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An Exploratory Study of the Relationship Between Quality Management and Manufacturing Competitive Capabilities

by

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Submitted in partial fulfillment of the requirements for the Doctor of Philosophy degree in Manufacturing Management

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An Abstract of

AN EXPLORATORY STUDY OF THE RELATIONSHIP BETWEEN QUALITY MANAGEMENT AND MANUFACTURING COMPETITIVE CAPABILITIES

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The purpose of this study is to assess the relationships between a firm's quality management practices and its competitive capabilities. In developing competitive and sustaining competitive capabilities quality management plays a vital role. To understand the relationship between quality management practices and capabilities of a company not only the direct relationship between them but also the mediating role of internal quality performance has to be considered. In this

dissertation a model is proposed in which competitive capabilities are related directly quality practices and indirectly through internal quality performance. Competitive capabilities are measured in a number of dimensions like value to customer, delivery, etc. Quality management practices are measured in terms of management based, employee based, customer based, information based, product/process based, and supplier based practices. Internal quality performance is measured by quality failures, manufacturing cost, and manufacturing lead time.

To achieve the objective of the study, valid and reliable measures of quality management practices, competitive capabilities and internal quality performance were developed. The methodology used to derive measures included an extensive literature review, interviews with quality and plant managers, consultants, and academics. This process helped to refine the content domain for each quality management construct. In addition, a pilot study using a sorting procedure was conducted with quality managers and plant managers of manufacturing companies acting as judges. The pilot study indicated that the initial instrument design had the potential for high content, convergent and discriminant validity. Data from 300 manufacturing companies collected in a large scale survey was used to establish the validity and reliability of the proposed constructs in the model proposed. Exploratory factor analysis was used for this purpose.

Structural equation modeling was used to test the hypothesized relationships in the research model. These results confirmed that quality management practices play a significant role in building and supporting competitive capabilities essential

for the success of manufacturing firms. Sixty five percent of the variance in competitive capabilities was explained by the quality management practices proposed in the research model. Specifically, competitive capabilities are directly influenced by quality management practices, while quality failures were the only significant internal quality performance variable influencing competitive capabilities. The present research confirms that a reduction in the level of quality failures leads to reduced product cost and lead-time. However, the research could not establish the mediating role of product cost and lead-time between quality management practices and competitive capabilities. Directions and recommendations for future research include confirmatory factor analysis for the quality management practices scales using structural equation modeling approach, testing alternative hypothesized models, and incorporating contextual and organizational outcome variables.

To my beloved wife

Maribel

Her support and love made possible this journey.

To my sons

Luis Eduardo and Juan Carlo

My teachers

Whose simple questions are still unanswered

To my mother

Enriqueta Galván Ambríz

With love

In memory of

my grandfathers

Domingo Galvan † and Esteban Solis †

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# CHAPTER 1

# INTRODUCTION

Worldwide manufacturing companies are immersed in a new era of increased global competition, worldwide production, and rapid dissemination of advanced manufacturing, communication, and information technologies. Global competition has become more intensified with the passage of the General Agreement on Tariffs and Trade (GATT 1994), North America Free Trade Agreement (NAFTA 1994), the World Trade Organization Agreement (WTO 1995), and other free trade agreements (Noble, 1995). Moreover, trade in manufactures is the largest component of the world trade (World Economic and Social Survey, United Nations, 1996) with 70 percent of U.S. manufacturing output facing direct foreign competition. Essentially, in the age of globalization of manufacturing operations, products made in one country are shipped across national borders for further work, packaging, assembly, storage, or sales, and will accelerate (Ferdows, 1997).

In addition, extensive and rapid dissemination of information and communication technologies are transforming manufacturing by expanding dramatically their operations and capabilities. For example, the newest Ford project is to design a world car. Given the technological advances, the project is now feasible, because telecommunications, computer-aided design, and computer-aided manufacturing allows engineers to work simultaneously and cooperatively on the same design. Also, major innovations in the organization of manufacturing and technology like total quality management (TQM), just-in time (JIT), and lean manufacturing, have been disseminated and implemented by companies around the world with the purpose of achieving and sustaining competitive advantage.

Further, the interaction of increased competition, globalization of production, and rapid dissemination and diffusion of technologies have significantly increased the complexity of the industrial markets. For decision makers in manufacturing companies, this complexity has intensified the pressure to develop strategically aligned competitive capabilities that will allow them to qualify for, and to win customer orders before the competitors do (Hill, 1989). In other words, a critical process in attaining competitive advantage is the building of core capabilities (Hayes and Pisano, 1994). In a study of American, European, and Korean firms (Noble, 1995), better performing plants competed on the basis of multiple capabilities. In fact, world class manufacturers are found to excel in more than one of the following characteristics: quality, dependability, delivery, cost, flexibility, and innovation (Minor, Hensley, and Wood, 1994; Swamidass, and Newell, 1987; Ward, Leong, and Boyer, 1994; Schonberger, 1986).

Moreover, a manufacturing firm's choice of competitive capabilities is based on how corporate management sees the role of manufacturing. More specifically, the selection of capabilities for competitive advantage involves the interrelationships between manufacturing strategy, business strategy and other functional strategies. Once, the needed capabilities have been selected, it is essential for all managers to understand how to support the development, maintenance, and renewal of these capabilities in order to effectively achieve the intended outcomes.

The reason for advocating this idea is simple. In developing and sustaining capabilities for competitive advantage, quality management must play a vital role. In a study of Japanese manufacturers, Nakane (1986) suggested that quality provides a solid foundation upon which to build manufacturing capabilities. Likewise, Hall (1987) stated that quality improvement is the first step in the stepwise progression manufacturers should follow to achieve capabilities for competitive advantage. Hall further contends, it would be appropriate to concentrate on quality first. In looking at the issue from a historical perspective, De Meyer, Nakane, Miller, and Ferdows (1989), suggested that Japanese manufacturers started competitive capabilities development in the 1950s and 1960s with examining quality, and later progressed to the other capabilities. Thereby, Japanese manufacturers in the 1980s were focusing on flexibility capabilities, but in the 1990s the Japanese focus is changing to innovation capabilities (Miller and Kim, 1994).

Another study, by Ferdows and De Meyer (1990) proposed that for lasting improvements, manufacturers should sequentially build one capability upon another starting with quality as the foundation for developing competitive advantage. Noble (1995), underscores the importance of quality to manufacturing competitiveness, because the findings by the researcher show that better performing plants often compete with multiple capabilities and see quality as the overall foundation. The results Noble found highlight the importance of projecting quality as the cornerstone of any manufacturing company and the power of quality management practices in building competitive capabilities.

Despite ample literature on total quality management (TQM) techniques, the research effort in investigating TQM in detail, in developing new theories, and testing existing ones is minimal. To date, no comprehensive and systematic examination of TQM relating to manufacturing competitive capabilities has been done or conducted. As Ahire, Landeros, and Golhar (1995) observed, no previous framework has provided a holistic perspective between these two critical variables. In addition, the research has been unbalanced, leaning in favor of concepts and prescriptive writings. Although The Decision Sciences ( 26(5), 1995), The Academy of Management Review (19(3), 1994), and The Production and Operations Management (4(3), 1995) all published special issues in encouraging the development of theories of TQM, none of the researchers investigated the outcomes of TQM implementation, leaving a host of unanswered questions concerning what quality practices should be emphasized by a specific company employing a particular strategy (Salegna and Fazel, 1995).

Therefore, it is essential for manufacturing managers to understand how to master, nurture, and develop the competitive capabilities. This issue is vital because, the poor understanding of the interdependence between quality management practices and competitive capabilities has been the one important reason behind total quality management implementation failures (Salegna and Fazel, 1995). In other words, more empirical studies that develop hypothesis and test relationship between total quality management and manufacturing capabilities for competitive advantage are needed. The primary objective of the present research is to fill this void.

Theory and research cannot be separated since the function of each depend upon the realization of the other (Dubin, 1976). A theory is defined as "a system of constructs and variables in which the constructs are related to each other by propositions, and variables are related to each other by hypotheses" (Bacharach, 1989). Whetten (1989) exemplifies this idea with his with his idea of four components for theory development: (1) what, (2) how, (3) why, and (4) who, where, when. The "what" are factors that should be considered as part of explanation of the phenomenon of interest. The "how" explains the relation among factors. The "why" describes the logic underlying the model. "Who"," where", "when" place parameters upon the generalizability of the theory. According to Whetten, why is the most difficult part of theory development. Why usually embraces borrowing a viewpoint from other fields. Moreover, in addressing real problems of organization, theories look through two distinct goals: understanding, and prediction. Understanding means possessing knowledge about the relationships among the units of a theory and focuses on the process of how the theoretical system operates. On the other hand, prediction focuses on outcomes so that we can describe the future values of the units making up a system in order to anticipate the condition of system (Fry and Smith, 1987).

The quest for understanding and prediction is addressed in this study by developing a new model, borne of three perspectives borrowed from organization theory, organization strategy, and performance. The relationships between total quality management, internal quality performance, and competitive capabilities are examined by employing the theories of the relationship between innovation, performance, and strategy. As Jemison (1981) argues, integration of ideas and findings from different disciplines helps increase our understanding of the phenomena being studied.

Although, there is a large amount of studies in TQM, these studies have not included a strong theoretical foundation (Kaynak, 1997). More empirical research founded on robust theory is needed to explain and predict some behaviors of TQM implementation. By focusing on both the theory of innovation and the relationship between innovation, performance, and strategy, an attempt to explain the strategic value of total quality management practices as management innovation in manufacturing organizations will be made. Furthermore, competitive capabilities is examined from the viewpoint of theories of business strategy, and operations management. Based on this theoretical foundation, the general research question "Are TQM practices positively related to a firm's competitive capabilities?" emerged.

To answer this question, two steps were used. A cross-sectional mail survey research method investigated the research question. Based on the literature review, an instrument for measuring the quality practices and competitive capabilities was developed, and pilot tested with the target population consisting of manufacturing companies located in the United States. The survey requested information from chief officers, managers, quality and plant managers. The identified firms and subjects were found through the roster provided by the American Society for Quality (ASQ). Reliability and validity of the instrument was established with Cronbach's alpha and factor analysis. In addition, total, direct, indirect, and non-causal effects are tested by using structural equation modeling approach.

For researchers, the significance of this study is in terms of its contribution to the research in the quality management field, and its contribution to the research in the general management field. Several authors have pointed out the need for more empirical research (Flynn, Schroeder, and Sakakibara, 1995; Ahire, Gholar, and Waller, 1996; Anderson, Rungtusanatham, Schroeder, and Devaraj, 1995; Meredith, Raturi, Amoako-Gyampah, and Kaplan, 1989; Swamidass, 1991; Walton, and Handfield, 1996), and the need for more sophisticated research designs in the study of the quality management field (Ahire, et al.,1995). By studying the relationships between quality management practices and competitive capabilities with a causal model in an empirical setting, this research aims to fuel the call for more empirical and sophisticated research designs.

In the past, several writers pointed out the narrow scope of the research in the operations management field (Buffa, 1980; Chase, 1980) and argued little has been learned about the relationship between the operations subsystems. Previous researchers emphasized the need to view the operations management field as a whole system rather than a collection of seemingly unrelated subsystems. This narrow focus is still seen in some empirical studies relating to TQM, and the scope of empirical research in TQM has been limited to instrument development for measurement purposes (e.g., Rao, Solis, and Ragu-Nathan, 1998; Ahire, Golhar, and Waller, 1996; Black and Porter, 1996; Flynn, Schroeder, and Sakakibara, 1994, and Saraph, Benson, and Schroeder, 1989).

In comparing TQM practices in the United States with other countries, mostly Japanese companies are the standard (Ebrahimpour and Cullen, 1993; Garvin, 1983; Solis, Rao, and Ragu-Nathan, 1998). However, a few studies stand apart and serve as a model. These are by Benson, Saraph, and Schroeder (1991), who studied TQM in organizational context, and Flynn, et al, (1995) who explored quality management practices and competitive advantage. By examining the antecedent roles of quality management practices and internal quality performance in relation to competitive capabilities, this present study will add significantly to the scope of research in the quality management field.

Contributions to the general management field are derived from the investigation of some of the issues addressed in this study. For instance, Tornatzky and Kleing (1982) note the need for an examination of innovations adopted by organizations to add knowledge to the organizational innovation process. This research reported in this dissertation, contributes to management research by studying TQM as a management innovation in manufacturing firms are expected. As a result of this study, quality management practices as a management innovation can be used more confidently as a strategic weapon by firms to build and sustain competitive capabilities. Finally, by measuring different aspects of internal quality performance and by employing multiple data sources, theory is advanced in the management field.

On the other hand the contribution of this study to practitioners exists in terms of its practical significance. As a starting point, one must understand the needs of the practitioners. Thomas and Tymon (1982), suggest four practitioner needs requiring the attention of researchers: descriptive relevance, goal relevance, operational validity, and timeliness.

Descriptive relevance refers to the validity of research findings in identifying phenomena encountered by practitioners in their organizational setting. By employing a cross-sectional mail survey, several research issues are examined. Furthermore, the current research tests for the validity and reliability of the data collected. In other words, this research is designed such that findings from the study are reliable and valid.

From a theoretical perspective, goal relevance refers to the examination of dependent variables that concern practitioners. In the literature, the dependent variables are identified as more comprehensive set of outcome-related variables in organizational science studies (Thomas and Tymon, 1982). However, Hambrick (1980), suggests the investigation of different strategies in relation to organizational performance is the most useful set of research issues for practitioners. While most studies examined the benefits of TQM at the operational level, few examined the impact of TQM on the bottom line performance indicators, market and financial performance. Although an examination of these benefits is important, the effects of TQM practices on the capabilities that directly generate competitive advantage are more vital for the success and survival of the organization. The need for goal relevance by practitioners is met in this study by examining a comprehensive set of competitive capabilities as well as three important internal quality performance measures (dependent variables).

Operational validity relates to the ability of a practitioner to apply action indications of theory by manipulating independent variables. Sufficient evidence in the literature exists verifying that TQM can be implemented successfully in organizations (Steeples, 1992; Juran, 1994; Ansari and Modarress, 1990; Cortada and Woods, 1994). If this study indicates a significant relationship between TQM and competitive capabilities, then a firm can improve its abilities and skills to achieve superior competitive position in relation to its competitors by effectively managing total quality.

Finally, the need for timeliness is satisfied when a theory is available to practitioners solve problems. Though some companies have implemented TQM successfully, the literature suggests that many firms are struggling with the implementation of this technique. The findings of this dissertation reveal patterns of implementation of this technique in successful firms, and provide suggestions to solve implementation challenges for improving the competitive capabilities and overall business performance of firms.

In summary, the research presented in this dissertation assists those seeking a greater understanding of the dynamics underlying the relationship between quality management practices and competitive capabilities. This issue is addressed by proposing, and extensively testing a research framework to explore the direct relationship between quality management practices and competitive capabilities, as well as the mediating role of internal quality performance factors. The importance of this research involves the possibility to improve the performance and competitiveness of manufacturing firms. The outcomes will help to increase the understanding of manufacturing managers about the interdependence between quality management practices and competitive capabilities and identify the quality factors critical for achieving and sustaining competitive advantage. For researchers, this study aids in developing and testing theory, and makes a significant contribution to the empirical quality literature by studying a segment of the American manufacturing industry.

A literature review and theory development are presented in the next Chapter. The research methodology for generating items for the measurement instrument appears in Chapter 3. In addition, Chapter 3 presents preliminary assessment of construct validity through a pilot study (Q-sort method). Chapter 4 describes the large scale sample and the results for instrument validation using exploratory factor analysis. Chapter 5 presents the exploratory structural analysis, the causal model, and the hypothesis testing. Finally, Chapter 6 highlights the contributions of this research and provides a discussion and recommendations for future research.

# CHAPTER 2

# LITERATURE REVIEW AND THEORY DEVELOPMENT

In this chapter the research model which describes the relationships between quality management practices, quality performance, and competitive capabilities as well as the research framework leading to the model are developed and presented. Quality management practices are conceptualized as an integrated and interfunctional means to create and sustain competitive advantage. Quality management practices comprise a set of management, employee, customer, product/process, supplier and information based practices. The competitive capabilities of a firm are characterized in terms of value to customer, pricing, delivery and innovation. The research model posits that the quality management practices are expected to result in improved quality performance and increased competitive capabilities.

Figure 1 illustrates the proposed framework for quality management practices and its effect on internal quality results and competitive capabilities. The box at the left depicts the quality management practices which are expected to have both a direct effect on competitive capabilities and an indirect effect, through their impact on internal quality performance. Internal quality performance measured in terms of quality failures, manufacturing cost, and led-times is shown in the box in

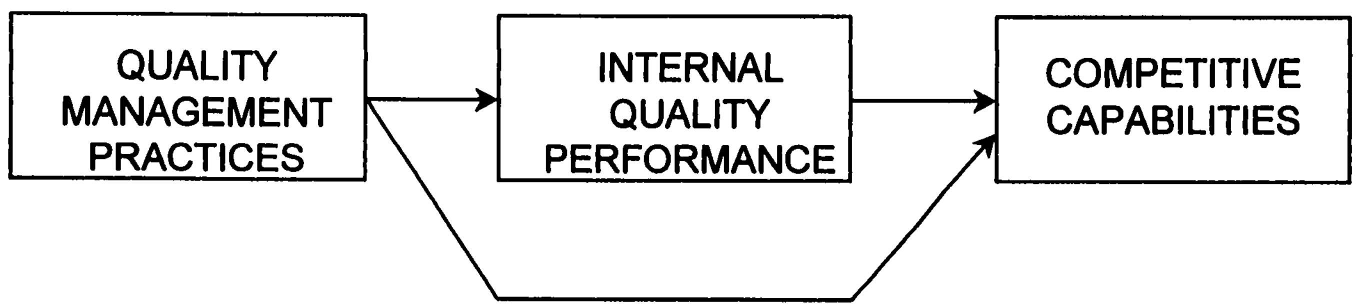


FIGURE 2.1. QUALITY MANAGEMENT AND COMPETITIVE CAPABILITIES RESEARCH FRAMEWORK

the center. Internal quality performance measures are expected to have a direct effect on competitive capabilities. The box at the right represents the competitive capabilities.

As seen, the model focuses on the relationship among three constructs: (1) quality management practices, (2) internal quality performance, and (3) competitive capabilities. The model suggests that quality management practices affect directly and indirectly the achievement of manufacturing competitive capabilities.

This chapter consists of five sections: (1) a theoretical foundation for this study presented through a literature review on innovation, strategy, performance and a summary of TQM as a management innovation; (2) an examination of the empirical literature on the impact of TQM has on competitive capabilities and performance, and a review of the empirical scales developed to measure TQM; (3) an extensive literature review of TQM including a historical development of the field describing the key characteristics and components of TQM; (4) an analysis of the competitive capabilities literature and a discussion of the relationship between TQM and competitive capabilities; and (5) hypotheses relating to the main effects of TQM based on a proposed research framework.

## 2.1 Innovation, Strategy, and Performance

In order to establish the theoretical foundation that total quality management is a managerial innovation that can be used to develop and sustain strategic capabilities for competitive advantage, a review of the literature about innovation, strategy and organizational performance ensues.

**Innovation**

A considerable quantity of literature on innovation exists, but minimal agreement on the definition of innovation, on types of innovation, or on the innovation process (Kaynak, 1997) is available. The main disagreement over the definition of innovation relates to the generation of ideas for the first time in studying organizations. One school of scholars defines innovation as the generation, acceptance and implementation of new ideas, processes, products or services for the first time within an organizational setting (Pierce and Delbecq, 1977; Thompson, 1965). Another party of scholars does not include the generation of ideas in defining innovation but considers any new practice or concept as an innovation (Van de Ven, 1986; Rogers, 1983; Damanpour and Evan 1984). The second definition approximates how the present research understands innovation: "the implementation of an internally generated or a borrowed idea -whether pertaining to a product, device, system, process, policy, program, or service- that is new to the organization at the time of adoption" (Damanpour and Evan 1984).

Moreover, the diversity in classifying types of innovation is even more complicated. On one hand, several researchers classify the types of innovation as either technological, managerial, or ancillary (Damanpour, 1987; Aiken, Bacharach, and French, 1980; Kimberly and Evanisko, 1981). Technological innovations involve changes in the technology of the organizations. Managerial innovations relate to changes in organization's structure or its management processes. Ancillary innovations are organization-environmental boundary innovations.

However, a different taxonomy classify innovations as radical or incremental

(Dewar and Dutton, 1986; Ettlie, 1983; Ettlie, Bridges, and O'Keefe, 1984). Radical innovations require fundamental changes in technology, whereas incremental innovations are small or simple changes in the existing technology. The main difference between radical and incremental innovations is the degree of knowledge contained in the innovation (Dewar and Dutton, 1986). Normann (1971) identifies radical innovations as reorientation innovations, and incremental innovations as variation innovations.

Furthermore, innovations have also been classified by their associated risk level as either being low and high (Kaluzny, Veney, and Gentry, 1974). High-risk innovations bring high payoff, high clarity of results, and high association with major activities of the organization. Low-risk innovations bring low payoff, low complexity, low clarity of results, and low association with the major activities of the organization.

In addition, Knight (1967) proposed a taxonomy based on four categories of innovation: product or service innovations, production-process innovation, organizational structure innovation, and people innovations. Product or service innovations are new products and services which the organization provides. Production process innovations are those pertaining to the organization's task, decision, and information systems, or its physical production or service operations, and the advances in the technology of the company. Organizational-structure innovations are related to changes in work assignments, authority relations, communication systems, or formal reward systems in the organization. People innovations produce direct changes in the people within the organization.

Although there are numerous taxonomies of the innovation process, scholars agree the innovation process starts with an awareness of the innovation (Becker and Whisler, 1967; Knight, 1967; Meyer and Goes, 1988). Knight (1967) described the innovation process in an organization as consisting of two stages: the creation and development of the idea, and the introduction and adoption of the idea. Becker et al. (1967) proposed four stages in the innovation process: (1) stimulus, (2) conception, (3) proposal, and (4) adoption. Meyer and Goes (1988) used the term assimilation for the innovation process and divided the process into three stages: (1) the knowledge-awareness stage, (2) the evaluation-choice stage, and (3) the adoption-implementation stage. As a summary, the classification of innovation by Knight provides guidelines for all classifications. What can be concluded are two distinctive stages are common in all innovation processes: awareness of the innovation, and implementation and adoption of the innovation.

An examination of the relationship between innovation and business strategy through the link between innovation and competitive advantage reveals four correlating factors (Lengnick-Hall, 1992): (1) capitalizing on the strategic configuration, (2) making product/market choices emphasizing high value factors and excluding both low value factors and excessive differentiation, (3) capitalizing on industry-specific timing advantages, and (4) nurturing the specific organizational capabilities enabling the firm to exploit the results of innovation activity. Although Lengnick-Hall sees the role of product quality and the buyer/supplier relationship in innovation and competitive advantage; the emphasis is on the relation of product and technology innovation to competitive advantage rather than the linkage of management innovation to competitive advantage. Despite the strengths of the research by Lengnick-Hall, it would be advantageous to see TQM as a management innovation that facilitates the achievement of strategically needed capabilities to achieve competitive advantage (Kaynak, 1997).

Subsequent evidence will show that with the implementation of TQM techniques, changes will occur throughout the organization, making the classification of these practices (e.g., technological or administrative) difficult. According to Gerwin (1988), innovations in manufacturing processes in the long run protects the technical core from uncertainties. Whether the innovations are seen as manufacturing process innovations or administrative innovations, the literature documents an adoption of TQM techniques by organizations as strategic tools to improve competitiveness. Moreover, innovative organizations are both adaptive and reactive to the particular environments. These organizations use their resources and skills in response to the environments to improve organizational performance.

Furthermore, the role of innovation in supporting the achievement of significant improvements in the capabilities of an organization were discussed by Schroeder, Scudder, and Elm (1989). That research found managers look at quality improvement programs (e.g., employee involvement, supplier partnership, etc.) for generating and implementing new ideas to enhance organization's competitive capabilities. Despite the recognition of the importance of innovation for organization's competitiveness, a lack of research on the innovation-strategic outcomes link exists (Schroeder, 1990).

The following section reviewing literature about organizational strategy will, in greater detail, discuss the strategic value of TQM.

**Strategy**

An examination of the literature of strategy research shows two distinctive camps: strategy process and strategy content. The literature about strategy process deals with strategic planning process and models. Whereas, the literature about strategic content examines strategy types (Adam and Swamidas, 1989). For this research, advocates of strategic content are more relevant since TQM is investigated as a strategic type.

Kotha and Orne (1989) identified four levels of strategies which influence competitiveness: industry level strategy, corporate level strategy, business level strategy, and functional level strategy. Industry level and corporate level strategies are beyond the scope of this study, and therefore not discussed. Business strategy is the development of a set of well-coordinated action programs meant to achieve long-term sustainable competitive advantage (Hax and Maijuf, 1984). The fourth level, operations strategy, refers to the strategy for an operation functions of an organization.

In achieving competitive advantage Porter (1980, 1985) proposes three generic competitive strategies: cost leadership, differentiation, and focus. Companies looking to achieve competitive advantage through cost leadership, are employing varied operational and tactical approaches: economies of scale, proprietary technology, preferential access to raw materials and other cost reduction techniques. Firms pursuing a differentiation strategy position products/services as being unique in the respective industries. Business that follows a focus strategy chooses a segment of the industry and adjusts strategies to serve only those markets. In conclusion, Porter(1980,1985) argues a firm cannot achieve cost leadership and differentiation at the same time because differentiation is costly.

Galbraith and Schendel (1983) empirically identified various strategy types in the consumer and industrial markets. In the consumer market the researchers identified six strategy types: harvest, builder, continuity, climber, niche, and cashout. In the industrial market four different strategies were identified: low commitment, maintenance, growth, and niche. Moreover, these findings point out that performance differs with strategy type and that important trade-offs between performance occur contingent to strategy and competitive capabilities.

In a study of manufacturing firms, Richardson, Taylor, and Gordon (1985) identified six types of manufacturing strategies: technological frontiersmen, technology exploiters, technological service people, customizers, cost-minimizing customizers, and cost minimizers. Richardson et al. (1985) also observed that manufacturing strategy was contingent to business strategy.

From the perspective of relative cost and differentiation, White (1986) identifies four generic strategies: pure cost describes organizations with both low cost and low differentiation; pure differentiation describes firms with high differentiation and high cost; high cost and low differentiation describes firms with no competitive advantage; and low cost and high differentiation is seen as the ideal strategy. White findings suggest the highest return on investment is achieved by firms with a cost and differentiation strategy. However, the highest growth on real sales is achieved by firms with pure differentiation strategies. Also White contends managers should put greater attention to the factors impacting specific business strategies that differentiation strategies require: creativity, innovation, flexibility, quality, availability, and delivery.

A synthesis of the strategic grid of Porter and process-product matrix of Hayes and Wheelwright's by Kotha and Orne (1989) resulted in eight distinctive manufacturing strategies. The assumptions of this synthesis emphasize cost reductions to achieve leadership in cost and the creation of unique products or services to achieve differentiation leadership. In addition, the three primary dimensions of manufacturing strategies are process structure complexity, product line complexity, and organizational scope.

Parthasarthy and Sethi (1992) offered a different perspective to business strategy. The researchers suggest three business strategic options: cost leadership, quality leadership, and flexibility. However, Miller and Roth (1994) identify three different types of manufacturing strategies; caretakers, marketers, and innovators. Also, Miller and Roth suggest market differentiation and market scope determine the differences among their strategy types.

While Porter(1980, 1985) argues that a firm cannot achieve cost leadership and differentiation at the same time, Ferdows and De Meyer (1990) suggest that the implementation of TQM enhances the possibilities for firms to simultaneously pursue cost and differentiation strategies. The basic concept behind the model of Ferdows and DeMeyer concerns competitive capabilities. The researchers argue synergy between manufacturing capabilities results in lasting improvement in competitive advantage. Further, the first step in building cumulative and lasting manufacturing capabilities is to focus on quality. In addition, while efforts to improve quality continue, attention is required to enhance the operational dependability of a firm. Once the foundation for quality and dependability has been established, management should pay attention to increasing flexibility. Thereby, management can focus attention to cost efficiency and still increase efforts to enhance quality, dependability, and flexibility capabilities.

In summarizing the different strategy types the purpose of adopting specific strategies is to achieve a superior competitive position to increase market share and profitability. Specific strategies must be able to reduce costs or be able to differentiate the product/service. In other words, capabilities and strategy must be aligned if competitive advantage is to be achieved. The adoption of TQM as the foundation to build competitive capabilities, enables firms to reduce costs and differentiate products. As discussed later in the chapter, through the implementation of TQM, firms realize enhanced product quality and reduced costs (Schonberger, 1992). In the next section, the literature on competitiveness and performance in the operations management literature is reviewed.

## Performance

The literature of operations management examines performance from the operations strategy perspective (Kaynak, 1997). Traditional performance measure of operations strategy include quality, delivery, flexibility, and price or cost (Nemetz, 1990; Roth and Miller, 1990). Recently, scholars started to examine the relationship between operations performance and business strategy, with particular attention given to the impact of manufacturing capabilities on business performance.

Different researchers have focused on particular aspects of manufacturing competencies and its relationship to performance. Zahra and Das (1993) examined the relationship between innovation capabilities and average net profit margin, average growth in sales, and return on assets. The findings indicated innovation capabilities are positively related to business performance. Parthasarthy and Sethi (1993) focused on the moderating role of strategy-structure fit on the relationship between flexibility and performance, and converged the objective data with the secondary data and found close agreement. In a different study, manufacturing proactiveness was suggested to have significant relationships with performance (Ward, Leong, and Boyer (1994).

In addition, the importance of manufacturing capabilities to achieve superior performance was supported by Swamidass and Newell (1987) study of the relationship between manufacturing strategy, environmental uncertainty, and performance. The researchers found that there is a significant relationship between manufacturing flexibility and business performance in both stable and unstable environments. Moreover, the role of manufacturing managers in strategic decision making, was found to be the only significant factor related to business performance in stable environments. In another study, Cleveland, Schroeder, and Anderson (1989) suggested that a relationship exists between manufacturing competence and performance. A positive relationship between production competence and performance was found in an empirical study conducted by Vickery, Droge, and Markland (1993). They concluded that in achieving market success, manufacturing capabilities in quality, customization, service, and/or speed are becoming increasingly important. Relevant to the present study is the content of the manufacturing competence measures including cost, quality, dependability, and flexibility. The next section presents a discussion of the empirical TQM literature in terms of its impact and contributions to TQM measurement.

## 2.2 TQM Impact and Scales Development: Empirical Contributions

During the last decade a growing interest in empirical research in TQM emerged, with scale development and TQM outcomes receiving predominant attention. To date, most empirical studies conclude total quality management produces value, and several measurement scales were proposed for TQM constructs and outcomes. A brief description of the relevant empirical research on TQM impact and scales development follows.

### Empirical Studies on TQM Impact

Only two empirical studies focused on the relationship between quality management and competitive advantage (Flynn, Schroeder and Sakakibara, 1995; Powell, 1995). Flynn et al., found a significant relationship between the two variables. However, the set of quality management practices included in Flynn et al. was limited, and the conceptualization of competitive advantage too narrow in scope. Quality management factors such as benchmarking, strategic quality planning, quality information availability, quality information usage, customer orientation were not considered. Also, the conceptualization of competitive advantage by Flynn et al. did not include core capabilities' product innovation, competitive pricing, premium pricing, and value to customers. The Powell study examined TQM as a potential source of sustainable competitive advantage, and suggested most features generally associated with TQM do not produce advantage, but only certain features produce advantage.

Other attempts to empirically relate the use of certain quality management practices to quality performance and to the overall performance by the organization are by Garvin (1984) who studied quality practices and performance in the room air conditioner industry, and Roth, DeMeyer, and Amano (1990) who compared the relationship of various quality practices to quality performance in the U.S., Europe and Japan. In both studies, superior levels of quality practices yielded superior quality and business performance. Roth and Miller (1992) found quality programs a strong predictor of manufacturing strength. In addition, Solis, Rao, and Ragu-Nathan (1996) studied the impact of quality management practices on quality performance in 257 U.S. manufacturing companies, and found a positive relationships between the two constructs. In 1983, *The Union of Japanese Scientists and Engineers* published a study of Japanese companies that won the Deming Prize between 1961 and 1980. The findings concluded the winning firms maintained above-average long-term performance, as measured by earnings, productivity, growth rates, liquidity, and worker safety.

Furthermore, *The Conference Board* (Hiam, 1993), a New York business research group, studied the quality practices of large U.S. corporations. Out of 800 surveys mailed, 149 responses were returned and reported 111 (74.5%) had quality initiatives. Over 30 percent stated TQM improved company performance, and less than 1 percent experienced performance declines as a result of TQM. In 1989, *The*

*Gallup Organization* surveyed 600 senior executives for *The American Society for Quality*, and reported 54 percent of respondents were at least pleased with company's quality efforts, and half respondents claimed significant performance impacts. In 1991, the U.S. Government General Accounting Office (GAO), produced a study of 20 highest-scoring applicants for the 1988 and 1989 Baldrige Awards. The GAO reported that these firms achieved better employee relations, improved product quality, lower costs, and improved customer satisfaction.

Later, Arthur D. Little Corporation produced an in-house report of 500 large U.S. firms in which 93 percent of the respondents claimed to have some form of TQM, 35 percent reported TQM efforts have had significant performance impacts, and 62 percent expected significant impacts over the next three years. However, the most widely-cited TQM research project to date is the *International Quality Study* (American Quality Foundation, 1992), that studied the TQM efforts of over 500 automotive, computer, banking, and health care organizations in the U.S., Canada, Germany, and Japan. That study found some TQM practices -particularly process improvement and supplier certification - did improve performance -but the performance of the remaining TQM practices varied depending on the firm's stage of TQM advancement. Besides these studies, there exists a General Securities fund that trades only in stocks of firms that adhere to the TQM philosophy. This fund matched the performance of the Standard & Poor's 500 and Morningstar awarded a 4-star rating for its 5-year performance. In 1993, *Business Week* examined the stock performance of 10 Baldrige winners, and reported if a person invested equal amounts in each Baldrige winner, the stocks would have appreciated a cumulative

89.2 percent since 1988, compared to 33.1 percent for the Standard and Poor's 500. In sum, most existing empirical studies concluded TQM produces value. However, the question is not resolved since most research did not conform with accepted standards of methodological rigor (Powell, 1995).

**Empirical Scales Developments in TQM**

During the last decade, a growing number of attempts to synthesize frameworks for measuring quality management practices occurred. The pioneer study of Saraph, Benson, and Schroeder (1989), used 20 companies of the Minneapolis/St. Paul area, developed and empirically tested a quality management instrument and identified eight critical factors of quality management. In a study of 75 plants from the industries of electronic, transportation components, and machinery across the USA, Flynn, Schroeder, and Sakakibara, (1994) developed and validated an empirical framework consisting of 7 quality dimensions and 11 constructs. In another study, Ahire, Golhar, and Waller (1996) identified 12 constructs of integrated quality management strategies, and the scales validation was based on the vehicle parts and accessories industries located in the Midwest. Black and Porter (1996) identified 10 critical factors of TQM based on the Malcolm Baldrige framework, for members of *The European Foundation for Quality Management*. Overall the scales were proved valid and reliable. Rao, Solis, and Ragu-Nathan (1998) developed a research instrument of thirteen scales, tested the scales across five countries, and found the scales to be valid and reliable.

Yet, the empirical research in TQM remains limited and premature, and theory building efforts based on empirical research in TQM are still needed

(Kaynak, 1997). In the next section, TQM development, characteristics, and values are presented.

## 2.3 Total Quality Management Literature Review

In the first part of this section, a historical development of TQM is presented. The content and value of TQM are discussed in the second part.

### TQM Evolution

Concepts of quality can be traced to the craft guilds of the Middle Ages. However, the scientific approach to improved quality began with the railroad management and with the advent of modern statistical methods in the early part of the twentieth century. To be specific, the historical development of TQM can be traced over different periods of evolution. Some authors identify three periods in this evolution process: quality control, quality assurance, and total quality management (Steeples, 1992). Other authors propose a four stage evolution: inspection, statistical quality control, quality assurance, and strategic quality management (Garvin, 1988). In the early 1800s, the development of the rational jig, fixture, and gauging system, proved a turning point in quality control science. In the early 1900s, Frederick W. Taylor legitimized inspection activities when he assigned a task to the functional foreman. In 1922, G.S. Radford published "The Control of Quality in Manufacturing" that argued the quality function became a separate management responsibility and function (Garvin, 1988). Walter A. Shewhart, laid further the groundwork during the 1920s. Pioneering work in statistical quality control was done by Shewhart for Bell Telephone Laboratories. Shewhart recognized the natural existence of variability in industrial processes and showed that variability could be understood by using principles of probability and statistics.

Later, W. Edward Deming, Joseph M. Juran, Harold Dodge, Harry Romig, refined and broadened the usefulness of the techniques Shewhart developed. In the early 1940s, the U.S. Department of War converted quality theory into a practical means for fighting World War II. A committee was established to maintain quality standards classified under the name Z-1 in the United States and Standard 600 in England. The main focus was the development and use of control charts that were published in 1941 and 1942. As a result, a new set of sampling tables based on the concept of acceptable quality levels was developed. In 1946, *The American Society for Quality Control* was formed and became a prominent professional society in the quality science field (Garvin, 1988).

After World War II, Japan experienced a quality crisis worse than the one suffered by the U.S. industry during the 1980s and early 1990s. An interesting connection exists in that fact. U.S. occupation of Japan prescribed the use of statistical methods to help Japan rebuild its industries. To reconstruct the economy, the Japanese set out to improve quality. During the 1950s, Japan enlisted the help of Dr. Deming and Dr. Juran. Specially, Japanese shown great attention to quality control methods Deming proposed. Japanese senior managers began to master total quality control and integrate a broader management philosophy of quality values throughout all business activities. Starting in 1946, with the formation of *The Union of Japanese Scientists and Engineers* (JUSE), coordinated and guided the effort. The Japanese attributed industrial success to the teachings of Deming and institutionalized a Deming Prize Award, for companies that made outstanding contributions to product quality and dependability (Hunt, 1993).

In 1960, the first quality circles were formed to promulgate quality improvement. Japanese workers learned and applied simple statistical techniques. During the 1970s Japanese quality matched Western quality as Japanese products flooded the marketplace. By the late 1970s, Japanese electronics and autos made considerable inroads into major U.S. markets. By the early 1980s, U.S. managers made frequent trips to Japan to tour plants with defects levels 500 to 1000 times lower than U.S. counterparts (Steeples, 1992). Given the 20-year head start, Japanese companies developed a strong lead in the race for improved quality and continue efforts for improvement by systematically applying TQM principles.

However, the beginning of strategic use of TQM in the United States cannot be precisely documented (Garvin, 1988). It appears that in the late 1980s companies adopted TQM practices as a strategy to withstand competitive pressures from foreign competitors (Besterfield, 1990). As a result, American businesses made dramatic quality improvements, with more than 87 percent of the largest industrial corporations expanding quality improvement initiatives since 1987.

In the next section, the critical dimensions of TQM are identified and examined. Then empirical studies on the measurement of TQM implementation and on various aspects of TQM practices are presented.

## Quality Management Definition and Orientations

Total quality management is an integrative management philosophy aimed at always improving the quality of products and processes to achieve a competitive advantage. What constitutes TQM differs across organizations and quality proponents. However, major characteristics exist that provide a unifying theme to the variety of programs under the rubric of TQM. An agreement is apparent among the quality movement founders and principal spokesmen (e.g., Crosby, 1989; Deming, 1986; Ishikawa, 1985; Juran, 1988) regarding fundamental philosophy, assumptions, and recommended practices (Hackman and Wageman, 1995). In addition, a fundamental shared characteristic of the TQM approach is an emphasis placed on preventing rather than detecting defective products or inadequate services (Cardy, Dobbins and Carson, 1995; Walton, 1986). Another fundamental characteristics of TQM perceives customer satisfaction as a driving force behind work processes (Cardy and Dobbinns, 1996). Thereby ,the internal or external customer of the product or service becomes the focus of determining standards and for measuring performance. Another important characteristic of the TQM approach is continuous improvement. In general, TQM organizations are dynamic and constantly striving to improve. A final characteristic is that people are naturally motivated to do a good job and improve quality (Hackman and Wageman, 1995).

Yet, the universal definition of quality has yielded inconsistent results. Different definitions of quality are appropriate under different circumstances (Reeves and Bednar, 1994). Relevant to this study is the quality management definition provided by Flynn et al. (1994): "TQM is an integrated approach to achieving and sustaining high quality output, focusing on the maintenance and continuous improvement of processes and defect prevention at all levels and in all functions of the organization, in order to meet or exceed customer expectations."

The quality management literature exhibits different orientations: overview, conceptual, case study, empirical, analytical, and simulation. Overview articles present a holistic treatment of all TQM aspects reflecting its integrative approach to managing quality (Aggarwal, 1993; Becker, 1993; Cole, 1992; Drayton, 1991; Easton, 1993; Flynn, 1992; Garvin, 1991; Madu and Kuei, 1993; Tillery, Rutledge, and Inman, 1993; and Zairi, 1993). For example, Garvin examines the various aspects of the Baldrige criteria, providing insight into the overall process assessing an applicant organization and discussing each of the seven areas in depth. Overview articles range from insights into the Baldrige criteria (Garvin, 1991; Easton, 1993), comparison of Japanese versus U.S. quality practices (Ebrahimpour, 1985; Handfield, 1989; Flynn, 1992), comparison of the quality approaches proposed by the quality management gurus (Kathawala, 1989), linkages of TQM to an organization's strategic position (Madu and Kuei, 1993; Zairi, 1993), practices of TQM in American firms (Kano, 1993; Price and Chen, 1992), coverage of TQM in production or operations management textbooks (Tillery, Rutledge, and Inman, 1993), and philosophical discussions of TQM (Robinson, et al. 1991; Cole, 1992; Singhal and Hayes, 1992).

Furthermore, conceptual articles include topics such as prescriptive models and methods for implementing TQM and opinions of researchers on various aspects of TQM. Conceptual literature dominates the published TQM research (Juran, 1993; Ross, 1991; Sloan, 1992; Suresh and Meredith, 1985; Tillery and Rutledge, 1991; Water and Vries, 1992; Zeithaml, 1988). In addition, case studies present detailed studies of a few organizations (Ciery, Sampson, and Sohal, 1991; Garvin, 1993;

Kumar and Gupta, 1993; Lascelles and Dale, 1989; Modarres and Ansari, 1990; Voss, 1992). Also conceptual and case studies account for most of the quality literature which is consistent with the fact that TQM has been recognized only recently as a powerful competitive strategy (Madu and Kuei, 1993).

However, more recently, researchers have started using empirical studies to examine TQM implementation (Flynn, Schroeder, and Sakakibara, 1995; Rao, Ragu-Nahan, and Solis, 1996, 1995; Solis, Rao, and Ragu-Nahan, 1995; Benson, Saraph and Schroeder, 1991; Ebrahimpour and Lee, 1988; Garvin, 1984, 1986; Benson, Saraph, and Schroeder, 1991). It is important to note that the nature of empirical research requires the availability of broad databases for theory and model testing, and since TQM is a long-term, ongoing program with real payoffs accruing years after implementation (Erickson, 1992) the empirical quality literature is just starting to be generated (Roth and Miller, 1992; Saraph, Benson, and Schroeder, 1989; Schroeder, Sakakibara, Flynn, and Flynn, 1992; Ferdows and Demeyer, 1990; Rao, Raghu-Nathan, and Solis, 1997; Solis, Rao, Ragu-Nathan, Chen, and Pan, 1988).

Another area, the analytical literature, focused on analytical modeling of various aspects of TQM (e.g., cost models) (Karp and Ronen, 1992; Pignatiello, 1988; Tosirisuk, 1990; and Wacker, 1989). Moreover, simulation articles focused on simulated experiments (Knight, Beningfield, and Kizzort, 1987). Overall, few articles have been published in the last two categories. One reason for the infrequency could be the complex interaction of technical and human processes at both micro- and macro-levels of management (Ahire, et al. 1995).

As seen from the discussion of the quality field, the TQM body of knowledge remains in the infant stage of developing a theoretical and empirical base. Most research of TQM has emerged from practical needs of organizations embracing this philosophy, whereas the quality management literature is mostly practitioner-oriented and conceptual. Total quality management applications now preceded the theoretical framework (Griffin, 1988). The following sections are devoted to a discussion of quality management practices and internal quality performance.

## Quality Management Content: Critical Factors

In this research a taxonomy framework developed by Salegna and Fazel (1995) was used to develop the analysis of the content and scope of quality management. By focusing on the quality management practices primary area of implementation, Salegna and Fazel proposed the following quality management practices categories that will be used in this analysis: (1) management based; (2) employee based; (3) customer based; (4) information based; (5) product/process based; (6) and supplier based. A detailed description of each category is presented below.

### *Management Based Quality Practices*

Management based quality practices are based on two critical components, top management support and strategic quality planning (Fuch, 1993). Without top management support and organizational strategic intent, TQM initiatives will not possess any significant impact on the building of organizational capabilities for competitive advantage.

*Top Management Support*

Top management support has been identified as one major determinant of successful quality management. The reason for its identification is that top management support plays a critical role in how quality values are projected, and how adoption of the values through the company are determined and enforced. This critical role was illustrated in Asahi Breweries Ltd., Japan (Nakajo and Kono, 1989, Xerox, Inc., U.S.A. (Kennedy, 1989), Dunlop, Ltd., Malaysia (Fah, 1988), and Dow-Corning Pvt. Ltd., Australia (Chapman, Clarke, and Sloan, 1991). Both practitioner and empirical quality literature acknowledged the importance of top management involvement for the getting in action the quality practices, and in the achievement of higher levels of internal and external quality performance (Puffer and McCarthy, 1996; Steeples, 1992; Crosby, 1979; Deming, 1982, 1986; Garvin, 1983, 1984; Juran, 1986; Leonard and Sasser, 1982; Gilbert, 1990; Gibson, 1990; Gryna, 1991). Moreover, top management drives quality management by formulating clear quality values and goals. In addition, through the implementation of management systems top management guides all activities of the company to satisfy customer expectations and to improve on organization's performance. The message is a simple one. Clarity of quality goals for an organization determines the effectiveness of quality efforts (Senge, 1990; Stalk, Evans, and Schulman, 1992). In other words, support for quality should convey the philosophy that quality will receive a higher priority over cost or schedule, and in the long run, superior and consistent quality will improve strategic competitive capabilities (Ferdows and Demeyer, 1990; Krajewski and Ritzman, 1993; Garvin, 1984).

Furthermore, top management support should not be reflected in formal statements declaring the quality vision and company mission, but by providing adequate resources to the implementation of quality management efforts through considerable investment in human and financial resources (Chapman, Clarke, and Sloan, 1991). In projecting a tota7l commitment for quality and installing organizational mechanisms ensuring top management support, performance assessment for plant managers and corporate executives should also include the quality dimension (Chase and Aquilano, 1992).

*Strategic Quality Planning*

Improving quality is a long-term competitive strategy (Barclay, 1993; Lascelles and Dale, 1989; Peters, 1988; Juran, 1986; Deming, 1986; Tillery and Rutledge, 1991). It requires developing a quality culture which is a lengthy process. Given the time factors, organizations must plan the process for achieving quality and integrating quality improvement planning into the overall business plan. Although companies often seek immediate benefits from the start of a quality improvement process, a long term focus is a greater objective. In a study, *The American Quality Foundation and Ernst & Young* (1992) found in the United States, Canada, Germany and Japan strategic quality planning had significant effects on organizational performance measures. A strategic view of quality leads to: (1) the integration of quality management and customer satisfaction in the organizational strategic and operational plans; (2) long term quality vision of the organization; and (3) the deployment and understanding of quality goals and policies throughout entire organization.

***Employee Based Quality Practices***

Quality can be achieved through the effective management of people. However, the average worker gives less than 20% of his potential (Choppin, 1991). In contrast a study of Baldrige companies found these companies integrate a set of practices involving people "skills" to meet customer and process requirements. In fact, Powell (1995) found that employee related practices were one feature of TQM organizations that produced competitive advantages. Moreover, employee based quality practices seeks to increase employee knowledge, employee involvement, employee empowerment, inform employees, and reward employee's contributions to improved quality performance (Lawrence, 1986; Knouse, 1995; Prince, 1994; Steeples, 1992; Powell, 1995).

*Employee Training*

More than any other factors, human resources are the most important in determining the long term success of the quality management firm (Edwards, Collinson, and Rees, 1998). Moreover, training workers to reach full potential is critical in an economy dependent upon knowledge as for competitiveness and for survival. Usage of a knowledge by workers makes training a fundamental requirement to achieve world-class status (Chen, 1997). Training in quality related concepts and tools are prerequisites for the effectiveness of quality improvement activities, employee involvement and employee empowerment. In addition, knowledge of the basic quality concepts and principles facilitates understanding of the quality relevant issues and provides a common language for cross-functional team problem solving. Numerous case studies documented the linkage between training and different measures of performance by an organization - productivity, product quality, process quality, costs, implementation of advanced manufacturing technologies, etc. The impact of training is experienced at the individual level in the form of tangible (training can help workers move ahead in the company) and intangible benefits ( higher self-esteem and greater confidence, more satisfaction from their work, and a feeling of greater attachment and loyalty to the company). Also, quality training provides a new way to manage, improve the whole organization, and a new perspective to manage and improve the individual workplace. Another key component is that training produces a deep change in employee attitudes. The reason is that without such a change, quality management would remain an utopian idea (Galgano, 1994).

*Employee Involvement*

Another important component of all total quality management programs is employee involvement. In order to increase company performance, organizations need to change the internal processes and management systems to involve all employees in problem solving, decision making, and enhancing financial success. Furthermore, the basic idea behind involvement is employees' control of the work and participation in the business of the organization. Specifically, employee involvement encompasses a range of policies: permitting suggestions of improvements, giving employees the ability, motivation and authority to improve organizational operations. When frontline employees are provided with the skills, motivation, and the appropriate environment productivity and moral increased. One extraordinary example that illustrates the potentials of successful employee involvement the NUMMI case study (Lawler III, Morhman, and Ledford Jr., 1992). NUMMI was a joint venture between GM and Toyota, concerning an old GM plant plagued with serious problems of low quality, high absenteeism, and very poor labor relations. Despite initial difficulties, employee involvement was established and maintained at NUMMI. Work teams planned job rotation, balanced assignments to equalize workloads, and engaged in continuous improvement of the job safety, quality, and efficiency. During the first few years workers-hours per car was reduced by approximately 40 percent, sat atop U.S. autoplants quality, and enjoyed the lowest absenteeism of any U.S. plant. More than any actor employee involvement provides a coherent structure to support changes in work organization, improves productivity and profitability of business enterprises, and creates more rewarding jobs for the workforce.

*Employee Empowerment*

Today workers are a key factor of production determining the competitive advantage. People are the creative source for new ideas and innovation. In order to tap into this resource, successful quality companies not just train and involve employees, but also empower them. Many researchers attempted to provide a concise definition of employee empowerment. The definition adopted for this study is based on the successful experiences of companies that implemented the concept. Empowerment gives the workers the authority to do what is necessary to solve quality related problems and please their customers. Employee empowerment involves a great deal of trust. Without trust it cannot be expected of human imagination to pursue value-added activities (Kinlaw, 1995).

*Employee Reward and Recognition*

An essential component of employee based quality practices is recognition. Recognition is the public acknowledgment of success and when managed appropriately a high effective motivating tool. Several researchers acknowledged the importance of recognition for total quality management to succeed (Powell, 1995; Knouse, 1995). In a TQM environment, recognition plays three important functions: an indicator of performance, a feedback tool, and a way to show appreciation for effort by the organization.

In actuality, the roots of understanding recognition emerged from behavioral psychology. Behavioral psychologists define reward as anything that increases the frequency of behavior (Skinner, 1969). In a TQM environment rewards are used to:

(1) Improve behaviors by working in teams, using TQM tools, solving quality problems and interacting with internal and external customers.

(2) Improve TQM culture. The reward system reflects the corporate philosophy and cements employee commitment to organizational values. In fact, reward serves to internalize organizational values. Then, reward serves to reinforce commitment to quality improvement within the organization. According to Deming, reward can help transform the organization toward a philosophy of quality.

(3) Make visible statements of organizational values. The reward system makes a statement about what is important to the organization. It is a public statement about the priorities of the organization consisting of quality, customer satisfaction, and continuous improvement.

However, there is no ultimate way to achieve effective reward and recognition in organizations, because a rich variety in effective reward and recognition techniques have developed. For example, Granite Rock, a small manufacturer of road construction materials and winner of the Malcolm Baldrige Award in 1992, gives recognition awards to individuals and teams on "Recognition Day" and monetary "Incentive Recognition Awards" for excellence beyond normal job duties. As a result, Granite Rock has determined reward and recognition incentives contributed to a 30 percent higher productivity level than the national industry level. In addition, employee surveys show Granite Rock employees are more satisfied in every category than national averages.

On the other hand, a second different approach is the decentralized reward and recognition system process used by Appleton Papers. The systems Appleton Paper employs, make rewards more personal and immediate. Each line manager has a recognition budget to reward quality behaviors by buying personalized items, jewelry, and other items that individual employees value (Knouse, 1995). In conclusion, the recognition step of the quality improvement process is valuable and gains appreciation of the workforce (Crosby, 1979).

***Information Based Quality Practices***

An additional key element of quality management success is information (Godfrey, 1993). Three different aspects of information based quality practices are critical as a sound foundation: availability, usage, and benchmarking. However, information based quality practices is an almost untapped area and few researchers looked at the data and information needs of companies engaged in serious TQM efforts.

*Quality Information Availability*

Traditional approaches of random management of quality information systems with vague, incomplete, inaccurate and outdated information are inadequate for the competitiveness of the company. Companies must start from a different approach. For example, availability of exact information on quality is a prerequisite for effective and efficient quality management practices and is a solid foundation for the development of critical competitive capabilities (Sarkis and Reimann, 1996). Despite this assessment, different case studies described how inadequate quality systems provide mountains of useless data (Kern, 1990). Above all, the availability of the right quality information must satisfy management needs for information on the status and developments relevant to the quality system and the capability to meet the quality goals of the company. In addition, a quality information system encloses the manual and computer based structures that gather, process and distribute information on quality to all levels of decision making within the organization (Juran, 1980).

*Quality Information Usage*

In essence, the usage of quality information will aid manufacturing companies to achieve effective and efficient quality. Research by Schlange (1991) on quality information systems in two Swiss and four U.S. companies found one company using the quality information provided by the quality information system employed. The other five companies possessed the data, the information, but no evidence of use. As a contrast, Xerox transformed quality data into useful information applied to drive quality improvement actions: improvement of the next generation of products, improvement of the business process, reducing of cycle times, improvement of distribution, improvement of field services, better understanding of the needs of customers, and improving products and services designs.

*Benchmarking*

As a result of the increasing sophistication of marketplaces and rise in competition, the competitive capabilities of organizations are being eroded as barriers to entry decrease. A solution to this problem is benchmarking. Benchmarking helps organizations identify, understand, and adapt outstanding practices from leading competitors in the same industry, or other industries using similar processes to help improve performance. When comparing practices and procedures with the "best", an organization could make improvements in products and processes. In turn, the results will better satisfy the customer requirements for quality, cost, product and service (Cook, 1995). A remarkable example of benchmarking practices is Rank Xerox. From the mid 1960s to the mid 1970s profits rose 20 percent a year. However, by 1980 Xerox saw market share halved, as aggressive competitors emerged and beated Xerox in price, quality and other important competitive capabilities measures. The Xerox solution was to benchmark the way photocopiers were built, the cost of each stage of production, the cost of selling, the quality of the servicing it offered, and several aspects of its business against its competitors and other leading businesses. Whenever Xerox found something that someone else did better, the company insisted that level of performance became its new base standard. Therefore, Xerox tied benchmarking practices to its quality management program, because benchmarking could identify where quality improvements are needed. As a result, Xerox improved its worldwide financial position, stabilized its market share, and increased customer satisfaction by 40 percent during the period between 1984 and 1988.

### ***Product/Process Management Based Quality Practices***

Product and process management based quality practices are focused on improving the quality of the product and operation processes within the company. By nature, these practices are technical, involved with the areas of product design, and process design and control.

#### *Product Design*

The assurance of quality design of products affects internal quality performance and competitive capabilities through its effect on product manufacturability, product complexity, product reliability, product features, and product serviceability. Moreover, the efficiency of the manufacturing process is affected by considerations of producibility (materials, specifications, tolerances, etc.) at the product design stage. When the product components are designed in such way that are easy to manufacture and assemble, the manufacturing process variance is reduced. As a consequence, the reduction in variance will be reflected on different measures of internal quality performance (waste, rework, cost, time, etc.). Furthermore, designs that reduce the complexity of the final product increases its reliability since the fewer the parts the lower its failure rate will be. In addition, fewer parts also facilitate the coordination during the manufacturing process, reduce the manufacturing throughput time, and reduce the manufacturing cost. Of critical importance is the assurance of the incorporation of customer desired product features at the early design stage because it improves the quality, and enhances the value in the eyes of the customer, and minimizes changes during the production stage which affect the efficiency and productivity of the manufacturing process. The design of products' ease of use enhances the serviceability of the product, which is believed to impact the product's value perception by customers (Hauser and Clausing, 1988).

*Process Design and Control*

Work processes are collection of activities that take one or more input and create an output that is of value to the customer (Hamer and Champy, 1993). Yet, the assurance of quality design of work processes is also believed to be an important practice affecting internal quality performance and competitive capabilities through effecting process flexibility, process reliability, and process maintainability. In assuring that work processes add value and reduce the potential for error several key design principles are followed: simplicity reduces the complexity and variation in the manufacturing system increasing its reliability and reducing the amount of defective production and waste; increasing scope of work activities reduces the hand-off transactions between work groups, and eliminates many types of mistakes and misunderstandings; work processes with imbedded feedback, assessment, and control help workers to know whether the task is as it is forwarded; the integration of decision making as part of the production task increases the responsiveness to process failures and reduces the likelihood of defective products that require reworking. An example of one successful approach to design mistake-proof processes poka-yoke concept of Shingo. In fact, poka-yoke eliminates defects that result from types of errors by making it impossible for those errors to occur at all.

Furthermore, statistical process control is becoming the core for both quality improvement and quality maintenance. However, a major obstacle to achieving high quality is product variability, yet an alternative exists. The usage of SPC in monitoring manufacturing processes helps to determine the production of substandard products, and prevent further defects. In SPC, statistical signals are used to improve a process systematically preventing the production of substandard materials. The following are primary effects of SPC usage: minimize the production costs with a "make it right the first time" program eliminates costs associated with making, finding, and repairing or scrapping substandard products; attain consistency of products and services that will meet production specifications, customer expectations, reduce variability to a level well within specifications of desired design quality. In summary, this leads to consistency, process predictability, and benefits to the company by helping management meet quantity targets.

**Customer Based Quality Practices**

Customer based quality strategies are critical for TQM programs, because it is also the point for formulating other strategies. In achieving customer satisfaction customers play a critical role in the organization's process of implementing and improving quality. Customer based quality practices are focused on customer orientation and customer closeness.

*Customer Orientation*

Knowing and understanding customer needs and expectations emerged as a top priority for Motorola, Federal Express, Xerox, and Corning among others. These companies learned that the new paradigm of being customer oriented is a requisite to compete in the post-industrial environment (Doll and Vonderembse, 1991). A customer oriented company is fundamentally different from a company that is not. In customer driven companies, customer satisfaction of needs and expectations drive the company. Also, another important requirement for a customer oriented company is to have thorough and accurate knowledge of customer requirements. A remarkable example of the customer orientation approach is provided by the Boeing company with its design of the 777 aircraft. It was the first commercial aircraft whose major design features originated with its primary customers, United Airlines and British Airways (Schonberger, 1992). In a different industry, customer orientation by Xerox was seen as the primary way to sustain competitive advantage and the only alternative to improve financial returns, fulfill the needs of its employees, and provide an integrating focus for empowerment.

In a customer oriented company, total customer satisfaction becomes the goal of the entire organization. Total quality management is organized around customer satisfaction which makes knowing what customers expect is the most important job for the company (George and Weimerskirch, 1998). At Whirlpool Corporation, a standardized appliance measurement satisfaction survey is mailed out to 180,000 households annually asking customers to rate Whirlpool appliances on numerous attributes and to compare its appliances with the appliances of the principal competitors. If the appliance of a competitor scored higher, Whirlpool wasted no time in finding out the reasons (Whiteley, 1991).

*Customer Closeness*

Doll and Vonderembse (1991) maintain the manufacturing system of the industrialized world is undergoing a transition from an industrial stage. In this transformation, it is imperative for manufacturers to place greater value on customers. Paralleling this transition, is a paradigm shift from the narrow economic and technical perspective to a customer perspective. During this post-industrial stage, manufacturers want to be close to the customer in order to attain sustainable competitive advantage. In the new paradigm, customers are not just sources of market information; but providers of key resources including technology, knowledge, skills, and other essential services necessary for the competitiveness of the manufacturer. World class manufacturers now understand that customers play important roles in the development of critical capabilities of quality, price, delivery, and flexibility (Schonberger, 1986, 1990; Whiteley, 1991; Kinni, 1996).

Yet, there is no unanimity on the meaning of customer closeness. Some researchers describe it in terms of such traits or attributes as communication, permeable boundaries, organic structures, empowerment, customer knowledge, field linkages, service support, etc. Others describe it in terms of outcomes like loyalty, growth, satisfaction, profits, innovation, etc. (McQuarrie, 1993; Newman, 1989). For example, for KLM Royal Dutch Airlines customer closeness means working cooperatively with customers (Griffiths, 1990). In a comparable interpretation, Naumann, and Giel 1995, viewed it as a more cooperative relationship between the customer and manufacturer. In the AMA study (Bohl, 1987) closeness is related to gathering and using information from customers strategically. Bergen Brunswing Corporation defines customer closeness as the capability of the organization to anticipate customer needs (American Marketing Association, 1992).

On the other hand, Solis and Kim (1995) proposed a definition of customer closeness which builds on and integrates many of the ideas found in academic literature and current managerial practices. Virtually all of the definitions described above capture very limited aspects of customer closeness, the definition offered by Solis and Kim reflects a totality of the interaction between the manufacturer and customer. The proposed definition is:

$$MCC = f(F, FS, VS),$$

where MCC = manufacturer-customer closeness,

F = frequency,

FS = functional scope, and

VS = vertical scope (VS).

Clearly, a distinctive feature of this definition is that it is highly inclusive in terms of the locus of interchange. In addition, the definition addresses manufacturer-customer interaction not along a single dimension, but along three dimensions of diverse nature. An assumption underlying this definition is that the interaction involves the interchange not only of information, but also of resources, technology, and critical capabilities. It is also assumed that the driving force for the interaction is the mutual benefits accruing to both parties. In other words, the customer receives products of greater value, which in turn will enhance the manufacturer's competitive advantage. These benefits indicated in the literature include: (1) faster product development, (2) rapid production/delivery of highly customized products, (3) continuous cost control and reduction, (4) continuous quality improvement, (5) faster customer service, (6) operational flexibility, and (7) production/operations process improvement (Bohl, 1987; Shopey and Dodd, 1997).

**Supplier Based Quality Practices**

Supplier based quality practices provide a means to increase the likelihood of an organization having suppliers who are reliable and willing to work toward the company's goals of achieving quality excellence.

*Relationships with Suppliers*

One great contribution of quality management is the recognition of suppliers as one of the most important resources companies have (Galgano, 1994). This recognition grew out of the realization of three critical facts:

(1) The quality of the products depends to a large extent on the quality of its components. In many companies, the procurement costs range from 50 to 70 percent of sales volume.

(2) To design and develop new products in shorter times and with higher reliability, a company needs the full cooperation of the supplier, beginning with the initial phases of development.

(3) Quality cost and delivery are not the only factors to consider when establishing and maintaining a customer-supplier relationship. Technological innovation and constant improvement are also essential.

Leonard and Sasser (1982) found a major source of quality product/processes problems have their source in defective incoming supplies. The impact of defective supplies on quality performance has raised the importance of quality procured materials, parts, and services, and brought supplier relationships as a major component of quality management (Ahire, Golhar, and Waller, 1996, Flynn et al. 1994). In short, quality performance of suppliers is critical in many ways. For example, the quality of incoming material, parts, and components, determine the levels of SPC usage. Furthermore, quality of supplied parts impact the quality of the final product and the capability of suppliers the abilities of manufacturers to satisfy needs and expectations of its customers. Additionally, knowledge and experience of the vendor has been found valuable during the initial design of new products and in the solution of problems to achieve high quality and faster response to market needs (Deming, 1986; Crosby 1979; Ishikawa, 1985; Garvin, 1984; Feigenbaum, 1983; Lascelles and Dale, 1989; Steeples, 1992). Supplier relationships with management have helped Japanese companies achieve world class leadership. To obtain the best quality parts at a given price, Japanese managers promote long-term relationships and mutual cooperation with suppliers, extending from product development to manufacturing. In short, the vendor relationships in total quality management can be described as mutual trust and maximum cooperation within a long-term framework for the purpose of ensuring the greatest customer satisfaction.

## Quality Performance

An important goal of quality management is to measurably improve quality.

The effort of the quality improvement process must be reflected in improved quality levels based upon objective measures derived from analysis of customer requirements and expectations, from analysis of internal and external business operations, and by comparing the current quality levels of the company benchmarked against competing firms (Steeples, 1992; Deming, 1982; Garvin, 1987; Ishikawa, 1985; Stratton, 1991; Juran, 1991).

*Internal Quality Performance*

Internally, quality management practices are relevant in the context of improving product quality, reducing manufacturing costs, and improving operational performance. Garvin (1987), provided a comprehensive description of the attributes that customers consider important to assess the quality of products. The researcher found that customers are concerned with product features, product performance, product conformance, product reliability, product durability, product serviceability, product aesthetics, and perceived quality. A wide arrange of performance measures for internal operational performance include: rework, scrap, productivity, throughput time, finished product defect rate, cost, and lead time among others (Garvin, 1984; Schonberger, 1983). In this research, the following internal quality performance measures were selected: (1) quality failures, (2) manufacturing cost, and (3) time. Quality failures relate to the consequences of failing to do things right the first time and includes the aspects of scrap, rework, warranty claims, customer complaints, etc. Furthermore, manufacturing cost includes the total cost of producing one unit of the finished product. Time includes the following aspects of manufacturing operation: time for new product development, throughput time, and service delivery time. The reason for this selection is that these measures are implicitly considered as important antecedents to competitive capabilities (Koufteros, 1995).

## 2.4 Competitive Capabilities

The globalization of business is changing the way companies manufacture and deliver goods and services. More than 70 percent of goods are estimated to operate in an international market place, forcing organizations to formulate strategies within a global context. To be a world class manufacturer requires increasingly higher levels of sophistication and integration in both products and processes. Deloitte Touche Thomatsu (1993) reported:

> "*Superior manufacturers perform exceedingly well over factors that are important to customers. Over the past decade, quality and customer service capabilities have become significantly more important on the manufacturing battlefield....Continual improvements in these areas have become the rule, not the exception, for competing worldwide. North American manufacturers have focused on these two critical competitive capabilities (quality and customer service) and are showing signs of improvement... Superior product quality and service capabilities may become prerequisites for successful global manufacturers.*"

### Competitive Capabilities Concept and Typologies

Definitions of capabilities come from several viewpoints. In the strategic planning and competitive advantage literature, capability has been defined in terms of the source of uniqueness: economic/financial, marketing, and technology (Hale, 1995). However, these views have deficiencies when used to improve competitiveness. In addition, these definitions describe only a portion of what companies need to do to build sustained competitive advantage. Any of these views, has the implicit assumption that businesses operate exclusively through rational processes. Furthermore, by analyzing these processes management can always make decisions that will help business prosper. However, organizational theorists suggested organizations do not operate on rational premises alone. Also, the history, management style, and organizational structure of a firm are important factors. A pure rational analysis may not take into account the kind of non-rational decision-making that often occurs within organizations.

Second, the partial view of capabilities may rely on a static view of competitive advantage. Often, factors that enable a business to compete successfully today will no longer serve the same function tomorrow. The capacity to manage strategic change often determines how organizations sustain competitive advantage. Without the capacity to manage changing strategies, firms may lock themselves into historical success patterns rather than adapting to new situations. Relying on past strategies and its compatibility with industry encourages firms to emphasize the use of existing competencies than develop new capabilities to new situations.

A third problem with defining competitiveness in terms of the partial views of capabilities is that evades the question of the execution of strategies. In other words, organizations do not think, make decisions, or allocate resources people do. Any analysis of how an internal system of a firm adapt to changing capabilities for gaining competitive advantage must include the role of people. In addition, the traditionally acknowledged views of capabilities are not necessarily integrated with each other. A major challenge in creating competitive capabilities is to ensure that they do not operate in isolation, and that they are integrated.

Capabilities of manufacturers are those specific competencies that set the manufacturer apart from the competitors. The selection of those capabilities should be a reflection of the strategic business objectives (Giffy, Roth, and Seal, 1990), and should be expressed in terms of the primary manufacturing task or order-winning attributes. Furthermore, consensus on the identification of the following important competitive capabilities exist within the empirical literature (Ward, Leong, and Snyder, 1990; White, 1993; Fitzsimmons, Kouvelis, and Mallick, 1991; Skinner, 1985; Lockamy and Cox, 1995; Hayes, 1985; Maskell, 1991; Nemetz, 1990; Roth and Miller, 1990; Wood, Ritzman, and Sharma, 1990):

1. *Price/Cost*. The ability to sell similar products at a lower price than competition due to low production cost.
2. *Quality*. The ability to produce products with significant higher levels of conformance and performance than competitors.
3. *Delivery*. The ability to meet all delivery commitments on time and to manufacture products more quickly than competitors.
4. *Flexibility*. The ability to make significant changes in product design, introduce new products quickly, and be responsive to demand shifts in volume.

However, a recent empirical study expanded upon the above list, identified and developed measurement scales for the following five distinctive competitive capabilities in manufacturing firms (Koufteros, 1995):

1. *Competitive Pricing*. The extent to which the manufacturing enterprise is capable of competing against major competitors based on low price. Competitive pricing manifest the ability of the organization to withstand competitive pressure (Koufteros, 1995; Wood, Ritzman, and Sharma, 1990; Miller, DeMeyer, and Nakane, 1992)
2. *Premium Pricing*. The extent that a manufacturing enterprise can sell at premium prices. Firms that have shorter customer delivery cycle or possess the ability to better and more innovative product design and superior product performance have the opportunity to charge higher prices (Stalk and Hout, 1990; Blackburn, 1991; Hall, Rosenthal, and Wade, 1993).
3. *Value to Customer Quality*. The extent a manufacturing enterprise is capable of offering product quality and performance that creates higher value for customer(s). Moreover, it gauges the capability of the firm to produce products that would satisfy customer needs and expectations for quality performance (Gray and Harvey, 1992; Arogyaswamy and Simmons, 1993).
4. *Dependable Deliveries*. The extent a manufacturing enterprise is capable of providing on time the type and volume of product required by customer(s). Dependability is viewed as the consistency of the company in performing at the time scheduled or promised (Hall, 1993).
5. Product Innovation. It is the extent to which the manufacturing enterprise is

capable of introducing new products and features in the market place (Koufteros, 1995; Clark and Fujimoto, 1991).

Considerations of actual or future capabilities needs are essential for managers to decide the "best practices" for building the capabilities key to the long-term competitive advantage of the respective companies (Hayes and Pisano, 1994). The measures developed for the above five capabilities (Koufteros, 1995) follow the generic descriptions presented in the literature to establish the relationship of competitive capabilities with quality management practices.

## The Quality Management Practices-Competitive Capabilities Connection

Increasingly, organizations are realizing the strategic importance of quality and quality management to enhance competitive capabilities and provide strategic advantages in the marketplace (Anderson, Rungtusanatham, and Schroeder, 1994). Until recently, quality was rarely a priority. At best, quality was viewed as an affordable ideal or a tradeoff because the quintessential American approach to quality was reactive and localized in nature. Quality concerns were delegated to a quality department within the organizational structure and possessed little input in producing the product. In addition, quality was defined in terms of acceptable levels. Extensive dealer networks were implemented to deal with quality problems in a post-mortem corrective fashion. These reactive responses could be tolerated with little negative impact on profitability when a firm commanded the market and faced few serious competitors. However, the situation described no longer exists for American businesses.

What changed the American approach to quality was the recognition of a shrinking globe that is reflected in nearly every aspect of life. Economic, technological, and social conditions over the past twenty years culminated in what Marshall McLuhan called a "global village". The globalization of life has increased competitive pressures placed upon manufacturers by bringing more entrants into markets, and geometrically increased the complexity of doing business (United States. Congress. House. Committee on Science, Space, and Technology. Subcommittee on Technology and Competitiveness, 1991; Yang, 1995; Muroyama, and Stever, 1988). Global competitive pressures require that quality improvement be proactive and pervasive in nature. Competitiveness concerns demands for building and sustaining organizational capabilities through the effective implementation of quality management practices.

Today, acceptable levels of quality are defined in terms of defects per million. Manufacturers are finding that the systematic pursuit of quality is essential for attaining and sustaining competitive advantage in the global market-place. Through a quality emphasis, companies hope to achieve a global competitive position via unique capabilities that differentiates them from competitors (Garone, 1995). More specifically, being a world-class company no longer means being the first to get your product to market, but to develop superior competitive capabilities to do things better than the competitors can. As a result, a world-class company is significantly better than its competitors from rapid product development to low cost. In addition, recent empirical research attests that firms may compete on multiple dimensions to quickly and efficiently respond to changing demands (Roth and Miller, 1992). An example illustrates that point. Merck described as being the miracle company, because it possesses the capability to develop breakthrough products and deliver the products faster than its competitors. The key challenge in this global environment for manufacturing firms is to provide the capability of multidimensional competitiveness as Merck did.

An examination of contingency theory and resource based theory links quality and competitive capabilities in the organization. Powelll (1995) suggests quality management practices are contingent on organizational competitive capabilities which itself are contingent on business strategy. Powell further contends that total quality management practices should be useful for capabilities leading towards incremental or evolutionary refinements of organizational products and processes, but less applicable to fast-moving organizations whose capabilities should support risk-taking, creativity, or quantum changes in short periods of time. In a similar vein, Krishnan, Calingo (1995) state that quality management programs are most effective when a company which is in a stable strategic position wishes to enhance its competitive capabilities through long term improvement in product performance and customer satisfaction. In general, this work reflects the contingent view in which quality management practices support the required capabilities for the chosen strategy as follows:

Business Strategy → Competitive Capabilities → Quality Management Practices

A different view of the quality management practices-competitive capabilities relationship is drawn from the resource-based theory of competitive advantage (Peteraf, 1993). Peteraf argues that the resources and capabilities of an organization serve as the foundation for its strategy. Resources are basic inputs to the production process ranging from employee skills to hard technology. Capabilities represent the organization's capacity to perform a task or an activity. Capabilities are built from resources and yield strategic competitive advantage. Therefore, capabilities should be built around the strategy of an organization. Belohlav (1993) proposes that high quality influences competitive capabilities, which opens a new range of strategic options to the company. Therefore, by implementing quality management practices, a firm develops new capabilities that leads to the development of new strategies. Hammel and Phahalad (1994) use the term core competencies to describe these key capabilities. Spitzer (1993) also reflects this view when describing total quality management as the only source of competitive advantage. Drawing on the work by Barney (1991), Spitzer shows how quality management practices help a company to build generic lead time, leverage competitive asymmetries, and create preemption potential, all crucial to sustainable competitive capabilities. The implication is that quality management will create these sources of competitive advantage (capabilities) and companies should formulate strategies around them.

In combining the two approaches between quality management practices and competitive capabilities suggests reciprocal relationship. Whatever the causality, it is clear that a link between quality management practices and competitive capabilities for competitive advantage exists.

## 2.5 Research Framework and Hypotheses Development

This section describes the research framework. The framework provides the basis for describing the relationships in the model. As a result, a set of hypotheses is proposed.

### Model

The first-order level research framework (Figure 1) is based on a compilation of theory and empirical research on quality (Anderson, Rungtusanatham, and Schroeder, 1996; Ahire, Golhar, and Waller, 1996; 1989; Rao, Ragu-Nathan, Solis, 1996; Flynn, Schroeder, and Sakakibara, 1994; Saraph, Benson, and Schroeder, 1989); internal quality performance (Flynn, Schroeder, and Sakakibara, 1995a) and competitive capabilities (Koufteros, 1995; Hale, 1995). It merits its holistic emphasis on the conceptualization of the quality management construct as suggested by Ahire, et. al (1995). This conceptualization of quality management practices is consistent with the approach adopted by researchers and practitioners of quality as an integrated, and interfunctional means to create and sustain competitive capabilities (Flynn, Schroeder, and Sakakibara, 1995; Powell, 1995). In the present research model, the group of quality management practices are expected to lead directly to improved internal quality results and to improved competitive capabilities.

Figure 1, at the beginning of this chapter, illustrates the proposed framework for quality management practices and its effect on internal quality results and competitive capabilities. The box at the left contains the quality management practices expected to have both a direct effect on competitive capabilities and an indirect effect, through their impact on internal quality performance. At the center, the internal quality performance measures (quality failures, manufacturing cost, and time) are found. Internal quality performance measures are expected to have a direct effect on competitive capabilities. The box at the right represents the competitive capabilities.

As seen, the model focuses on the relationship among three constructs: (1) quality management practices, (2) internal quality performance, and (3) competitive capabilities. The model suggests that quality management practices affect directly and indirectly the achievement of manufacturing competitive capabilities.

## Hypotheses

This dissertation examines relationships between quality management practices, and competitive capabilities. The hypothesized relationships and directions are depicted in Figure 2. The model suggests that quality management practices predict and antecede both internal quality performance and competitive capabilities. The analysis of the relationships in the multi-construct model presented allows one to assess the construct validity of a measure by relating it to other constructs (Churchill, 1979). For this study, the relationships will be tested at an aggregate level; the scores of all quality management practices, and competitive capabilities will be added into their respective categories and used in hypothesis testing. The relationships portrayed in Figure 2, give rise to a number of hypotheses. The first set of five hypotheses deals with interrelationships among the endogenous variables (quality failures, product cost, lead time, and competitive capabilities).

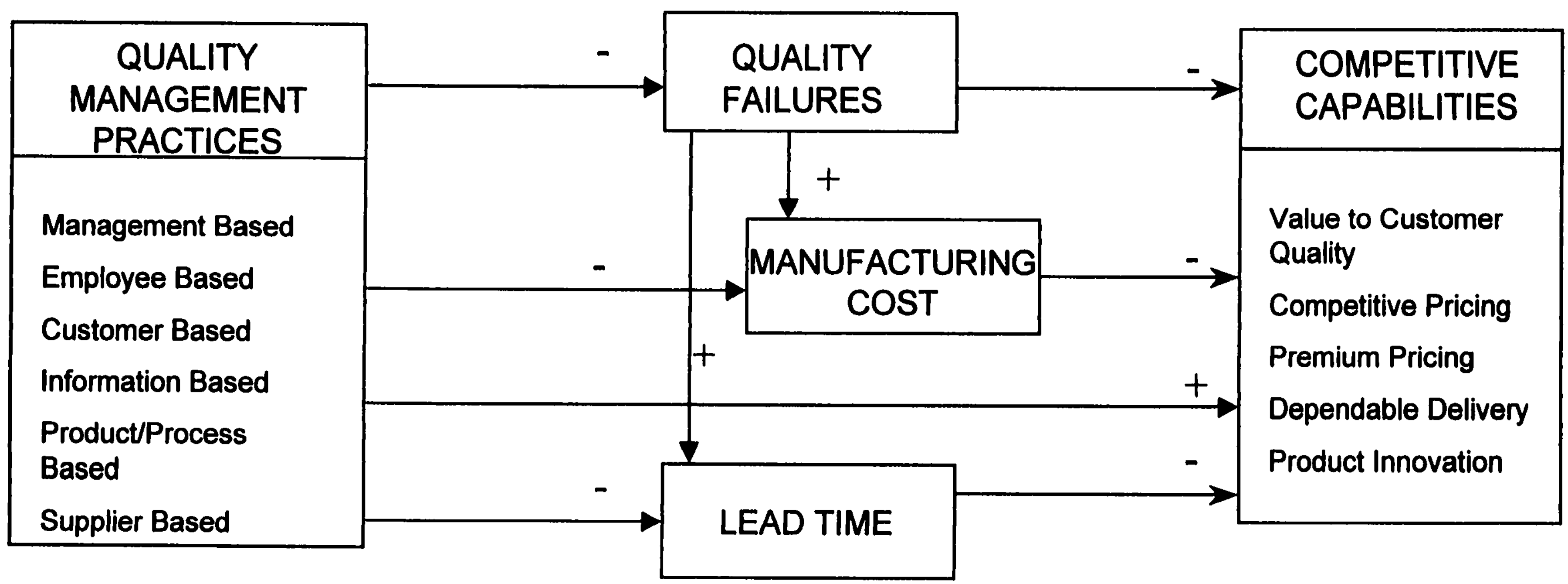


FIGURE 2.2. QUALITY MANAGEMENT PRACTICES- COMPETITIVE CAPABILITIES RELATIONSHIPS

*Hypothesis 1: Competitive capabilities have negative relationships with quality failures.*

Competitive capabilities are affected by many variables, including quality failures (rework, defective levels, warranty claims, and customer complaints). When quality failures are reduced, the competitive capabilities of the manufacturing firm would be improved. Reducing the level of quality failures leads to a reduction of manufacturing cost. The reduced manufacturing cost provides the firm with the flexibility to reduce the price increasing customer value. Resources that are released from repairing and monitoring defective products also enable the firm to use the released capacity to produce additional orders by customers and increasing the efficiency and productivity. Lower quality failures reduce cost, increases firm's profitability, and leads to faster deliveries since the orders do not wait to replace defective units. In addition, when the number of quality failures is reduced, customer's value is also enhanced through higher reliability and quality consistency in the delivered product.

*Hypothesis 2: Competitive capabilities have a negative relationship with manufacturing cost.*

A reduction in manufacturing cost is expected to improve competitive capabilities. When the cost of production is reduced through the efficient and effective improvement of product and process management and control, the firms achieve higher price flexibility. Price flexibility gives the firm the capability to charge premium prices thereby increasing profitability, reduce sale prices thereby providing better value to the customers.

*Hypothesis 3: Competitive capabilities have a negative relationship with lead time.*

Reducing lead time increases competitive capabilities. Moreover, a reduction in lead time improves customer delivery service and helps reduce both direct and indirect costs. When lead time is reduced, less resources are spent on each product unit. At the same time, inventory costs are also reduced as time spent in inventories is reduced when lead throughput time is lessened. Firms with shorter lead times will claim premium prices and provide better quality value to customers.

*Hypothesis 4: Quality failures have a positive relationship with manufacturing cost.*

Quality failures is hypothesized as being an antecedent for manufacturing cost. The impact of poor quality on total manufacturing cost is huge. When resources are wasted in redoing things caused by poor quality, the total cost of manufacturing the product goes up. In many companies, poor quality costs run at about 20 to 40 percent of sales (Juran, 1988). When defective production decreases, less material is required to manufacture the product, production capacity is released, productivity increases, less amount of inventory is required, warranty claims reduced, and the overall cost of production is reduced.

*Hypothesis 5: Quality failures have a positive relationship with lead time.*

It is expected that a reduction in lead time would occur when the level of quality failures is reduced. The time it takes to fill a customer order can be significantly impacted by quality problems. When machines, parts and components are not properly calibrated, or when supplied raw materials and components are out of specifications; the manufacturing process produces nonconforming products. Moreover, improvements in the level of quality failures (reduction) contribute to the improvement of lead times (reduction).

*Hypothesis 6:* *Quality management practices have a negative relationship with quality failures.*

Quality management practices are hypothesized as being antecedents to quality failures. They are aimed at doing things right the first time. For example, through the implementation and usage of statistical process control (SPC) minimization of in-production quality problems can be achieved. Variations in the production process variables (raw materials, machines, workers, etc.) contribute to a variation in product quality. In addition, SPC techniques can detect assignable causes contributing to the variation in production quality and help to investigate critical areas needing improvements. SPC techniques applied effectively by workers have a significant impact on prevention of production problems reducing the amount of quality failures. Above all, the integration of quality in all processes, systems, and practices help systematically prevent problems and reduce the likelihood of producing defective products. A study of companies that have implemented total quality management practices found 87.5 percent of the companies achieved a mean reduction of 11 percent in the defect rate on an annual basis (Steeples, 1992).

*Hypothesis 7:* *Quality management practices have a negative relationship with manufacturing cost.*

Quality management practices are hypothesized being antecedents to product cost. Lower product cost is realized by improving quality through the improvement of the process (Deming, 1982). When quality is improved through higher levels of quality management practices, defects in materials, tools, equipment, and other process variables are reduced thereby improving the cost of production by eliminating waste of resources. Also, costs decreases when employees are more involved in the quality improvement efforts and when multifunctional teams are used during the product process design (Vonderembse, M., Van Fossen, T., & Ragu-Nathan, T.S. 1997).

*Hypothesis 8: Quality management practices have a negative relationship with lead time.*

Improved quality management practices reduce lead time. When effective process management is in place, a significant impact on lead time through reduction of process variance occurs (Flynn, Schroeder, and Sakakibara, 1995). Process management involves a heavy reliance on preventive maintenance, emphasizing scheduled maintenance to avoid equipment breakdowns, and redoing the parts while waiting for the machine or equipment to be repaired. Furthermore, a good process design reduces the process variance by making inaccurate performance difficult (Cole, 1992). In summary, a study of companies that implemented total quality management found that 83 percent of the companies achieved a mean reduction in the defect rate on annual basis (Steeples, 1992).

*Hypothesis 9: Quality management practices have a positive relationship with competitive capabilities.*

It is posited that quality management practices impact competitive capabilities. This effect results from multiple sources of quality practices. For example, employee based quality practices at the shop floor-level can have an effect on product and/or process innovation through the implementation of work teams working with suppliers and customers, and empowering the team to make decisions regarding specifications and quality. These quality practices are also responsible for increasing value to customer by considering satisfaction and dissatisfaction factors involving customers during the design process.

Assessing relationships between variables has two steps; measurement and testing. Prior to testing a research question, valid and reliable measures of the relevant construct must be developed. The next chapter and the one that follows it describe and establish the measurement and test aspects.

# CHAPTER 3

# INSTRUMENT DEVELOPMENT - ITEM GENERATION AND PILOT TEST

Recently, there has been a growing call for methodological rigor in instrument validation and model testing in quality management research (Flynn, Schroeder, and Sakakibara, 1994). To further develop and empirically test the emerging quality management theories, the researchers need to develop better quality management measurement instruments with high validity, stability, and reliability (Ahire, Golhar, and Walker, 1996). Even though it is acknowledged that poor measurement properties of instruments lead to erroneous conclusions, many empirical quality management studies employed instruments that failed to meet minimal standards of reliability and validity.

Given the growing interest in understanding relationships between variables that cannot be observed makes the measurement issue more important than ever. Unobserved constructs that cannot be measured accurately are ubiquitous in TQM research: customer satisfaction and orientation, top management support, employee empowerment, employee involvement, supplier relationships, etc. Without a proper methodology to assess the validity of measurement instruments, the degree of confidence in substantive theory building and research findings would be dubious.

In this section, the need to fill the methodological rigor in quality management instrument development is addressed. Measurement scales are proposed for each construct in the conceptual model depicted in Figure 1 (Chapter 2). In addition, the content of the proposed research framework attempts to synthesize the findings from the literature and previous developed scales by Saraph, Benson, and Schroeder, (1989); Flynn, Sakakibara, and Schroeder, (1994); Ahire, Golhar, and Waller, (1996); and Rao, Solis, and Ragu-Nathan, (1998).

The development of the instrument was carried out in two stages. The first stage consisted of two steps. The first step was item creation. The purpose of item creation is to create pools of items for each of the quality management constructs by identifying items from existing scales, and by creating additional items that fit the construct definitions. The initial pool of items was distributed to a random sample of 12 respondents in industry for comments about the overall set of scales. The respondents were asked to provide feedback about the clarity of the questions, instructions, the length of the questionnaire, and provide relevant comments meant to improve the questionnaire. Based on the feedback, items were modified or discarded to strengthen the constructs and content validity. The second step was scale development and testing. Items placed in a common pool were subjected to three sorting rounds by judges to establish which items should be in the various scales. The objective was to pre-assess the convergent and discriminant validity of the scales by examining how the items were sorted into various construct categories. Analysis of inter-judge agreement about item placement identified both bad items as well as weaknesses in the original definitions of the constructs. The various scales were then combined into an overall instrument for the next stage. The second stage is later described in Chapter 4, includes all the validity and reliability tests using the data from a large-scale sample.

### 3.1. Item Creation

The first step was to ensure content validity. Content validity represents the adequacy with which a specific domain of content has been sampled (Nunally, 1967). Determination of content validity is subjective. The two standards for ensuring content validity described by Nunally are whether the instrument contains a representative collection of items and whether sensible methods of test construction were used. To ensure that a representative collection of items were used, all items identified in the existing instruments (Rao, Solis, and Ragu-Nathan, 1998; Ahire, Golhar, and Waller, 1996; Flynn, Schroeder, and Sakakibara, 1994; and Saraph, Benson, and Schroeder, 1989) were categorized under the various quality management constructs which they intended to address. Then, items that were considered to be too narrow in focus and applicable only in particular situations were discarded. Once this procedure was completed, new items were created for those categories with few items. In addition, new items were created for all dimensions of the construct that had not been covered in previous literature. The typical item in previous instruments tended to be a statement and the respondent was asked to indicate a degree of agreement. This approach for the study was retained with a five-point Likert scale ranging from strongly disagree to strongly agree as the response format.

Once the item pools were created, items for the various quality management constructs were re-evaluated to eliminate redundant or ambiguous items. The culling process left the following number of items in each pool:

| | |
|---|---|
| Management Based Quality Practices | 16 |
| Employee Based Quality Practices | 19 |
| Information Based Quality Practices | 13 |
| Customer Based Quality Practices | 15 |
| Product/Process Based Quality Practices | 14 |
| Supplier Based Quality Practices | 7 |
| Internal Quality Performance | 14 |
| Competitive Capabilities | 21 |

## 3.2. Scale Development: The Q-Sort Method

The basic procedure was to have quality managers, plant managers, and top management executives judge and sort the items from the first stage into separate quality management categories, based on similarities and differences among items. A group of potential judges were identified from the local Chapter of the *American Society for Quality*. All of the potential participants were representatives of the population targeted for this study, and considered as knowledgeable in the quality field, and with the required experience and position to assess the impact of TQM practices in their organization. From this group, a random sample of six judges was selected to participate during this stage.

Based on the placements made by the judges the items could then be examined and inappropriately worded or ambiguous item could be eliminated or reworded. Two goals for this stage were: to attempt to identify any ambiguous items, and to pre-assess the construct validity of the various scales being developed. First, judges sorted through the various items into construct categories. This procedure is similar to the technique Davis (1986, 1989) used in assessing the coverage of the domains of his constructs. First, Davis asked judges to rank how well the items fit the construct definitions provided, and then asked the judges to sort items into construct categories. By comparing the categories developed, Davis was then able to assess domain coverage of the particular construct. The second step in this research is similar to procedure employed by Davis. An indicator of construct validity was the convergence and divergence of items within the categories. If an item was consistently placed within a particular category, then it was considered to demonstrate convergent validity with the related construct, and discriminant validity with the others.

**Sorting Procedures**

Each item was printed on a 3 x 5 -inch index card. The cards were shuffled into random order for presentation to the judges. Each judge sorted the cards into categories. A "not available" category definition was included to ensure that the judges did not force any item into a particular category. During the three sorting rounds three different pairs of judges were utilized. Each set of judges included a quality management director or a top management executive to ensure that the perceptions of the target population would be included in the analysis. Prior to sorting the cards, the judges were briefed with a standard set of instructions that were previously tested with a separate judge to ensure comprehensiveness and comprehensibility. Judges were allowed to ask as many questions as necessary to ensure they understood the procedure.

**Inter-rater reliabilities**

To assess the reliability of the sorting conducted by the judges, two different measures were made. First, for each pair of judges in each sorting step, their level of agreement in categorizing items was measured using Cohen's Kappa (Cohen, 1960). A description of the Cohen's Kappa concept and methodology is included in Appendix A.

***Results of First Sort***

Two judges were involved in the first sorting round, which included items developed for the quality management constructs. In the first round, the inter-judge raw agreement scores averaged 0.71 (Table 1), the initial overall placement ratio of items within the target constructs was 84 % (Table 2), and the Kappa scores averaged 0.64.

The calculations for the Cohen's Kappa coefficient are shown below.

$$k = \frac{N_i X_{ii} - \sum_i (X_{i+} X_{+i})}{N_i^2 - \sum_i (X_{i+} X_{+i})} = \frac{(84)(57) - 534}{(84^2) - 534} = 0.64$$

A summary of the first round inter-judge agreement indices is shown in Table 3. Following the guidelines of Landis and Koch for interpreting the Kappa coefficient, the value of 0.64 indicates a moderate level of agreement beyond chance for the judges in the first round. This value is slightly lower than the value for raw agreement which is 0.67 (Table 3). The level of item placement ratios averaged 84%. For instance, the lowest item placement ratio value was 56% for the customer orientation construct, indicating a low degree of construct validity. On the other hand, several constructs (employee recognition, quality information

**Table 1. Inter-judge Raw Agreement Scores: First Sorting Round**

| Judge 2 \ Judge 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | | | | | | | | | | | | | | |
| 2 | | 3 | | | | | | | | | | | | | |
| 3 | | | 4 | | | | | | | | | | | | |
| 4 | | | | 4 | | | | | | | | | | | |
| 5 | | | | | 4 | | | | | | | | | | |
| 6 | | | | | | 4 | | | | | | | | | |
| 7 | | | | | | | 5 | | | | | | | | |
| 8 | | | | | | | | 4 | | | | | | | |
| 9 | | | | | | | | | 1 | | | | | | |
| 10 | | | | | | | | | | 5 | | | | | |
| 11 | | | | | | | | | | | 4 | | | | |
| 12 | | | | | | | | | | | | 3 | | | |
| 13 | | | | | | | | | | | | | 1 | | |
| 14 | | | | | | | | | | | | | | 6 | |
| 15 | | | | | | | | | | | | | | | 4 |

| Total Items Placement: 84 | Number of Agreements: 60 | Agreement Ratio: .71 |
|---|---|---|

1. Top management support
2. Strategic quality planning
3. Employee training
4. Employee involvement
5. Employee empowerment
6. Employee recognition
7. Quality information availability
8. Quality information usage
9. Customer orientation
10. Customer closeness
11. Product design
12. SPC usage
13. Process design
14. Supplier quality
15. Benchmarking

## Table 2. Items Placement Ratios: First Sorting Round

| | | ACTUAL CATEGORIES | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | N A | T | TG % |
| THEORETICAL | 1 | 19 | 3 | | | | | | | | | | | | | | | 22 | 86 |
| | 2 | 2 | 8 | | | | | | | | | | | | | | | 10 | 80 |
| | 3 | 1 | 1 | 8 | | | | | | | | | | | | | | 10 | 80 |
| | 4 | | | | 8 | 1 | | | | | | | | | | | 1 | 10 | 80 |
| | 5 | | | | 2 | 8 | | | | | | | | | | | | 10 | 80 |
| | 6 | | | | | | 8 | | | | | | | | | | | 8 | 100 |
| | 7 | | | | | | | 10 | | | | | | | | | | 10 | 100 |
| | 8 | | | | | | | | 8 | | | | | | | | | 8 | 100 |
| | 9 | 2 | | 1 | 1 | | | | | 10 | 3 | 1 | | | | | | 18 | 56 |
| | 10 | | | | | 1 | | | | | 11 | | | | | | | 12 | 92 |
| | 11 | | | | 1 | | | | | 2 | | 12 | | | 1 | | | 16 | 75 |
| | 12 | | | | | | | | | | | | 6 | | | | | 6 | 100 |
| | 13 | | | | | | | | | | | 2 | | 4 | | | | 6 | 66 |
| | 14 | | | | | | | | | | | | | 1 | 13 | | | 14 | 93 |
| | 15 | | | | | | | | | | | | | | | 8 | | 8 | 100 |

Total Items Placement: 168 | Hits: 141 | Overall Hit Ratio: 84%

1. Top management support
2. Strategic quality planning
3. Employee training
4. Employee involvement
5. Employee empowerment
6. Employee recognition
7. Quality information availability
8. Quality information usage
9. Customer orientation
10. Customer closeness
11. Product design
12. SPC usage
13. Process design
14. Supplier quality
15. Benchmarking

| Table 3. Inter-Judge Agreements | | | |
|---|---|---|---|
| Agreement Measure | Round 1 | Round 2 | Round 3 |
| Raw Agreement | .71 | .70 | .81 |
| Cohen's Kappa | .64 | .68 | .81 |
| Placement Ratio Summary | | | |
| Top Management Involvement | 86 | 91 | 91 |
| Strategic Quality Planning | 80 | 80 | 90 |
| Employee Training | 80 | 100 | 100 |
| Employee Involvement | 80 | 50 | 80 |
| Employee Empowerment | 80 | 70 | 80 |
| Employee Recognition | 100 | 80 | 88 |
| Availability of Quality Information | 100 | 100 | 100 |
| Usage of Quality Information | 100 | 100 | 75 |
| Customer Orientation | 55 | 67 | 83 |
| Closeness to Customers | 91 | 63 | 75 |
| Product Design | 75 | 78 | 83 |
| Statistical Process Control Usage | 100 | 100 | 100 |
| Process Management | 66 | 100 | 100 |
| Supplier Relationships | 93 | 88 | 100 |
| Benchmarking | 100 | 88 | 100 |
| Average | 84 | 82 | 89 |

availability, quality information usage, usage of statistical quality control, and benchmarking) obtained a 100% item placement ratio, indicating a high degree of construct validity.

In order to improve the Cohen's Kappa measure of agreement, an examination of the off-diagonal entries in the placement matrix (Table 2) was conducted. The first part of the analysis revealed two significant clusters. The first one, involved the constructs top management support, strategic quality planning, and employee training. The second cluster involved the constructs employee involvement and employee empowerment. Nevertheless, clustering argued well for potential internal consistency measurements because the off-diagonals showed clustering, rather than a scattering of items. An analysis of the two clusters was conducted to identify ambiguous items (fitting in more than one category) or too indeterminate items (fitting in no category), and were reworded. In the second part of the analysis, the customer orientation and product design constructs revealed a light scattering of items raising concern for the level of its internal consistency. Items classified in a construct different from what they were intended to be, were identified and reworded. One additional item was included in the product design construct after reviewing its definition. Feedback obtained from both judges lead to the creation of two additional items for the customer closeness construct and one additional item for the supplier quality construct.

***Results of Second Sort***

Again, two judges were involved in the second sorting round, which included the reworded and new items developed after the first sort round. In the second

**Table 4. Inter-judge Raw Agreement Scores: Second Sorting Round**

| Judge 4 \ Judge 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | | | | | | | | | | | | | | |
| 2 | | 4 | | | | | | | | | | | | | |
| 3 | | | 5 | | | | | | | | | | | | |
| 4 | | | | 2 | | | | | | | | | | | |
| 5 | | | | | 3 | | | | | | | | | | |
| 6 | | | | | | 4 | | | | | | | | | |
| 7 | | | | | | | 5 | | | | | | | | |
| 8 | | | | | | | | 4 | | | | | | | |
| 9 | | | | | | | | | 3 | | | | | | |
| 10 | | | | | | | | | | 2 | | | | | |
| 11 | | | | | | | | | | | 5 | | | | |
| 12 | | | | | | | | | | | | 3 | | | |
| 13 | | | | | | | | | | | | | 3 | | |
| 14 | | | | | | | | | | | | | | 6 | |
| 15 | | | | | | | | | | | | | | | 4 |

| | | |
|---|---|---|
| Total Items Placement: 88 | Number of Agreements: 62 | Agreement Ratio: .71 |

1. Top management support
2. Strategic quality planning
3. Employee training
4. Employee involvement
5. Employee empowerment
6. Employee recognition
7. Quality information availability
8. Quality information usage
9. Customer orientation
10. Customer closeness
11. Product design
12. SPC usage
13. Process design
14. Supplier quality
15. Benchmarking

round the inter-judge raw agreement scores averaged 0.70 (Table 4), the initial overall placement ratio of items within the targets constructs was 82 % (Table 5), and the Kappa scores averaged 0.68.

The calculations for the Cohen's Kappa coefficient for the second sorting round are shown below.

$$k = \frac{N_i X_{ii} - \sum_i (X_{i+} X_{+i})}{N_i^2 - \sum_i (X_{i+} X_{+i})} = \frac{(88)(62) - 548}{(88^2) - 548} = 0.68$$

A summary of the second round inter-judge agreements indices is shown in the second column of Table 3. The value for Kappa coefficient of 0.68 is higher than the value obtained in the first round, but still indicated a moderate level of agreement beyond chance for the judges in the second round. The level of item placement ratios averaged 82%. The lowest item placement ratio value was that of 50% for the employee involvement construct, indicating a low degree of construct validity. Again several constructs (employee recognition, quality information availability, quality information usage, usage of statistical quality control, and process design ) obtained a 100% item placement ratio, indicating a high degree of construct validity.

In order to further improve the Cohen's Kappa measure of agreement, an examination of the off-diagonal entries in the placement matrix (Table 5) was conducted. The analysis revealed two significant clusters. The first involved the constructs employee involvement and employee empowerment, while the second involved the constructs customer orientation and customer closeness. The results of the second round show an improvement over the type of problems found in the

## Table 5. Items Placement Ratios: Second Sorting Round

| THEORETICAL | ACTUAL CATEGORIES: 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | NA | T | TG % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 20 | 1 | | | 1 | | | | | | | | | | | | 22 | 91 |
| 2 | 2 | 8 | | | | | | | | | | | | | | | 10 | 80 |
| 3 | | | 10 | | | | | | | | | | | | | | 10 | 100 |
| 4 | | 4 | | 5 | 1 | | | | | | | | | | | | 10 | 50 |
| 5 | | | | 3 | 7 | | | | | | | | | | | | 10 | 70 |
| 6 | | | | | | 8 | | | | | | | | | | | 8 | 100 |
| 7 | | | | | | | 10 | | | | | | | | | | 10 | 100 |
| 8 | | | | | | | | 8 | | | | | | | | | 8 | 100 |
| 9 | | | | | 1 | | | | 12 | 3 | | | | | | 2 | 18 | 67 |
| 10 | | | | | | | | | 5 | 10 | | | | 1 | | | 16 | 63 |
| 11 | | | | | | | | | | | 14 | | 3 | | | 1 | 18 | 78 |
| 12 | | | | | | | | | | | | 6 | | | | | 6 | 100 |
| 13 | | | | | | | | | | | | | 6 | | | | 6 | 100 |
| 14 | | | | | | | | | | | 1 | | | 14 | | 1 | 16 | 88 |
| 15 | | | | | | | | | | | 1 | | | | 7 | | 8 | 88 |

Total Items Placement: 176 | Hits: 145 | Overall Hit Ratio: 82%

1. Top management support
2. Strategic quality planning
3. Employee training
4. Employee involvement
5. Employee empowerment
6. Employee recognition
7. Quality information availability
8. Quality information usage
9. Customer orientation
10. Customer closeness
11. Product design
12. SPC usage
13. Process design
14. Supplier quality
15. Benchmarking

first round since no scattering patterns were identified. The second round results argue well for any potential internal consistency measurements, because the off-diagonals showed clustering, rather than a scattering of items. Furthermore, an analysis of the two clusters was conducted. Items that were classified in a construct different from where they were intended to be, were reviewed and reworded as needed. Four items belonging to the constructs customer orientation, product design, and supplier quality were found to be too indeterminate (fitting in no category), and were reworded. One additional question suggested by two judges was added to the process design construct.

***Results of Third Sort***

As it was done in the previous two sorting rounds, two judges participated in the third sorting round, which included the reworded items and the new item added to the SPC usage construct. In the third round the inter-judge raw agreement scores averaged 0.81 (Table 6), the initial overall placement ratio of items within the targets constructs was 89 % (Table 7), and the Kappa scores averaged 0.81.

The calculations for the Cohen's Kappa coefficient for the third sorting round are shown below.

$$k = \frac{N_i X_{ii} - \sum_i (X_{i+} X_{+i})}{N_i^2 - \sum_i (X_{i+} X_{+i})} = \frac{(89)(73) - 610}{(89^2) - 610} = 0.8052$$

A summary of the third round inter-judge agreements indices is shown in the third column of Table 3. The value for Kappa coefficient of 0.80 is significantly higher than the value obtained in the second round, and indicates an excellent level

**Table 6. Inter-judge Raw Agreement Scores: Third Sorting Round**

| Judge 6 \ Judge 4 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | | | | | | | | | | | | | | |
| 2 | | 4 | | | | | | | | | | | | | |
| 3 | | | 5 | | | | | | | | | | | | |
| 4 | | | | 3 | | | | | | | | | | | |
| 5 | | | | | 3 | | | | | | | | | | |
| 6 | | | | | | 3 | | | | | | | | | |
| 7 | | | | | | | 5 | | | | | | | | |
| 8 | | | | | | | | 2 | | | | | | | |
| 9 | | | | | | | | | 7 | | | | | | |
| 10 | | | | | | | | | | 5 | | | | | |
| 11 | | | | | | | | | | | 7 | | | | |
| 12 | | | | | | | | | | | | 4 | | | |
| 13 | | | | | | | | | | | | | 3 | | |
| 14 | | | | | | | | | | | | | | 9 | |
| 15 | | | | | | | | | | | | | | | 4 |

| Total Items Placement: 89 | Number of Agreements: 72 | Agreement Ratio: .81 |
|---|---|---|

1. Top management support
2. Strategic quality planning
3. Employee training
4. Employee involvement
5. Employee empowerment
6. Employee recognition
7. Quality information availability
8. Quality information usage
9. Customer orientation
10. Customer closeness
11. Product design
12. SPC usage
13. Process design
14. Supplier quality
15. Benchmarking

**Table 7. Items Placement Ratios: Third Sorting Round**

| | | ACTUAL CATEGORIES | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | NA | T | TG % |
| THEORETICAL | 1 | 20 | 2 | | | | | | | | | | | | | | | 22 | 91 |
| | 2 | 1 | 9 | | | | | | | | | | | | | | | 10 | 80 |
| | 3 | | | 10 | | | | | | | | | | | | | | 10 | 100 |
| | 4 | | | | 8 | 1 | 1 | | | | | | | | | | | 10 | 50 |
| | 5 | 1 | | | 1 | 8 | | | | | | | | | | | | 10 | 70 |
| | 6 | | | | 1 | | 7 | | | | | | | | | | | 8 | 100 |
| | 7 | | | | | | | 10 | | | | | | | | | | 10 | 100 |
| | 8 | | | | 1 | | 1 | | 6 | | | | | | | | | 8 | 100 |
| | 9 | | | | | 1 | | | | 15 | 2 | | | | | | | 18 | 67 |
| | 10 | 1 | | | | | | | | 3 | 12 | | | | | | | 16 | 63 |
| | 11 | | | | | | | | | 1 | | 15 | | | 2 | | | 18 | 78 |
| | 12 | | | | | | | | | | | | 8 | | | | | 6 | 100 |
| | 13 | | | | | | | | | | | | | 6 | | | | 6 | 100 |
| | 14 | | | | | | | | | | | | | | 16 | | | 16 | 88 |
| | 15 | | | | | | | | | | | | | | | 8 | | 8 | 88 |

Total Items Placement: 178 | Hits: 158 | Overall Hit Ratio: 89%

1. Top management support
2. Strategic quality planning
3. Employee training
4. Employee involvement
5. Employee empowerment
6. Employee recognition
7. Quality information availability
8. Quality information usage
9. Customer orientation
10. Customer closeness
11. Product design
12. SPC usage
13. Process design
14. Supplier quality
15. Benchmarking

of agreement beyond chance. The level of item placement ratios averaged 89%. The lowest item placement ratio value was that of 75% for the quality information usage construct, indicating a moderate to good degree of construct validity. The constructs employee training, quality information availability, usage of statistical quality control, process design, supplier quality, and benchmarking obtained a 100% item placement ratio. This placement of items within the target construct shows that a high degree of construct validity and potential reliability were achieved.

The final refinement of the scales for the pilot test was to reword two of the items in the customer closeness construct. The resultant measurement instrument from the three sorting rounds is shown in Appendix B. In the next chapter the test for the quantitative assessment of construct validity and reliability using the large-scale sample is presented.

# CHAPTER 4

# INSTRUMENT DEVELOPMENT: LARGE SCALE DATA ANALYSIS

Identifying and selecting the right respondents for this study played a key role in enabling the results to be useful for improving the effectiveness of quality management practices implementation and to advance quality management theory. Respondents needed possess the ability and occupational position to perceive: (1) the extent to which quality management practices were being implemented, (2) the level of quality performance that was being attained, and (3) their competitive position in relation to competitors or industry leaders in terms of several different core capabilities.

*The Quality Management Division of the American Society for Quality* co-sponsored this phase of the study and provided the mailing list. A stratified sample from the membership of the ASQ was deemed appropriate for the study, since ASQ members are top managers, quality managers, presidents, owners, etc. First, a cover letter on a Quality Management Division letterhead signed by its Chairman and the researcher was sent out. The letter encouraged participation in the study and included the questionnaire that resulted from the pilot test (see Appendix B). This letter was mailed to 2900 ASQ members. Moreover, each of the 2900 randomly selected respondents represented a different discrete unit manufacturing firm. In addition, the letter stated that a benchmark report and a summary of the results would be offered as an incentive to the respondents.

The following paragraphs summarize the composition of the respondents:

Five responses were returned undeliverable. Of the responses received, fourteen were evaluated as unsuitable for the large-scale analysis. In addition, All rejected responses were due to uncompleted surveys, leaving a total of 300 responses usable for a response rate of 10.4% [300 / (2900-5-14)].

The respondents came from companies with SIC codes between 2000 and 3900. Five manufacturing sectors accounted for 55.2 percent of the responses: food and kindred products, chemicals, rubber and plastics, fabricated metal products, and electronic products. Furthermore, the respondents identified their positions and size of the firms. The majority held positions as quality managers at a middle management position and 30 percent identified themselves as owners, presidents, vice-presidents, or CEOs. The majority of the responses came from firms with 500 employees or less (70.5%). Firms with more than 1000 employees accounted for 18% of the sample. Appendix C contains detailed information regarding the demographics of the 300 respondents.

## 4.1 Item Refinement Methodology

The second stage in the instrument development process was the large-scale data analysis of the quality management constructs. The 300 responses from the large-scale survey were analyzed using the following criteria: *simplicity of factor structure, purification, reliability, brevity, convergent validity, discriminant validity,* *and predictive validity.*

Given the exploratory nature of this study, during step 2, the items resulting from the implementation of Q-sort method in the pilot study (Appendix B) were submitted to exploratory factor analysis. The primary reason for the factor analysis was to determine how many latent variables underlie the set of items proposed for the six groups of quality management practices, the internal quality performance, and the competitive capabilities dimensions described in Chapter 2. A second reason was to assess the factors consistency. Following Nunally's (1983) suggestion, Kaiser's eigenvalues greater than 1 were the rule for the number of factors to extract. The amount of variance explained for factors with eigenvalues greater than 1 is greater than the average amount explained by one of the original items. Maximum likelihood was selected as the extraction procedure and the varimax method was utilized for factor rotation. The MEANSUB command was used within SPSS® to replace missing values with the variable mean for the item. Items which did not load at 0.60 or above or with cross-loadings greater than 0.40 were eliminated at this stage to streamline the process. Following, Dillon, Kumar, and Mulani (1987) suggestion that researchers need to consider an item's importance to research objective and its loading during factor interpretation, an exception was made as described in the next paragraph. To facilitate the factor interpretation process, loadings below 0.40 were not reported. Moreover, the stability of the factors was analyzed by measuring the ratio of respondents to items, and the Tinsley and Tinsley guideline of having a minimal ratio between 5 and 10 was followed.

As described by Churchill (1979), during step 2 the scales were purified by examining the corrected-item total correlations of the items with respect to a particular dimension of a specific construct. The item inter-correlation matrices were utilized to discard items if they did not contribute to Cronbach's alpha for the dimension under consideration (Flynn, Schroeder, and Sakakibara, 1995). Items were eliminated if CITC was lower than 0.60. However, items with moderate contribution to alpha (CITC above 0.50) and whose content considered valuable were selected for further analysis. Considering the recommendations by Dillon and Goldstein (1984) caution was used in eliminating items. In addition, the reliability of the remaining items comprising each dimension was examined by using Cronbach's alpha reliability coefficient and the average variance extracted. The average variance extracted measured the amount of variance for the specified indicators accounted by the latent construct (Fornell and Larcker, 1981). In other words, higher variance extracted values occur when the indicators are truly representative of the latent construct. This measure proved complementary to the construct reliability value. Evidence for following this tactic was suggested by Baggozi and Yi (1992) who justified the value of 0.50 for the minimum variance extracted for a construct.

In addition, discriminant validity was assessed by examining the cross-loading values during factor analysis. The test for convergent validity was accomplished by the exploratory factor analysis. The factor structure testifies to convergence validity. Predictive validity was assessed by correlating composite measures of management based quality practices, employee based quality practices, customer based quality practices, information based quality practices, product/process based quality practices, and supplier based quality practices with the measure of internal quality performance namely quality failures. The predictive validity of competitive capabilities was evaluated based on correlations between the scales and a measure of profitability and competitive position (i.e., Relative to our industry/competitors our profits (competitive position) are (is): 1. Much lower, 2. Lower, 3. About the same, 4. Higher, 5. Much higher).

### 4.2 Results of the Analysis

The following sections present the results of applying the methodology described in section 4.1 to the 300 usable responses received via the questionnaire mailing. Sections 4.2.1 to 4.2.8 present the outcomes related to each practice of interest: management based quality practices, employee based quality practices, customer based quality practices, information based quality practices, product/process bases quality practices, supplier based quality practices, internal quality performance, and competitive capabilities. In each section three tables are given. The pilot study items regarding the construct and their codings are listed in the first table. Factor loadings for the pilot study items are listed in the second table. The dimension-level corrected-item total correlation, and Cronbach's alpha reliability coefficients before and after purification are presented in the third table.

#### 4.2.1 Management Based Quality Practices

The items corresponding to the domain of management based quality practices and their codes are presented in Table 8. The purification process began with exploratory factor analysis using principal components as the means of extraction and varimax as the method of rotation. The ratio of respondents to items for the management based quality practices was 17.6, justifying the use of exploratory factor analysis. As expected, factor analysis revealed two factors: top management support (TMS) and strategic quality planning (SQP) with relative high loadings. However, items MB6 and MB12 proved to be exceptions with loadings below 0.60 and cross-loadings values above 0.40 (see Table 9). Therefore, both items were eliminated from further analysis. The factor matrices in Table 9 for the remaining 10 items show that they are unifactorial. In other words, the items in each factor load only on that factor. These results can be used as tentative evidence for discriminant validity within the factor in this category.

The remaining items for each factor were subjected to reliability analysis. Items were considered for elimination, if corrected-total item correlation was less than or equal to 0.60. The domain sampling model is that all items, that belong to the domain of the concept, have an equal amount of common core. If all items in a measure are drawn from the domain of a single construct, responses to those items should be highly intercorrelated. The CITC index provides a measure of this correlation (Churchill, 1979). The CITCs for each item in the top management support factor are shown on Table 10. All eleven items in this construct had a CITC above 0.60 and no item could be eliminated without reducing the reliability. The Cronbach's alpha coefficient for the top management support construct was 0.95. The average variance extracted for this scale was 66%. The CITCs for the strategic quality management construct had values ranging from 0.79 to 0.83 (Table 11) and all four items were retained. Cronbach's alpha coefficient for the strategic quality

**Table 8. Purification for Management Based Quality Practices- Large Scale**

| ITEMS | CODE |
|---|---|
| Top management takes responsibility for the company's quality performance | MB1 |
| Top management is visibly involved in improving company's quality performance | MB2 |
| Top management drives the company's efforts towards excellence in quality | MB3 |
| Top management assigns a higher priority to quality than to cost and scheduling objectives | MB4 |
| Top management provides a work environment that is supportive of the quality mission and policies | MB5 |
| Top management includes quality issues in their meetings' agenda | MB6 |
| Top management actions encourage a culture of trust | MB7 |
| Top management actions encourage change for the better | MB8 |
| Top management actions show that customer satisfaction is important | MB9 |
| Top management takes responsibility for communication and employee understanding of quality mission and policies | MB10 |
| Top management allocates adequate resources to improve company's quality performance | MB11 |
| Top management considers company's quality performance as a major factor in their performance evaluation | MB12 |
| Top management provides a clear vision for achieving quality excellence | MB13 |
| Our strategic plan supports long term (3 years or more) quality improvement efforts | MB14 |
| Our strategic plan supports short term (1-2 years) quality improvement efforts | MB15 |
| Our strategic plan is supported by our company's quality mission and policies | MB16 |
| In our strategic plan quality is an integral part | MB17 |

planning construct was 0.92. As a result, no item could be eliminated without reducing reliability. Overall, the average variance extracted for this scale was 81%.

In addition to the factor analysis, as a further test, for convergent validity, the lowest correlation within a construct was found and tested for whether it was different from zero. The lowest correlations for top management support was 0.41 (Table 12), and for strategic quality planning

**Table 9. Purification for Management Based Quality Practices- Factor Loadings (Large Scale)**

| ITEMS | Factor 1 | Factor 2 |
|---|---|---|
| MB1 | .7762 | |
| MB2 | .7918 | |
| MB3 | .7856 | |
| MB4 | .7041 | |
| MB5 | .7890 | |
| **MB6*** | **.5460** | **.4451** |
| MB7 | .7632 | |
| MB8 | .7253 | |
| MB9 | .6743 | |
| MB10 | .6874 | |
| MB11 | .6808 | |
| **MB12*** | **.5441** | **.4688** |
| MB13 | .6914 | |
| MB14 | | .8436 |
| MB15 | | .8500 |
| MB16 | | .8160 |
| MB17 | | .7975 |

*Item dropped

**Table 10. Purification for Management Based Quality Practices- Corrected Item Total Correlation for (CITC) Top Management Support**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| MB1 | .7851 | α = .9479 | 66% | 0.41** |
| MB2 | .8107 | | | |
| MB3 | .8235 | | | |
| MB4 | .6937 | | | |
| MB5 | .8201 | | | |
| MB7 | .7647 | | | |
| MB8 | .7751 | | | |
| MB9 | .6597 | | | |
| MB10 | .7964 | | | |
| MB11 | .7115 | | | |
| MB13 | .7995 | | | |

**Significant at p<0.01

**Table 11. Purification for Management Based Quality Practices- Corrected Item Total Correlation for (CITC) Strategic Quality Planning**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| MB14 | .7967 | α = .9204 | 81% | 0.70** |
| MB15 | .8352 | | | |
| MB16 | .8251 | | | |
| MB17 | .8088 | | | |

**Significant at p<0.01

**Table 12. Correlation Matrix for Top Management Support Items**

| | MB 1 | MB 2 | MB 3 | MB 4 | MB 5 | MB 7 | MB 8 | MB 9 | MB 10 | MB 11 | MB 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MB1 | 1 | | | | | | | | | | |
| MB2 | 0.76 | 1 | | | | | | | | | |
| MB3 | 0.73 | 0.83 | 1 | | | | | | | | |
| MB4 | 0.57 | 0.60 | 0.59 | 1 | | | | | | | |
| MB5 | 0.70 | 0.68 | 0.66 | 0.69 | 1 | | | | | | |
| MB7 | 0.58 | 0.59 | 0.61 | 0.57 | 0.68 | 1 | | | | | |
| MB8 | 0.59 | 0.59 | 0.64 | 0.52 | 0.72 | 0.78 | 1 | | | | |
| MB9 | 0.55 | 0.53 | 0.57 | 0.41 | 0.58 | 0.56 | 0.63 | 1 | | | |
| MB10 | 0.68 | 0.71 | 0.74 | 0.56 | 0.66 | 0.60 | 0.63 | 0.57 | 1 | | |
| MB11 | 0.57 | 0.57 | 0.57 | 0.56 | 0.66 | 0.57 | 0.56 | 0.50 | 0.59 | 1 | |
| MB13 | 0.62 | 0.66 | 0.69 | 0.65 | 0.65 | 0.66 | 0.63 | 0.52 | 0.70 | 0.67 | 1 |

**Table 13. Correlation Matrix for Strategic Quality Planning Items**

| | MB 14 | MB 15 | MB 16 | MB 17 |
|---|---|---|---|---|
| MB14 | 1 | | | |
| MB15 | 0.78 | 1 | | |
| MB16 | 0.70 | 0.76 | 1 | |
| MB17 | 0.71 | 0.72 | 0.79 | 1 |

0.70 (Table 13). Both correlations were significant at $p < 0.01$, providing further evidence for convergence validity. To test for predictive validity, top management support and strategic quality management were correlated with a measure of internal quality performance namely quality failures (Table 14). Both correlation coefficients proved significant (TMS-QF=-0.30; SQP-QF=-0.29) at $p<0.01$.

After the large scale analysis for the management based quality practices, 15 items and 2 scales were proposed. Overall, two items were eliminated. The number of items varies from 4 for strategic quality planning to 11 for the top management support. In addition, both scales had high reliabilities and behave well when subjected to an assortment of validity tests.

### 4.2.2 Employee Based Quality Practices

The items corresponding to the domain of employee based quality practices after the pilot study, and the codes are shown in Table 15. Again the purification process began with an exploratory factor analysis using principal components as the mean of extraction and varimax as the method of rotation. The ratio of respondents to items is 15.78, proved adequate for exploratory factor analysis. As expected, factor analysis revealed four dimensions *employee training* (ET) , *employee involvement* (EI), *employee empowerment* (EE), and *employee recognition* (ER). The loadings were moderately high for each four factors, with the exception of items EB3, EB4, EB6, and EB9 which had loadings below 0.60, and cross-loadings above 0.40 (see Table 16). Therefore the four items were eliminated from further analysis.

**Table 14. Correlations Coefficients for Predictive Validity Test**

| Factor | Quality Failures (QF) | Profitability (P) | Competitive Position (COP) |
|---|---|---|---|
| TMS | -0.30** | | |
| SQP | -0.29** | | |
| ET | -0.28** | | |
| EI | -0.19** | | |
| EE | -0.34** | | |
| ER | -0.27** | | |
| CO | -0.37** | | |
| FC | -0.16** | | |
| FCC | -0.25** | | |
| QIA | -0.42** | | |
| B | -0.30** | | |
| PD | -0.32** | | |
| PDC | -0.23** | | |
| SQ | -0.31** | | |
| CP | | 0.22** | |
| PP | | 0.33** | |
| VCQ | | 0.18** | |
| DD | | 0.21** | |
| PI | | | 0.23** |
| QF | | | -0.28** |
| UMC | | | -0.15* |
| LT | | | -0.17** |

**Significant at p<.01
* Significant at p<.05

The remaining items for each factor were subjected to reliability analysis. Items were considered for elimination if the corrected-total item correlation was less or equal to 0.60 Corrected-item total correlations (CITCs) for the employee training construct are shown in Table 17. In assessing CITC, the employee training scale had two items with CITCs greater than 0.60, while item EB5 had a CITC slightly lower than 0.60. It was decided to retain the item because its elimination could have affected the content validity of the construct. The Cronbach's alpha reliability coefficient for this construct was 0.80. The average variance extracted for this scale was 71%.

Moreover, all the CITCs for the employee involvement construct had values above 0.60 (Table 18). The Cronbach's alpha coefficient alpha for this construct was 0.82, and no item could be eliminated without reducing reliability. The average variance extracted for this factor was 85%. The employee empowerment scale had four out of its five items with CITCs greater than 0.60 (Table 19). Item EB10 has a low CITC value (0.4982) and eliminated. The Cronbach's alpha coefficient for the employee empowerment construct was 0.90, and no item could be eliminated without reducing reliability. The average variance extracted for this factor was 75%. All five employee recognition items were retained since the CITCs were above 0.70 (Table 20). The Cronbach's alpha coefficient for this construct was 0.91. Reliability improvement could not be achieved by eliminating any item. The average variance extracted for this factor was 74%.

**Table 15. Purification for Employee Based Quality Practices- Large Scale**

| ITEMS | CODE |
|---|---|
| Training in quality is provided to all employees | EB1 |
| Training in basic quality tools (histograms, problem solving, etc.) is provided to all employees | EB2 |
| Our employees receive training in specific job skills | EB3 |
| Training in multiple skills is given to our hourly workers | EB4 |
| Training in advanced quality techniques (e.g. design of experiments) is provided to those employees who require it | EB5 |
| Throughout the company employees participate in our continuous improvement efforts | EB6 |
| Employee participation in our suggestion programs is ongoing | EB7 |
| Employee suggestions receive rapid attention and quick response | EB8 |
| We use teams to involve our employees in our continuous improvement efforts | EB9 |
| Our hourly workers inspect the quality of their own work (inspection is not the responsibility of an inspector) | EB10 |
| Our hourly workers fix problems they identify | EB11 |
| Our hourly workers are provided with the necessary resources to fix quality problems they identify | EB12 |
| Our hourly workers are empowered to make decisions regarding the managing of their workplace | EB13 |
| Our hourly workers are empowered to make improvements related with their immediate and extended processes | EB14 |
| Our employees receive recognition for outstanding quality performance | EB15 |
| We recognize our employees contributions to improve company's quality performance | EB16 |
| Employee's suggestions for quality improvement are rewarded | EB17 |
| We give our employees recognition for contribution to improve customer satisfaction | EB18 |
| We recognize teams contributions to our continuous improvement efforts | EB19 |

**Table 16. Purification for Employee Based Quality Practices- Factor Loadings**

| ITEMS | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|---|---|---|---|---|
| EB1 | .7338 | | | |
| EB2 | .7412 | | | |
| **EB3*** | **.5141** | **.4749** | | |
| **EB4*** | **.4161** | **.5254** | **.4374** | |
| EB5 | .7054 | | | |
| **EB6*** | **.5951** | | | **.4184** |
| EB7 | | .7272 | | |
| EB8 | | .7780 | | |
| **EB9*** | **.5441** | | | **.4617** |
| EB10 | | | .5508 | |
| EB11 | | | .8555 | |
| EB12 | | | .7563 | |
| EB13 | | | .7485 | |
| EB14 | | | .7378 | |
| EB15 | | | | .7291 |
| EB16 | | | | .7285 |
| EB17 | | | | .7700 |
| EB18 | | | | .7417 |
| EB19 | | | | .6648 |

*Item dropped

**Table 17. Purification for Employee Based Quality Practices- Corrected Item Total Correlation for (CITC) Employee Training**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| EB1 | .6584 | α = .8007 | 71% | 0.51** |
| EB2 | .6681 | | | |
| EB5 | .5728 | | | |

** Significant at p<.01

**Table 18. Purification for Employee Based Quality Practices- Corrected Item Total Correlation for (CITC) Employee Involvement**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| EB7 | .6976 | α = .8213 | 85% | 0.70** |
| EB8 | .6976 | | | |

** Significant at p<.01

**Table 19. Purification for Employee Based Quality Practices- Corrected Item Total Correlation for (CITC) Employee Empowerment**

| ITEMS | CITC | Reliability | Reliability Retained Items | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|---|
| **EB10** | **.4982*** | α = .8651 | | | |
| EB11 | .7505 | | α = .9000 | 75% | 0.60** |
| EB12 | .7137 | | | | |
| EB13 | .7701 | | | | |
| EB14 | .7448 | | | | |

* Item Dropped
** Significant at p<.01

**Table 20. Purification for Employee Based Quality Practices- Corrected Item Total Correlation for (CITC) Employee Recognition**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| EB15 | .8205 | α = .9111 | 74% | 0.57** |
| EB16 | .8327 | | | |
| EB17 | .7416 | | | |
| EB18 | .7720 | | | |
| EB19 | .7101 | | | |

**Significant at p<.01

Overall, 5 items were eliminated from the employee based quality practices category. The factor matrices in Table 16 for the remaining 16 items show that they are unifactorial and can be used as tentative evidence for discriminant validity within the factor in this category.

The lowest correlations for employee training, employee involvement, employee empowerment, and employee recognition were 0.51, 0.70, 0.60, and 0.57 (Tables 21 to 24). All correlations were significant at $p < 0.01$ providing evidence for convergence validity. To test for predictive validity, the four factors were correlated with a measure of internal quality performance named quality failures. The 4 correlation coefficients proved significant (ET-QF=-0.28; EI-QF=-0.19; EE-QF=-0.34; ER-QF=-0.27) at $p<0.01$ (Table 14).

After the large scale analysis for the employee based quality practices, 14 items and 4 scales were proposed. The number of items varies from 2 for employee involvement to 5 for the employee recognition. The four scales had good reliabilities and behaved well when subjected to an assortment of validity tests.

### 4.2.3. Customer Based Quality Practices

The eighteen items corresponding to the domain of customer based quality practices and codes are shown on Table 25. The ratio of respondents to items is

**Table 21. Correlation Matrix for Employee Training Items**

| | EB1 | EB2 | EB5 |
|---|---|---|---|
| EB1 | 1 | | |
| EB2 | .64 | 1 | |
| EB5 | .51 | .52 | 1 |

**Table 22. Correlation Matrix for Employee Involvement Items**

| | EB7 | EB8 |
|---|---|---|
| EB7 | 1 | |
| EB8 | .70 | 1 |

**Table 23. Correlation Matrix for Employee Empowerment Items**

| | EB 11 | EB 12 | EB 13 | EB 14 |
|---|---|---|---|---|
| EB11 | 1 | | | |
| EB12 | .71 | 1 | | |
| EB13 | .66 | .63 | 1 | |
| EB14 | .60 | .64 | .80 | 1 |

**Table 24. Correlation Matrix for Employee Recognition Items**

| | EB 15 | EB 16 | EB 17 | EB 18 | EB 19 |
|---|---|---|---|---|---|
| EB15 | 1 | | | | |
| EB16 | .83 | 1 | | | |
| EB17 | .66 | .66 | 1 | | |
| EB18 | .67 | .69 | .71 | 1 | |
| EB19 | .66 | .67 | .57 | .61 | 1 |

**Table 25. Purification for Customer Based Quality Practices- Large Scale**

| ITEMS | CODE |
|---|---|
| We are committed to satisfy customer's needs and expectations | CB1 |
| Customer satisfaction drives our company's quality improvement actions | CB2 |
| We know which attributes of our products and services our customers' value most | CB3 |
| We seek our customers feedback about company's performance in satisfying their needs and expectations | CB4 |
| We encourage our employees to satisfy customers' needs and expectations | CB5 |
| Our employees are aware of the need to satisfy to our customers' needs and expectations | CB6 |
| We involve our customers in our continuous quality improvement efforts | CB7 |
| We encourage our customers to give us feedback about current and future requirements | CB8 |
| We measure the levels of customer satisfaction systematically and regularly | CB9 |
| We know how our customers use our products | CB10 |
| Our customers and top management are in direct contact | CB11 |
| Our customers and middle managers are in direct contact | CB12 |
| Our customers regularly visit our plants | CB13 |
| Our customers are only in direct contact with our marketing/sales department | CB14 |
| Our customers are personally contacted at least once a year by someone else than a sales representative | CB15 |
| Our customer contacts strategy is frequent and pervasive | CB16 |
| Our customers are in direct contact with all our functional departments | CB17 |
| Managers visit our customer's site regularly | CB18 |

16.6, thereby very adequate for exploratory factor analysis. Principal components factor analysis with varimax rotation revealed four factors named customer orientation (CO), customer knowledge (CK), functional contact (FC), and frequency of customer contact (FCC). The complex and multidimensional nature of customer based quality practices is revealed by the four emerged factors during the principal components factor analysis procedure. The loadings were relatively high for each factor, with the exception of items CB4, CB7, CB8, CB9, and CB11 all with loadings below 0.60 (see Table 26). Moreover, items CB4 and CB8 exhibited moderately cross-loadings with factors 2 and 3. Both items were eliminated from further analysis. Items CB7, CB9, and CB11 had relatively low loadings. However, these items were considered important for the content definition of each factor and were retained for further analysis. The factor matrices in Table 26 for the remaining 16 items show that they are unifactorial and can be used as tentative evidence for discriminant validity within the factor in this category.

The remaining items in each factor were subjected to reliability analysis. Items were considered for elimination if the corrected-total item correlation was less or equal to 0.60. Corrected-item total correlations (CITCs) for the customer orientation construct are shown on Table 27. This construct had four items with CITCs greater than 0.69. Item CB7 had a CITC lower than 0.60 and eliminated from further consideration. The Cronbach's alpha reliability coefficient for the four customer orientation items was 0.89. The average variance extracted for this scale was 73%.

CITCs for the three items of the customer knowledge construct had values below 0.60 (Table 28). The Cronbach's alpha coefficient for this factor was

**Table 26. Purification for Customer Based Quality Practices- Factor Loadings**

| ITEMS | Factor 1 | Factor 2 | Factor 3 | Factor 4 |
|---|---|---|---|---|
| CB1 | .7478 | | | |
| CB2 | .7121 | | | |
| CB3 | | | .7033 | |
| **CB4*** | **.4099** | **.4024** | **.5599** | |
| CB5 | .8183 | | | |
| CB6 | .8520 | | | |
| CB7 | .4684 | | | |
| **CB8*** | **.5396** | | **.4601** | |
| CB9 | | | .5588 | |
| CB10 | | | .7111 | |
| CB11 | | | | .5806 |
| CB12 | | | | .6907 |
| CB13 | | | | .6226 |
| CB14 | | | | .7393 |
| CB15 | | .8189 | | |
| CB16 | | .7703 | | |
| CB17 | | .6404 | | |
| CB18 | | .6207 | | |

*Item dropped

**Table 27. Purification for Customer Based Quality Practices- Corrected Item Total Correlation for (CITC) Customer Orientation**

| ITEMS | CITC | Reliability | Reliability Retained Items | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|---|
| CB1 | .6934 | α = .8674 | α = .8900 | 73% | 0.44** |
| CB2 | .7316 | | | | |
| CB5 | .7550 | | | | |
| CB6 | .7435 | | | | |
| **CB7** | **.5704** | | | | |

** Significant at p<.01

**Table 28. Purification for Customer Based Quality Practices- Corrected Item Total Correlation for (CITC) Knowledge of Customer**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| **CB3** | **.5253*** | α = .6586 | - | - |
| **CB9** | **.4783*** | | | |
| **CB10** | **.4242*** | | | |

* Item dropped

**Table 29. Purification for Customer Based Quality Practices- Corrected Item Total Correlation for (CITC) Functional Contact**

| ITEMS | CITC | Reliability | Reliability Retained Items | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|---|
| CB11 | .5711 | α =.7633 | α=.7904 | 68% | 0.47** |
| CB12 | .6287 | | | | |
| CB13 | .6005 | | | | |
| **CB14** | **.4677*** | | | | |

* Item dropped

** Significant at p<.01

relatively poor $\alpha$ (=0.65) and the whole construct was eliminated from further consideration.

Two of the four items (CB11 and CB14) of the functional contact scale exhibited CITCs values lower than 0.60 (Table 29). Item CB14 was dropped from further consideration. It was decided to keep item CB11 to maintain the content validity of this factor. The Cronbach's alpha coefficient functional contact factor was 0.79, and no additional item could be eliminated without reducing reliability. The average variance extracted for this scale was 68%.

All four items in the frequency of customer contact construct were retained because the CITCs values were above 0.64 (Table 30). The Cronbach's alpha coefficient for this factor was 0.83. Reliability improvement could not be achieved by eliminating any item. The average variance extracted for this scale was 66%. Overall, there were 7 items that were eliminated from the customer based quality practices constructs.

**Table 30. Purification for Customer Based Quality Practices- Corrected Item Total Correlation for (CITC) Frequency of Customer Contact**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| CB15 | .6617 | $\alpha$ = .8300 | 66% | .042** |
| CB16 | .6686 | | | |
| CB17 | .6485 | | | |
| CB18 | .6467 | | | |

**Significant at p<.01

The lowest correlations for customer orientation, functional contact, and frequency of customer contact, were 0.44, 0.47, and 0.42 (Tables 31 to 33). All correlations were significant at $p < 0.01$ providing evidence for convergence validity. To test for predictive validity, the three factors were correlated with a measure of internal quality performance named quality failures. The 3 correlation coefficients were significant (CO-QF=-0.37; FC-QF=-0.16; FCC-QF=-0.25) at $p<0.01$ (Table 14).

**Table 31. Correlation Matrix for Customer Orientation Items**

| | CB1 | CB2 | CB5 | CB6 |
|---|---|---|---|---|
| CB1 | 1 | | | |
| CB2 | .70 | 1 | | |
| CB5 | .60 | .61 | 1 | |
| CB6 | .58 | .58 | .79 | 1 |

**Table 32. Correlation Matrix for Functional Contact Items**

| | CB 11 | CB 12 | CB 13 |
|---|---|---|---|
| CB11 | 1 | | |
| CB12 | .55 | 1 | |
| CB13 | .47 | .54 | 1 |

**Table 33. Correlation Matrix for Frequency of Customer Contact Items**

| | CB 15 | CB 16 | CB 17 | CB 18 |
|---|---|---|---|---|
| CB15 | 1 | | | |
| CB16 | .66 | 1 | | |
| CB17 | .49 | .52 | 1 | |
| CB18 | .52 | .49 | .61 | 1 |

After the large scale analysis for the customer based quality practices, 11 items and 3 scales were proposed. The number of items varies from 3 for functional contact to 4 for the customer orientation and frequency of customer contact. The three scales had good reliabilities and behave well when subjected to an assortment of validity tests.

**4.2.4. Information Based Quality Practices**

The 15 items corresponding to the domain of information based quality practices and the codes are shown on Table 34. The ratio of respondents to items is 20, proved very adequate for exploratory factor analysis. The emerged factors in Table 35 were identified as quality information availability (QIA) and benchmarking (B). Surprisingly, respondents did not separate the issues of availability and usage of quality information as suggested in the literature, and should explored in future

**Table 34. Purification for Information Based Quality Practices- Large Scale**

| ITEMS | CODE |
|---|---|
| Quality information (quality costs, rework, customer complaints, etc.) Is systematically and regularly collected | IB1 |
| Quality information (quality costs, rework, customer complaints, etc.) is available on time | IB2 |
| Quality information is (control charts, histograms, etc.) displayed on the shop floor at the majority of the work stations | IB3 |
| Productivity and quality reports are readily available on the production process critical points | IB4 |
| Quality information is readily available to managers and supervisors | IB5 |
| Work place's quality performance information is available to hourly workers | IB6 |
| Quality information is used at the right time by top management in decision making | IB7 |
| Quality information is used at the right time by middle management in planning and control | IB8 |
| Our hourly workers use quality information to control and improve quality at their work stations | IB9 |
| Quality information is used at the right time to identify company wide improvement opportunities | IB10 |
| We study the "best product development practices" of other companies to get ideas how to do things better | IB11 |
| We compare our current quality levels for products and services with those of competitors and/or industry leaders | IB12 |
| We study the best "quality practices" of other companies to get ideas to improve our quality performance | IB13 |
| We benchmark the best "customer service practices" with recognized industry leaders | IB14 |
| We study the "best production process design practices" of other companies to get ideas how to do things better | IB15 |

**Table 35. Purification for Information Based Quality Practices- Factor Loadings**

| ITEMS | Factor 1 | Factor 2 |
|---|---|---|
| IB1 | .7574 | |
| IB2 | .7759 | |
| IB3 | .5764 | |
| IB4 | .7414 | |
| IB5 | .8019 | |
| IB6 | .7588 | |
| IB7 | .7535 | |
| IB8 | .7745 | |
| IB9 | .6722 | |
| IB10 | .7060 | |
| IB11 | | .8663 |
| IB12 | | .7998 |
| IB13 | | .8477 |
| IB14 | | .8411 |
| IB15 | | .8450 |

**Table 36. Purification for Information Based Quality Practices- Corrected Item Total Correlation for (CITC) Quality Information Availability**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| IB1 | .6576 | $\alpha$ = .9215 | 69% | 0.36** |
| IB2 | .6925 | | | |
| IB3 | .6032 | | | |
| IB4 | .7364 | | | |
| IB5 | .7192 | | | |
| IB6 | .7269 | | | |
| IB7 | .7708 | | | |
| IB8 | 7732 | | | |
| IB9 | .6853 | | | |
| IB10 | .7049 | | | |

**Significant at p<.01

research. The loadings for all fifteen items were relatively high with values above 0.60, with the exception of item IB3 with a loading value of 0.58. Given the importance of this item for the content of the factor, it was decided to retain it for further analysis. The factor matrices in Table 35 for the 15 items show that they are unifactorial, and can be used as tentative evidence for discriminant validity within the factor in this category.

Next, all items in each of the two factors were subjected to reliability analysis. Corrected-item total correlations (CITCs) for the quality information availability are shown in Table 36. All the CITCs values were above 0.60 and no item eliminated at this stage. The Cronbach's alpha coefficient for the quality information availability factor was 0.92, and this reliability could not be further improved by eliminating any item. The average variance extracted for the quality information availability was 69%. The CITCs values for the benchmarking factor are shown in Table 37. All five CITCs values were above 0.72. As a result no items were eliminated. The Cronbach's alpha coefficient for the benchmarking construct was 0.92. Reliability could not be further improved by eliminating any item. The average variance extracted for the benchmarking scale was 76%.

To test for convergent validity, the lowest correlation within a construct was found and tested if it was different from zero. The lowest correlations for quality information availability, and benchmarking were 0.36, and 0.60 (Tables 38 and 39). All correlations were significant at $p < 0.01$, providing evidence for convergence

**Table 37. Purification for Information Based Quality Practices- Corrected Item Total Correlation for (CITC) Benchmarking**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| IB11 | .8031 | | | |
| IB12 | .7226 | | | |
| IB13 | .8189 | α = .9190 | 76% | 0.60** |
| IB14 | .8112 | | | |
| IB15 | .8056 | | | |

**Significant at p<.01

**Table 38. Correlation Matrix for Quality Information Availability Items**

| | IB1 | IB2 | IB3 | IB4 | IB5 | IB6 | IB7 | IB8 | IB9 | IB 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| IB1 | 1 | | | | | | | | | |
| IB2 | .78 | 1 | | | | | | | | |
| IB3 | .36 | .37 | 1 | | | | | | | |
| IB4 | .49 | .52 | .61 | 1 | | | | | | |
| IB5 | .60 | .63 | .40 | .60 | 1 | | | | | |
| IB6 | .50 | .51 | .52 | .60 | .69 | 1 | | | | |
| IB7 | .49 | .54 | .51 | .59 | .53 | .58 | 1 | | | |
| IB8 | .51 | .53 | .46 | .58 | .55 | .55 | .83 | 1 | | |
| IB9 | .37 | .41 | .52 | .58 | .50 | .61 | .60 | .65 | 1 | |
| IB10 | .52 | .53 | .41 | .51 | .50 | .51 | .70 | .69 | .54 | 1 |

**Table 39. Correlation Matrix for Strategic Benchmarking Items**

| | IB 11 | IB 12 | IB 13 | IB 14 | IB 15 |
|---|---|---|---|---|---|
| IB11 | 1 | | | | |
| IB12 | .65 | 1 | | | |
| IB13 | .75 | .68 | 1 | | |
| IB14 | .69 | .65 | .73 | 1 | |
| IB15 | .73 | .60 | .71 | .79 | 1 |

validity. To test for predictive validity, the two factors were correlated with a measure of internal quality performance named quality failures. The 2 correlation coefficients were significant (QIA-QF=-0.42; B-QF=-0.30) at p<0.01 (Table 14).

After the large scale analysis for the information based quality practices, 15 items and 2 scales are proposed. Overall, no items were eliminated for the information based quality practices constructs. The number of items varies from 5 for benchmarking to 10 for the quality information availability. The two scales had good reliabilities, and behaved well when subjected to an assortment of validity tests.

### 4.2.5 Product/Process Based Quality Practices

The content of the product/process based quality practices domain is represented by the 13 items shown in Table 40. The ratio of respondents to items was 23, proved very adequate for exploratory factor analysis. Principal components factor analysis (Table 41) resulted in two factors named product design (PD), and process design and control (PDC). The factor loadings were relatively high with values ranging between 0.62 and 0.82. One item, PB10 exhibited loadings below 0.60 and moderately high cross-loadings between the two factors, and as a result, PB10 was eliminated from further analysis. The factor matrices in Table 41 for the remaining 12 items show that they are unifactorial, and can be used as tentative evidence for discriminant validity within the factor in this category.

Afterwards, the remaining items for each factor were subjected to reliability analysis. The CITCs values for the product design factor with the exception of item PB6 had values above 0.60 (Table 42). An analysis of item PB6 revealed that its content was important for the content definition of the factor and retained. The

**Table 40. Purification for Product/Process Based Quality Practices-Large Scale**

| ITEMS | CODE |
|---|---|
| Our product design process incorporates manufacturability as an important component | PB1 |
| Our product design process generates product and service design requirements that conform to customers needs | PB2 |
| We involve external suppliers early in the product design process | PB3 |
| Our product design process applies customer-driven techniques (such as quality function deployment) | PB4 |
| Our product design process is supported by a multidisciplinary approach (marketing, manufacturing, R&D, etc.) | PB5 |
| Our product design process addresses environmental and legal concerns | PB6 |
| In our production process we apply statistical process control techniques | PB7 |
| Our equipment and machines are under statistical quality control | PB8 |
| In our production process variance is reduced through the implementation of SPC techniques | PB9 |
| Our process design provides specifications that are clear and easy to understand | PB10 |
| Our process design integrates quality engineering techniques (such as Taguchi methods) | PB11 |
| Our process design incorporates error prevention techniques (such as Shingo, Poka Yoke) | PB12 |
| Our production processes are designed to be foolproof | PB13 |

**Table 41. Purification for Product/Process Based Quality Practices- Factor Loadings.**

| ITEMS | Factor 1 | Factor 2 |
|---|---|---|
| PB1 | .7905 | |
| PB2 | .7997 | |
| PB3 | .7248 | |
| PB4 | .6216 | |
| PB5 | .7017 | |
| PB6 | .6853 | |
| PB7 | | .7970 |
| PB8 | | .8250 |
| PB9 | | .8070 |
| **PB10*** | **.4127** | **.4820** |
| PB11 | | .8170 |
| PB12 | | .7782 |
| PB13 | | .6908 |

* Item Dropped

Cronbach's alpha reliability coefficient for the product design factor was 0.85. The average variance extracted for this scale was 57%. CITCs values for the process design and control construct were all above 0.61 (Table 43). The Cronbach's alpha coefficient was 0.90. Therefore, reliability could not be improved by eliminating any item. The average variance extracted for this scale was 70%. Overall, one item was eliminated from the product/process based quality management constructs.

**Table 42. Purification for Product/Process Based Quality Practices-Corrected Item Total Correlation for (CITC) Product Design**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| PB1 | .6860 | α = 8545 | 57% | 0.34** |
| PB2 | .6587 | | | |
| PB3 | .6398 | | | |
| PB4 | .6054 | | | |
| PB5 | .6342 | | | |
| PB6 | .5386 | | | |

**Significant at p<.01

**Table 43. Purification for Product/Process Based Quality Practices-Corrected Item Total Correlation for (CITC) Process Design and Control**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| PB7 | .7179 | α = .9005 | 70% | 0.40** |
| PB8 | .7716 | | | |
| PB9 | .7616 | | | |
| PB11 | .7568 | | | |
| PB12 | .6973 | | | |
| PB13 | .6160 | | | |

**Significant at p<.01

Convergent validity was tested using the lowest correlation within a construct and checking if it was different from zero. The lowest correlations for product design, and process design and control were 0.34, and 0.40 (Tables 44 and 45). All correlations were significant at $p < 0.01$, providing evidence for convergence validity. To test for predictive validity, the two factors were correlated with a measure of internal quality performance named quality failures. The 2 correlation coefficients were significant (PD-QF=-0.32; PDC-QF=-0.23) at $p<0.01$ (Table 14).

After the large scale analysis for the product/process based quality practices, 12 items and 2 scales are proposed. The number of items is six for both scales. The two scales had good reliabilities and behaved well when subjected to an assortment of validity tests.

### 4.2.6 Supplier Based Quality Practices

The six items corresponding to the domain of supplier based quality practices and their codes are shown on Table 46. The ratio of respondents to items is 50, very adequate for exploratory factor analysis. As expected factor analysis revealed one factor named suppliers relationships (SR). The loadings were relatively high for this factor with values above 0.67 (see Table 47). The factor vector in Table 33 for the 6 items show that they are unifactorial, and can be used as tentative evidence for discriminant validity within the factor in this category.

**Table 44. Correlation Matrix for Product Design Items**

| | PB1 | PB2 | PB3 | PB4 | PB5 | PB 6 |
|---|---|---|---|---|---|---|
| PB1 | 1 | | | | | |
| PB2 | .67 | 1 | | | | |
| PB3 | .51 | .53 | 1 | | | |
| PB4 | .49 | .44 | .56 | 1 | | |
| PB5 | .48 | .44 | .48 | .50 | 1 | |
| PB6 | .46 | .43 | .36 | .34 | .51 | 1 |

**Table 45. Correlation Matrix for Process Design and Control Items**

| | PB1 | PB8 | PB9 | PB 11 | PB 12 | PB 13 |
|---|---|---|---|---|---|---|
| PB7 | 1 | | | | | |
| PB8 | .73 | 1 | | | | |
| PB9 | .77 | .76 | 1 | | | |
| PB11 | .53 | .63 | .60 | 1 | | |
| PB12 | .49 | .51 | .48 | .76 | 1 | |
| PB13 | .40 | .48 | .46 | .59 | .67 | 1 |

**Table 46. Purification for Supplier Based Quality Practices- Large Scale**

| ITEMS | CODE |
|---|---|
| Our primary criteria to select suppliers is quality not price | SB1 |
| Our supplier relationships are focused on the long term | SB2 |
| Our supplier relationships have achieved high levels of confidence and trust | SB3 |
| Our suppliers are readily to participate in solving quality problems | SB4 |
| We work with our suppliers to improve each other's processes | SB5 |
| Our suppliers are involved in our continuous improvement effort | SB6 |

**Table 47. Purification for Supplier Based Quality Practices – Factor Loadings.**

| ITEMS | Factor 1 |
|---|---|
| SB1 | .6723 |
| SB2 | .7880 |
| SB3 | .8255 |
| SB4 | .7560 |
| SB5 | .7514 |
| SB6 | .7584 |

Next, the items were subjected to reliability analysis. The CITCs for each item in the suppliers relationships factor are shown on Table 48. Five items had a CITC above 0.60. Item SB1 had a CITC value of 0.56 and was retained since it was considered important for the content definition of the construct. The Cronbach's alpha coefficient for this construct was 0.86, and no item could be eliminated without reducing reliability. The average variance extracted for this scale was 59%.

**Table 48. Purification for Supplier Based Quality Practices- Corrected Item Total Correlation for (CITC) Supplier Relationships**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| SB1 | .5563 | | | |
| SB2 | .6897 | | | |
| SB3 | .7383 | $\alpha$ = 8619 | 59% | 0.35** |
| SB4 | .6465 | | | |
| SB5 | .6419 | | | |
| SB6 | .6513 | | | |

**Significant at p<.01

To test for convergent validity, the lowest correlation within this construct was found and tested to see if it was different from zero. The lowest correlation of supplier relationships was 0.354 (Table 49). This correlation was significant at $p < 0.01$, providing evidence for convergence validity. To test for predictive validity, this factor was correlated with a measure of internal quality performance named quality failures. The correlation coefficient was significant (SR-QF=-0.31) at $p<0.01$ (Table 14).

**Table 49. Correlation Matrix for Supplier Relationships Items**

| | SB1 | SB2 | SB3 | SB4 | SB5 | SB6 |
|---|---|---|---|---|---|---|
| SB1 | 1 | | | | | |
| SB2 | .50 | 1 | | | | |
| SB3 | .54 | .66 | 1 | | | |
| SB4 | .40 | .48 | .68 | 1 | | |
| SB5 | .35 | .53 | .47 | .55 | 1 | |
| SB6 | .39 | .50 | .54 | .49 | .61 | 1 |

After the large scale analysis for the supplier based quality practices, 6 items and 1 scale are proposed. The scale had good reliabilities and behaved well when subjected to an assortment of validity tests.

### 4.2.7 Internal Quality Performance

The fourteen items corresponding to the domain of internal quality performance and their codes are shown on Table 50. The ratio of respondents to items is 21.4, very adequate for exploratory factor analysis. Factor analysis revealed three factors named quality failures (QF), manufacturing cost (MC), and lead time (T). Items O4 and O5 had loadings below 0.60 and were dropped from the analysis. The loadings for all the remaining items were relatively high with values above 0.60 (Table 51). The factors matrix in Table 51 for the remaining 12 items show that they are unifactorial, and can be used as tentative evidence for discriminant validity within the factor in this category.

**Table 50. Purification for Internal Quality Performance - Large Scale**

| ITEMS | CODE |
|---|---|
| Our reworks levels are | O1 |
| Our finished product defect rate is | O2 |
| Our scrap levels are | O3 |
| Our productivity is | O4 |
| Our cost of quality is | O5 |
| Our customer complaints are | O6 |
| Our warranty claims are | O7 |
| Our total cost per unit of product is | O8 |
| Our labor costs per unit of product are | O9 |
| Our material costs per unit of product are | O10 |
| Our overhead cost per unit of product is | O11 |
| Our new product introduction lead time is | O12 |
| Our order delivery time is | O13 |
| Our manufacturing throughput time is | O14 |

The items for each factor were subjected to reliability analysis. The CITCs values for the quality failures construct are shown on Table 52. Four items had a CITC value above 0.60. Item O7 had a CITC value of 0.41 and eliminated from further consideration. The Cronbach's alpha coefficient for this construct after purification was 0.83 and no item could be eliminated without reducing the reliability. The amount of variance extracted for this scale was 66%. The results of the

**Table 51. Purification for Internal Quality Performance - Factor Loadings.**

| ITEMS | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| O1 | .7336 | | |
| O2 | .7755 | | |
| O3 | .7970 | | |
| **O4** | **<.40*** | | |
| **O5** | **.5329*** | | |
| O6 | .7387 | | |
| O7 | .6022 | | |
| O8 | | .8152 | |
| O9 | | .7887 | |
| O10 | | .6756 | |
| O11 | | .7118 | |
| O12 | | | .7406 |
| O13 | | | .7620 |
| O14 | | | .6550 |

*Item Dropped

**Table 52. Purification for Internal Quality Performance - Corrected Item Total Correlation for (CITC) Quality Failures**

| ITEMS | CITC | Reliability | Variance Explained | Items Lowest Correlation |
|---|---|---|---|---|
| O1 | .6528 | $\alpha$ = .8272 | 66% | 0.46** |
| O2 | .6095 | | | |
| O3 | .6550 | | | |
| O6 | .6131 | | | |
| **O7** | **.4115*** | | | |

* Item dropped

**Significant at p<.01

analysis of the CITCs for the four items belonging to the manufacturing cost revealed the following (Table 53). One O10 item had CITC less than 0.5, two items O9, O11 between 0.5 and 0.6, and one item O8 above 0.6. O10 was eliminated and O9 and O11 were retained in addition to O8 because they help in the content definition of the construct. The construct was renamed "unit manufacturing cost" (UMC) to more accurately reflect the nature of these items. Since one item remained, no further validity test could be conducted.

**Table 53. Purification for Internal Quality Performance - Corrected Item Total Correlation for (CITC) Manufacturing Cost**

| ITEMS | CITC | Reliability | Variance Explained | Items Lowest Correlation |
|---|---|---|---|---|
| O8 | .6327 | | | |
| **O9** | **.5320** | | | |
| **O10** | **.4429*** | | | |
| **O11** | **.5080** | | | |

* Item dropped

The analysis for the three items of the Time construct revealed relatively low (Table 54) CITCs values for items O12 and O14 (below 0.60). Item O12 had the lowest CITC (0.32) and was eliminated. Item O14 was retained for further analysis because it was considered important for the content definition of the construct. The content of the final two retained items (O13 and O14) was analyzed and the factor (Time) was renamed as Lead Time (LT) to reflect more accurately its measurement nature. The Cronbach's alpha coefficient for the lead time construct was 0.70. The amount of variance extracted for this scale was 0.74. Overall, seven items were eliminated from the internal quality performance category.

**Table 54. Purification for Internal Quality Performance - Corrected Item Total Correlation for (CITC) Lead Time**

| ITEMS | CITC | Reliability | Variance Explained | Items Lowest Correlation |
|---|---|---|---|---|
| **O12** | **.3225*** | α = .7030 | 74% | 0.48** |
| O13 | .6231 | | | |
| O14 | .5064 | | | |

* Item dropped
**Significant at p<.01

The lowest correlations for quality failures, unit manufacturing cost, and lead time were 0.46, 1, and 0.48 (Tables 55 and 56). All correlations were significant at $p < 0.01$, providing evidence for convergence validity. To test for predictive validity, the three factors were correlated with a measure of external quality performance named competitive position (CP). The 3 correlation coefficients were significant (QF-CP=-0.28; UMC-CP=-0.15; and LT-CP=-0.17) at $p<0.01$ for QF and LT, and $p<0.05$ for UMC (Table 14).

**Table 55. Correlation Matrix for Quality Failures Items**

| | O1 | O2 | O3 | O6 |
|---|---|---|---|---|
| O1 | 1 | | | |
| O2 | .76 | 1 | | |
| O3 | .65 | .57 | 1 | |
| O6 | .46 | .59 | .67 | 1 |

**Table 56. Correlation Matrix for Lead Time Items**

| | O15 | O16 |
|---|---|---|
| O13 | 1 | |
| O14 | .48 | 1 |

After the large scale analysis for the internal quality performance group, 9 items and 3 scales were proposed. The number of items varies from 2 for lead time to 4 for the quality failures. The three scales had acceptable reliabilities and behaved well when subjected to an assortment of validity tests.

### 4.2.8 Competitive Capabilities

From the final 24 items proposed for the competitive capabilities instrument by Koufteros (1995), 21 items were adopted in this research. Fifteen of those adopted items were used as originally defined, and six items were slightly modified to fit the purpose of this study. All the modified items were related to the value to customer quality factor. A confirmatory factor analysis was conducted on the 21 items using principal components and varimax as the method of rotation. Table 57 shows the 21 items corresponding to the domain of competitive capabilities and the codes. The ratio of respondents to items was 14.2 and meets the general guidelines. As expected there were five factors with eigenvalues greater than one. As named by Koufteros, these five factors were: competitive pricing, premium pricing, value to customer quality, dependable deliveries, and product innovation. All items loaded in their respective factors (Table 58) and there were no items with loadings lower than 0.60 or cross-loadings above 0.40. All the loadings for the competitive pricing factors proved greater than 0.84. Loadings for the premium pricing factor ranged from 0.83 to 0.87. Value to customer quality loadings ranged from 0.69 to 0.87. In addition, dependable deliveries exhibited high loadings values ranging from 0.85 to 0.94. Finally, loadings for the product innovation construct ranged from 0.65 to 0.91. Overall, the factor pattern matrix was simple, all of the items loaded high in their respective factors and low on others. This results can be used as tentative evidence for discriminant validity within the factor in this category. The CITCs values for the five competitive capabilities construct are shown in Tables 59, 60, 61, 62 and 63. With the exception of item CC18, all CITC values were above 0.60. Item O18 had a CITC value of 0.56 and eliminated. Then, Cronbach's alpha and average variance extracted were calculated for the five competitive capabilities factors. The competitive pricing factor had four items and a reliability coefficient alpha of 0.90, while the average variance extracted for this scale was 0.77. The premium pricing scale with four items had a coefficient alpha of 0.91 and average variance extracted of 0.79. The value to customer quality had six items and a reliability coefficient alpha of 0.90, and the average variance extracted for this scale was 0.67. The reliability for the dependable delivery scale was 0.92, and the average variance extracted for this scale was 0.87. The product innovation scales had three items and reliability alpha of 0.91 after the elimination of item O18. The average variance extracted for this scale was 0.85. Overall, there was only one item (CC18) deleted at this stage. In addition, the reliabilities were high, and the average variance extracted met the acceptable criterion of 0.50.

**Table 57. Purification for Competitive Capabilities - Large Scale**

| ITEMS | CODE |
|---|---|
| Our capability of offering prices that are competitive is | CC1 |
| Our capability of offering prices as low or lower than competitors prices is | CC2 |
| Our capability of competing based on prices is | CC3 |
| Our capability of offering prices that match competition is | CC4 |
| Our capability of selling at high prices that only a few firms can achieve is | CC5 |
| Our capability of selling at price premiums is | CC6 |
| Our capability of commanding premium prices is | CC7 |
| Our capability of selling at prices above the average is | CC8 |
| Our capability of offering products that perform according to customer needs is | CC9 |
| Our capability of offering products that meet customer's safe-to-use needs is | CC10 |
| Our capability of offering products that meet customer's reliability needs is | CC11 |
| Our capability of offering products that meet customer's durability needs is | CC12 |
| Our capability of offering products that meet customer's preestablished standards is | CC13 |
| Our capability of offering products that meet customer's value expectations is | CC14 |
| Our capability of providing dependable deliveries is | CC15 |
| Our capability of providing on-time deliveries is | CC16 |
| Our capability of delivering the correct quantity of products needed on time is | CC17 |
| Our capability of developing customized products is | CC18 |
| Our capability of developing a number of "new" product features is | CC19 |
| Our capability of developing a number of "new" products is | CC20 |
| Our capability of developing unique features is | CC21 |

**Table 58. Purification for Competitive Capabilities - Factor Loadings**

| ITEMS | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|---|---|---|---|---|
| CC1 | .8495 | | | | |
| CC2 | .8854 | | | | |
| CC3 | .8996 | | | | |
| CC4 | .8504 | | | | |
| CC5 | | .8378 | | | |
| CC6 | | .8729 | | | |
| CC7 | | .8757 | | | |
| CC8 | | .8533 | | | |
| CC9 | | | .8022 | | |
| CC10 | | | .7894 | | |
| CC11 | | | .8748 | | |
| CC12 | | | .8515 | | |
| CC13 | | | .7388 | | |
| CC14 | | | .6989 | | |
| CC15 | | | | .9221 | |
| CC16 | | | | .9443 | |
| CC17 | | | | .8574 | |
| CC18 | | | | | .6597 |
| CC19 | | | | | .9162 |
| CC20 | | | | | .8840 |
| CC21 | | | | | .8674 |

**Table 59. Purification for Competitive Capabilities - Corrected Item Total Correlation for (CITC) Competitive Pricing**

| ITEMS | CITC | Reliability | Variance Explained | Items Lowest Correlation |
|---|---|---|---|---|
| CC1 | .7496 | α = .9022 | 77% | 0.63** |
| CC2 | .7989 | | | |
| CC3 | .8174 | | | |
| CC4 | .7615 | | | |

**Significant at p<.01

**Table 60. Purification for Competitive Capabilities - Corrected Item Total Correlation for (CITC) Premium Pricing**

| ITEMS | CITC | Reliability | Variance Explained | Items Lowest Correlation |
|---|---|---|---|---|
| CC5 | .7178 | α = .9074 | 79% | 0.65** |
| CC6 | .8229 | | | |
| CC7 | .8416 | | | |
| CC8 | .7948 | | | |

**Significant at p<.01

**Table 61. Purification for Competitive Capabilities - Corrected Item Total Correlation for (CITC) Value to Customer Quality**

| ITEMS | CITC | Reliability | Variance Explained | Items Lowest Correlation |
|---|---|---|---|---|
| CC9 | .7348 | $\alpha = .9012$ | 67% | 0.49** |
| CC10 | .7151 | | | |
| CC11 | .7986 | | | |
| CC12 | .77692 | | | |
| CC12 | .6910 | | | |
| CC13 | .6744 | | | |

**Significant at p<.01

**Table 62. Purification for Competitive Capabilities - Corrected Item Total Correlation for (CITC) Dependable Deliveries**

| ITEMS | CITC | Reliability | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|
| CC15 | .8753 | $\alpha = .9241$ | 87% | 0.75** |
| CC16 | .8874 | | | |
| CC17 | .7810 | | | |

**Significant at p<.01

**Table 63. Purification for Competitive Capabilities - Corrected Item Total Correlation for (CITC) Product Innovation**

| ITEMS | CITC | Reliability | Reliability Retained Items | Variance Extracted | Items Lowest Correlation |
|---|---|---|---|---|---|
| **CC18** | **.5601*** | $\alpha = .8789$ | | | |
| CC19 | .8346 | | $\alpha = .9111$ | 74% | 0.71** |
| CC20 | .7709 | | | | |
| CC21 | .8045 | | | | |

*Item Dropped
**Significant at p<.01

The lowest correlations for competitive pricing, premium pricing, value to customer quality, dependable deliveries, and product innovation were 0.63, 0.65, 0.49, 0.75, and 0.71 (Tables 64, 64, 65, 66, 67, and 68). All correlations were significant at $p < 0.01$, providing evidence for convergence validity. To test for predictive validity, four of the five factors (expect product innovation) were correlated with a measure of external quality performance named profitability (P), while product innovation was correlated with another measure of external quality performance named competitive position (COP). The 5 correlation coefficients were significant (CP-P=0.22; PP-P=0.33, VCQ-P=0.18, DD-P=0.21, PI-COP=0.23) at $p<0.01$ (Table 14).

**Table 64. Correlation Matrix for Competitive Pricing Items**

| | CC1 | CC2 | CC3 | CC4 |
|---|---|---|---|---|
| CC1 | 1 | | | |
| CC2 | .71 | 1 | | |
| CC3 | .68 | .74 | 1 | |
| CC4 | .63 | .68 | .75 | 1 |

**Table 65. Correlation Matrix for Premium Pricing Items**

| | CC5 | CC6 | CC7 | CC8 |
|---|---|---|---|---|
| CC5 | 1 | | | |
| CC6 | .66 | 1 | | |
| CC7 | .67 | .81 | 1 | |
| CC8 | .65 | .73 | .77 | 1 |

**Table 66. Correlation Matrix for Value to Customer Quality Items**

| | CC9 | CC 10 | CC 11 | CC 12 | CC 13 | CC 14 |
|---|---|---|---|---|---|---|
| CC9 | 1 | | | | | |
| CC10 | .62 | 1 | | | | |
| CC11 | .63 | .66 | 1 | | | |
| CC12 | .57 | .64 | .87 | 1 | | |
| CC13 | .61 | .55 | .54 | .54 | 1 | |
| CC14 | .60 | .49 | .56 | .54 | .63 | 1 |

**Table 67. Correlation Matrix for Dependable Deliveries Items**

| | CC 15 | CC 16 | CC 17 |
|---|---|---|---|
| CC15 | 1 | | |
| CC16 | .89 | 1 | |
| CC17 | .75 | .77 | 1 |

**Table 68. Correlation Matrix for Product Innovation Items**

| | CC 19 | CC 20 | CC 21 |
|---|---|---|---|
| CC19 | 1 | | |
| CC20 | .85 | 1 | |
| CC21 | .76 | .71 | 1 |

<u>Summary</u>

As a result of the foregoing analysis, overall, 68 items are proposed to measure quality management practices; 9 items to measure internal quality performance, and 20 items to measure competitive capabilities.

# CHAPTER 5

# EXPLORATORY STRUCTURAL ANALYSIS

To explore the antecedent role of quality management practices to internal quality performance and competitive capabilities, and the mediating role of internal quality performance, linear structural equation modeling (LISREL) was used. LISREL allows for the assessment of construct validity in a nomological network of constructs, provides a strong method for testing causal models with both observable and latent variables and is capable of simultaneously evaluating both the measurement and causal components of complex models. In the operations management area and particularly in the quality management field, LISREL is becoming preferred to correlation and regression by researchers for testing causal models. However, results should be interpreted with caution, since the same data was used for both the measurement and structural models.

For the present study, second order-constructs were used for exploratory hypothesis testing in lieu of the numerous first order factors. Thus, five variables are entered for hypothesis testing: quality management practices, quality failures, manufacturing cost, lead time, and competitive capabilities.

### 5.1 Structural Analysis Methods

The measurement model for the constructs of quality management practices and competitive capabilities were identified in Chapter 2. Moreover, the measurement model can be described by two equations, which specify the relations between endogenous latent and manifest variables and between exogenous latent and manifest variables. To be congruent with the hypothesized model of Chapter 2, quality management practices are treated as the exogenous variable ($\xi_1$), whereas, the endogenous variables include quality failures ($\eta_1$), unit manufacturing cost ($\eta_2$), lead time ($\eta_3$), and competitive capabilities ($\eta_4$). For the endogenous variables we have

$$\mathbf{y} = \Lambda_y \eta + \varepsilon \qquad (1)$$

where **y** is a 4 x 1 vector of observed measures of dependent variables. $\Lambda_y$ is a 4 x 4 matrix of regression coefficients, or loadings, of **y** on the unobservable dependent variable $\eta$. Each $\lambda$ on the diagonal is equal to 1, indicating that the latent variable is a mirror of the observed variable with zero measurement error. $\varepsilon$ is a 4 x 1 vector of errors of measurement of **y**, and is empty. Similarly, the exogenous variable

$$\mathbf{x} = \Lambda_x \xi + \delta \qquad (2)$$

where **x** is a 1 x 1 vector of observed measure of the independent variable quality management practices. In fact, this independent variable is a second order measure of the six first-order constructs of quality based practices. $\Lambda_x$ is a 1 x 1 matrix of regression coefficients or loadings, of x on the unobservable independent $\xi$. The value of this loading is 1 and suggests that the latent exogenous variable is a mirror image of its observed exogenous variable with zero measurement error. Moreover, If a variable is measured by a single indicator the measurement error is assumed to be zero for each variable. $\delta$ is a 1 x 1 vector of errors of measurement of **x**, which in this particular case was empty.

The general structural equation model relating the above latent exogenous and endogenous variables is

$$\eta = \beta\eta + \Gamma\xi + \zeta \qquad (3)$$

where $\eta$ is a 4 x 1 vector of latent endogenous variables; $\xi$ is a 1 x 1 vector of the latent exogenous variable quality management practices; $\Gamma$ (gamma) is an 4 x 1 matrix of regression coefficients of the effects of the exogenous variable (quality management practices) on endogenous variables [quality failures ($\eta_1$), productivity ($\eta_2$), manufacturing cost ($\eta_3$), lead time ($\eta_4$), and competitive capabilities ($\eta_4$)]; and $\zeta$ is an 4 x 1 vector of residuals, or errors in equations. $\zeta$ indicates that the endogenous variables are not perfectly predicted by the structural equations.

The structural equation model as expressed by equations (1), (2), and (3), can be translated into a path diagram shown in Figure 5.1. The exogenous variable, $\xi_1$ (quality management practices) is located on the left side of Figure 5.1. At the right of the Figure 5.1, the four endogenous variables are listed. The research model presented in Chapter 2 postulated: quality failures are related to quality management practices (causal path represented in the structural equation 4 below); manufacturing cost is related to quality failures and quality management practices (causal path represented in the structural equation 5 below); lead time is related to quality failures and quality management practices (causal path represented in the structural equation 5 below); and competitive capabilities are related to quality failures, manufacturing cost, lead time, and quality management practices (causal path represented in the structural equation 7 below).

$$\eta_1 = \gamma_1 \xi_1 + \zeta_1 \quad (4)$$

$$\eta_2 = \beta_2 \eta_1 + \gamma_3 \xi_1 + \zeta_2 \quad (5)$$

$$\eta_3 = \beta_3 \eta_1 + \gamma_4 \xi_1 + \zeta_3 \quad (6)$$

$$\eta_4 = \beta_1 \eta_1 + \beta_4 \eta_2 + \beta_5 \eta_3 + \gamma_2 \xi_1 + \zeta_4 \quad (7)$$

$\zeta_1$, $\zeta_2$, $\zeta_3$, and $\zeta_4$ are residuals, that is error in equations.

If the model in Figure 5.1 fits the data, the magnitudes and t-values of the gamma and beta coefficients will be evaluated to test the research hypotheses. To assess the fit of the model to the data, various fit statistics were computed using multiple fit criteria in order to attenuate any measuring biases inherent in different measures (Chau, 1997; Bollen and Long, 1993; Breckler, 1990; Tanaka, 1993; Wheaton, 1987). . These measures include, the chi-square, chi-square/degrees of freedom, the goodness-of-fit index (GFI), adjusted-goodness-of-fit (AGFI), comparative-fit index (CFI), normated-fit index (NFI),and root-mean-square-residual index (RMR).

## 5.2 Results

### 5.2.1 Exploratory Correlation

The correlation matrix presented in Table 69 shows quality management

| ENDOGENOUS VARIABLES | | EXOGENOUS VARIABLES | |
|---|---|---|---|
| $X_1$ | Management Based Quality Practices | $Y_1$ | Rework |
| $X_2$ | Employee Based Quality Practices | $Y_2$ | Product Defect |
| $X_3$ | Customer Based Quality Practices | $Y_3$ | Scrap |
| $X_4$ | Information Based Quality Practices | $Y_4$ | Customer Complaints |
| $X_5$ | Product/Process Based Quality Practices | $Y_5$ | Unit Manufacturing Cost |
| $X_6$ | Supplier Based Quality Practices | $Y_6$ | Order Delivery Time |
| | | $Y_7$ | Throughput time |
| | | $Y_8$ | Competitive Pricing |
| | | $Y_9$ | Premium Pricing |
| | | $Y_{10}$ | Value to Customer Quality |
| | | $Y_{11}$ | Dependable Deliveries |
| | | $Y_{12}$ | Innovation |

**Table 69. Correlations for Variables in the Structural Model**

| Variables | Quality Management Practices | Quality Failures | Unit Manufacturing Cost | Lead Time | Competitive Capabilities |
|---|---|---|---|---|---|
| Quality Management Practices | 1 | | | | |
| Quality Failures | -0.40** | 1 | | | |
| Unit Manufacturing Cost | -0.18** | 0.23** | 1 | | |
| Lead Time | -0.13* | 0.33** | 0.17** | 1 | |
| Competitive Capabilities | 0.41** | -0.45** | -0.06 | -0.26** | 1 |

** Correlation is significant at $p<.01$
* Correlation is significant at $p<.05$

**Table 70. Fit Statistics for the Structural Equation Model**

| Goodness-of-fit Measure | Value | Recommended Value* |
|---|---|---|
| Chi-square | 185.45 | Not significant |
| Chi-square/degrees of freedom | 1.67 | ≤ 3.0 |
| Goodness-of-fit Index (GFI) | 0.93 | ≥ 0.90 |
| Adjusted Goodness-of-fit Index (AGFI | 0.91 | ≥ 0.80 |
| Normed Fit Index (NFI) | 0.90 | ≥ 0.90 |
| Non-Normed Fit Index (NNFI) | 0.95 | ≥ 0.90 |
| Comparative Fit Index (CFI) | 0.96 | ≥ 0.90 |
| Root Mean Square Residual (RMR) | 0.047 | ≤ 0.10 |

* From Hartwick & Barki, 1994, Segars & Grover, 1993

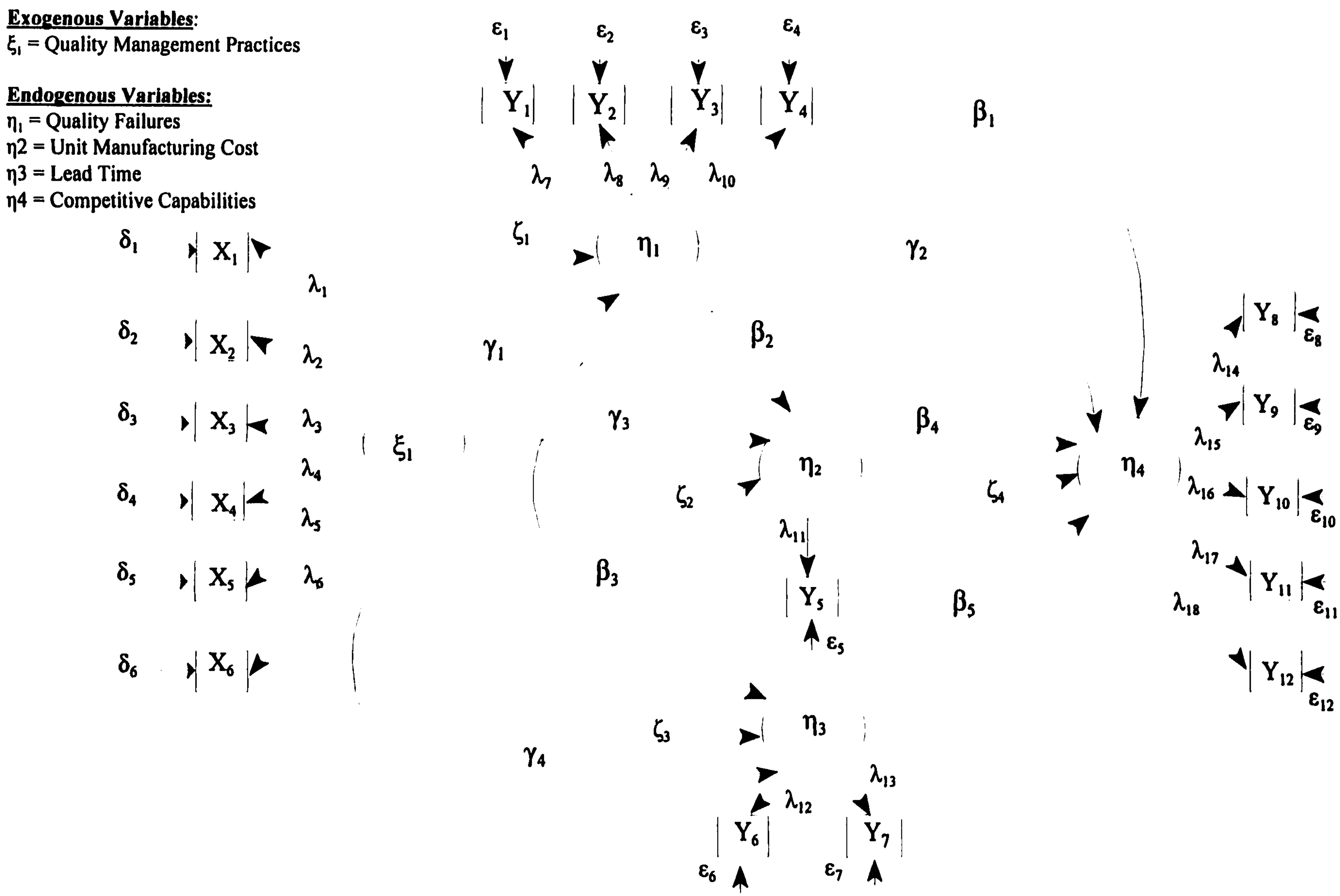


**Figure 5.1 : Path Diagram for the Structural Equation Model**

practices are significantly related to competitive capabilities, quality failures, manufacturing cost, and lead time. Although the relationship with lead time was relatively weak; the correlations between competitive capabilities and quality failures, competitive capabilities and lead time were significant and in the expected hypothesized direction. However, the correlation between competitive capabilities and manufacturing cost was not significant. Moreover, quality failures show a strong positive correlation with lead time and moderate correlation with unit manufacturing cost. In addition, there was no hypothesized relationship between manufacturing cost and lead time.

### 5.2.2 Exploratory Path Analysis Results-Overall Model

To further assess the proposed relationships, the LISREL methodology was used to conduct an exploratory path analysis. The chi-square value (185.45) was nonsignificant indicating that the model had a good fit. Furthermore, the chi/square/degrees of freedom index value (1.67) also indicated that the model had a good fit. The values for the goodness-of-fit-index (GFI), the adjusted-goodness-fit-index (AGFI), the comparative-fit-index (CFI), the normated-fit-index (NFI), the non-normated-fit-index (NNFI), and the root mean-square-residual (RMR) were 0,93, 0.91, 0.90, 0.95, 0.96, and 0.047 respectively. Table 70 depicts a summary of the model fit measures observed for the model. Overall, all measures surpassed the recommended acceptable levels giving evidence of the appropriateness of the model to the data. Since the model in Figure 5.2 fits the data, we now will analyze the magnitudes and t-values of the gamma and beta coefficients to test the research hypotheses.

### 5.2.3 Hypotheses Testing Results

Total effects can be divided into direct, indirect, and noncausal effects (Table 71), and to examine the total effects, the coefficients for indirect effects were also calculated (Jorsekog and Sorbom, 1993).

**Table 71: Decomposition of Effects – Beta Coefficients and t-values**

| Relationship | Total Effects | Direct Effect | Indirect Effects | Noncausal Effects |
|---|---|---|---|---|
| Quality Management Practices to Quality Failures ($\xi_1$ to $\eta_1$) | -0.47 (-6.62)** | -0.47 (-6.62)** | ——— | ——— |
| Quality Management Practices to Product Cost ($\xi_1$ to $\eta_2$) | -0.20 (-3.14)** | -0.10 (-1.34) | -0.10 (-2.67)** | ——— |
| Quality Management Practices to Lead Time ($\xi_1$ to $\eta_3$) | -0.15 (-2.01)* | 0.08 (0.91) | -0.23 (-3.99)** | ——— |
| Quality Management Practices to Competitive Capabilities ($\xi_1$ to $\eta_4$) | 0.61 (5.26)** | 0.36 (3.94)** | 0.25 (3.80)** | ——— |
| Quality Failures to Product Cost ($\eta_1$ to $\eta_2$) | 0.21 (2.86)** | 0.21 (2.86)** | ——— | ——— |
| Quality Failures to Lead Time ($\eta_1$ to $\eta_3$) | 0.49 (4.79)** | 0.49 (4.79)** | ——— | ——— |
| Quality Failures to Competitive Capabilities ($\eta_1$ to $\eta_4$) | -0.57 (-4.78)** | -0.55 (-4.26)** | -0.02 (-.37) | ——— |
| Product Cost to Competitive Capabilities ($\eta_2$ to $\eta_4$) | 0.11 (1.74) | 0.11 (1.74) | ——— | ——— |
| Lead Time to Competitive Capabilities ($\eta_3$ to $\eta_4$) | -0.08 (-0.95) | -0.08 (-0.95) | ——— | ——— |

** Significant at 0.01
* Significant at 0.05

Note Bold lines are for measurement

Dashed lines indicate non-significant paths
** Paths significant at 0.01

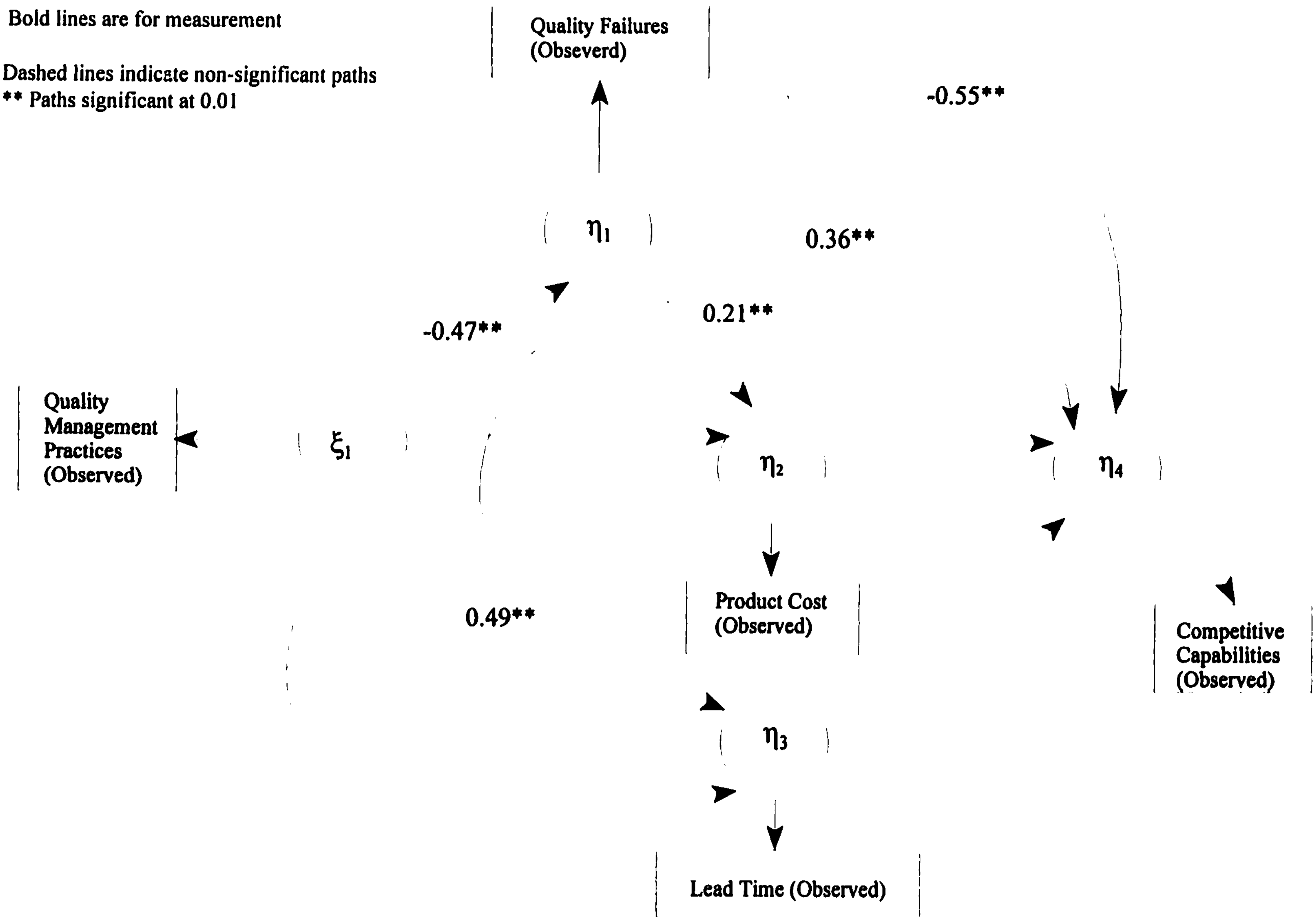


**Figure 5.2: Results of the Path Diagram for Structural Equation Model (Unstandardized Coefficients)**

#### 5.2.3.1 Endogenous to Endogenous Relationships

For the endogenous to endogenous relationships, it was expected that quality failures would affect competitive capabilities as expressed by hypothesis 1.

**Hypothesis 1: Competitive capabilities have negative relationships with quality failures.**

This effect of quality failures on competitive capabilities manifested itself in direct and indirect relationships (i.e., manufacturing cost, and lead time). The structural coefficient Beta for the direct relationship indicates a negative and very significant direct effect (t=-4.26). Thus this hypothesis is accepted. Further, the indirect relationship between quality failures and competitive capabilities through lead time and unit manufacturing cost is insignificant (t=-0.37). Therefore, improvement (reduction) in quality failures will improve competitive capabilities directly.

**Hypothesis 2: Competitive capabilities have a negative relationship with unit manufacturing cost.**

The Beta coefficient for the competitive capabilities-manufacturing cost relationships was found to be non significant (t=1.74). This hypothesis is not accepted. No indirect relationships were hypothesized and noncausal effects were not present. One can possibly conclude that manufacturing cost because of reductions in quality failures will not contribute to increased competitive capabilities.

**Hypothesis 3: Competitive capabilities have a negative relationship with lead time.**

It was proposed that reductions in manufacturing lead time (throughput time and delivery time) would have a significant impact on competitive capabilities. The Beta coefficient for this endogenous relationship was found to be non significant (t=-.095). Tus this hypothesis is not accepted. No indirect relationships were hypothesized and noncausal effects were not present. Further, improvements in lead time due to improvements in quality failures may not contribute to increased competitive capabilities.

**Hypothesis 4: Quality failures have a positive relationship with unit manufacturing cost.**

It was proposed that quality failures would have a significant impact on manufacturing cost. Indeed, the Beta coefficient is positive and highly significant (t=2.86) and this hypothesis is accepted indicating that reducing quality failures leads to improvements in manufacturing cost. No indirect relationships were hypothesized and noncausal effects were not present.

**Hypothesis 5: Quality failures have a positive relationship with lead time.**

In the model it was proposed that quality failures have a direct effect on lead time. The structural coefficient Beta relating the two variables indicates that the direct effect is positive and highly significant (t=4.79). This hypothesis is accepted and it may be concluded that reduction in quality failures results in lead time reductions. No indirect relationships were hypothesized and noncausal effects were not present.

#### 5.2.3.2 Exogenous to Endogenous Relationships

In the exogenous to endogenous relationships, quality management practices were hypothesized to be an antecedent for quality failures, manufacturing cost, lead time and competitive capabilities. The nature of the relationships are expressed in hypotheses 6 through 9. Tests of these hypotheses follow.

**Hypothesis 6: Quality management practices have a negative relationship with quality failures.**

The data supported this relationship as manifested by the negative and highly significant t-value (-6.62). The hypothesis is accepted. Quality management practices result in decreased quality related failures. No indirect relationships were hypothesized and noncausal effects were not present.

**Hypothesis 7: Quality management practices have a negative relationship with unit manufacturing cost.**

The structural coefficient for quality management practices and manufacturing cost was non-significant (t=-1.34). The hypothesis is thus rejected. However, the analysis shows the negative indirect relationship (t=-2.67) was highly significant, the implication being that quality management practices reduce quality failures which in turn reduce unit manufacturing cost.

**Hypothesis 8: Quality management practices have a negative relationship with lead time.**

Quality management practices were hypothesized to have a negative relationship with lead time. The analysis shows that this hypothesis is rejected. Quality management practices did not have a significant direct impact on lead time (t=0.91). Nevertheless, the indirect relationship is negative and highly significant (t=-3.99). The indirect relationship works itself through quality failures. Quality management practices reduce quality failures which reduce lead time.

**Hypothesis 9: Quality management practices have a positive relationship with competitive capabilities.**

Quality management practices and competitive capabilities have a significant positive direct and indirect relationship with competitive capabilities (t=3.94). The hypothesis is accepted. The indirect relationship is also highly significant (t=3.80). Improvements in quality management practices result in improved competitive capabilities directly as well as indirectly through quality failures.

As a measure of the entire structural equation, an overall coefficient of determination (R-square) was calculated for each endogenous variable. Although no test of statistical significance can be performed, the results provide a relative measure of fit for each structural equation. The highest among the four R-square coefficients was 0.65, for the competitive capabilities structural equation ($\eta_4$). For manufacturing cost structural equation ($\eta_2$), the R-square was the lowest at 0.07, while for quality failures ($\eta_1$) it was 0.22, and for lead time ($\eta_3$) it was 0.21.

In conclusion, the results of testing the various hypothesis can be summarized as follows. Quality management practices lead to improvements in competitive capabilities. Quality management practices lead to reductions in quality failures too. In addition, improvements in quality failures have a direct effect competitive capabilities. However, quality management practices do not appear to affect lead time and unit manufacturing cost. Reductions in unit manufacturing cost and lead time do not appear to improve competitive capabilities.

However, these conclusions should be taken with some caution as it may be constrained by the sample obtained for this research. It is also possible that a measurement problem exists with unit manufacturing cost and lead time variables. Additional efforts are needed in future research to address the adequate measurement of unit manufacturing cost and lead time.

# CHAPTER 6

# SUMMARY, RECOMMENDATIONS AND DISCUSSION

## 6.1 SUMMARY

The aim of the research presented in this dissertation was to add to knowledge on quality management by exploring the relationship between quality management practices and competitive capabilities. By developing and testing a nomological network of quality management-competitive capabilities constructs and conducting an analysis across a large number of manufacturing organizations with a valid and reliable instrument, this study represents one of the first to empirically investigate the relationship between quality management practices, quality failures, product cost, lead time, and competitive capabilities. Overall, this study contributes to our knowledge of the role of quality based competitiveness in numerous ways.

First, it proposed a theoretical quality-based competitiveness framework that identified quality management practices, internal quality performance (quality failures, product cost, and lead time), and competitive capabilities. This framework provides a foundation for further research in quality based competitiveness by identifying the salient dimensions of quality based competitiveness. In the future, other constructs may be added to complement the nomological network of constructs.

Second, this research responds to the call for more scientific rigor in the development for measurement for quality management practices (Black and Porter, 1996). It provides a set of validated scales of quality based constructs. All the scales are shown to meet the requirements for reliability and validity and thus can be used in future research. Such valid and reliable scales have been otherwise lacking in the literature of empirical quality management practices. All the scales far exceed the criteria in terms of reliability, factorial validity, as well as discriminant, convergent, and predictive validity.

Third, this study provides a practical and useful tool for quality managers to audit and assess quality management practices. For instance, the quality management practices scales can be used to evaluate the extent to which quality practices have been implemented, and their impact on the competitive capability of the company. Eighty percent of the respondents in the study indicated they would like to receive the results of the study to benchmark their own development and to benchmark their company's position relative to industry. This is a strong confirmation of the need to provide a useful tool to industry for assessment.

Fourth, this study provides supporting evidence to the conceptual and prescriptive literature about previously untested statements regarding quality based competitive constructs. The results lend support to the claim that higher level of quality management practices lead to higher levels of competitive capabilities. The analysis also supports the notion that improved quality (lower levels of quality failures) lead to lower product costs and lead time and higher levels of competitive capabilities. However, the results did not support the hypothesis that higher levels of quality management practices lower product costs and lead time. The analysis also failed to provide evidence of a relationship between product cost, lead time, and competitive capabilities.

The lack of support for some of these relationships between quality-based constructs points to possible measurement and structural problems that may have contributed to the lack of significant correlations among these constructs. Exploring these issues further possible directions for future research are provided in the next section.

## 6.2 RECOMMENDATIONS FOR FUTURE RESEARCH

One contribution of this research was developing of a comprehensive instrument that should allow for broad usage in studying the generic nature of quality management practices, internal quality performance, and competitive capabilities. The scales established provided reliable and valid measurement of these constructs, and their component dimensions. The scales were developed with the objective to enable empirical research in quality areas that have received little pragmatic attention across manufacturing industries.

However, certain manufacturing practices may not be applicable. Future research could utilize confirmatory factor analysis to substantiate the generalizability of the proposed scales across industry types. In a similar vein, future studies could test the generalizability of the instrument in regards to such demographic variables like firm size, level of sales, the position of the respondent in the company, the presence/absence of unions, etc.

**Recommendation 1:** Future research should explore the generalizability of the quality management scales across industry type, firm size, title of respondent, union presence, etc.

The nature of this research was exploratory. The scales developed to study the proposed relationships between quality management, internal quality performance, and competitive capabilities were developed using an exploratory factor analysis. In order to complete the two step research cycle for developing standardized scales, future research should conduct confirmatory factor analysis to test the hypothesized measurement scales against new sample data from the same referent population of manufacturing companies. This factor is an important issue, since a minimal amount of confirmatory research in quality management exists. This lack of confirmatory studies presents a major obstacle for consensus on the use of instruments.

**Recommendation 2:** More rigorous and systematic test of alternative factor structures should be conducted in future research using confirmatory factor analysis.

Associations suggested in the quality literature as summarized in Chapter 2 and Figure 1 were empirically tested and verified in the chapter 5. Furthermore, the empirical validations using LISREL provided additional understanding of the relationships between quality management practices, internal quality performance, and competitive capabilities. It is certain that quality management practices play critical roles in affecting competitive capabilities at the organizational level. Though a significant contribution, more detailed questions about which management practices should be emphasized are raised (Flynn, Schroeder, and Sakakibara, 1994). As a result, more detailed information is needed to make the findings more meaningful for decision makers.

To unveil additional knowledge regarding the impact of quality management practices on competitiveness, future research should examine the relationship between quality management practices, internal quality performance, and specific competitive capabilities. Figures 6.1 to 6.5 show causal models that could be tested with LISREL to determine the influence of quality management practices and internal quality performance on the individual dimensions of competitive capabilities (Competitive Pricing (CP), Premium Pricing (PP), Value to Customer Quality (VCQ), Dependable Deliveries (DD), and Product Innovation (PI))

**Recommendation 3:** Future research should examine the relationship between quality management practices, quality failures, product costs, lead time, and specific competitive capabilities (competitive pricing, premium pricing, value to customer quality, dependable deliveries, and product innovation).

More in depth knowledge could be attained by examining the relationship between specific dimensions of quality management practices, the three internal quality performance measures, and competitive capabilities. Figures 6.6 to 6.11 display the causal models which could be submitted to LISREL analysis. The scales which have been developed for management based quality practices, employee based quality practices, customer based quality practices, information based quality

**Exogenous Variables**:
$\xi_1$ = Quality Management Practices

**Endogenous Variables:**
$\eta_1$ = Quality Failures
$\eta2$ = Unit Manufacturing Cost
$\eta3$ = Lead Time
$\eta4$ = **Competitive Pricing**

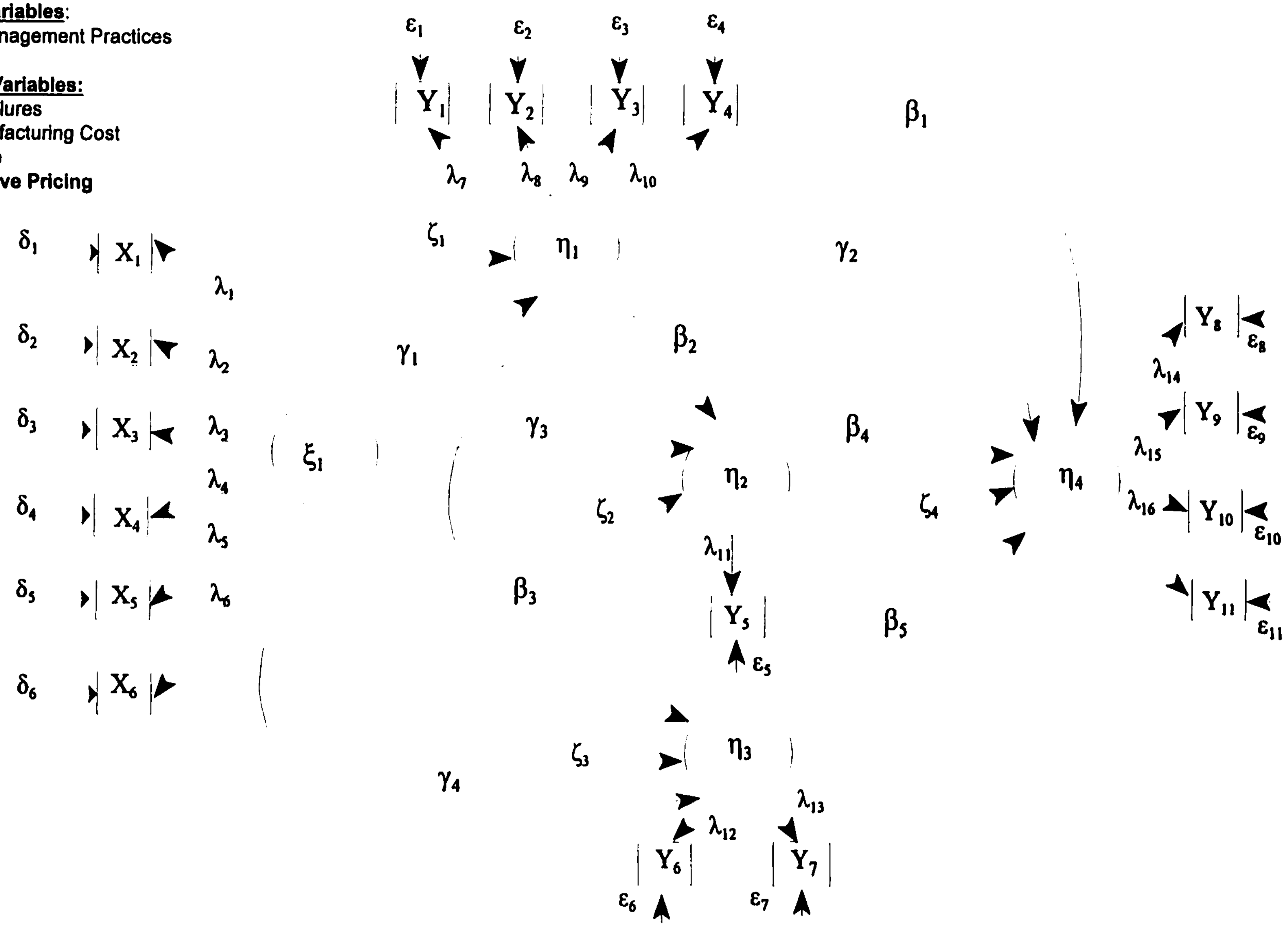


**FIGURE 6.1. AREAS OF FUTURE RESEARCH - PATH DIAGRAM FOR EXAMINING THE RELATIONSHIP BETWEEN QUALITY MANAGEMENT PRACTICES, QUALITY FAILURES, UNIT MANUFACTURING COST, LEAD TIME, AND COMPETITIVE PRICING.**

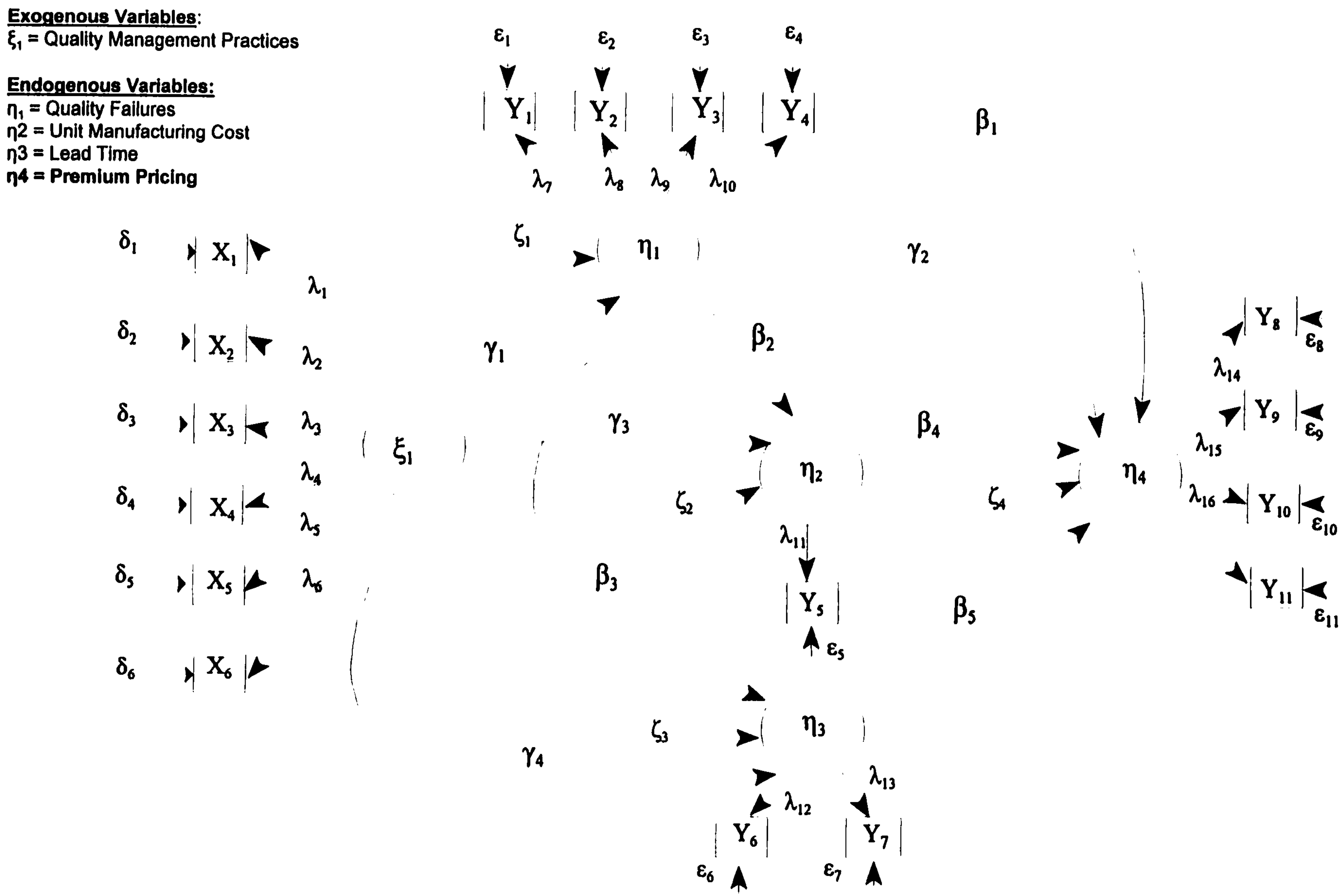


FIGURE 6.2. AREAS OF FUTURE RESEARCH - PATH DIAGRAM FOR EXAMINING THE RELATIONSHIP BETWEEN QUALITY MANAGEMENT PRACTICES, QUALITY FAILURES, UNIT MANUFACTURING COST, LEAD TIME, AND PREMIUM PRICING.

**Exogenous Variables:**
$\xi_1$ = Quality Management Practices

**Endogenous Variables:**
$\eta_1$ = Quality Failures
$\eta 2$ = Unit Manufacturing Cost
$\eta 3$ = Lead Time
**$\eta 4$ = Value to Customer Quality**

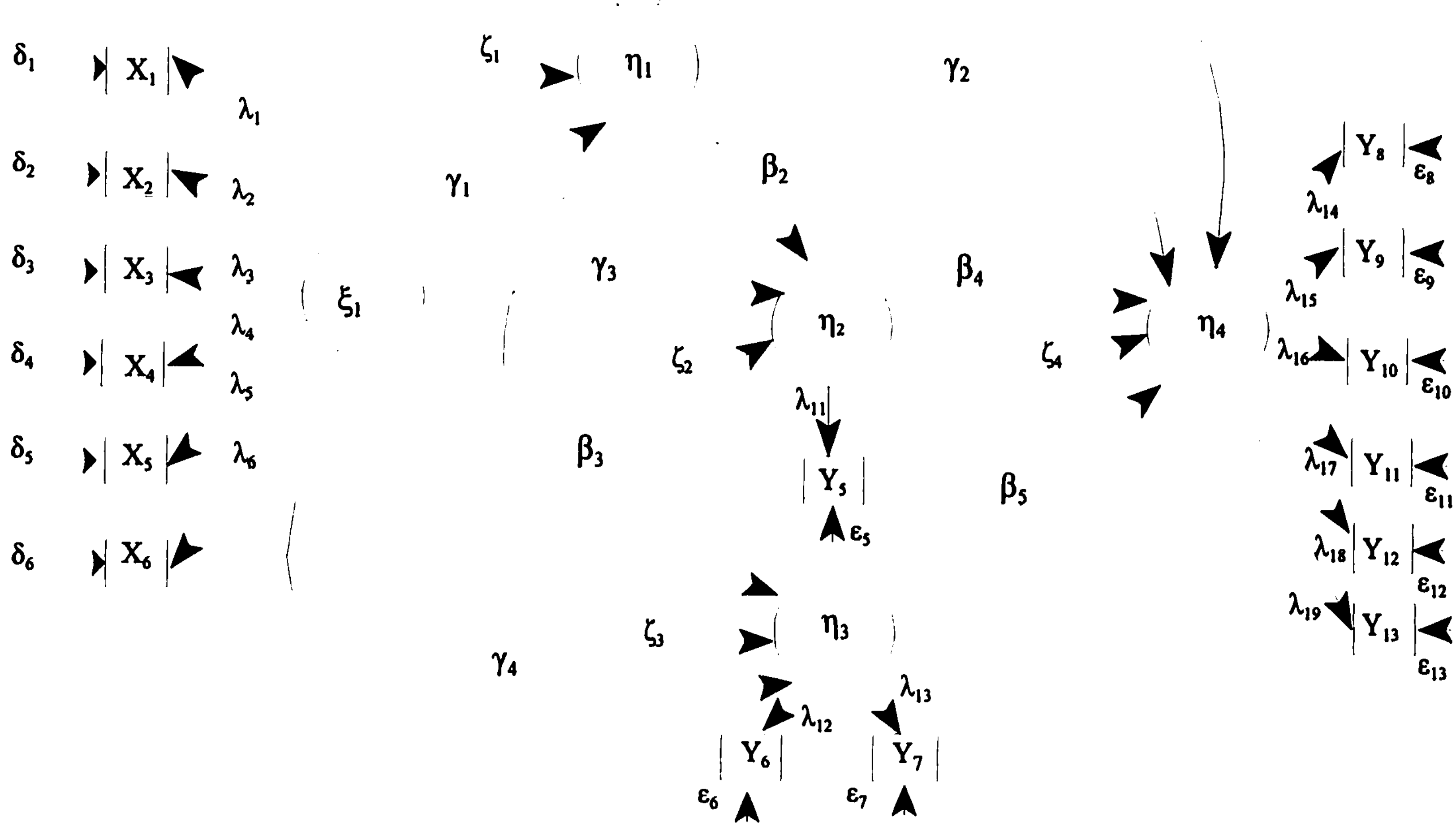


**Figure 6.3. Areas of Future Research - Path Diagram for Examining the Relationship Between Quality Management Practices, Quality Failures, Unit Manufacturing Cost, Lead Time, and Value to Customer Quality**

**Exogenous Variables**:
$\xi_1$ = Quality Management Practices

**Endogenous Variables:**
$\eta_1$ = Quality Failures
$\eta 2$ = Unit Manufacturing Cost
$\eta 3$ = Lead Time
$\eta 4$ = Dependable Deliveries

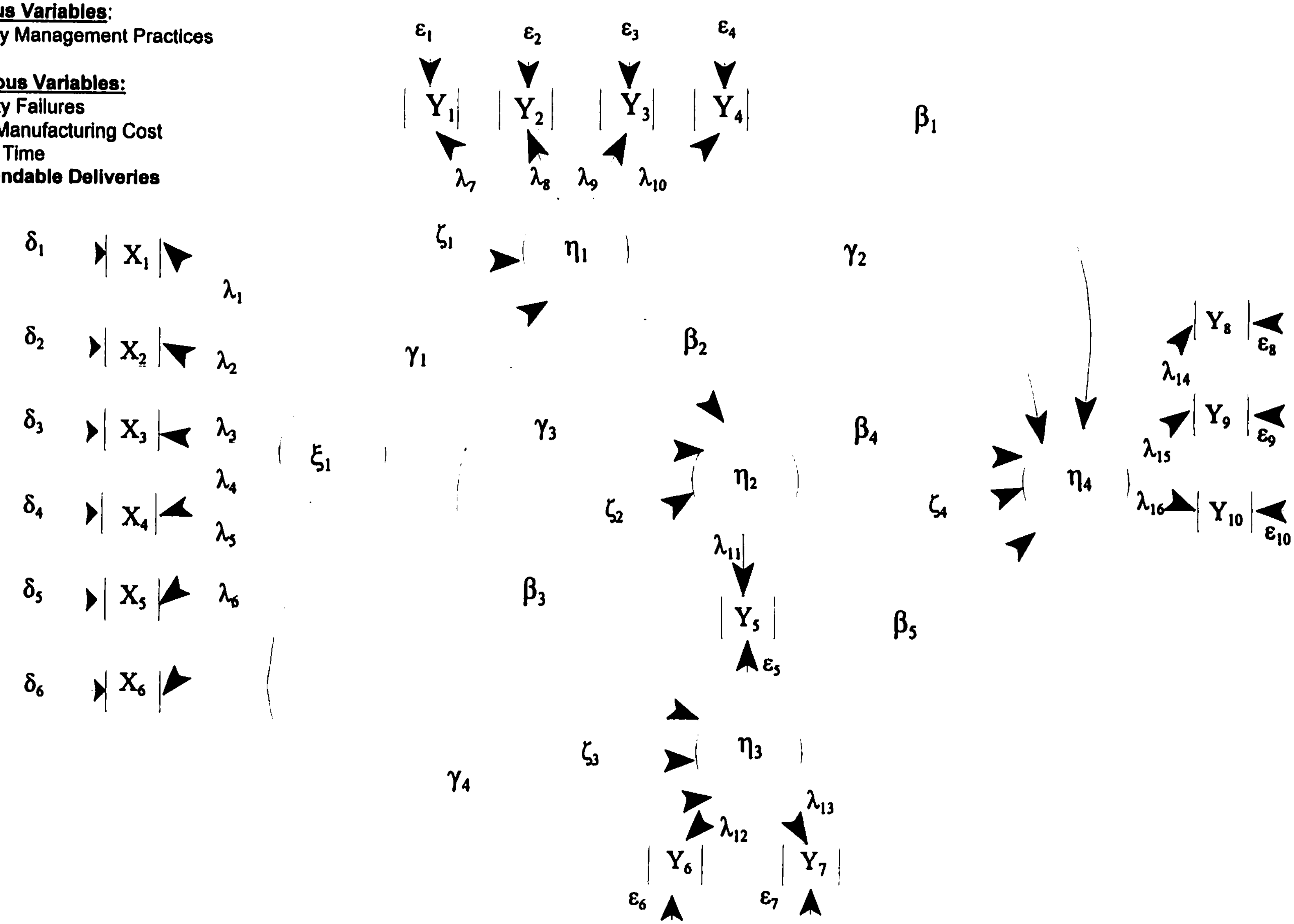


FIGURE 6.4. AREAS OF FUTURE RESEARCH - PATH DIAGRAM FOR EXAMINING THE RELATIONSHIP BETWEEN QUALITY MANAGEMENT PRACTICES, QUALITY FAILURES, UNIT MANUFACTURING COST, LEAD TIME, AND DEPENDABLE DELIVERIES

**Exogenous Variables:**
$\xi_1$ = Quality Management Practices

**Endogenous Variables:**
$\eta_1$ = Quality Failures
$\eta 2$ = Unit Manufacturing Cost
$\eta 3$ = Lead Time
$\eta 4$ = **Product Innovation**

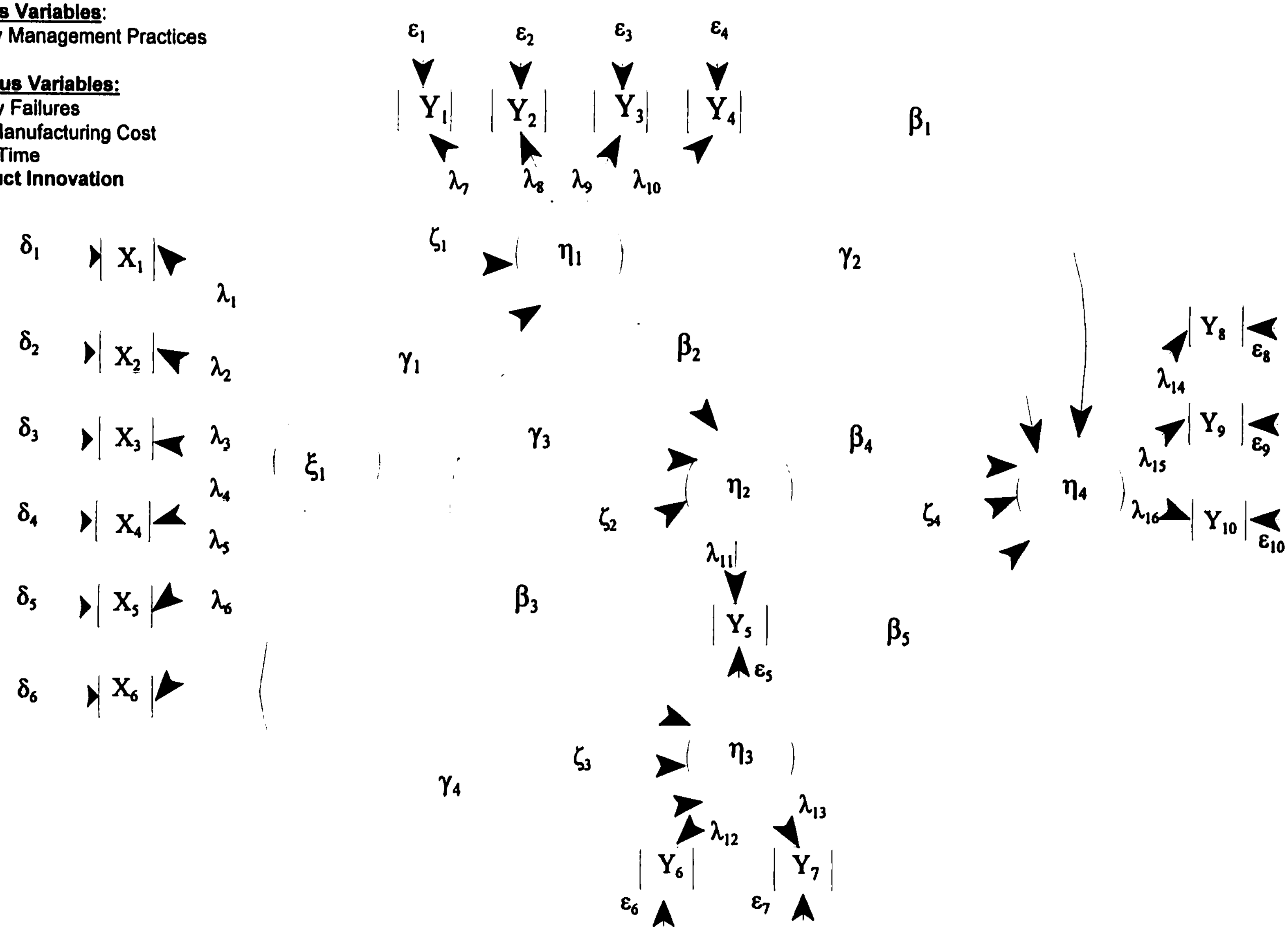


FIGURE 6.5. AREAS OF FUTURE RESEARCH - PATH DIAGRAM FOR EXAMINING THE RELATIONSHIP BETWEEN QUALITY MANAGEMENT PRACTICES, QUALITY FAILURES, UNIT MANUFACTURING COST, LEAD TIME, AND PRODUCT INNOVATION

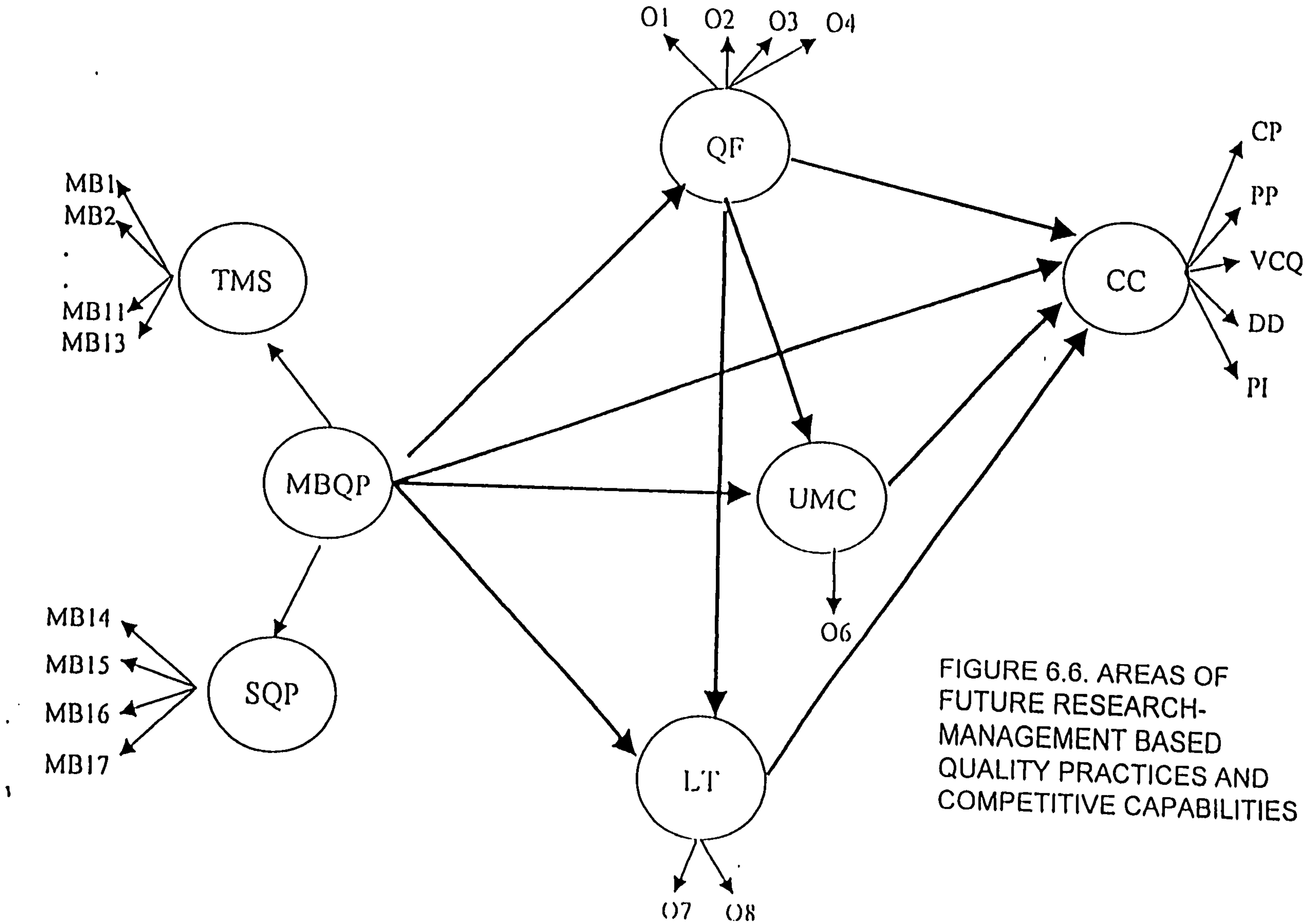


FIGURE 6.6. AREAS OF FUTURE RESEARCH-MANAGEMENT BASED QUALITY PRACTICES AND COMPETITIVE CAPABILITIES

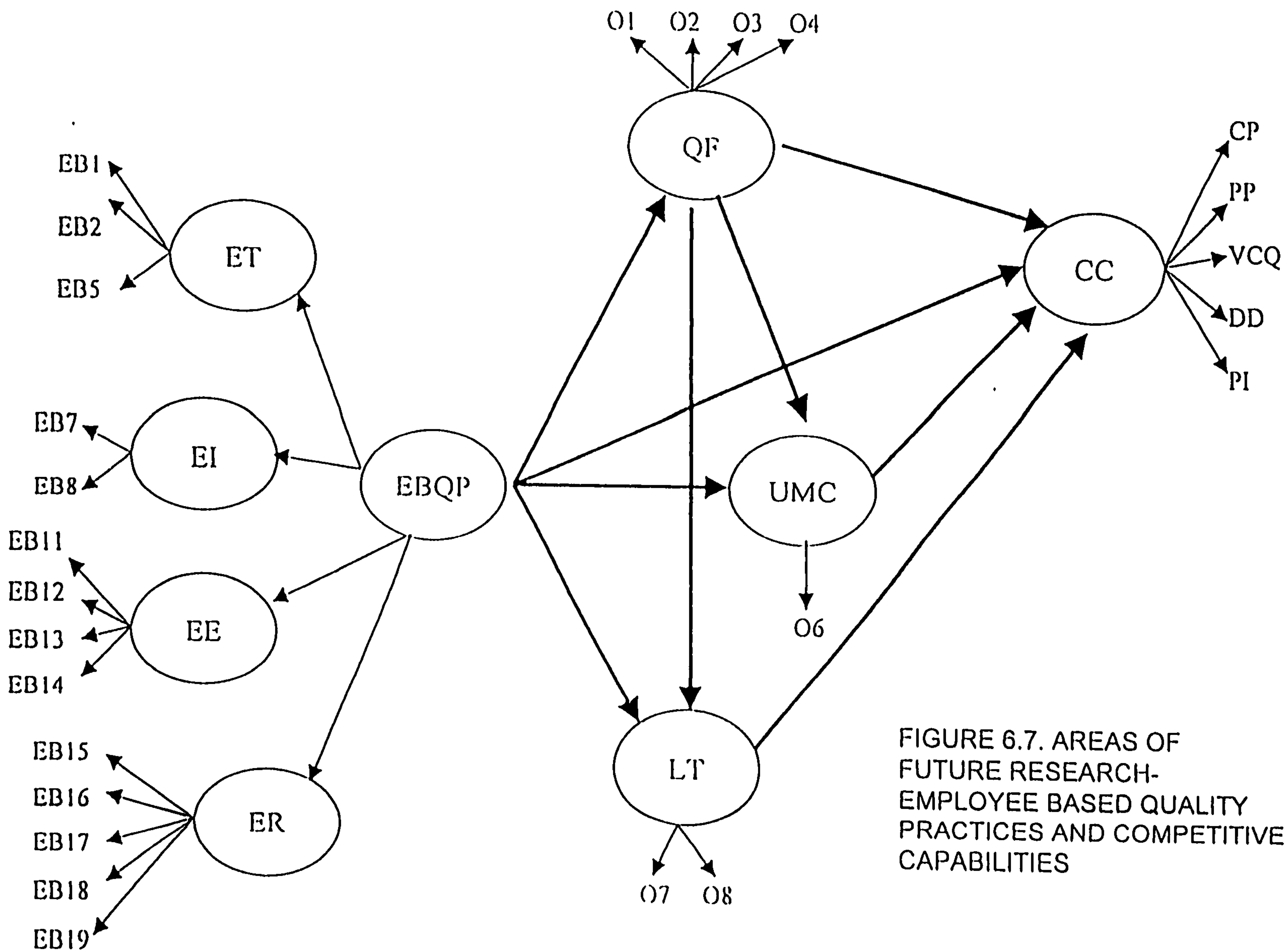


FIGURE 6.7. AREAS OF FUTURE RESEARCH- EMPLOYEE BASED QUALITY PRACTICES AND COMPETITIVE CAPABILITIES

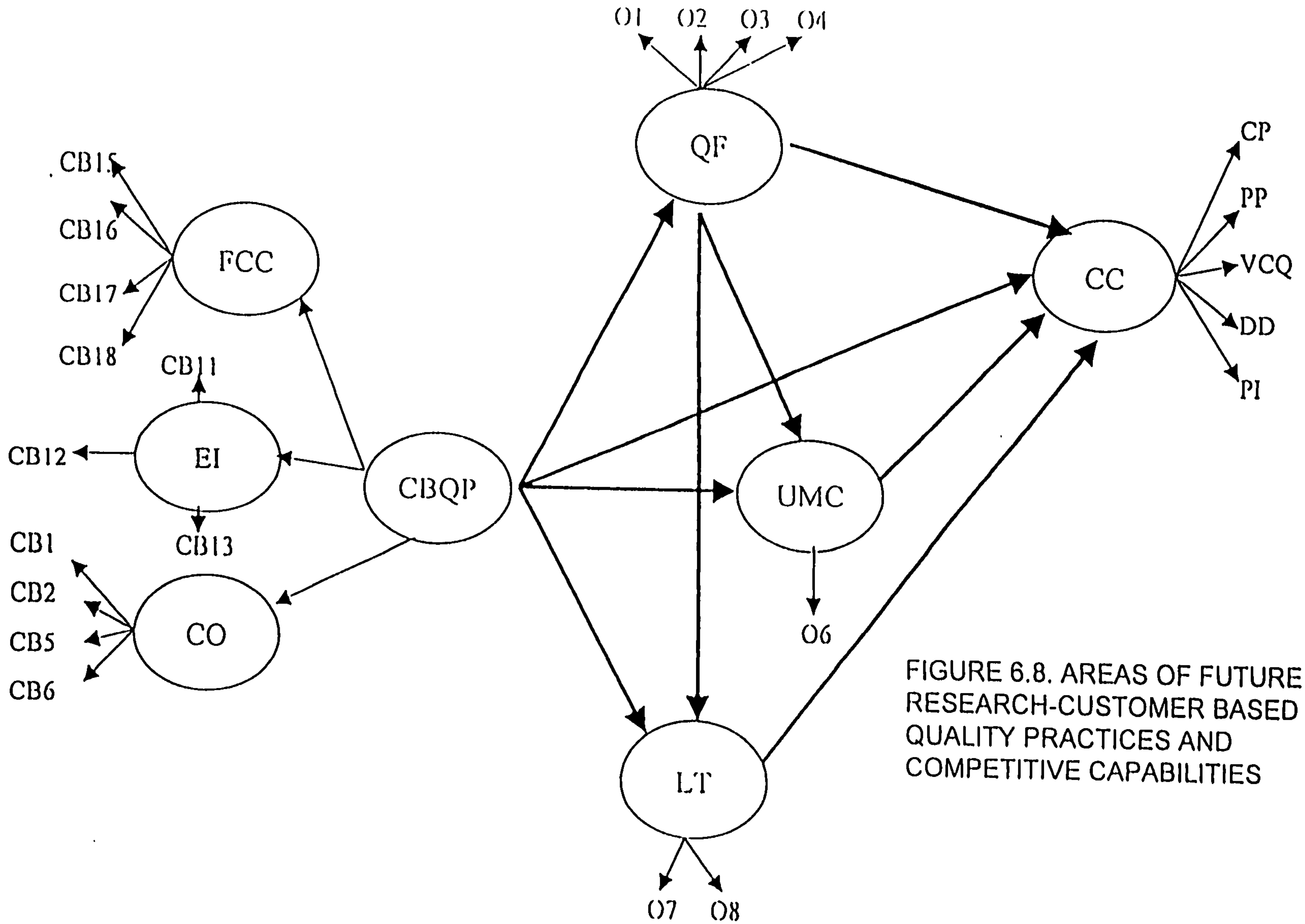


FIGURE 6.8. AREAS OF FUTURE RESEARCH-CUSTOMER BASED QUALITY PRACTICES AND COMPETITIVE CAPABILITIES

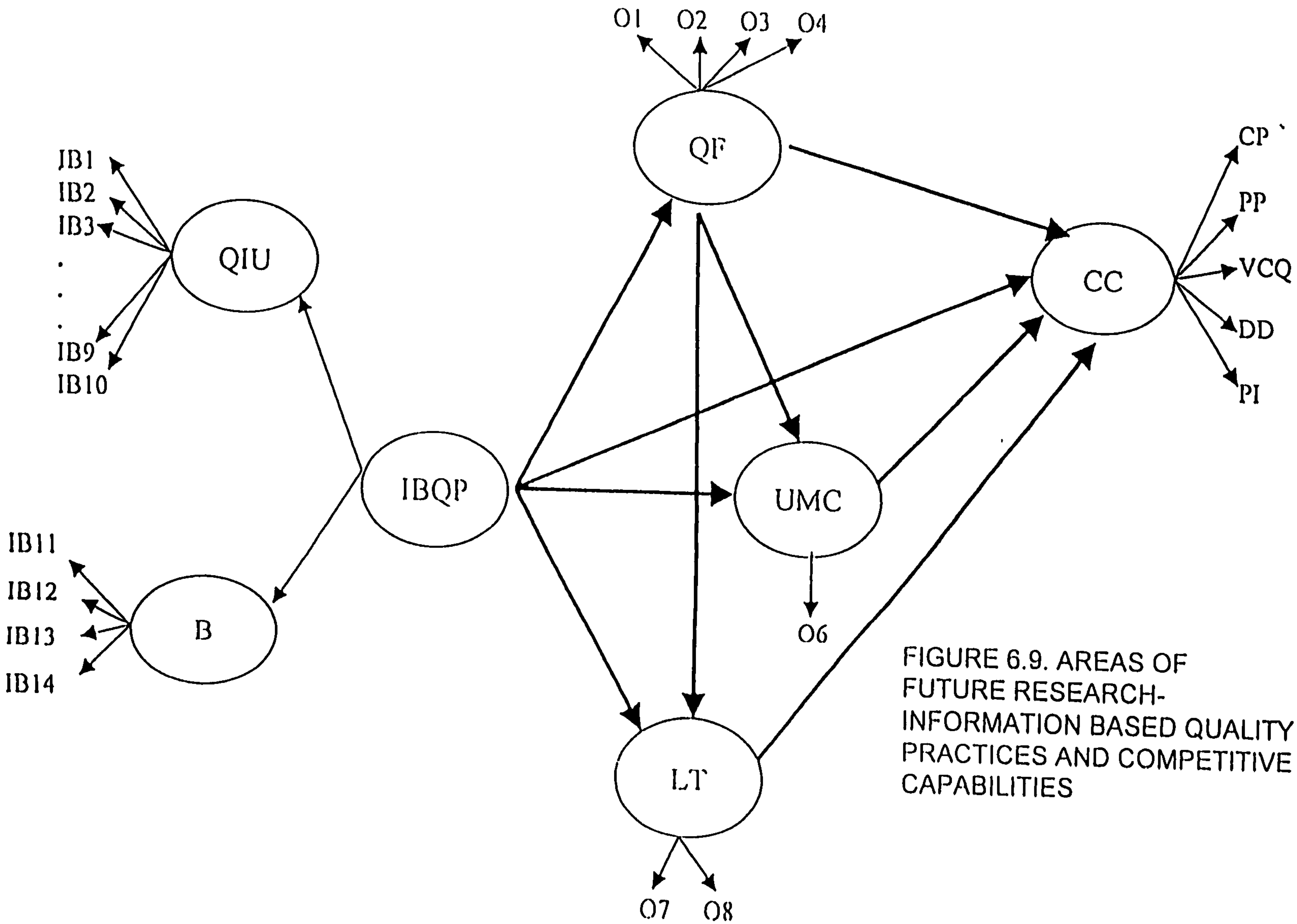


FIGURE 6.9. AREAS OF FUTURE RESEARCH- INFORMATION BASED QUALITY PRACTICES AND COMPETITIVE CAPABILITIES

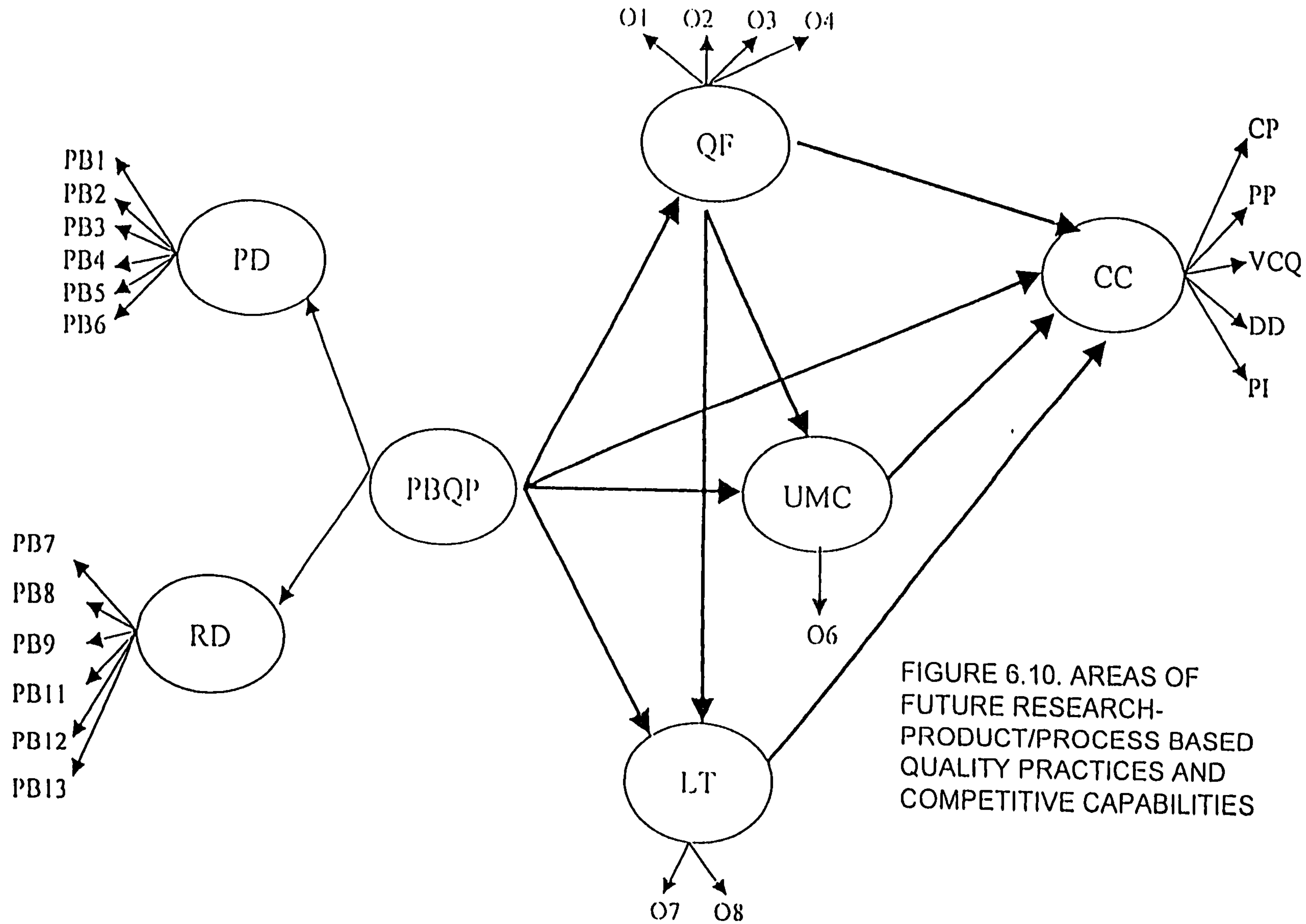


FIGURE 6.10. AREAS OF FUTURE RESEARCH-PRODUCT/PROCESS BASED QUALITY PRACTICES AND COMPETITIVE CAPABILITIES

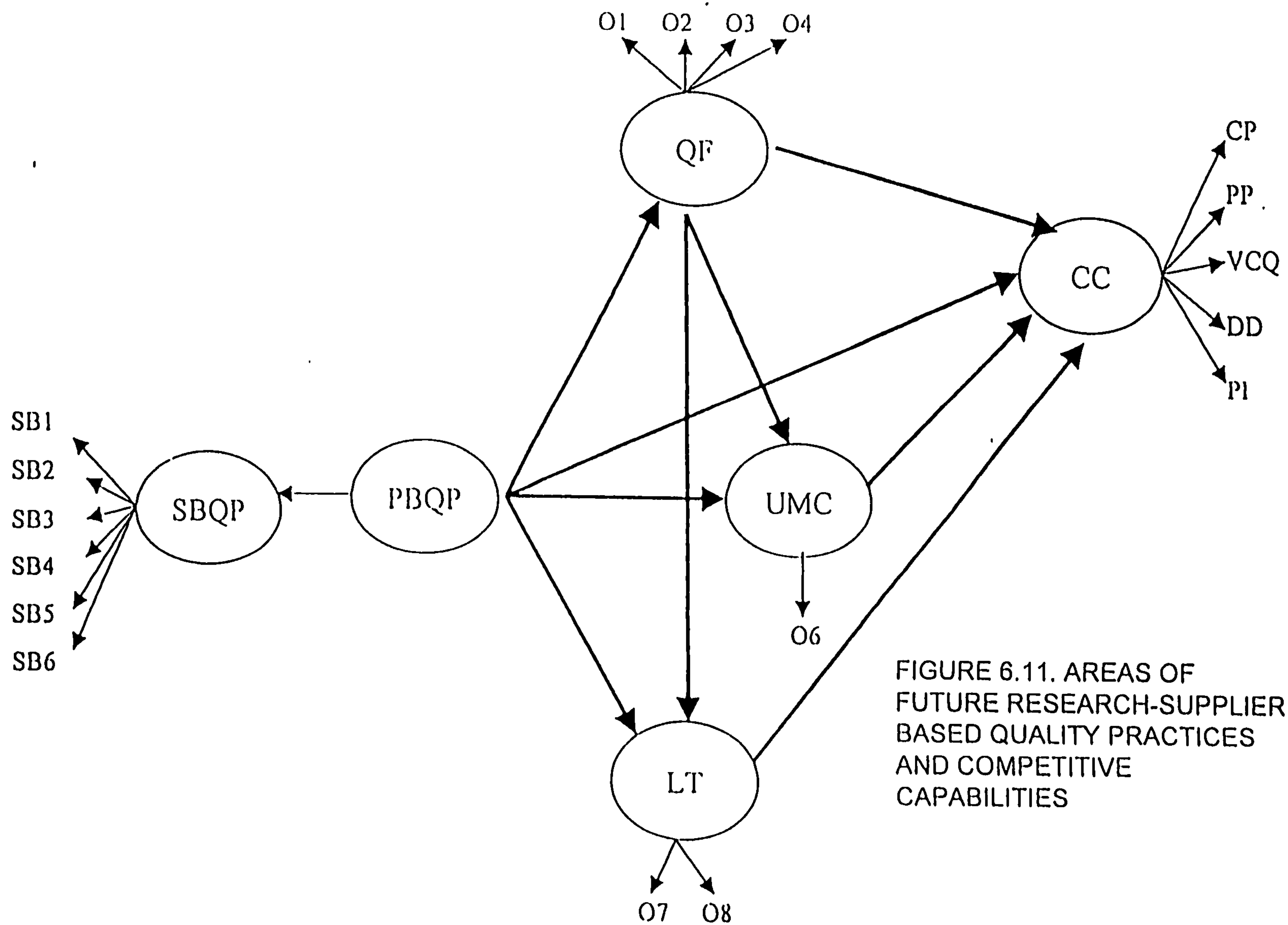


FIGURE 6.11. AREAS OF FUTURE RESEARCH-SUPPLIER BASED QUALITY PRACTICES AND COMPETITIVE CAPABILITIES

practices, product/process based quality practices, and supplier based quality practices, internal quality performance, and competitive capabilities can now be employed to examine the hypothesized relationships among these variables.

**Recommendation 4:** Future research should examine the effect of specific quality management practices on internal quality performance and competitive capabilities.

A combination of the last two recommendations helps to increase our understanding at a more detailed level of the impact of specific quality management practices on specific competitive capabilities and the mediating role of internal quality performance.

**Recommendation 5:** Future research should examine the effect of specific quality management practices on specific competitive capabilities.

The detailed level of analysis described above allows for more informed decisions regarding quality management practices at the strategic and operational levels. By accomplishing this idea, it would enable decision makers to improve the effectiveness of resource allocation for quality implementation to strengthen certain competitive capabilities with the ultimate goal of improving firm performance.

As described in Chapter 2, contingency and resource based theories provide a theoretical foundation for the linkage among quality management practices, competitive capabilities, and business strategy. Grant (1991) argues that an organization's capabilities serve as the foundation for its strategy. In other words, the selection of specific competitive capabilities will vary across strategy types

(Obert and Spencer, 1996). Moreover, quality management practices can support competitive capabilities by improving the skills and developing resources allowing for the firm to establish the foundation for competitive advantage. It follows that a link should exist between competitive capabilities and quality management practices in organizations. In other words, companies pursuing different capabilities should emphasize different quality management practices. For example, companies stressing innovation, are likely to implement different quality management practices than those emphasizing efficiency and low cost. Furthermore, some capabilities could require greater attention to quality overall than do others. In other words, which quality management practices should be emphasized to better support the alignment between competitive capabilities and firm's strategy, is a question that requires empirical research. Figure 12 shows a research model that could be tested with LISREL, and employing the database created for the present research to determine the moderating role of business strategy between quality management practices and competitive capabilities.

**Recommendation 6**: Future research should examine the moderating role of strategy type on the relationship between quality management practices, internal quality performance, and competitive capabilities.

In the present study, unit manufacturing costs did not correlate significantly with quality management practices or competitive capabilities. One possible explanation is that only one measure of unit manufacturing costs was used for this research. Without additional measurement items for assessing unit manufacturing

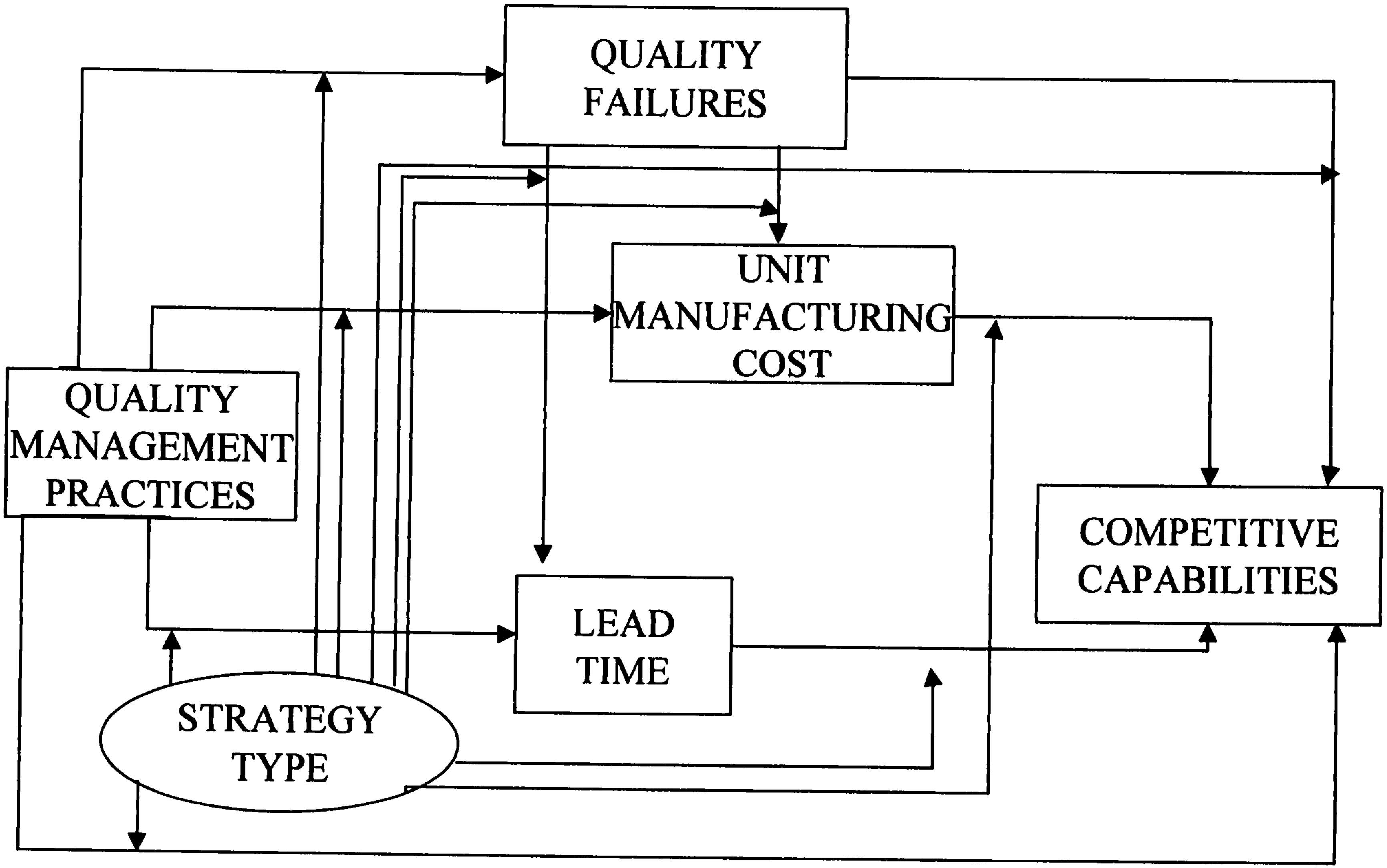


**FIGURE 6.12. AREAS OF FUTURE RESEARCH-STRATEGY IMPACT ON QUALITY MANAGEMENT AND COMPETITIVE CAPABILITIES**

costs, it is impossible to determine the reliability of the reported costs. Thus, it is not certain that the lack of significant relationships resulted from problems or lack of real relationships. Future research might include other than self-reported measurements of direct labor costs, overhead costs, materials costs, inventory costs, etc.

**Recommendation 7:** Future research should incorporate multiple measures of unit manufacturing costs.

It was evident too from this research that lead time had a nonsignificant correlation with quality management practices and competitive capabilities. One possible explanation is the two measurement items for the lead time scale may account only for a portion of the total response time, thereby its significance to quality management practices and competitive capabilities are potentially limited. As a consequence, future research should consider using time measurements along the value added chain.

**Recommendation 8:** Future research should include measurement of lead time along the value added chain.

A shared consensus exists among quality researchers and practitioners that the implementation of a program of quality management practices requires commitment and patience. According to Ishikawa (1985), the success of a company quality improvement effort takes at least five years. Van Ham and Williams (1986), report that the kind of organizational change needed to achieve significant breakthrough in total quality management takes time, because manufacturing companies are at different stages of time experience in implementing quality management practices. In fact, not all practices can be implemented simultaneously. For example, employee empowerment and teamwork must be implemented after the necessary training and organizational processes are in place to provide an adequate environment for it to succeed. As such, some benefits from quality management practices can not be immediately realized.

**Recommendation 9:** Future research should study the moderating role of length of quality management experience on the relationship between quality management practices and internal quality performance.

In this research, a set of relationships was proposed across a nomological network of quality based competition constructs. In future research, additional scales could be developed and incorporated to complement the research model proposed here. For example, in internal quality results the addition of variables measuring productivity, employee satisfaction, and equipment and machinery breakdowns could be explored.

**Recommendation 10:** Future research should expand the internal quality performance construct to include more indicators.

The dynamic of markets' environment requires companies to continuously adapt and align resources and skills to qualify for and to win customer orders. Changes in needs of customers in terms of volume and product specifications demands that companies maintain flexibility to adapt to such changes. However, the present research did not measure the extent to which companies have flexible capabilities. By measuring this variable, future research may find significant relationships between quality management practices and flexibility capabilities, and which specific quality practices need emphasis to strengthen the capability of being flexible.

**Recommendation 11:** Future research should expand the content of competitive capabilities by including flexibility measures.

The ultimate goals of quality management practices and competitive capabilities are enhancing customer satisfaction and the performance of the firms. TQM adherents claim that TQM generates more satisfied customers (Powell, 1995). More satisfied customers are most likely to do repeat business with the company, and customer satisfaction should be reflected in business performance. The ability of the firm to satisfy customers in a unique way is also dependent upon its competitive capabilities. Capabilities yield competitive advantage as reflected in business performance (Obert and Spencer, 1996). Figure 6.13 depicts a model which could be tested with LISREL.

**Recommendation 12:** Future research should incorporate consequences to quality management practices and competitive capabilities such as customer satisfaction and firm performance.

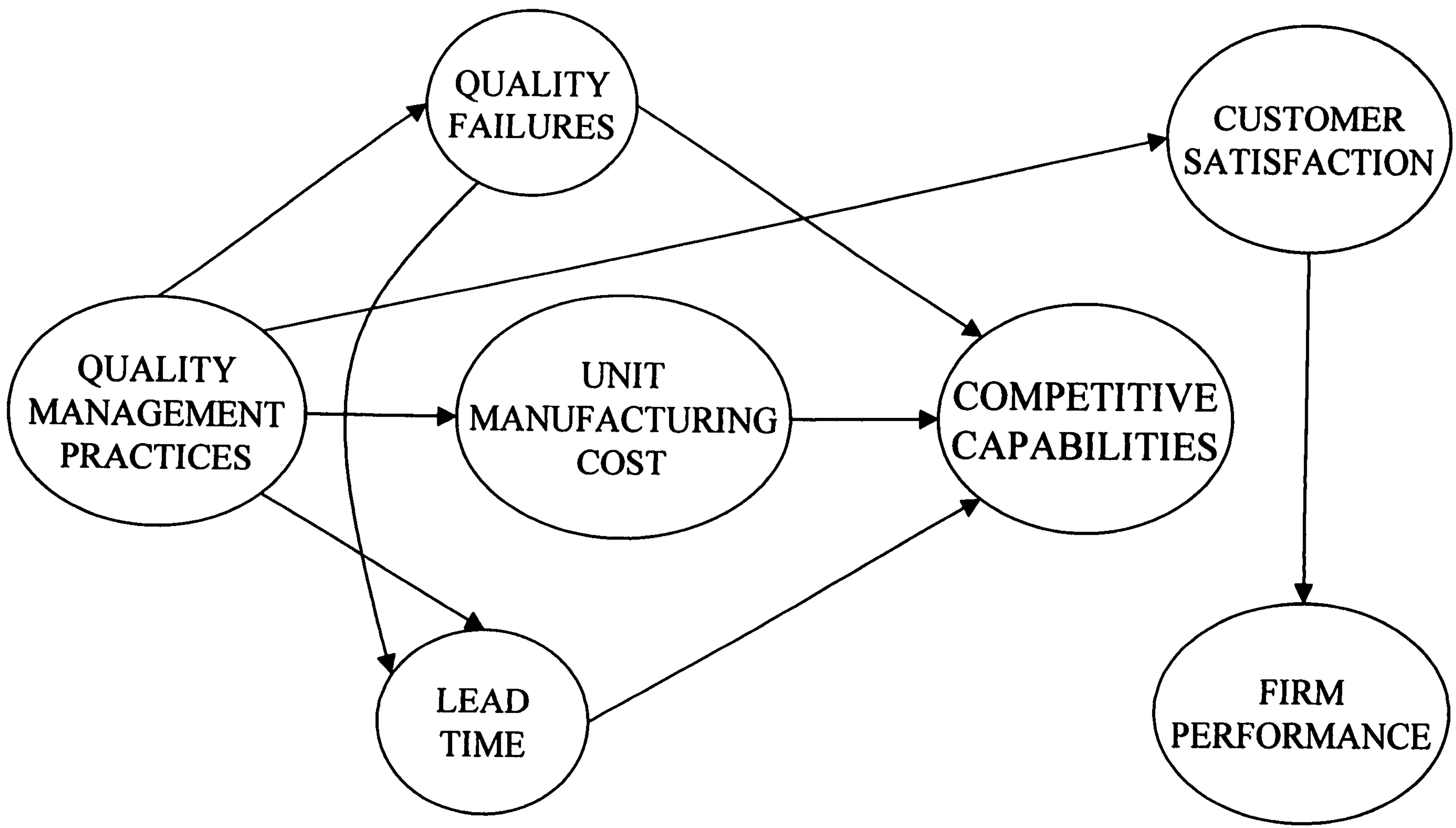


**FIGURE 6.13. AREAS OF FUTURE RESEARCH-QUALITY MANAGEMENT PRACTICES/ COMPETITIVE CAPABILITIES IMPACT ON FIRM RELATED OUTCOMES**

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## Appendix A

## Cohen's Kappa and Moore and Benbassat Coefficients

The following example will to describe the Cohen's Kappa measure of agreement. Two judges independently classified a set of N components as either acceptable or rejectable. After the work was finished the following table was constructed:

| | Judge 1 | | | |
|---|---|---|---|---|
| Judge 2 | | Acceptable | Rejectable | Totals |
| | Acceptable | $X_{11}$ | $X_{12}$ | $X_{1+}$ |
| | Rejectable | $X_{21}$ | $X_{22}$ | $X_{2+}$ |
| | Totals | $X_{+1}$ | $X_{+2}$ | N |

Xij = the number of components in the $i^{th}$ row and $j^{th}$ column, for i,j = 1,2.

The above table can also be constructed using percentages by dividing each numerical entry by N. For the population of components, the table will look like:

| | | Judge 1 | | |
|---|---|---|---|---|
| Judge 2 | | Acceptable | Rejectable | Totals |
| | Acceptable | $P_{11}$ | $P_{12}$ | $P_{1+}$ |
| | Rejectable | $P_{21}$ | $P_{22}$ | $P_{2+}$ |
| | Totals | $P_{+1}$ | $P_{+2}$ | N |

Pij = the percentage of components in the $i^{th}$ row and $j^{th}$ column.

We will use this table of percentages to describe the Cohen's Kappa coefficient of agreement. The simplest measure of agreement is the proportion of components that were classified the same by both judges, i.e., $\Sigma_I P_{ii} = P_{11} + P_{22}$. However, Cohen suggested comparing the actual agreement, $\Sigma_I P_{ii}$ , with the chance of agreement that would occur if the row and columns are independent, i.e., $\Sigma_I P_{i+}P_{+I}$. The difference between the actual and chance agreements, $\Sigma_I P_{ii} - \Sigma_I P_{i+}P_{+I}$, is the percent agreement above that which is due to chance. This difference can be standardized by dividing it by its maximum possible value, i.e., 100% - $\Sigma_I P_i + P_{+I}$ = 1 - $\Sigma_I P_i + P_{+I}$. The ratio of these is denoted by the Greek letter kappa and is referred to as Cohen's kappa.

$$k = \frac{\Sigma_i P_{ii} - \Sigma_i (P_{i+} P_{+i})}{1 - \Sigma_i (P_{i+} P_{+i})}$$

Thus, Cohen's Kappa is a measure of agreement that can be interpreted as the proportion of joint judgement in which there is agreement after chance agreement is excluded. The three basic assumptions for this agreement coefficient are: 1) the units are independent, 2) the categories of the nominal scale are independents, mutually exclusive, and 3) the judges operate independently. For any problem in nominal scale agreement between two judges, there are only two relevant quantities:

$p_o$= the proportion of units in which the judges agreed

$p_c$= the proportion of units for which agreement is expected by chance

Like a correlation coefficient, *k*=1 for complete agreement between the two judges. If the observed agreement is greater than or equal to chance $K \leq 0$. The minimum value of k occurs when $\Sigma P_{ii} = 0$, i.e.,

$$\min(k) = \frac{-\Sigma_i (P_{i+} P_{+i})}{1 - \Sigma_i (P_{i+} P_{+i})}$$

When sampling from a population where only the total N is fixed, the maximum likelihood estimate of *k* is achieved by substituting the sample proportions

$$k = \frac{N_i Xii - \Sigma_i (X_{i+} X_{+i})}{N^2 - \Sigma_i (X_{i+} X_{+i})}$$

for those of the population. The formula for calculating the sample kappa (*k*) is:

For kappa, no general agreement exists with respect to required scores. However, recent studies have considered scores greater than 0.65 to be acceptable (e.g. Vessey, 1984; Jarvenpaa 1989; Todd and Benbasat, 1989). Landis and Koch (1977), have provided a more detailed guideline to interpret kappa by associating different values of this index to the degree of agreement beyond chance. The following guideline is suggested:

| Value of Kappa | Degree of Agreement Beyond Chance |
|---|---|
| .76 - 1.00 | Excellent |
| .40 - .75 | Fair to Good (Moderate) |
| .39 or less | Poor |

A second overall measure of both the reliability of the classification scheme and the validity of the items was developed by Moore and Benbasat, (1991). The method required analysis of how many items were placed by the panel of judges for each round within the target construct. In other words, because each item was included in the pool explicitly to measure a particular underlying construct, a measurement was taken of the overall frequency with which the judges placed items within the intended theoretical construct. The higher the percentage of items placed in the target construct, the higher the degree of inter-judge agreement across the panel which must have occurred.

Moreover, scales based on categories which have a high degree of correct placement of items within them can be considered to have a high degree of construct validity, with a high potential for good reliability scores. It must be emphasized that this procedure is more a qualitative analysis than a rigorous quantitative procedure. There are no established guidelines for determining good levels of placement, but the matrix can be used to highlight any potential problem areas. The following exemplifies how this measure works.

**Item Placement Scores**

| CONSTRUCTS | | ACTUAL | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | A | B | C | D | N/A | Total | % Hits |
| THEORETICAL | A | 26 | 2 | 1 | 0 | 1 | 30 | 87 |
| | B | 8 | 18 | 4 | 0 | 0 | 30 | 60 |
| | C | 0 | 0 | 30 | 0 | 0 | 30 | 100 |
| | D | 0 | 1 | 0 | 28 | 1 | 30 | 93 |

Item Placements: 120 Hits: 102 Overall "Hit Ratio": 85%

The item placement ratio is an indicator of how many items were placed in the intended, or target, category by the judges. As an example of how this measure could be used, consider the simple case of four theoretical constructs with ten items developed for each construct. With a panel of three judges, a theoretical total of 30 placements could be made within each construct. Thereby, a theoretical versus actual matrix of item placements could be created as shown in the figure below (including an ACTUAL "N/A: Not Applicable" column where judges could place items which they felt fit none of the categories).

Examination of the diagonal of the matrix shows that with a theoretical maximum of 120 target placements (four constructs at 30 placements per construct), a total of 102 "hits" were achieved, for an overall "hit ratio" of 85%. More important, an examination of each row shows how the items created to tap the particular constructs are actually being classified. For example, row C shows that all 30-item placements were within the target construct, but that in row B, only 60% (18/30) were within the target. In the latter case, 8 of the placements were made in construct A, which might indicate the items underlying these placements are not differentiated enough from the items created for construct A. This finding would lead one to have confidence in scale based on row C, but be hesitant about accepting any scale based on row B. In an examination of off-diagonal entries indicate how complex any construct might be. Actual constructs based on columns with a high number of entries in the off-diagonal might be considered too ambiguous, so any consistent pattern of item misclassification should be examined.

**Appendix B:**

**Items after the Initial Pilot Study**

1. Management Based Quality Practices Items

| |
|---|
| Top management takes responsibility for the company's quality performance |
| Top management is visibly involved in improving company's quality performance |
| Top management drives the company's efforts towards excellence in quality |
| Top management assigns a higher priority to quality than to cost and scheduling objectives |
| Top management provides a work environment that is supportive of the quality mission and policies |
| Top management includes quality issues in theirs meetings' agenda |
| Top management actions encourage a culture of trust |
| Top management actions encourage change for the better |
| Top management actions show that customer satisfaction is important |
| Top management takes responsibility for communication and employee understanding of quality mission and policies |
| Top management allocates adequate resources to improve company's quality performance |
| Top management considers company's quality performance as a major factor in their performance evaluation |
| Top management provides a clear vision for achieving quality excellence |
| Our strategic plan supports long term (3 years or more) quality improvement efforts |
| Our strategic plan supports short term (1-2 years) quality improvement efforts |
| Our strategic plan is supported by our company's quality mission and policies |
| In our strategic plan quality is an integral part |

2. Employee Based Quality Practices Items

| |
|---|
| Training in quality is provided to all employees |
| Training in basic quality tools (histograms, problem solving, etc.) is provided to all employees |
| Our employees receive training in specific job skills |
| Training in multiple skills is given to our hourly workers |
| Training in advanced quality techniques (e.g. design of experiments) is provided to those employees who require it |
| Throughout the company employees participate in our continuous improvement efforts |
| Employee participation in our suggestion programs is ongoing |
| Employee suggestions receive rapid attention and quick response |
| We use teams to involve our employees in our continuous improvement efforts |
| Our hourly workers inspect the quality of their own work (inspection is not the responsibility of an inspector) |
| Our hourly workers fix problems they identify |
| Our hourly workers are provided with the necessary resources to fix quality problems they identify |
| Our hourly workers are empowered to make decisions regarding the managing of their workplace |
| Our hourly workers are empowered to make improvements related with their immediate and extended processes |
| Our employees receive recognition for outstanding quality performance |
| We recognize our employees' contributions to improve company's quality performance |
| Employee's suggestions for quality improvement are rewarded |
| We give our employees recognition for contribution to improve customer satisfaction |
| We recognize teams contributions to our continuous improvement efforts |

3. Customer Based Quality Practices Items

| |
|---|
| We are committed to satisfy customer's needs and expectations |
| Customer satisfaction drives our company's quality improvement actions |
| We know which attributes of our products and services our customers' value most |
| We seek our customers' feedback about company's performance in satisfying their needs and expectations |
| We encourage our employees to satisfy customers' needs and expectations |
| Our employees are aware of the need to satisfy to our customers' needs and expectations |
| We involve our customers in our continuous quality improvement efforts |
| We encourage our customers to give us feedback about current and future requirements |
| We measure the levels of customer satisfaction systematically and regularly |
| We know how our customers use our products |
| Our customers and top management are in direct contact |
| Our customers and middle managers are in direct contact |
| Our customers regularly visit our plants |
| Our customers are only in direct contact with our marketing/sales department |
| Our customers are personally contacted at least once a year by someone else than a sales representative |
| Our customer contacts strategy is frequent and pervasive |
| Our customers are in direct contact with all our functional departments |
| Managers visit our customer's site regularly |

4. Information Based Quality Practices Items

| |
|---|
| Quality information (quality costs, rework, customer complaints, etc.) Is systematically and regularly collected |
| Quality information (quality costs, rework, customer complaints, etc.) is available on time |
| Quality information is (control charts, histograms, etc.) displayed on the shop floor at the majority of the work stations |
| Productivity and quality reports are readily available on the production process critical points |
| Quality information is readily available to managers and supervisors |
| Work place's quality performance information is available to hourly workers |
| Quality information is used at the right time by top management in decision making |
| Quality information is used at the right time by middle management in planning and control |
| Our hourly workers use quality information to control and improve quality at their workstations |
| Quality information is used at the right time to identify company wide improvement opportunities |
| We study the "best product development practices" of other companies to get ideas how to do things better |
| We compare our current quality levels for products and services with those of competitors and/or industry leaders |
| We study the best "quality practices" of other companies to get ideas to improve our quality performance |
| We benchmark the best "customer service practices" with recognized industry leaders |
| We study the "best production process design practices" of other companies to get ideas how to do things better |

5. Product/Process Based Quality Practices Items

| |
|---|
| Our product design process incorporates manufacturability as an important component |
| Our product design process generates product and service design requirements that conform to customers needs |
| We involve external suppliers early in the product design process |
| Our product design process applies customer-driven techniques (such as quality function deployment) |
| Our product design process is supported by a multidisciplinary approach (marketing, manufacturing, R&D, etc.) |
| Our product design process addresses environmental and legal concerns |
| In our production process we apply statistical process control techniques |
| Our equipment and machines are under statistical quality control |
| In our production process variance is reduced through the implementation of SPC techniques |
| Our process design provides specifications that are clear and easy to understand |
| Our process design integrates quality engineering techniques (such as Taguchi methods) |
| Our process design incorporates error prevention techniques (such as Shingo, Poka Yoke) |
| Our production processes are designed to be foolproof |

6. Supplier Based Quality Practices Items

| |
|---|
| Our primary criteria to select suppliers is quality not price |
| Our supplier relationships are focused on the long term |
| Our supplier relationships have achieved high levels of confidence and trust |
| Our suppliers are readily to participate in solving quality problems |
| We work with our suppliers to improve each other's processes |
| Our suppliers are involved in our continuous improvement effort |

## Appendix C: Description of the Sample

| RESPONDENTS BY SIC CODE | | |
|---|---|---|
| SIC Code | Name | Percent |
| 3400 | Fabricated Metal Products Except Machinery and Transportation Equipment | 20.3 |
| 3600 | Electric and Other Electronic Equipment and Components Except Computers | 14.5 |
| 3000 | Rubber and Miscellaneous Plastic Products | 11.6 |
| 2800 | Chemical and Allied Products | 9.1 |
| 2000 | Food and Kindred Products | 6.2 |
| 3900 | Miscellaneous Manufacturing Industries | 10 |
| Others | | 24.7 |
| Total | | 100 |

| RESPONDENTS BY POSITION | |
|---|---|
| Position | Percent |
| Top Management | 29.8 |
| Middle Management | 61.8 |
| Others | 8.4 |
| Total | 100 |

| FIRMS BY SIZE | |
|---|---|
| Number of Employees | Percent |
| Up to 100 | 27.1 |
| 101 to 500 | 43.4 |
| 505 to 1000 | 11.1 |
| 1001 to 5000 | 10.8 |
| Over 5000 | 7.6 |
| Total | 100 |

| FIRMS EXPORTS ACTIVITY | |
|---|---|
| Percent of Sales in Exports | Percent of Respondents |
| 0 | 14.9 |
| Less than 25 | 60.1 |
| 25 to 50 | 14.9 |
| 51 to 75 | 8.3 |
| Over 75 | 1.7 |
| Total | 100 |

| ISO-9000 POSITION | |
|---|---|
| Position | Percent |
| ISO-9001 Registered | 34 |
| ISO-9002 Registered | 14.2 |
| ISO-9003 Registered | |
| Not Registered but Planning | 35.9 |
| Not Interested | 15.9 |
| Total | 100 |

| RESPONDENT LEVEL OF EDUCATION | |
|---|---|
| EDUCATION LEVEL | Percent |
| High School | 6.3 |
| College | 63.5 |
| Master | 26 |
| Ph.D. | 2.8 |
| Other | 1.4 |
| Total | 100 |

# APPENDIX D: LARGE SCALE QUESTIONNAIRE

**QUALITY MANAGEMENT PRACTICES AND COMPETITIVE CAPABILITIES STUDY**

Luis E. Solis
University of Toledo
College of Business Administration
Department of ISOM
Toledo, OH 43606

If you have any questions regarding this questionnaire please:
Phone: (419) 530-2420
Fax: (419) 530-7744
E-mail: lsolisg@uoft02.utoledo.edu

Dear ASQ/Quality Management Division member:

The following points will assist you in completing this questionnaire:

☺............Ideally the Quality Director, Plant Manager, or a member of the management team familiar with all aspects of your organization's quality management effort should complete this questionnaire.

☺............Before answering each question, please read the relevant scoring scales as these do change throughout the questionnaire.

☺............Unless otherwise specifically requested, for each question please circle the number which accurately reflects your organization's **PRESENT** position.

☺............It is critical to the success of this study that you answer the questions as they relate to the **CURRENT** practices of your organization- **NOT** as you wish them to be, or plan them to be in the future. This study aims to take a snap shot of manufacturing quality practices and competitive capabilities as they exist **CURRENTLY**.

☺............On completion, please return in the enclosed postage paid envelope.

*For the following items please circle the number which accurately reflects your company's* ***PRESENT*** *position, where:*

**1= Strongly Disagree 2=Disagree 3=Neither Agree nor Disagree 4=Agree 5=Strongly Agree**

## MANAGEMENT BASED QUALITY PRACTICES

| | | | | | |
|---|---|---|---|---|---|
| Top management takes responsibility for the company's quality performance | 1 | 2 | 3 | 4 | 5 |
| Top management is visibly involved in improving company's quality performance | 1 | 2 | 3 | 4 | 5 |
| Top management drives the company's efforts towards excellence in quality | 1 | 2 | 3 | 4 | 5 |
| Top management assigns a higher priority to quality than to cost and scheduling objectives | 1 | 2 | 3 | 4 | 5 |
| Top management provides a work environment that is supportive of the quality mission and policies | 1 | 2 | 3 | 4 | 5 |
| Top management includes quality issues in their meetings' agenda | 1 | 2 | 3 | 4 | 5 |
| Top management actions encourage a culture of trust | 1 | 2 | 3 | 4 | 5 |
| Top management actions encourage change for the better. | 1 | 2 | 3 | 4 | 5 |
| Top management actions show that customer satisfaction is important. | 1 | 2 | 3 | 4 | 5 |
| Top management takes responsibility for communication and employee understanding of quality mission and policies | 1 | 2 | 3 | 4 | 5 |
| Top management allocates adequate resources to improve company's quality performance | 1 | 2 | 3 | 4 | 5 |
| Top management considers company's quality performance as a major factor in their performance evaluation | 1 | 2 | 3 | 4 | 5 |
| Top management provides a clear vision for achieving quality excellence | 1 | 2 | 3 | 4 | 5 |
| Our strategic plan supports long-term (3 years or more) quality improvement efforts | 1 | 2 | 3 | 4 | 5 |
| Our strategic plan supports short-term (1-2 years) quality improvement efforts | 1 | 2 | 3 | 4 | 5 |
| Our strategic plan is supported by our company's quality mission and policies | 1 | 2 | 3 | 4 | 5 |
| In our strategic plan quality is an integral part | 1 | 2 | 3 | 4 | 5 |

*For the following items please circle the number which accurately reflects your company's* ***PRESENT*** *position, where:*

**1= Strongly Disagree   2=Disagree   3=Neither Agree nor Disagree**
**4=Agree   5=Strongly Agree**

## EMPLOYEE BASED QUALITY PRACTICES

| | | | | | |
|---|---|---|---|---|---|
| Training in quality concepts is provided to all employees | 1 | 2 | 3 | 4 | 5 |
| Training in basic quality tools(histograms, control charts, etc.) is provided to all employees | 1 | 2 | 3 | 4 | 5 |
| Our employees receive training in specific job skills. | 1 | 2 | 3 | 4 | 5 |
| Training in multiple skills is given to our hourly workers | 1 | 2 | 3 | 4 | 5 |
| Training in advanced quality techniques (e.g. design of experiments) is provided to those employees who require it | 1 | 2 | 3 | 4 | 5 |
| Throughout the company employees participate in our continuous quality improvement efforts | 1 | 2 | 3 | 4 | 5 |
| Employees participation in our suggestion programs is ongoing | 1 | 2 | 3 | 4 | 5 |
| Employees' suggestions receive rapid attention and quick response | 1 | 2 | 3 | 4 | 5 |
| We use teams to involve our employees in our continuous improvement efforts | 1 | 2 | 3 | 4 | 5 |
| Our hourly workers inspect the quality of their own work (inspection is not the responsibility of an inspector) | 1 | 2 | 3 | 4 | 5 |
| Our hourly workers fix problems they identify | 1 | 2 | 3 | 4 | 5 |
| Our hourly workers are provided with the necessary resources to fix quality problems they identify | 1 | 2 | 3 | 4 | 5 |
| Our hourly workers are empowered to make decisions regarding the managing of their workplace | 1 | 2 | 3 | 4 | 5 |
| Our hourly workers are empowered to make improvements related with their immediate and extended process | 1 | 2 | 3 | 4 | 5 |
| Our employees receive recognition for outstanding quality performance | 1 | 2 | 3 | 4 | 5 |
| We recognize our employees' contributions to improve company's quality performance | 1 | 2 | 3 | 4 | 5 |
| Employee's suggestions for quality improvement are rewarded | 1 | 2 | 3 | 4 | 5 |
| We give our employees recognition for contributions to improve customer satisfaction | 1 | 2 | 3 | 4 | 5 |
| We recognize teams contributions to our continuous improvement efforts | 1 | 2 | 3 | 4 | 5 |

*For the following items please circle the number which accurately reflects your company's **PRESENT** position, where:*

**1= Strongly Disagree 2=Disagree 3=Neither Agree nor Disagree 4=Agree 5=Strongly Agree**

## CUSTOMER BASED QUALITY PRACTICES

| | | | | | |
|---|---|---|---|---|---|
| We are committed to satisfy customers' needs and expectations | 1 | 2 | 3 | 4 | 5 |
| Customer satisfaction drives our company's quality improvement actions | 1 | 2 | 3 | 4 | 5 |
| We know which attributes of our products and services our customers' value most | 1 | 2 | 3 | 4 | 5 |
| We seek our customers feedback about company's performance in satisfying their needs and expectations | 1 | 2 | 3 | 4 | 5 |
| We encourage our employees to satisfy customers' needs and expectations | 1 | 2 | 3 | 4 | 5 |
| Our employees are aware of the need to satisfy to our customer's needs and expectations | 1 | 2 | 3 | 4 | 5 |
| We involve our customers in our continuous quality improvement efforts | 1 | 2 | 3 | 4 | 5 |
| We encourage our customers to give us feedback about current and future requirements | 1 | 2 | 3 | 4 | 5 |
| We measure the levels of customer satisfaction systematically and regularly | 1 | 2 | 3 | 4 | 5 |
| We know how our customers use our products | 1 | 2 | 3 | 4 | 5 |
| Our customers and top management are in direct contact | 1 | 2 | 3 | 4 | 5 |
| Our customers and middle managers are in direct contact | 1 | 2 | 3 | 4 | 5 |
| Our customers regularly visit our plant | 1 | 2 | 3 | 4 | 5 |
| Our customers are only in direct contact with our marketing/sales department | 1 | 2 | 3 | 4 | 5 |
| Our customers are personally contacted at least once a year by someone else than a sales representative | 1 | 2 | 3 | 4 | 5 |
| Our customer contacts strategy is frequent and pervasive | 1 | 2 | 3 | 4 | 5 |
| Our customers are in direct contact with all our functional departments | 1 | 2 | 3 | 4 | 5 |
| Managers visit our customer's site regularly | 1 | 2 | 3 | 4 | 5 |

*For the following items please circle the number which accurately reflects your company's* ***PRESENT*** *position, where:*

**1= Strongly Disagree 2=Disagree 3=Neither Agree nor Disagree 4=Agree 5=Strongly Agree**

## INFORMATION BASED QUALITY PRACTICES

| | | | | | |
|---|---|---|---|---|---|
| Quality information (quality costs, rework, customer complains, etc.) is systematically and regularly collected | 1 | 2 | 3 | 4 | 5 |
| Quality information is (quality costs, rework, customer complains, etc.) available on time | 1 | 2 | 3 | 4 | 5 |
| Quality information is (control charts, histograms, etc.) displayed on the shop floor at the majority of the work stations | 1 | 2 | 3 | 4 | 5 |
| Productivity and quality reports are readily available on the production process critical points. | 1 | 2 | 3 | 4 | 5 |
| Quality information is readily available to managers and supervisors | 1 | 2 | 3 | 4 | 5 |
| Work place's quality performance information is available to hourly workers | 1 | 2 | 3 | 4 | 5 |
| Quality information is used at the right time by top management in decision making | 1 | 2 | 3 | 4 | 5 |
| Quality information is used at the right time by middle management in planning and control | 1 | 2 | 3 | 4 | 5 |
| Our hourly workers use quality information to control and improve quality at their work station | 1 | 2 | 3 | 4 | 5 |
| Quality information is used at the right time to identify company wide improvement opportunities | 1 | 2 | 3 | 4 | 5 |
| We study the "best product development practices" of other companies to get ideas how to do things better | 1 | 2 | 3 | 4 | 5 |
| We compare our current quality levels for products and services with those of competitors and/or industry leaders. | 1 | 2 | 3 | 4 | 5 |
| We study the "best quality practices " of other companies to get ideas to improve our quality performance | 1 | 2 | 3 | 4 | 5 |
| We benchmark the "best customer service practices" with recognized industry leaders | 1 | 2 | 3 | 4 | 5 |
| We study the "best production process design practices" of other companies to get ideas how to do things better | 1 | 2 | 3 | 4 | 5 |

*For the following items please circle the number which accurately reflects your company's **PRESENT** position, where:*

**1= Strongly Disagree  2=Disagree  3=Neither Agree nor Disagree**
**4=Agree  5=Strongly Agree**

## PRODUCT/PROCESS BASED QUALITY PRACTICES

| | | | | | |
|---|---|---|---|---|---|
| Our product design process incorporates manufacturability as an important component | 1 | 2 | 3 | 4 | 5 |
| Our product design process generates product and service design requirements that conform to customers needs | 1 | 2 | 3 | 4 | 5 |
| We involve external suppliers early in the product design process | 1 | 2 | 3 | 4 | 5 |
| Our product design process applies customer-driven planning techniques (such as quality function deployment). | 1 | 2 | 3 | 4 | 5 |
| Our product design process is supported by a multidisciplinary approach (marketing, manufacturing, R&D, etc.) | 1 | 2 | 3 | 4 | 5 |
| Our product design process addresses environmental and legal concerns | 1 | 2 | 3 | 4 | 5 |
| In our production process we apply statistical process control (SPC) techniques | 1 | 2 | 3 | 4 | 5 |
| Our equipment and machines are under statistical quality control | 1 | 2 | 3 | 4 | 5 |
| In our production process variance is reduced through the implementation of SPC techniques | 1 | 2 | 3 | 4 | 5 |
| Our process design provides specifications that are clear and easy to understand | 1 | 2 | 3 | 4 | 5 |
| Our process design integrates quality engineering techniques (such as Taguchi methods) | 1 | 2 | 3 | 4 | 5 |
| Our process design incorporates error prevention techniques (such as Shingo, Poka-Yoke). | 1 | 2 | 3 | 4 | 5 |
| Our production process are designed to be foolproof | 1 | 2 | 3 | 4 | 5 |

*For the following items please circle the number which accurately reflects your company's **PRESENT** position, where:*

**1= Strongly Disagree 2=Disagree 3=Neither Agree nor Disagree 4=Agree 5=Strongly Agree**

## SUPPLIER BASED QUALITY PRACTICES

| | | | | | |
|---|---|---|---|---|---|
| Our primary criteria to select suppliers is quality not price | 1 | 2 | 3 | 4 | 5 |
| Our supplier relationships are focused on the long term | 1 | 2 | 3 | 4 | 5 |
| Our supplier relationships have achieve high levels of confidence and trust | 1 | 2 | 3 | 4 | 5 |
| Our suppliers are readily to participate in solving quality problems | 1 | 2 | 3 | 4 | 5 |
| We work with our suppliers to improve each others' processes | 1 | 2 | 3 | 4 | 5 |
| Our suppliers are involved in our continuous improvement efforts | 1 | 2 | 3 | 4 | 5 |

Our suppliers' current performance in satisfying our expectations is: **(Circle ONE number only)**

| | |
|---|---|
| Sometimes meet expectations | 1 |
| Generally meet expectations | 2 |
| Consistently meet expectations | 3 |
| Always meet expectations | 4 |
| Exceeds Expectations | 5 |

# QUALITY RELATED OUTCOMES

Please circle the number that accurately reflects your plant's **PRESENT** position, where:

**1 = Much Lower  2 = Lower  3 = About the same  4 = Higher**
**5 = Much Higher  0 = Unable to answer**

(It may be necessary to consult other members of the management team in order to answer some of the questions)

**Relative to our competitors/industry:**

| | | | | | | |
|---|---|---|---|---|---|---|
| Our rework levels are | 1 | 2 | 3 | 4 | 5 | 0 |
| Our finished product defect rate is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our scrap levels are | 1 | 2 | 3 | 4 | 5 | 0 |
| Our productivity is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our workers' satisfaction is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our employee morale is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our turnover is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our absenteeism level is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our total cost per unit of product is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our labor costs per unit of product are | 1 | 2 | 3 | 4 | 5 | 0 |
| Our material costs per unit of product are | 1 | 2 | 3 | 4 | 5 | 0 |
| Our overhead costs per unit of product are | 1 | 2 | 3 | 4 | 5 | 0 |
| Our cost of quality is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our new product introduction lead time is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our manufacturing throughput time is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our order delivery time is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our customer complaints are | 1 | 2 | 3 | 4 | 5 | 0 |
| Our competitive position | 1 | 2 | 3 | 4 | 5 | 0 |
| Our market share is | 1 | 2 | 3 | 4 | 5 | 0 |
| Our profits are | 1 | 2 | 3 | 4 | 5 | 0 |
| Our warranty claims are | 1 | 2 | 3 | 4 | 5 | 0 |

Please indicate your company's current performance in satisfying your customers: (Circle **ONE** number only)

| | |
|---|---|
| Sometimes meets expectations | 1 |
| Generally meets expectations | 2 |
| Consistently meets expectations | 3 |
| Always meets expectations | 4 |
| Exceed expectations | 5 |

# COMPETITIVE CAPABILITIES

Please circle the number that accurately reflects your plant's **PRESENT** position, where:

**1 = Much Below 2 = Below 3 = About the same 4 = Above 5 = Much Above**

**Relative to our competitors/industry :**

| | | | | | |
|---|---|---|---|---|---|
| Our capability of offering prices that are competitive is | 1 | 2 | 3 | 4 | 5 |
| Our capability of offering prices as low or lower than competitors prices is | 1 | 2 | 3 | 4 | 5 |
| Our capability of competing based on prices is | 1 | 2 | 3 | 4 | 5 |
| Our capability of offering prices that match competition is | 1 | 2 | 3 | 4 | 5 |
| Our capability of selling at high prices that only a few firms can achieve is | 1 | 2 | 3 | 4 | 5 |
| Our capability of selling at price premiums is | 1 | 2 | 3 | 4 | 5 |
| Our capability of commanding premium prices is | 1 | 2 | 3 | 4 | 5 |
| Our capability of selling at prices above the average is | 1 | 2 | 3 | 4 | 5 |
| Our capability of offering products that perform according to customer needs is | 1 | 2 | 3 | 4 | 5 |
| Our capability of offering products that meet customer's safe-to-use needs is | 1 | 2 | 3 | 4 | 5 |
| Our capability of offering products that meet customer's reliability needs is | 1 | 2 | 3 | 4 | 5 |
| Our capability of offering products that meet customer's durability needs is | 1 | 2 | 3 | 4 | 5 |
| Our capability of offering products that meet customer's preestablished standards is | 1 | 2 | 3 | 4 | 5 |
| Our capability of offering products that meet customer's value expectations is | 1 | 2 | 3 | 4 | 5 |
| Our capability of providing dependable deliveries is | 1 | 2 | 3 | 4 | 5 |
| Our capability of providing on-time deliveries is | 1 | 2 | 3 | 4 | 5 |
| Our capability of delivering the correct quantity of products needed on time is | 1 | 2 | 3 | 4 | 5 |
| Our capability of developing customized products is | 1 | 2 | 3 | 4 | 5 |
| Our capability of developing a number of "new" product features is | 1 | 2 | 3 | 4 | 5 |
| Our capability of developing a number of "new" products is | 1 | 2 | 3 | 4 | 5 |
| Our capability of developing unique features is | 1 | 2 | 3 | 4 | 5 |

## BUSINESS PROFILE

Has your organization embarked upon a program aimed specifically at implementing "Quality Management" or a similar effort?
(Circle your response)........................................................................YES NO

If yes, how long has your quality program been in place ? (Mark only **ONE** of the boxes)

| Less than 1 year | | 1 to 3 years | | 3 to 5 years | | 5 to 10 years | | More than 10 years | |
|---|---|---|---|---|---|---|---|---|---|

Please rank the following factors (from 1 - **most important** - through to 5 - **least important**) in relation to your company 's business strategy for the **next three years** by placing a **different** number in each box (Use each number only once)

| Cost | | Quality | | Flexibility | | Dependability | | Innovation | |
|---|---|---|---|---|---|---|---|---|---|

To what extent is your company's environment characterized by the following conditions:

**1. Little or no Extent** **2. Some Extent** **3. Moderate Extent** **4. Great Extent** **5. Very Great Extent**

| | | | | | |
|---|---|---|---|---|---|
| Subject to heavy foreign competition........................................... | 1 | 2 | 3 | 4 | 5 |
| Rapidly growing market.......................................................... | 1 | 2 | 3 | 4 | 5 |
| Shorter product life cycles....................................................... | 1 | 2 | 3 | 4 | 5 |
| Declining markets.................................................................. | 1 | 2 | 3 | 4 | 5 |
| Intense quality competition...................................................... | 1 | 2 | 3 | 4 | 5 |
| Intense delivery speed............................................................. | 1 | 2 | 3 | 4 | 5 |
| Intense cost competition.......................................................... | 1 | 2 | 3 | 4 | 5 |
| Rapid change to market conditions............................................ | 1 | 2 | 3 | 4 | 5 |

Please indicate the importance that your site assigned to each one of the following quality practices, principles, or techniques during the **last three** years as well as the expected importance during the **next three** years.

**0 = Unable to answer** **1 = Very low** **2 = Low** **3 = Medium** **4 = High** **5 = Very high**

| Importance Last 3 years | Quality practice /technique/ principle | Importance Next 3 years |
|---|---|---|
| | Employee Involvement | |
| | Employee Empowerment | |
| | Employee Recognition | |
| | Employee Training | |
| | Customer Satisfaction | |
| | Customer Orientation | |
| | Getting Close to the Customers | |
| | Strategic Quality Planning | |
| | Supplier Partnership | |
| | Product Design | |
| | Process Design | |
| | Quality Information Systems | |
| | Quality Information Usage | |
| | Benchmarking | |
| | Top Management Leadership for Quality | |
| | Statistical Process Control Usage | |

For the following questions please mark your answer. (Mark only **ONE** of the boxes)

| CATEGORY | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Level of education of your work force | Very low | Low | Average | High | Very high |
| Your position vis-a-vis ISO-9000 registration is | ISO-9001 registered | ISO-9002 registered | ISO-9003 registered | Not registered but planning to | Not interested |
| We have been in business for | < 2 years | 2 to 5 years | 6 to 10 years | > than 10 years | |
| The range of our annual sales is | < than 10 million | 11 to 50 million | 51 to 500 million | 501 to 1000 million | > than 1 billion |
| Our percentage of sales in | 0 % | Less than 25% | 26 to 50 % | 51 to 75 % | 76 to 100% |
| Our number of employees is | 101 to 500 | 501 to 1000 | 1001 to 5000 | > than 5000 | |
| Your title | Top level management | Middle Management | Supervisor | Staff | Other |
| Your level of education | High School | College | Master | Ph.D. | Other |
| Your seniority at this company | Less than 1 year | 1 - 2 years | 2 - 5 years | 5 - 10 years | 10 + years |
| Our company is | Unionized | Not unionized | Partially unionized | | |
| Company ownership | Wholly U.S. owned | Joint Venture | Wholly non U.S. owned | | |
| Your position vis-a-vis QS-9000 certification is | QS-9000 certified | Not certified but planning to | Not required in our industry | | |
| Answers to this questionnaire are at the following business level | Plant | Division | Company | Corporate | |

If you know your SIC code please insert it in the box :

| |
|---|
| |

otherwise indicate the industry subdivision in which you operate, from the list below.

(Please circle ONE number only)

| | |
|---|---|
| Food and kindred products | 01 |
| Tobacco | 02 |
| Textile mill products | 02 |
| Apparel and other textile products | 04 |
| Lumber and wood products. | 05 |
| Furniture and fixtures. | 06 |
| Paper and allied products | 07 |
| Printing and publishing | 08 |
| Chemical and allied products. | 09 |
| Petroleum and coal products. | 10 |
| Rubber and plastic products. | 11 |
| Leather and leather products | 12 |
| Stone, clay and glass products | 13 |
| Primary metal industries | 14 |
| Fabricated metal products | 15 |
| Machinery, except electrical | 16 |
| Electric and electronic equipment | 17 |
| Transportation equipment | 18 |
| Instruments and related products | 19 |
| Miscellaneous manufacturing industries | 19 |
| Other | 20 |

Business Name:______________________________

Address:______________________________

Your name:______________ Tel:__________ Fax__________

Would you like to receive a benchmark report? Yes___ No___
Would you like to receive an executive report? Yes___ No___

Thank you for completing this questionnaire and please note that the data you have provided will remain strictly confidential

## APPENDIX E: LETTER FOR LARGE SCALE SURVEY

July 01, 1997

Subject: **Quality Management Practices and Competitive Capabilities Study.**

**Dear ASQ/Quality Management Division Member:**

We are inviting you to participate in a research study on quality. I, Luis Solis, am a member of the Quality Management Division and a doctoral candidate in the Manufacturing Management Program at the University of Toledo. I am conducting this research study about quality management as part of my doctoral dissertation work. The insights gained through this research are expected to contribute to the advancement of the quality management frontiers and to increase our understanding of the strategic impact of quality management practices on the company's competitive capabilities.

**The Quality Management Division of the American Society for Quality is supporting this research effort. An executive report of the study findings will be available to the participants by request through the University of Toledo.** Additionally I offer to provide you with a benchmark report of your company in all the different dimensions of quality management measured in this inquiry. I want to invite you to be part of this research effort. Your participation is critical to the success of this study. In order to have a reliable and valid analysis, I need at least 300 responses. I am inviting 3000 ASQ members to share their quality experience. Previous research work has shown that less than 10 percent of the people respond to questionnaire research. But I hope that your interest in quality and its advancement could make a difference. With your participation I should be able to get more than the minimum number of responses required.

Enclosed is a questionnaire which is part of this research. Please complete the questionnaire and send it to me in the postage prepaid envelope. I would like to assure you that the information provided by you will be treated in the **strictest confidence** Your response will be entered in a coded format and in no instance will a company ever be identified as having given a particular response. If you have any questions regarding this study please feel free to contact me at the University of Toledo.

Sincerely yours,

Luis E. Solis ABD

Michael Murphy
Quality Management Division Chair
American Society for Quality

# IMAGE EVALUATION TEST TARGET (QA-3)

150mm

6"

APPLIED IMAGE . Inc
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