 34 35 36 27 28 29 30 14 16 18 19 20 8 6 10 11
12 1 2 3 4 7 9 41 42 33 37 15 17 5 21 26 13 25 38  31 32 22 23 24
 MO NY=5 NE=1 NX=24 NK=5 LY=FU,FI LX=FU,FI TD=FU,FI TE=FU,FI
 LE
 POSL
 LK
 PC CE OEMPC SUPERCM OEMCA

 FR LY(2,1) LY(3,1) LY(4,1) LY(5,1) LX(2,1) LX(3,1) LX(5,2) LX(6,2)
LX(8,3) LX(9,3) LX(10,3) LX(12,4) LX(13,4) LX(14,4) LX(15,4) LX(16,4)
LX(17,4) LX(18,4) LX(19,4) LX(20,4) LX(21,5) LX(23,5) LX(24,5) TD(1,1)
TD(2,2) TD(3,3)  TD(5,5) TD(6,6) TD(7,7) TD(8,8) TD(9,9) TD(11,11)
TD(12,12) TD(13,13) TD(14,14) TD(15,15) TD(16,16) TD(17,17) TD(18,18)
TD(19,19) TD(20,20) TD(21,21) TD(22,22) TD(23,23) TD(24,24) TD(19,18)
TD(20,19) TD(20,18) TE(1,1) TE(2,2) TE(3,3) TE(4,4) TE(5,5) TE(5,4)

 VA 1.0 LY(1,1)  LX(1,1) LX(4,2) LX(7,3) LX(11,4) LX(22,5)
 VA .05 TD(4,4) TD(10,10)
 PD
 OU SE SC TV RS MI AD=OFF

                           Number of Input Variables 48
                           Number of Y - Variables    5
                           Number of X - Variables   24
                           Number of ETA - Variables  1
                           Number of KSI - Variables  5
                           Number of Observations   124
                           Number of Groups           2
```

Group: Low

```
 Number of Iterations = 58

LISREL Estimates (Maximum Likelihood)

         LAMBDA-Y

                POSL
            --------
   Phase1       1.00

   Phase2       1.15
              (0.07)
               16.66

   Phase3       1.09
              (0.07)
               14.84

   Phase4       0.77
              (0.09)
                9.09

   Phase5       0.83
              (0.08)
                9.89


         LAMBDA-X

                  PC         CE      OEMPC    SUPERCM      OEMCA
            --------   --------   --------   --------   --------
      Q43       1.00       - -        - -        - -        - -

      Q44       1.33       - -        - -        - -        - -
              (0.56)
                2.39

      Q47       0.95       - -        - -        - -        - -
              (0.39)
                2.42

      Q38        - -       1.00       - -        - -        - -

      Q39        - -      -0.02       - -        - -        - -
                         (0.08)
                          -0.33

      Q40        - -      -0.04       - -        - -        - -
                         (0.06)
                          -0.73
```

Q31	- -	- -	1.00	- -	- -
Q32	- -	- -	0.12 (0.16) 0.72	- -	- -
Q33	- -	- -	0.83 (0.27) 3.11	- -	- -
Q34	- -	- -	2.44 (0.44) 5.61	- -	- -
Q18	- -	- -	- -	1.00	- -
Q20	- -	- -	- -	0.97 (0.12) 8.18	- -
Q22	- -	- -	- -	0.44 (0.08) 5.21	- -
Q23	- -	- -	- -	0.64 (0.10) 6.12	- -
Q24	- -	- -	- -	0.66 (0.12) 5.42	- -
Q12	- -	- -	- -	0.31 (0.08) 3.99	- -
Q10	- -	- -	- -	0.51 (0.14) 3.73	- -
Q14	- -	- -	- -	0.53 (0.15) 3.55	- -
Q15	- -	- -	- -	0.49 (0.14) 3.50	- -
Q16	- -	- -	- -	0.65 (0.16) 3.93	- -

```
      Q5        - -         - -         - -         - -        0.22
                                                              (0.15)
                                                               1.44

      Q6        - -         - -         - -         - -        1.00

      Q7        - -         - -         - -         - -        0.93
                                                              (0.13)
                                                               7.12

      Q8        - -         - -         - -         - -        0.80
                                                              (0.12)
                                                               6.58
```

GAMMA EQUALS GAMMA IN THE FOLLOWING GROUP

Group: High

```
 DA NG=2 NI=48 NO=134
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 44 45 46 47 48 39 40 43 34 35 36 27 28 29 30 14 16 18 19 20 8 6 10 11
12 1 2 3 4 7 9 41 42 33 37 15 17 5 21 26 13 25 38  31 32 22 23 24
 MO NY=5 NE=1 NX=24 NK=5 LY=FU,FI LX=FU,FI TD=FU,FI TE=FU,FI GA=IN
 LE
 POSL
 LK
 PC CE OEMPC SUPERCM OEMCA

 FR LY(2,1) LY(3,1) LY(4,1) LY(5,1) LX(2,1) LX(3,1) LX(5,2) LX(6,2)
LX(8,3) LX(9,3) LX(10,3) LX(12,4) LX(13,4) LX(14,4) LX(15,4) LX(16,4)
LX(17,4) LX(18,4) LX(19,4) LX(20,4) LX(21,5) LX(23,5) LX(24,5) TD(2,2)
TD(3,3)  TD(5,5) TD(6,6) TD(7,7) TD(8,8) TD(9,9) TD(10,10) TD(11,11)
TD(12,12) TD(13,13) TD(14,14) TD(15,15) TD(16,16) TD(17,17) TD(18,18)
TD(19,19) TD(20,20) TD(21,21) TD(22,22) TD(23,23) TD(24,24) TD(19,18)
TD(20,19) TD(20,18) TE(1,1) TE(2,2) TE(3,3) TE(4,4) TE(5,5) TE(5,4)

 VA 1.0 LY(1,1)  LX(1,1) LX(4,2) LX(7,3) LX(11,4) LX(22,5)
 VA .05 TD(4,4) TD(1,1)
 PD
 OU SE SC TV RS MI AD=OFF

                           Number of Input Variables 48
                           Number of Y - Variables    5
                           Number of X - Variables   24
                           Number of ETA - Variables  1
                           Number of KSI - Variables  5
                           Number of Observations   134
                           Number of Groups           2
```

Group: High

```
 Number of Iterations = 58

 LISREL Estimates (Maximum Likelihood)
```

LAMBDA-Y

	POSL
Phase1	1.00
Phase2	1.14 (0.08) 15.06
Phase3	1.15 (0.08) 14.92
Phase4	0.62 (0.09) 6.74
Phase5	0.80 (0.09) 8.69

LAMBDA-X

	PC	CE	OEMPC	SUPERCM	OEMCA
Q43	1.00	- -	- -	- -	- -
Q44	0.44 (0.09) 4.77	- -	- -	- -	- -
Q47	0.25 (0.10) 2.53	- -	- -	- -	- -
Q38	- -	1.00	- -	- -	- -
Q39	- -	0.22 (0.09) 2.39	- -	- -	- -
Q40	- -	-0.14 (0.10) -1.33	- -	- -	- -
Q31	- -	- -	1.00	- -	- -
Q32	- -	- -	0.97 (0.15) 6.60	- -	- -

Q33	- -	- -	0.65 (0.17) 3.75	- -	- -
Q34	- -	- -	0.95 (0.18) 5.34	- -	- -
Q18	- -	- -	- -	1.00	- -
Q20	- -	- -	- -	1.01 (0.11) 9.54	- -
Q22	- -	- -	- -	0.58 (0.09) 6.71	- -
Q23	- -	- -	- -	0.87 (0.10) 8.45	- -
Q24	- -	- -	- -	0.51 (0.11) 4.47	- -
Q12	- -	- -	- -	0.31 (0.08) 3.78	- -
Q10	- -	- -	- -	0.56 (0.13) 4.41	- -
Q14	- -	- -	- -	0.62 (0.15) 4.15	- -
Q15	- -	- -	- -	0.61 (0.14) 4.33	- -
Q16	- -	- -	- -	0.62 (0.15) 4.18	- -
Q5	- -	- -	- -	- -	0.68 (0.23) 2.94
Q6	- -	- -	- -	- -	1.00

Q7	- -	- -	- -	- -	1.03
					(0.20)
					5.25
Q8	- -	- -	- -	- -	0.93
					(0.18)
					5.10

GAMMA

	PC	CE	OEMPC	SUPERCM	OEMCA
POSL	0.18	0.03	-0.54	0.51	0.12
	(0.19)	(0.15)	(0.26)	(0.17)	(0.18)
	0.95	0.21	-2.06	3.05	0.66

Global Goodness of Fit Statistics

Degrees of Freedom = 725
Minimum Fit Function Chi-Square = 1127.82 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 1066.69 (P = 0.00)
Estimated Non-centrality Parameter (NCP) = 341.69
90 Percent Confidence Interval for NCP = (258.36 ; 433.01)

Minimum Fit Function Value = 4.41
Population Discrepancy Function Value (F0) = 1.33
90 Percent Confidence Interval for F0 = (1.01 ; 1.69)
Root Mean Square Error of Approximation (RMSEA) = 0.061
90 Percent Confidence Interval for RMSEA = (0.053 ; 0.068)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.014

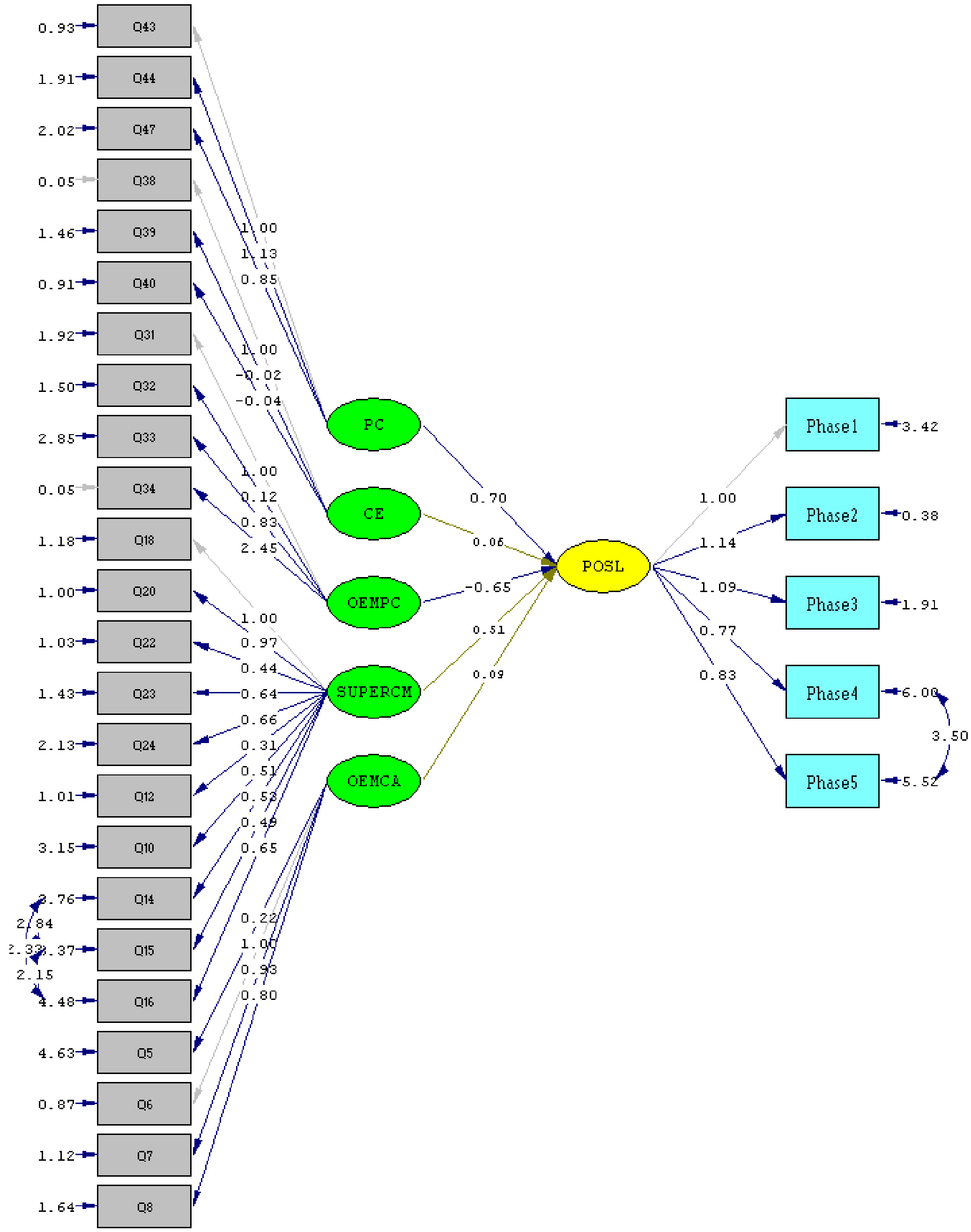
Expected Cross-Validation Index (ECVI) = 5.30
90 Percent Confidence Interval for ECVI = (4.97 ; 5.66)
ECVI for Saturated Model = 3.40
ECVI for Independence Model = 17.67

Chi-Square for Independence Model with 812 Degrees of Freedom = 4465.48
Independence AIC = 4581.48
Model AIC = 1356.69
Saturated AIC = 1740.00
Independence CAIC = 4845.55
Model CAIC = 2016.87
Saturated CAIC = 5701.07

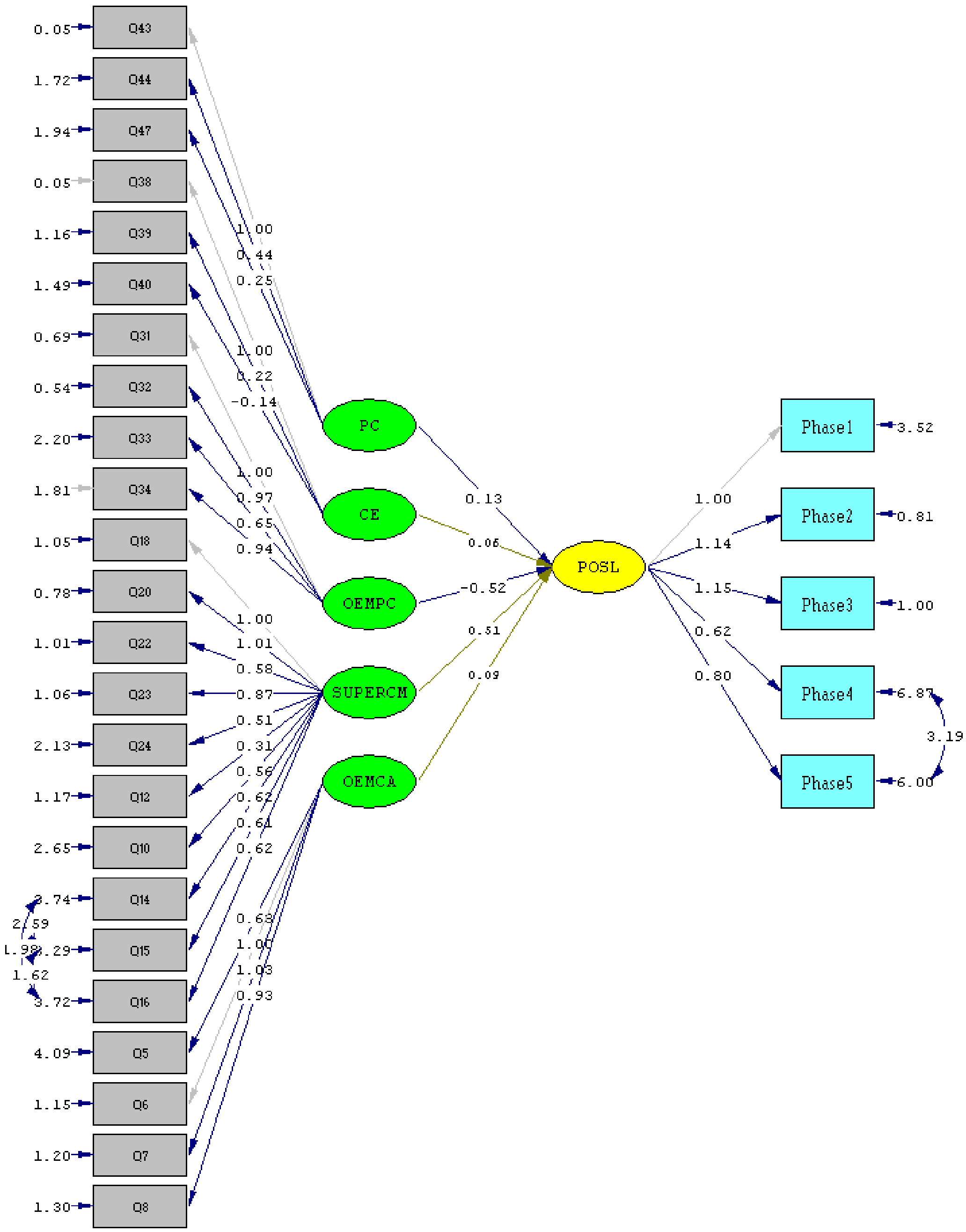
Normed Fit Index (NFI) = 0.75
Non-Normed Fit Index (NNFI) = 0.88
Parsimony Normed Fit Index (PNFI) = 0.67
Comparative Fit Index (CFI) = 0.89
Incremental Fit Index (IFI) = 0.89
Relative Fit Index (RFI) = 0.72

Critical N (CN) = 186.34

Free Model
Low Group



High Group



Q43
Q44
Q47
Q38
Q39
Q40
Q31
Q32
Q33
Q34
Q18
Q20
Q22
Q23
Q24
Q12
Q10
Q14
Q15
Q16
Q5
Q6
Q7
Q8
0.05
1.72
1.94
0.05
1.16
1.49
0.69
0.54
2.20
1.81
1.05
0.78
1.01
1.06
2.13
1.17
2.65
3.74
2.59
1.98
3.29
1.62
3.72
4.09
1.15
1.20
1.30
1.00
0.44
0.25
1.00
0.22
-0.14
1.00
0.97
0.65
0.94
1.00
1.01
0.58
0.87
0.51
0.31
0.56
0.62
0.61
0.62
0.63
1.00
1.03
0.93
PC
CE
OEMPC
SUPERCM
OEMCA
0.13
0.06
-0.52
0.51
0.09
POSL
1.00
1.14
1.15
0.62
0.80
Phase1
Phase2
Phase3
Phase4
Phase5
3.52
0.81
1.00
6.87
6.00
3.19

```
                                L I S R E L  8.72

                                       BY

                           Karl G. Jöreskog & Dag Sörbom

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files\Dissertation SEM EVERYTHING SUPERCM 10 REV1 W PARTIALS
Interaction FREE PLUS 3 wo SBM.LS8:
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Group: Low

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 SE
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12 1 2 3 4 7 9 41 42 33 37 15 17 5 21 26 13 25 38  31 32 22 23 24
 MO NY=5 NE=1 NX=24 NK=5 LY=FU,FI LX=FU,FI TD=FU,FI TE=FU,FI
 LE
 POSL
 LK
 PC CE OEMPC SUPERCM OEMCA

 FR LY(2,1) LY(3,1) LY(4,1) LY(5,1) LX(2,1) LX(3,1) LX(5,2) LX(6,2)
LX(8,3) LX(9,3) LX(10,3) LX(12,4) LX(13,4) LX(14,4) LX(15,4) LX(16,4)
LX(17,4) LX(18,4) LX(19,4) LX(20,4) LX(21,5) LX(23,5) LX(24,5) TD(1,1)
TD(2,2) TD(3,3)  TD(5,5) TD(6,6) TD(7,7) TD(8,8) TD(9,9) TD(11,11)
TD(12,12) TD(13,13) TD(14,14) TD(15,15) TD(16,16) TD(17,17) TD(18,18)
TD(19,19) TD(20,20) TD(21,21) TD(22,22) TD(23,23) TD(24,24) TD(19,18)
TD(20,19) TD(20,18) TE(1,1) TE(2,2) TE(3,3) TE(4,4) TE(5,5) TE(5,4)

 VA 1.0 LY(1,1)  LX(1,1) LX(4,2) LX(7,3) LX(11,4) LX(22,5)
 VA .05 TD(4,4) TD(10,10)
 PD
 OU SE SC TV RS MI AD=OFF

                           Number of Input Variables 48
                           Number of Y - Variables    5
                           Number of X - Variables   24
                           Number of ETA - Variables  1
                           Number of KSI - Variables  5
                           Number of Observations   124
                           Number of Groups           2
```

Group: Low

Number of Iterations = 32

LISREL Estimates (Maximum Likelihood)

LAMBDA-Y

	POSL
Phase1	1.00
Phase2	1.14 (0.07) 16.77
Phase3	1.09 (0.07) 14.94
Phase4	0.77 (0.08) 9.15
Phase5	0.83 (0.08) 9.94

LAMBDA-X

	PC	CE	OEMPC	SUPERCM	OEMCA
Q43	1.00	- -	- -	- -	- -
Q44	1.13 (0.47) 2.40	- -	- -	- -	- -
Q47	0.85 (0.36) 2.34	- -	- -	- -	- -
Q38	- -	1.00	- -	- -	- -
Q39	- -	-0.02 (0.08) -0.33	- -	- -	- -
Q40	- -	-0.04 (0.06) -0.73	- -	- -	- -

Q31	- -	- -	1.00	- -	- -
Q32	- -	- -	0.12 (0.16) 0.72	- -	- -
Q33	- -	- -	0.83 (0.27) 3.09	- -	- -
Q34	- -	- -	2.45 (0.45) 5.48	- -	- -
Q18	- -	- -	- -	1.00	- -
Q20	- -	- -	- -	0.97 (0.12) 8.17	- -
Q22	- -	- -	- -	0.44 (0.08) 5.20	- -
Q23	- -	- -	- -	0.64 (0.10) 6.12	- -
Q24	- -	- -	- -	0.66 (0.12) 5.43	- -
Q12	- -	- -	- -	0.31 (0.08) 3.98	- -
Q10	- -	- -	- -	0.51 (0.14) 3.74	- -
Q14	- -	- -	- -	0.53 (0.15) 3.55	- -
Q15	- -	- -	- -	0.49 (0.14) 3.50	- -
Q16	- -	- -	- -	0.65 (0.16) 3.92	- -

```
      Q5        - -         - -         - -         - -        0.22
                                                              (0.15)
                                                               1.43

      Q6        - -         - -         - -         - -        1.00

      Q7        - -         - -         - -         - -        0.93
                                                              (0.13)
                                                               7.12

      Q8        - -         - -         - -         - -        0.80
                                                              (0.12)
                                                               6.58

        GAMMA

                    PC          CE       OEMPC     SUPERCM       OEMCA
              --------    --------    --------    --------    --------
    POSL          0.70        0.06       -0.65        0.51        0.09
                (0.57)      (0.16)      (0.42)      (0.17)      (0.18)
                  1.22        0.41       -1.54        3.01        0.50
```

Group: High

```
 DA NG=2 NI=48 NO=134
 RA FI='C:\DISS\IHDissertation 134.psf'
 SE
 44 45 46 47 48 39 40 43 34 35 36 27 28 29 30 14 16 18 19 20 8 6 10 11
12 1 2 3 4 7 9 41 42 33 37 15 17 5 21 26 13 25 38  31 32 22 23 24
 MO NY=5 NE=1 NX=24 NK=5 LY=FU,FI LX=FU,FI TD=FU,FI TE=FU,FI GA=IN
 LE
 POSL
 LK
 PC CE OEMPC SUPERCM OEMCA

 FR LY(2,1) LY(3,1) LY(4,1) LY(5,1) LX(2,1) LX(3,1) LX(5,2) LX(6,2)
LX(8,3) LX(9,3) LX(10,3) LX(12,4) LX(13,4) LX(14,4) LX(15,4) LX(16,4)
LX(17,4) LX(18,4) LX(19,4) LX(20,4) LX(21,5) LX(23,5) LX(24,5) TD(2,2)
TD(3,3)  TD(5,5) TD(6,6) TD(7,7) TD(8,8) TD(9,9) TD(10,10) TD(11,11)
TD(12,12) TD(13,13) TD(14,14) TD(15,15) TD(16,16) TD(17,17) TD(18,18)
TD(19,19) TD(20,20) TD(21,21) TD(22,22) TD(23,23) TD(24,24) TD(19,18)
TD(20,19) TD(20,18) TE(1,1) TE(2,2) TE(3,3) TE(4,4) TE(5,5) TE(5,4)
GA(1,1) GA(1,3)

 VA 1.0 LY(1,1)  LX(1,1) LX(4,2) LX(7,3) LX(11,4) LX(22,5)
 VA .05 TD(4,4) TD(1,1)
 PD
 OU SE SC TV RS MI AD=OFF

                           Number of Input Variables 48
                           Number of Y - Variables    5
                           Number of X - Variables   24
                           Number of ETA - Variables  1
```

```
                             Number of KSI - Variables  5
                             Number of Observations   134
                             Number of Groups           2
```

Group: High

```
 Number of Iterations = 32

 LISREL Estimates (Maximum Likelihood)

         LAMBDA-Y

                POSL
            --------
   Phase1       1.00

   Phase2       1.14
              (0.08)
               14.96

   Phase3       1.15
              (0.08)
               14.82

   Phase4       0.62
              (0.09)
                6.71

   Phase5       0.80
              (0.09)
                8.64


         LAMBDA-X

                  PC          CE       OEMPC     SUPERCM       OEMCA
            --------    --------    --------    --------    --------
      Q43       1.00        - -         - -         - -         - -

      Q44       0.44        - -         - -         - -         - -
              (0.09)
                4.77

      Q47       0.25        - -         - -         - -         - -
              (0.10)
                2.53

      Q38        - -        1.00        - -         - -         - -

      Q39        - -        0.22        - -         - -         - -
                          (0.09)
                            2.39
```

Q40	- -	-0.14 (0.10) -1.33	- -	- -	- -
Q31	- -	- -	1.00	- -	- -
Q32	- -	- -	0.97 (0.15) 6.58	- -	- -
Q33	- -	- -	0.65 (0.17) 3.75	- -	- -
Q34	- -	- -	0.94 (0.18) 5.33	- -	- -
Q18	- -	- -	- -	1.00	- -
Q20	- -	- -	- -	1.01 (0.11) 9.52	- -
Q22	- -	- -	- -	0.58 (0.09) 6.71	- -
Q23	- -	- -	- -	0.87 (0.10) 8.45	- -
Q24	- -	- -	- -	0.51 (0.11) 4.48	- -
Q12	- -	- -	- -	0.31 (0.08) 3.78	- -
Q10	- -	- -	- -	0.56 (0.13) 4.41	- -
Q14	- -	- -	- -	0.62 (0.15) 4.15	- -
Q15	- -	- -	- -	0.61 (0.14) 4.33	- -

Q16	- -	- -	- -	0.62 (0.15) 4.17	- -
Q5	- -	- -	- -	- -	0.68 (0.23) 2.94
Q6	- -	- -	- -	- -	1.00
Q7	- -	- -	- -	- -	1.03 (0.20) 5.25
Q8	- -	- -	- -	- -	0.93 (0.18) 5.10

GAMMA

	PC	CE	OEMPC	SUPERCM	OEMCA
POSL	0.13 (0.20) 0.64	0.06 (0.16) 0.41	-0.52 (0.33) -1.58	0.51 (0.17) 3.01	0.09 (0.18) 0.50

Global Goodness of Fit Statistics

Degrees of Freedom = 723
Minimum Fit Function Chi-Square = 1126.89 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 1068.97 (P = 0.00)
Estimated Non-centrality Parameter (NCP) = 345.97
90 Percent Confidence Interval for NCP = (262.43 ; 437.49)

Minimum Fit Function Value = 4.40
Population Discrepancy Function Value (F0) = 1.35
90 Percent Confidence Interval for F0 = (1.03 ; 1.71)
Root Mean Square Error of Approximation (RMSEA) = 0.061
90 Percent Confidence Interval for RMSEA = (0.053 ; 0.069)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.011

Expected Cross-Validation Index (ECVI) = 5.32
90 Percent Confidence Interval for ECVI = (5.00 ; 5.68)
ECVI for Saturated Model = 3.40
ECVI for Independence Model = 17.67

Chi-Square for Independence Model with 812 Degrees of Freedom = 4465.48
Independence AIC = 4581.48
Model AIC = 1362.97
Saturated AIC = 1740.00
Independence CAIC = 4845.55
Model CAIC = 2032.25
Saturated CAIC = 5701.07

```
     Normed Fit Index (NFI) = 0.75
   Non-Normed Fit Index (NNFI) = 0.88
Parsimony Normed Fit Index (PNFI) = 0.67
   Comparative Fit Index (CFI) = 0.89
   Incremental Fit Index (IFI) = 0.89
    Relative Fit Index (RFI) = 0.72

       Critical N (CN) = 186.01
```