THE EFFECTS OF ISO 9000 REGISTRATION EFFORTS ON TOTAL QUALITY MANAGEMENT PRACTICES AND BUSINESS PERFORMANCE

BY

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ABSTRACT

Quality management has had considerable success in terms of its acceptance in organizations worldwide. Quality management is one of the most talked about areas for research and teaching. Due to its short history, however, there is still much confusion surrounding the effects of ISO 9000 registration efforts on the Total Quality Management (TQM) practices and business performance. A priori model is constructed on the basis of established beliefs, propositions, and findings of previous empirical studies in quality management, and several hypotheses are proposed and tested. In this study, Structural Equation Modeling (SEM) is applied to assist in explaining and predicting the relationships which have not been examined before in the operations management literature, between and among ISO 9000 registration efforts, TQM practices, organizational competitiveness, customer satisfaction, and business performance. Data is collected from 441 ISO 9000 registered manufacturing companies in the United States.

This study is developed from a theoretical foundation and provides a deeper insight into fundamental theories in quality management. The results

of this study raise as many questions as they answer. One important result is the strong evidence that the ISO 9000 registration efforts enhance organizational competitiveness, which in turn enhances customer satisfaction as well as business performance. Also, ISO 9000 registration efforts and TQM practices have a significant, positive relationship when the model is tested based on all 441 responses. However, TQM practices do not have a significant, positive relationship with customer satisfaction as the literature suggests. As ISO 9000 registration efforts, TQM practices enhance competitiveness, which in turn enhances customer satisfaction as well as business performance.

Multiple group analyses are performed by splitting the data set by industry type, U.S. owned and foreign owned firms, firm size in terms of the number of employees, as well as by firm's quality orientation to test exactly what effects these groupings have on the relationships among different constructs.

DEDICATION

To My Parents

Mr. & Mrs. Byung Chil Han

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CHAPTER ONE

INTRODUCTION

Today, consumers seek quality in the products and services they buy more than ever before. To attract and keep customers, organizations are under increasing pressure to provide high quality products or services on time and at reasonable prices. Increases in global competition, intensified by deregulation, have motivated organizations to adopt Total Quality Management (TQM) as a strategy to meet customers' requirements. TQM is a management philosophy of seeking excellence in all aspects of business through organization-wide continuous improvement. It is believed that TQM contributes to competitiveness which in turn helps to gain greater market share and profitability (Reimann and Hertz, 1994; Schonberger and Knod, Jr., 1997). To promote Total Quality Management practices in the United States, several awards such as the Malcolm Baldrige National Quality Award, the President's Award, IIE's Award for Excellence in Productivity Improvement, and NASA's George M. Low Trophy have been established. In addition, almost all fifty states have now developed their own versions of the Malcolm Baldrige National

Quality Award. Internationally, awards such as the Deming Prize of Japan and the European Quality Award have also been established to bring attention to the importance of quality issues.

Growing volume of international trade, higher requirements for improved quality, and customer pressures have led to another international quality thrust. In 1987, the International Organization for Standardization in Geneva, Switzerland developed a series of quality assurance standards known as ISO 9000. Since then, ISO 9000 standards have become the accepted basis for quality systems requirements for product conformity and assessment in the global market place. These standards require that companies document their practices and procedures with a uniform documented process that all employees must follow consistently. Having earned registration under ISO 9000 indicates that a firm has met the minimum standard for quality systems set forth by these standards.

In 1992, companies within the 12 nations that comprise the European Community (EC) - Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom -

began to require their suppliers to be registered under ISO 9000. Soon after, the countries of the European Free Trade Association (EFTA), including Austria, Finland, Iceland, Liechtenstein, Norway, Sweden, and Switzerland followed suit. As a result, companies doing business in Europe now consider ISO 9000 registration to be imperative. In 1994, approximately 70,500 companies had been registered in 70 countries (Steeples, 1994). By the end of 1997, over 225,000 ISO 9000 certificates had been awarded in more than 129 countries, including the members of the EC, Canada, Japan, Australia, and the United States (ISO, 1997). Worldwide, the number of ISO 9000 certificates grew by nearly 40% in 1997 alone; the vast majority was within the EC (ISO, 1997). According to Duffy (2000), by the end of 1998, 271,966 registration certificates had been issued in 143 countries, an increase of 22% over 1997. In the United States, many companies and government agencies such as AT&T, Department of Defense, and NASA have also adopted ISO 9000 and have made ISO 9000 compliance a requirement.

The demand for ISO 9000 registration is increasing rapidly, as many companies require that their suppliers obtain it. ISO 9000 registration requires the existence of proper quality plans, programs, documentation, and procedures. However, being registered to the standard does not guarantee quality or necessarily help to improve it. It only means that the company's processes follow documented procedures and therefore, should be consistent. Compliance with ISO 9000 indicates consistent use of documented, standardized procedures to produce the products for which the buyer contracts. The ISO 9000 standards are comprised of 20 quality system elements that range from assessments of management involvement to proper use of statistical process controls (see Appendix A: Part 2). ISO 9000 certificates are issued for individual production sites.

The goal of TQM is to improve overall quality in an organization in order to meet customer satisfaction, whereas the goal of ISO 9000 is to ensure that a basic quality system is in place to enhance and facilitate trade. TQM focuses on enhancing organizational competitiveness as opposed to ISO 9000, which focuses on providing customers with assurances that a documented quality system is in place and ensuring that those products are made in accordance with documented procedures. Even though companies can use the ISO 9000 standards to help to determine what is needed to maintain an efficient quality conformance system, ISO 9000 registration does not require that a firm demonstrate product quality or continuous quality improvement. As a matter of fact, ISO 9000 registration does not even guarantee that the product quality of registered firms is better than that of unregistered firms. ISO 9000 registration covers less than 10% of the scope of the Baldridge Award criteria (Reimann and Hertz, 1994), which measures TQM practices. The Baldridge Award Criteria address continuous improvement and competitiveness factors in seven categories: Leadership, Information and Analysis, Strategic Quality Planning, Human Resource Development and Management, Management of Process Quality, Quality and Operational Results, and Customer Focus and Satisfaction.

A revision took place in 1994 that shifted the balance of the ISO 9000 standards more towards a total quality approach. Changes included more emphasis on the need for an implemented quality policy and the addition of preventive action to complement corrective action. Sometime in the latter part of the year 2000, revised

ISO 9000 requirements will be launched. The updated requirements will include three major changes (West, Cianfrani, and Tsiakals, 1999). First, the emphasis has been shifted to continuous improvement in performance using information and data. Second, the emphasis has been underscored to achieving customer satisfaction through appropriate measurement. Third, statistical techniques need to be applied not only to the product realization activities but also to measurement of processes as well. This type of revision on ISO 9000 series of standards is expected to continue in the future.

ISO 9000 and TQM are often misunderstood as being equivalent and addressing the same requirements (Reimann and Hertz, 1994; Steeples, 1994). As a result, much confusion has arisen over the relationship between TQM and ISO 9000 registration. The term ISO 9000 has become more widely used than TQM in discussions of quality improvement and global competitiveness, primarily because ISO 9000 has become the most prevalent global quality initiative (Tsiotras and Gotsamani, 1996). There is an increasing awareness that TQM and ISO 9000 can compliment each other (Tsiotras and Gotsamani, 1996;

Vloeberghs and Bellens, 1996). Some claim that ISO 9000 is a good start on the road to total quality management (Corrigan, 1994; Merrill, 1995; Porter and Tanner, 1996; Frehr, 1997). Arter (1992) states that even though the ISO 9000 standards do not represent a total quality management system, they can form the base on which to build such a system.

Recently there has been an explosion of published work on issues associated with ISO 9000 certification in quality management journals. However, many of these works are prescriptive, descriptive, speculative, or anecdotal and lack rigorous statistical support. They focus on how to obtain ISO 9000 certification and do not generally address, with any statistical rigor, the business value of ISO 9000 certification and its relationship to TQM. Despite its overwhelming popularity, there is still considerable confusion surrounding the effects of ISO 9000 registration efforts on the TQM practices and organizational performance. A review of the literature identified a major gap in research in this area of quality management.

Research Objective

The research objective of this dissertation is to conduct an empirical study based on real data to better understand the relationships between ISO 9000 registration efforts and TQM practices, as well as their effects on customer satisfaction, organizational competitiveness and performance. Thus, a model will be developed and proposed based on the literature, and several hypotheses will be posed and tested. In this study, Structural Equation Modeling (SEM) will be applied to help explain and predict the relationships, which have not been examined before in the literature, between and among ISO 9000 registration efforts, TQM practices, competitiveness, customer satisfaction and business performance.

This study will contribute in several ways. First, it will identify significant research issues and offer promising new directions for further research. Second, it will evaluate current operations management theories by applying existing constructs to real problem settings and will provide new research insights. Third, a comprehensive model will be formulated and introduced based on the existing literature. Fourth, this empirical study will support or refute existing beliefs and propositions and will foster development of new theories and concepts in quality and operations management. Fifth, this research will extend the boundaries of the quality management literature. Sixth, the research will extend beyond the mere reporting of survey results by demonstrating original and meaningful conclusions.

After extensive literature review in Chapter Two, several research questions are specified to investigate the interrelationships among ISO 9000 registration efforts, TQM practices, competitiveness, customer satisfaction, and business performance. The need of a priori theory using SEM is articulated in Chapter Three, followed by discussions of various issues in research methodology in Chapter Four. Within the research methodology section, model constructs and variables are identified and research design and data considerations are then outlined. The results of the research are summarized in Chapter Five. Findings of the results and their implications for researchers and managers are discussed in Chapter Six. Summary and limitations of the study as well as suggestions for future research are provided in Chapter Seven.

CHAPTER TWO

LITERATURE REVIEW

There is a growing body of literature relating to quality management. This chapter begins with a review of existing research on ISO 9000 and TQM. The chapter examines the extent to which authors of the extant literature support or do not support the relations among five constructs discussed in the previous chapter. Each section concludes with a set of research questions to be investigated.

ISO 9000

By 1997, more than 150 articles on various issues associated with ISO 9000 registration have been published in quality management related journals (Terziovski, Samson, and Dow, 1997). However, almost all of these articles are prescriptive or descriptive and lack statistical and theoretical support. Porter and Tanner (1996) claim that, for many organizations, introduction to quality has been via ISO 9000 registration efforts. Zhu and Scheuermann (1999) argue that when used correctly, quality standards such as ISO 9000 can make a significant contribution to business improvement. Used incorrectly, it can result in a bureaucratic constraint of organizations.

A revision took place in 1994 that shifted the balance of standards more towards a total quality approach. Changes include more emphasis on the need for an implemented quality policy and the addition of preventative action to complement corrective action. Zuckerman (2000) indicates that the Year 2000 revision of the ISO 9000 series focus far more on continuous improvement and customer satisfaction. Conti (1999) believes that the new requirements are a big improvement from that of 1994 since they aim at customer satisfaction assurance, not just product quality assurance.

Proponents of ISO 9000 certification claim that ISO 9000 is the first step towards total quality and is a meaningful component of TQM (Askey and Dale, 1994; Frehr, 1997; Anderson, Dale, and Johnson, 1999). Critics claim that ISO 9000 has little relation to TQM and is a bureaucratic procedure for international trade (Brecka, 1994; Stratton, 1994). They argue that ISO 9000 is a barrier to market entry in countries that have used it as a regulatory standard. They view certification as a tariff on international trade. Askey and Dale (1994) found that managers tended to revert to their traditional practices after gaining certification. A large empirical study conducted by Anderson, Dale, and Johnson (1999) supports the view of proponents of ISO 9000. There seems to be wide support in the literature that ISO 9000 certification is a potential path to TQM. Anderson et al. (1999) found from their study that customer and regulatory compliance are not the major reasons for the widespread adoption of ISO 9000 in North American manufacturing companies. Their study indicates that managers adopt ISO 9000 as a way of acquiring recognition of quality assurance from their customers and external parties and achieving competitive advantage through quality management. The empirical question addressed here is whether managers obtain certification primarily in compliance with requirements of major customers or regulators, or whether ISO 9000 is a component of TQM.

Although there seems to be consensus in the literature that ISO 9000 is a potential path to TQM, the fundamental problem is that some managers perceive the ISO 9000 certificate as an end in itself, rather than a means to an end. For example, McAdam and McKeown (1999) found that although many small businesses in Northern Ireland are benefiting from ISO 9000, the majority of businesses are not progressing towards TQM. The businesses that were gaining most from TQM started with ISO 9000. ISO 9000 was seen as a starting point for TQM and as an ongoing integral part of TQM.

Even though ISO 9000 registration does not address what should be improved in order to gain a company's competitive position, Sissell (1996) reports that, based on a survey of 1880 respondents, some of the benefits of certification are higher perceived quality, competitive advantage, improved customer demand, and increased market share. Overall, the survey found that ISO 9000 registration produces favorable results.

Some studies found that the primary business value of ISO 9000 certification was to open doors to markets that were previously closed (Miller, 1993; Brecka, 1994). Although, increasing market share is one of the major reasons for achieving ISO 9000 certification, there is low expectation that ISO 9000 registration will lead to improvements in productivity or market share (Mann and Kehoe, 1994; Ebrahimpour, Withers, and Hikmet, 1997). Ebrahimpour et al. (1997), however, found that ISO 9000 registered companies expect a high degree of improvement in product design, process design, product quality, communication, and supplier relations. Terziovski et al. (1997) found in their study that ISO 9000 certification does not have a significant positive relationship with organizational performance by itself. Terziovski et al. (1997) failed to find a significant effect of ISO 9000 on organizational performance. They found that the benefits attributable to certification were mainly for procedural efficiency and error rates, and less likely for market share, employee motivation and costs. Powell (1995) also found that the key to performance does not lie in the tools and techniques such as ISO 9000 certification and benchmarking. Powell (1995) found that the intangible factors, such as employee empowerment and senior management commitment, had a greater influence on performance. Zhang (2000) believes that ISO 9000 has much lower effects on overall business performance than TQM.

ISO 9000 is one of the fastest growing quality systems in the world. Despite its overwhelming popularity, there is considerable confusion regarding the business value of ISO 9000 certification. ISO 9000 is about quality systems and about consistency. It aims to give customers confidence in their suppliers by assuring them that the suppliers have in place management processes that deliver consistency. It encourages but does not in and of itself directly assure product quality.

The review of the literature revealed a gap in research in this area of quality management. The following research questions will be empirically investigated in this study.

1. Do ISO 9000 registration efforts have a significantly positive effect on business performance?
2. Do ISO 9000 registration efforts have a significantly positive effect on customer satisfaction?
3. Do ISO 9000 registration efforts have a significantly positive effect on organizational competitiveness?
4. Is there a significantly positive relationship between ISO 9000 registration efforts and TQM practices?

TQM

A substantial portion of the quality management literature is prescriptive, suggesting how managers should manage quality. In an extensive review of 226 articles, Ahire, Landeros, and Golhar (1995) identified only 29 empirical studies of quality management practices. Of these, not one focused on the operational results of quality management programs.

TQM focuses on improving the organization's effectiveness and the responsiveness to customers' needs. In other words, the goals of TQM are organizational excellence and customer satisfaction. The focus is to improve a firm's competitiveness which in turn improves the overall business performance (Hendricks and Singhal, 1996; Hendricks and Singhal, 1997). Many studies have suggested a strong link between a TQM approach and superior financial performance (Porter and Tanner, 1996).

Easton and Jarrell (1998) examined the impact of Total Quality Management (TQM) on financial performance for a sample of 108 firms that began TQM implementation between 1981 and 1991. The study indicates that corporate performance, measured by publicly available financial and accounting data, has improved for the firms adopting TQM. They consistently found stronger financial performance for firms with more advanced TQM systems.

Hendricks and Singhal (1997) found that firms that have won quality awards have a stronger sales growth than a sample of firms that have not. Also, another study shows that the market value of firms responds positively to quality award announcements (Hendricks and Singhal, 1996). Previous recipients of Malcolm Baldridge National Quality Award, such as Motorola and Lucent Technologies, have demonstrated strong financial performances, with earning rates and growth rates well above their industry sector averages (Hendricks and Singhal, 1996).

Dow, Samson, and Ford (1999) showed that quality practices can be categorized into nine dimensions. However, they found that not all of them contribute to superior quality outcomes. Powell (1995) settled on 12 variables. Powell (1995) found the correlation between quality practices and firm performance to be positive and statistically significant.

McKinsey and Company found two-thirds of the TQM programs they examined were terminated due to the lack of improvement in financial performance (Economist, 1992). Conflicting results have been reported regarding the effectiveness of TQM programs.

Waldman (1994) and Madu et al. (1995) have acknowledged organizational performance as another key construct of the TQM model. Flynn et al. (1995) found a positive relationship between TQM practices and plant operation. Adam (1994) found a positive relationship between quality improvement approaches and performance.

Forza and Filippini (1998) suggest that TQM practices have a positive influence on customer satisfaction. Anderson et al. (1994) also found in their study that TQM practices lead to customer satisfaction. Rust and Zahorik (1993) and Babich (1992) claim customer satisfaction is an important element of a firm's overall performance. Customer satisfaction will increase a firm's market share and profits.

Zairi, Letza, and Oakland (1994) suggested that TQM practices enhance firm's business performance, although mediated through customer satisfaction. Choi and Eboch (1998) found that TQM practices have a strong impact on customer satisfaction. Choi and Eboch (1998) suggested future research to consider the organizational dynamics of other institutionally driven quality initiatives such as ISO 9000.

Even though Berquist and Ramsing (1999) could not determine whether quality award winning companies perform better than others financially, they found implementing quality management practices does seem to have a positive impact on employees in terms of their perception towards the organization's competitiveness and overall business performance.

Anderson, Fornell, and Lehmann (1994) found that their study supports that there is a positive impact of quality on customer satisfaction, and, in turn, profitability. Madu, Kuei, and Jacob (1996) indicate that practicing managers in manufacturing firms tend to think more widely that there is a positive correlation between quality dimensions, such as customer satisfaction and product and service quality, and organizational performance than managers in service firms.

Success of a firm depends on the firm's competitive position, and competitiveness depends on many important factors such as product and service quality, price, responsiveness, and variety (Reimann and Hertz, 1994; Steeples, 1994; Flynn, Schroeder, and Sakakibara, 1995;

Schonberger and Knod, Jr., 1997).

A review of the literature led to the following research questions which will be empirically investigated in this study.

5. Do TQM practices have a significantly positive effect on business performance?
6. Do TQM practices have a significantly positive effect on customer satisfaction?
7. Do TQM practices have a significantly positive effect on organizational competitiveness?
8. Is there a significantly positive relationship between organizational competitiveness and business performance?
9. Is there a significantly positive relationship between organizational competitiveness and customer satisfaction?
10. Is there a significantly positive relationship between customer satisfaction and business performance?

CHAPTER THREE

MODEL DEVELOPMENT

The first step in conducting empirical research is to establish the theoretical foundation for the study on hand. It is also important to determine initially whether the problem under examination involves theory verification (confirmatory in nature) or theory building (exploratory in nature) (Flynn, Sakakibara, Schroeder, Bates, and Flynn, 1990).

Theory verification is the most widely used approach and is based on the scientific method. Hypotheses are generated from prior studies or from the literature, and they are tested by the data collected. Inferential statistics and significance tests are used either to accept or not accept the hypotheses based within specified confidence levels (Flynn et al., 1990).

Theory building is the less widely used approach. However, even in theory building, a priori model provides the underlying theoretical foundation. The origin for a theory building study is some assumptions, frameworks, or a perceived problem. The goal of theory development is to gain an understanding of the observed effects in terms of the proposed theory (Flynn et al., 1990; Handfield and Melnyk, 1998; Malhotra and Grover, 1998).

The second step is to select an appropriate research design and data collection method. The survey design is the most commonly used methodology in empirical research. The questionnaire is most widely used in survey research. The foundation for questionnaire construction is the theory that underlies it (Flynn et al., 1990; Malhotra and Grover, 1998).

This study being conducted is confirmatory in nature and the model being proposed to test the research questions identified in Chapter Two is built on the basis of established beliefs, propositions, and findings of previous empirical studies conducted in quality management (See Figure 3-1). The review of the literature in the previous chapter identified five constructs: ISO 9000 registration efforts, TQM practices, competitiveness, customer satisfaction, and business performance. The proposed model will be tested using Structural Equation Modeling (SEM).

Hypotheses

This study investigates ten hypotheses concerning the relationships among ISO 9000 registration efforts, TQM practices, competitiveness, customer satisfaction, and performance. Ten hypotheses to be tested are as follows:

H1: ISO 9000 registration efforts enhance TQM practices.

H2: ISO 9000 registration efforts enhance organizational competitiveness.

H3: ISO 9000 registration efforts enhance customer satisfaction.

H4: ISO 9000 registration efforts enhance business performance.

H5: TQM practices enhance organizational competitiveness.

H6: TQM practices enhance customer satisfaction.

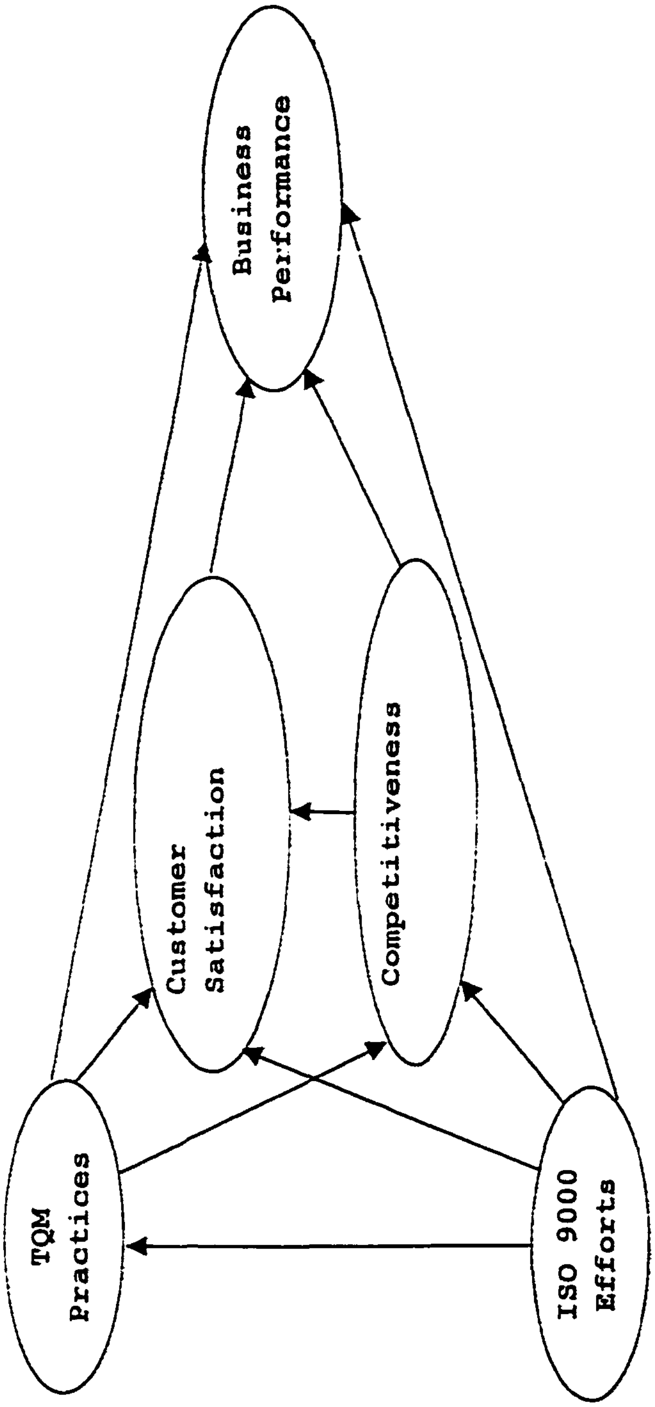
H7: TQM practices enhance business performance.

H8: Organizational competitiveness enhances customer satisfaction.

H9: Organizational competitiveness enhances business performance.

H10: Customer satisfaction enhances business performance.

Figure 3-1
Full Model



CHAPTER FOUR

METHODOLOGY

Model Constructs and Variables

Structural Equation Modeling (SEM) not only estimates multiple interrelated relationships but also has the ability to incorporate latent constructs into an analysis. A latent construct cannot be measured directly but can be approximated by observed or measured variables. The measured variables, which are also known as manifest variables or indicators, are obtained from respondents in response to questions in a questionnaire. The proposed model has five latent constructs: ISO 9000 registration efforts, TQM practices, competitiveness, customer satisfaction, and business performance. Wherever possible, empirically validated scales and items have been identified and adapted. All five constructs and their measured variables are summarized in Tables 4-1 through 4-5.

ISO 9000 registration efforts

The quality system requirements for ISO 9000 registration are well documented in the literature (e.g., Arter, 1992; Durand, Marquardt, Peach, and Pyle, 1993; Ebrahimpour et al., 1997). Please see Appendix A: Part 2 for the twenty quality system requirements for ISO 9000 registration. Ebrahimpour et al. (1997) found that internal quality audits, document and data control, corrective and preventive action, training, and quality records were perceived to be some of the most demanding elements in the ISO 9000 registration process. Those five elements received high scores in this survey. Two other elements, Quality Systems and Process Control, also received high scores in this survey. Thus, these seven elements are chosen as measured variables to represent the ISO 9000 registration efforts (see Table 4-1).

TQM practices

Operations Management literature provides the list of critical factors or criteria for measuring and evaluating TQM practices (Saraph, Benson, and Schroeder, 1989; Flynn, Schroeder, and Sakakibara, 1994; Ahire, Golhar, and Waller, 1996; Black and Porter, 1996). The above mentioned studies have published empirically validated scales for integrated quality management.

Saraph et al. (1989) derived an eight-factor framework for quality management. Flynn et al. (1994) identified seven major dimensions of TQM. Their focus was more on the manufacturing sector. Black and Porter (1996) extracted a series of items from the Baldrige model and established literature. Ahire et al. (1996) identified twelve constructs of TQM.

Among the identified critical factors of TQM, supplier relationship, customer involvement, training, information and analysis, top management commitment, product design, process design, and employee involvement are chosen as measured variables to describe TQM practices. Items for the respective measured variables are provided in Table 4-2 (Ahire et al., 1996; Black and Porter, 1996; Flynn et al., 1994; Flynn et al., 1995; Saraph et al., 1989; Powell, 1995; Choi and Eboch, 1998).

Competitiveness

Competitiveness refers to the firm's ability to grow and prosper among other firms in the marketplace. Skinner (1995) identified cost, quality, dependability, and flexibility as four major performance capabilities. Dependability is the ability of a firm to provide its goods or services on schedule. Flexibility is the ability of a firm to offer a wide variety of products to its customers. Adam and Swamidass (1989) found that cost, quality, delivery, and flexibility were most often mentioned in the manufacturing strategy literature. Manufacturing strategy refers to how operations function can contribute to a firm's ability in achieving a competitive advantage. Marucheck, Pannnesi, and Anderson (1990) also found that many firms consider cost, quality, delivery, and flexibility as four strategic advantages a business might want to achieve.

Wheelwright and Hayes (1985) argued that there are five manufacturing competitive advantages: cost, quality, dependability, flexibility, and innovation. Even though, Leong, Snyder, and Ward (1990) also suggested innovation as a fifth competitive advantage, innovation has not been operational as a competitive priority in the literature.

Jasinowski (1995) indicates that businesses need to be restructured in order to achieve competitive advantage(s) in the areas of quality, price (cost), flexibility, and availability (dependability). Even though organizations can pursue in one or more of these competitive priorities, quality initiatives have captured the greatest attention (Yusof, 1995).

Flynn, Schroeder, and Flynn (1999) also found that the world-class manufacturing practices leads to improvement in the following performance characteristics: cost, quality, dependability and flexibility. Hayes and Wheelwright (1984) first introduced the term 'world-class manufacturing' and described world-class manufacturing as a set of best practices that would lead to superior business performance.

Ward, McCreery, Ritzman, and Sharma (1998) believe that manufacturing competitive advantages can be expressed in terms of four basic elements: cost, quality, delivery, and flexibility. They developed scales for cost importance, quality importance, delivery time importance, and flexibility importance. They assessed how well the scales capture the constructs that they represent using data collected from 114 manufacturing plants in the United States, and found that the instrument developed is reliable and valid.

These four manifest variables (cost, quality, delivery, and flexibility) are chosen to assess a firm's competitiveness. Items for the respective measured variables are provided in Table 4-3 (Narasimhan and Jayaram, 1998; Ward et al., 1998; Flynn, Schroeder, and Flynn, 1999; Ward and Duray, 2000).

Customer Satisfaction

Customer satisfaction is an often-mentioned construct in the quality management literature. Anderson et al. (1994) found that there are positive relationships between quality and customer satisfaction, and customer satisfaction and profitability. Rust and Zahorik (1993) also demonstrated that the relationship between customer satisfaction and profitability is significantly positive for a health care organization. Fornell (1992) argues that high customer satisfaction increases loyalty for current customers which in turn, influences the firm's economic returns. Babich (1992) suggests that TQM practices lead to customer satisfaction. Woodruff and Gardial (1996) discuss the complex task of measuring customer satisfaction. Even though there are many different ways organizations learn about their customers' satisfaction, the following methods are used by companies in the hospitality industry:

1. Verbal/Written Complaints or Compliments

2. The Number of Repeat Customers

3. Customer Retention Rate

4. Level of Perceived Customer Satisfaction

Customer Satisfaction is measured by the following four indicators: number of customer compliments, number of repeat customers, customer retention rate, and the level of customer satisfaction as shown in Table 4-4 (Babich, 1992; Fornell, 1992; Rust and Zahorik, 1993; Anderson, Fornell, and Lehmann, 1994; Woodruff and Gardial 1996).

Performance

Two indicators often used to measure a firm's performance are profit and market share. Thus, they are chosen to measure organizational performance in the current study (Reimann and Hertz, 1994; Zairi et al., 1994; Flynn et al., 1995; Madu, Kuei, and Jacob, 1996; Schonberger and Knod, Jr., 1997; Easton and Jarrell, 1998; Smith and Reece, 1999; Ward and Duray, 2000). Items for the respective measured variables are provided in Table 4-5 (Flynn et al., 1995; Smith and Reece, 1999).

Zairi et al (1994) and Reimann and Hertz (1994) claim that TQM practices improve the firm's market share and profits, although mediated through competitiveness. Schonberger and Knod, Jr. (1997) suggest that higher customer satisfaction leads to higher customer retention rate which in turn, increases market share and profitability. Smith and Reece (1999) applied return on capital employed and sales growth rate to measure business performance. Ward and Duray (2000) indicate that business performance is often measured by market share and sales growth. Easton and Jarrell (1998) studied the effects of TQM on corporate performance. The study provides evidence that there is a positive association with an improvement in financial performance and the adaptation of TQM. Their findings further indicate that the improvement in performance is even stronger for firms with more advanced TQM systems. Madu et al. (1996) used components such as profitability, market share, sales growth, and earnings growth to measure organizational performance.

Research Design

Variable measurement issues and sample selection process are discussed in this section.

Questionnaire Development

Pilot testing is an integral part of questionnaire construction. It provides feedback on how easy the questionnaire is to complete and which concepts are unclear. The first draft of the questionnaire was developed based on a comprehensive literature review. Once compiled, the survey form was refined through a series of reviews by external judges. First, the director of ISO 9000 Collaborative Program at Merrimack College in Massachusetts was contacted to test the instrument for clarity, relevance, and technical accuracy. Comments were solicited regarding all aspects of the survey. Suggestions made to improve the survey were incorporated making the questionnaire more clear and less redundant. Operations Management, Marketing, Finance, and Accounting faculty members at two different institutions were then consulted as expert judges for content validation to determine how well the chosen items represent the defined constructs. Finally, quality managers at two ISO 9000 registered companies were interviewed while they reviewed the questionnaire to identify any language ambiguities and perceived omissions of other quality management practices used in manufacturing plants but not included in the survey. The discrepancies and comments were used to further refine the instrument in order to help ensure the validity and reliability of the measures, as well as making it more user-friendly.

All suggested clarifications, revisions, and deletions were carefully reviewed and the final questionnaire established. A copy of the final questionnaire is provided in Appendix 1.

Survey Instrument

Conducting empirical research without considering its reliability and validity is useless since the results can not be generalized (Flynn et al., 1990). The data collected by surveys is of little use unless its reliability and validity can be demonstrated.

Reliability is an evaluation of measurement consistency (Cook and Campbell, 1979). Reliability measures whether a questionnaire repeatedly administered to the same people will yield the same results. Thus, it measures the ability to replicate the study. Reliability is a prerequisite to establishing validity (Schwab, 1980). If a measure yields inconsistent results, even very highly valid results are meaningless. There are a number of methods for measuring various aspects of reliability.

However, for research that utilizes questionnaires as the case of this study, internal consistency is important since there is only one form of a measure available. There should be a high degree of correlation among the items that comprise the measure. The most widely accepted index of a measure's internal consistency is Cronbach's Coefficient Alpha (Cronbach, 1951). Coefficient Alpha is roughly the average of the correlation of each item with each other item. It is popular because it incorporates every possible split of the scale in its calculation, rather than one arbitrary split, such as the split-half measure. Cronbach's Coefficient Alpha is part of the standard reliability package in software packages such as SPSSX. In this study, Conbach's Alpha will be used to assess reliability. The minimum generally acceptable Alpha value is .70 (Nunnally, 1967).

In general, validity measures two things (Cook and Campbell, 1979). First, does the item or scale truly measure what it is supposed to measure? Second, does it measure nothing else? If either of these questions can be answered "no," the item or scale should not be used (Cook and Campbell, 1979). Content validity is a judgement by experts of the extent to which a scale truly measures the concept that it is intended to measure based on the content of the items (Nunnally, 1967). It can only be determined by experts and by reference to the literature (Flynn et al., 1990). The Delphi method is a very useful means for establishing the content validity of items. Content validity is very critical. If the content of a construct or theory is faulty, no amount of reliability or construct validity will suffice.

Construct validity measures whether a scale is an appropriate operational definition of a construct (Nunnally, 1967). In other words, the construct validity quantitatively checks whether the scale is measuring what it supposed to measure. To demonstrate construct validity, the scale should correlate highly with those variables with which it should theoretically correlate and should not correlate significantly with those variables with which it should differ (Anastasi, 1968; Rosenthal and Rosnow, 1991).

Factor analysis will be used in two ways. First, factor analysis will help to identify tentative dimensions, as well as suggest items for deletion and places where items should be added. Conducting a factor analysis on a single summated scale will show whether all items within the summated scale load on the same construct or whether the summated scale actually measures more than one construct. A second use for factor analysis is in testing hypotheses in an already-developed scale. In this case, the confirmatory factor analysis (CFA) is conducted on the scales that comprise several summated scales simultaneously. Confirmatory factor analysis is the most comprehensive method for assessing construct validity since it provides statistical tests (e.g. Chi-square test for the overall fit of the model and t-tests of the significance of the factor loadings). It allows for a more objective means of establishing construct validity (O'Leary-Kelly and Vokurka, 1998). Comparing this with the dimensions and loading from factor analysis will help in establishing construct validity of a previously developed summated scale.

Sample

For empirical studies, it is important to plan the sample sizes so that needed protection against both Type I and Type II errors can be obtained and so that the estimates of interest have sufficient precision to be useful (Hair, Anderson, Tatham, and Black, 1998). This planning is necessary to ensure that the sample sizes are large enough to detect important differences with high probability. Planning of sample sizes is therefore an integral part of the research design.

Sample size can impact the statistical test by either making it insensitive (at small sample sizes) or overly sensitive (at very large sample sizes) (Marsh, Balla, and McDonald, 1988; Bearden, Sharma, and Teel, 1982). In other words, an increase in the size of the sample chosen would result in an increase in power; a decrease in the size of the sample selected would result in a decrease in power.

Structural Equation Modeling requires large sample sizes due to the large number of estimations that take place (Hair et al., 1998). The critical question in SEM is how large a sample is needed? As the sample size becomes large (exceeding 400 to 500), the method becomes too sensitive and any difference between the proposed model and the actual pattern of relationships is almost always detected, making all goodness-of-fit measures indicate a poor fit (Tanaka, 1987; Marsh, Balla, and McDonald, 1988). While there is no correct sample size, a reasonable recommendation is to test a model with a sample size of about 200 (Bentler, 1995; Hoelter, 1983).

Two major industries were surveyed. The population for this study consisted of ISO 9000 registered manufacturing companies of electronic and other electrical equipment and components and chemicals and allied products in the United States. This included all ISO 9000 registered firms operating in the United States with Standard Industrial Classification codes 3600 and 2800. These two industries were selected because electronic/electrical industry was the first industry that embraced ISO 9000 and is best represented in terms of number of companies registered in the United States. The chemical industry was chosen because it is sufficiently different from electronic/electrical industry and is also well represented in terms of number of companies registered in the United States. It is also one of the major industries often mentioned in empirical studies done in the area of quality management (e.g. Withers, Ebrahimpour, and Hikmet, 1997).

The mailing list was obtained from the 1999 ISO 9000 Registered Company Directory which was compiled by the McGraw-Hill Companies. A total of 2130 firms were surveyed. Of these, 1600 belonged to the electronic/electrical industry and 530 belong to the chemical industry. These include all of the firms with their ISO 9000 champions identified. An effort was made so that no one person would receive more than one questionnaire. The survey forms were sent to the ISO 9000 champions of these firms. ISO 9000 champions are determined as the most appropriate respondents since they are most familiar with their firm's quality practices and its impact on firm's performances.

Analytical Methods

Structural Equation Modeling is a highly sophisticated multivariate technique that combines the best features of factor analysis, multiple regression, and path analysis into a single, more powerful method (Hair et al., 1998; Mueller, 1996). SEM is used to study complex relationships among a series of variables, some of which can be directly measured and some of which cannot be measured. This ability to deal with complex latent variables is what separates SEM from other multivariate analytical methods. In many cases, the most interesting theoretical constructs are those which cannot be measured directly, or have been limited in the past to single item measurement. The use of structural modeling allows for a more full representation of the constructs of interest.

SEM allows for estimation of multiple and interrelated relationships while including unobservable concepts in these relationships and accounting for measurement error in the estimation process (Hair et al., 1998). Multiple regression allows only one dependent variable and accepts only one measurement for each independent variable. Factor analysis examines the relationship between measured variables and individual latent constructs, but does not allow for study of directional relationships among latent constructs. Path analysis allows only one measure for each latent construct. The combination of all of these methods into SEM allows for a versatile method that considers multiple measurements and directional relationships in hypothetical models (Hair et al., 1998; Mueller, 1996).

SEM is well suited for this study. It provides a straightforward method of dealing with multiple relationships simultaneously while providing statistical efficiency. However, there has been growing concern for the correct use of, and the conclusions that can be legitimately drawn from, multivariate procedures. No statistical methodology, including SEM, can establish causal relations (Bullock, Harlow, and Mulaik, 1994). This is a design issue and not a statistical issue. Although SEM can not in and of itself determine causality, it can be argued that SEM methods may offer potential for tentative causal inferences to be drawn when used with a carefully specified and controlled design supported with theory (Bullock, Harlow, and Mulaik, 1994).

SEM allows us to examine the relationships based on a solid theory. If the theoretical foundation on which the model is based is flawed, the results of the analysis using SEM will also contain those flaws. SEM cannot overcome the inherent problems of the situations in which it is used; it is a method to analyze the fit of a model to the data collected.

Several sets of analyses will be conducted. First, general factor analyses with oblique rotation will be conducted for each of the latent constructs. Measured variables that load poorly or complexly will be either dropped or combined with other variables. Then, confirmatory factor analysis will be conducted for each of the latent constructs to establish construct validity. Next, descriptive statistics will be computed for all retained variables for each construct. Lastly, several sets of structural equation models will be conducted to support the selection of the most appropriate model in order to explain the relationships found in the data collected. This includes testing variations of the model with alternate paths deleted to assess the importance of model aspects.

SEM will be used to test the fit between a theoretical model and empirical data. In SEM applications, because the specified model represents the theoretical expectations about the data structure, the null hypothesis is that model fits the data (Fan and Wang, 1998). Contrary to most hypotheses testing situations, the name of the game is not to reject the null hypothesis. SEM requires a relatively large sample size for the results of the chi-square test to be valid (Bentler, 1995). However, a large sample size inflates the power of the chi-square test and makes it easy to reject the null hypothesis. Thus, a variety of alternative descriptive indices will also be used for assessing model fit. Structural Equation Models will be evaluated by chi-square significance tests supplemented with adjunctive fit indices such as the Comparative Fit Index (CFI: Bentler, 1990) and the root mean square error of approximation (RMSEA) as an index to quantify the amount of model misfit. The minimum threshold p-value is .05, a value required for an adequate fit of the overall model (Bagozzi and Yi, 1988; Bentler, 1995). Another way of assessing the fit of the overall model is by computing the ratio of chi-squared to the degrees of freedom. According to Matsueda (1982), a ratio of no more than four is considered a good fit. Bentler (1995) suggests that the CFI index value be at least 0.95 for confirmed models. Browne and Cudek (1993) suggest that

RMSEA values less than 0.08 imply adequate model fit and values less than 0.05 imply a good model fit. Fan and Wang (1998) found that sample size had little influence on the CFI and RMSEA indices.

To assess the local fit of specific parts of a model, z-ratios of unstandardized parameter estimates over standard errors and R-Square values for each dependent variable will also be examined.

Multiple group analyses will also be performed by splitting the data set by industry, U.S. owned and foreign owned firms, TQM and non-TQM firms as well as by firm sizes in terms of number of employees. These findings will be compared to the original study. These comparisons would show interesting and meaningful insights as to whether industry, firm type and firm size have any effect on the hypotheses that we are testing.

Other Considerations

Careful examination of completed questionnaires, prior to data entry, can prevent subsequent data analysis problems. Things to look for include incomplete or missing data and written comments. In this study, if less than 5% of the data is missing, the missing data will be filled in with the mean (Tabachnich and Fidell, 1996). Otherwise, if more than 5% of the data is missing, the information will be dropped from the study.

Table 4-1

ISO 9000 Registration Efforts

Measured Variables
Quality System
Document and Data Control
Process Control
Corrective and Preventive Action
Quality Records
Internal Quality Auditing
Training

Table 4-2

TQM Practices

Measured Variables	Items
Supplier Relationship	long-term relationship, small number of suppliers, suppliers are certified, supplier involvement
Customer Involvement	seek customers' input, involve customers in design, customers' feedback encouraged, customers visit our plant
Employee Involvement	quality circle programs, employee suggestions evaluated, feedback is provided, employees are held responsible
Training	training in problem-solving, training in basic statistics, employee training, management training
Information and Analysis	quality information displayed, progress report displayed, cost of quality data available, benchmarking available,
Top Mgmt Commitment	effective communication, adequate resources available, clear goals identified, managers serve as champions, promotes quality tools usage
Process Design	SPC is used extensively, Preventive program in place
Product Design	product designs are reviewed, customer requirements analyzed

Table 4-3

Competitiveness

Measured Variables	Items
Cost	unit production cost, inventory level, capacity utilization, productivity, waste
Quality	conformance to design specification, product performance, product durability, product reliability, perceived product quality,
Delivery	delivery speed, delivery reliability, on-time delivery
Flexibility	technical innovation customization, rapid capacity adjustment product design time set up time

Table 4-4

Customer Satisfaction

Measured Variables
Number of Customer Compliments
Number of Repeat Customers
Customer Retention Rate
Level of Customer Satisfaction

Table 4-5

Business Performance

Measured Variables	**Items**
Profit	return on investment, net income, revenue, financial performance, total sales,
Market Share	sales growth rate, export growth rate, number of new customers

CHAPTER FIVE

RESULTS

This chapter will first discuss the descriptive statistics of the sample population. Second, the performance of the scales used to measure constructs will be discussed followed by the assessment of the proposed model. Finally, the test results of ten hypotheses will be discussed.

Descriptive Statistics

Of the 2130 mailed surveys, 187 were returned as undeliverable. The most frequently mentioned reason for undeliverable surveys was that the addressee was no longer (at this address) with the company. Within two months of mailing, 445 completed surveys were returned giving a 23% response rate. Upon review, the responses of 4 surveys were deemed to be unusable due to missing or invalid information resulting in 441 usable responses. Four surveys were regarded unusable because the respondents either left Part 3 and/or Part 4 of the questionnaire blank or described why they could not answer them.

Table 5-1 summarizes the sample demographics.

Approximately 25% of the questionnaires were sent to firms in the chemical industry and 75% of the questionnaires were sent to firms in the electronics industry. Among the usable returned responses, approximately 29% were from firms in the chemical industry and 71% were from firms in the electronics industry. It is evident in this table that the response distribution relating to the industry type matches fairly well with the population distribution. Even though the respondents did very well in answering questions regarding the industry type and firm size, about 30% of them chose not to answer questions regarding the firm type.

Other interesting findings were that 193 respondents (44%) said that TQM has not been implemented in their plants. 236 respondents (54%) answered that TQM has been implemented or has been in process of being implemented. 353 responses (80%) indicated that ISO 9000 registration was either very important or required. None of the respondents replied that ISO 9000 registration was not important to their plant. Only 30 respondents (7%) indicated that their competition has not been registered to the ISO 9000 standard.

Investigation of these differences, however, was not part of the study. The exploration of any group differences will be discussed as part of the future directions in the next chapter.

Scales

Even though many scales employed in this study have been empirically tested for reliability and validity, it was necessary to review their performance under the actual conditions of the study. In this section, scales were examined to see if they met the accepted reliability and validity measurement standards. Summated scales have been used wherever possible to enhance the reliability of the measurement. In order to have construct validity, a set of items must represent one and only one concept. Thus, the factor analysis must highlight only one significant factor. Also, a set of items should not only correlate highly with each other, but should also have lower correlation with other constructs in the model.

Confirmatory factor analysis was also performed since it contains inferential statistics that allow for hypothesis testing regarding the unidimensionality of a set of measures. Each of the five constructs was assessed separately, and then they were analyzed together.

ISO 9000 Registration Efforts

The seven indicators meant to measure ISO 9000 registration efforts did, in fact, load together on an individual factor. A scree plot further supports this result. As can be seen in Table 5-2, all seven indicators correlate highly with each other and each was significantly associated with the underlying latent variable. 51.7% of the total variance can be explained by the first factor. In other words, the resulting factor explains 51.7% of the information yielded by the seven indicators. The seven indicators were X1=Quality System, X2=Document and Data Control, X3=Process Control, X4=Corrective and Preventive Action, X5=Quality Records, X6=Internal Quality Auditing, and X7=Training. The reliability for the scale containing these measures was calculated with an alpha value of .84.

Competitiveness

Conducting a principal component analysis with oblique rotation and four designated factors resulted in a pattern matrix shown in Table 5-3. Variables V33-V37 were loaded together. These five items were used to measure cost. The five items were V33=Unit Production Cost, V34=Inventory Level, V35=Capacity Utilization, V36=Productivity, and V37=Waste.

Variables V38-V42 were loaded together onto a different component. These five items were used to measure quality. The five items were V38=Conformance to Design Specification, V39=Product Performance, V40=Product Durability, V41=Product Reliability, and V42=Perceived Product Quality.

Variables V44-V46 were loaded together onto another component. These three items were used to measure delivery. The three items were V44=Delivery Speed, V45=Delivery Reliability, and V46=On-Time Delivery.

Finally, variables V43 and V47-V49 were loaded together onto a different component. These four items were used to measure flexibility. The four items were V43=Technical Innovation, V47=Customization, V48=Rapid Capacity Adjustment, and V49=Product Design Time.

V50=Set Up Time, which loaded complexly, was dropped from further analysis.

Cost

The five items meant to measure cost did, in fact, load together. As can be seen in Table 5-4, all five items correlate highly with each other. Each of them was significantly associated with the underlying variable. 70.7% of the total variance can be explained by the extracted factor. In other words, the measured variable, cost, explains 70.7% of the information yielded by the five items. The reliability for the scale containing these items was calculated with an alpha value of .89.

Quality

The five items meant to measure quality loaded together. As can be seen in Table 5-5, all five items correlate highly with each other and each was significantly associated with the underlying variable. 70.4% of the total variance can be explained by the extracted factor. In other words, the measured variable, quality, explains 70.4% of the information yielded by the five items. The reliability for the scale containing these items was calculated with an alpha value of .89.

Delivery

The three items meant to measure delivery loaded together. As can be seen in Table 5-6, all three items correlate highly with each other and each was significantly associated with the underlying variable.

89.4% of the total variance can be explained by the extracted factor. In other words, the measured variable, delivery, explains 89.4% of the information yielded by the three items. The reliability for the scale containing these items was calculated with an alpha value of .94.

Flexibility

The four items meant to measure flexibility did load together. As can seen in Table 5-7, all four items correlate highly with each other and each was significantly associated with the underlying variable. 68.1% of the total variance can be explained by the extracted factor. In other words, the measured variable, flexibility, explains 68.1% of the information yielded by the four items. The reliability for the scale containing these items was calculated with an alpha value of .84.

Competitiveness

The four measured variables meant to measure competitiveness did, in fact, load together on an individual factor. A scree plot further supports their loading on a single factor. As can be seen in Table 5-8, all four indicators correlate highly with each other and each was significantly associated with the underlying latent variable. 73.1% of the total variance can be explained by the first factor. In other words, the resulting factor, competitiveness, explains 73.1% of the information yielded by the four indicators. The four indicators are Y1=Cost, Y2=Quality, Y3=Delivery, and Y4=Flexibility. The reliability for the scale containing these measures was calculated with an alpha value of .87.

Customer Satisfaction

The four indicators meant to measure customer satisfaction did, in fact, load together on an individual factor. These results can be further supported with a scree plot. As can be seen in Table 5-9, all four indicators correlate highly with each other and each was significantly associated with the underlying latent variable. 80.3% of the total variance can be explained by the first factor. In other words, the resulting factor, customer satisfaction, explains 80.3% of the information yielded by the four indicators. The four indicators were S1=Number of Customer Compliments, S2=Number of Repeat Customers, S3=Customer Retention Rate, and S4=Level of Customer satisfaction. The reliability for the scale containing these measures was calculated with an alpha value of .92.

Business Performance

Conducting a principal component analysis with oblique rotation with two designated factors resulted in the pattern matrix shown in Table 5-10. Variables V57-V60 were loaded together. These four items were chosen to measure profit. The four items are V57=Return on Investment, V58=Net Income, V59=Revenue, and V60=Financial Performance.

Variables V63-V64 were loaded together onto a different component. They were used to measure market share. These two items were V63=Export Growth Rate and V64=Number of New Customers.

V61=Total Sales and V62=Sales Growth Rate loaded complexly and were dropped from further analysis.

Profit

The four items meant to measure profit did load together. As can be seen in Table 5-11, all four items correlate highly with each other and each was significantly associated with the underlying variable. 86.9% of the total variance is explained by the extracted factor. In other words, the measured variable, profit, explains 86.9% of the information yielded by the four items. The reliability for the scale containing these items was calculated with an alpha value of .95.

Market Share

The reliability for the scale containing the two items was calculated with an alpha value of .79.

Business Performance

The two measured variables were used to measure business performance. The two indicators were P1=Profit and P2=Market Share. The reliability for the scale containing these two indicators was calculated with an alpha value of .71.

TQM Practices

Process design was dropped from further analysis because the reliability for the scale containing the two items, SPC is used extensively and preventive program is in place, was calculated with an alpha value of .45. Conducting a principal component analysis using oblique rotation with six designated factors resulted in a pattern matrix shown in Table 5-12. Variables V65-V68 were loaded together. These items were chosen to measure supplier relationship. The four items were V65=Long-Term Relationship, V66=Small Number of Suppliers, V67=Suppliers Are Certified, and V68=Supplier Involvement.

Variables V69-V72 loaded together onto a different component. These four items were to measure customer involvement. They were V69=Seek Customers' Input, V70=Involve Customers in Design, V71=Encourage Customers' Feedback, and V72=Encourage Customers' Visit.

Variables V79-V80 also loaded together onto another component. These two items were chosen to measure training. The two items were V79=Employee Training and V80=Management Training.

Variables V82-V83 were loaded together onto another component. These items were chosen to measure information and analysis. The two items were V82=Quality-Related Goals Displayed and V83=Cost of Quality Data Available.

Variables V85-V88 and V91 were loaded together onto a different component. These five items were chosen to measure top management commitment. They were V85=Effective Employee/Management Communication System, V86=Adequate Resources Available, V87=Clear Quality Goals Identified, V88=Top managers Serve as Champions, and V91=Management Promotes Quality Tool and Methods. Finally, variables V92-V93 were loaded together onto another component. These two items were chosen to measure product design. Items included were V92=Product Design Reviewed and V93=Customer Requirements Analyzed.

Other items which loaded complexly or theoretically unjustified were dropped from further analysis.

Supplier Relationship

The four items meant to measure supplier relationship did load together. As can be seen in Table 5-13, all four items correlate highly with each other and each item was significantly associated with the underlying variable. 59.8% of the total variance was explained by the extracted factor. In other words, the measured variable, supplier relationship, explains 59.8% of the information yielded by the four items. The reliability for the scale containing these four items was calculated with an alpha value of .78.

Customer Involvement

One of the four items, V72, did not load well and thus was dropped. The remaining three items meant to measure customer involvement did, in fact, load together. As can be seen in Table 5-14, all three items correlate highly with each other and each was significantly associated with the underlying variable. 71.9% of the total variance was explained by the extracted factor. In other words, the measured variable, customer involvement, explains 71.9% of the information yielded by the three items. The reliability for the scale containing these items was calculated with an alpha value of .80.

Training

The reliability for the scale containing the two items was calculated with an alpha value of .93.

Information and Analysis

The reliability for the scale containing the two items was calculated with an alpha value of .57. Thus, this indicator was dropped from further analysis.

Top Management Commitment

The five items meant to measure top management commitment did load together. As can be seen in Table 5-15, all five items correlate highly with each other and each is significantly associated with the underlying variable. 68% of the total variance was explained by the extracted factor. In other words, the measured variable, top management commitment explains 68% of the information yielded by the five items. The reliability for the scale containing these items was calculated with an alpha value of .88.

Product Design

The reliability for the scale containing the two items was calculated with an alpha value of .79.

TQM Practices

The five indicators meant to measure TQM Practices did, in fact, load together on an individual factor. A scree plot further supports their loading on a single factor. As can be seen in Table 5-16, all five indicators correlate highly with each other and each was significantly associated with the underlying latent variable. 56.6% of the total variance was explained by the first factor. In other words, the resulting factor, TQM practices, explains 56.6% of the information yielded by the five indicators. The five indicators were T1=Supplier Relationship, T2=Customer Involvement, T3=Training, T4=Top Management Commitment, and T5=Product Design. The reliability for the scale containing these measures was calculated with an alpha value of .78.

Constructs

Conducting a principal component analysis with oblique rotation resulted in a pattern matrix shown in Table 5-17. Measured variables X1-X7 were loaded together. These indicators were chosen to measure ISO 9000 registration efforts.

Measured variables T1-T5 were loaded together onto a different component. These five were chosen to measure TQM practices.

However, measured variables Y1-Y4 which were chosen to measure competitiveness, measured variables S1-S4 which were chosen to measure customer satisfaction, and measured variables P1-P2 which were chosen to measure business performance were all loaded onto the same component.

Conducting a principal component analysis using oblique rotation on indicators X1-X7, T1-T5, and Y1-Y4 resulted in a pattern matrix as shown in Table 5-18. The analysis revealed that the three constructs, ISO 9000 registration efforts, TQM practices and competitiveness are distinct factors.

Similarly, conducting a principal component analysis using oblique rotation on indicators X1-X7, T1-T5, and S1-S4 resulted in a pattern matrix as shown in Table 5-19. The analysis revealed that the three constructs, ISO 9000 registration efforts, TQM practices, and customer satisfaction are distinct factors.

Also, conducting a principal component analysis using oblique rotation on indicators X1-X7, T1-T5, and P1-P2 resulted in a pattern matrix as shown in Table 5-20 indicating that the constructs, ISO 9000 registration efforts, TQM practices and business performance are distinct factors.

Conducting a principal component analysis with oblique rotation and three designated factors on indicators Y1-Y4, S1-S4, and P1-P2 resulted in a pattern matrix shown in Table 5-21. Measured variables Y1-Y4 were loaded together. Even though Y2=Quality loaded complexly, it was not dropped since it is theoretically justified as an essential element to measure competitiveness. These four indicators were chosen to measure competitiveness.

Measured variables S1-S4 were loaded together onto a different component. These four indicators were chosen to measure customer satisfaction.

Measured variables P1-P2, which were chosen to measure business performance, were loaded onto another component. Although P1=Profit loaded complexly, it was not dropped since it is theoretically justified as an essential element to measure business performance. These findings support convergent and discriminant validity.

The correlation matrix of five constructs is shown in Table 5-22. As expected, the correlations between competitiveness and customer satisfaction, competitiveness and business performance, and customer satisfaction and business performance are very high.

Confirmatory factor analysis was also conducted. First, the convergent validity of all scales to their respective constructs was examined. The results were similar to what was previously discussed. All scales showed significant loading at the .001 level. Then, the convergent validity of the constructs was addressed. Again, all indicators showed significant loading at the .001 level (see Appendix B). The correlation matrix of measured variables is also given in Appendix C.

Model Assessment

To address the discriminant validity, the unconstrained model and the constrained models were compared. Each model has five constructs. However, the unconstrained model allows the correlation between all ten pairs of the five constructs to vary, and the constrained models eliminate the structural paths for each one of the constructs, separately, allowing a test of each construct's importance to the model (see Figures 5-1 to 5-5).

Figure 5-1 shows the unconstrained full model. For this model, the chi-square value is 411.5 and the degrees of freedom are 199. The result is an acceptable ratio of 2.07. The CFI for this model is .993 which certainly satisfies the criterion that the CFI index value be at least .95. Also, the RMSEA value of .049 implies a good model fit. The proportion of the variance that is explained in the dependent variable, business performance, is .83.

Figure 5-2 shows the constrained model that leaves out paths linked with ISO 9000 registration efforts. For this model, the chi-square value is 484.1 and the degrees of freedom are 203 resulting in an acceptable ratio of 2.38. The CFI for this model is .990 which again satisfies the criterion that the CFI index value be at least .95. Also, the RMSEA value of .056 implies a good model fit. However, the proportion of the variance that is explained in the dependent variable, competitiveness, is reduced to .32 from .42. The substantial drop in the R-square value suggests that ISO 9000 registration is an important construct in explaining competitiveness. The R-square value for business performance does not change (.83), indicating that ISO 9000 is not directly linked with performance.

Figure 5-3 shows the constrained model without the structural paths linked to TQM practices. For this model, the chi-square value is 531.0 and the degrees of freedom are 203 resulting in a ratio of 2.62. The CFI for this model is .988, which again satisfies the CFI index criterion that the value be at least .95. Also, the RMSEA value of .061 implies an adequate model fit. However, the proportion of the variance that is explained in the dependent variable, competitiveness, is reduced to .20 from .42. Such a drastic drop in the R-square value suggests that TQM is an important construct to explain competitiveness.

Figure 5-4 shows the constrained model leaving out paths linked with competitiveness. For this model, the chi-square value is 943.3 and the degrees of freedom are 203, resulting in a ratio of 4.66 which is not a good fit. The CFI for this model is .974 which satisfies the criterion that the CFI index value be at least .95. However, the RMSEA value of .091 is higher than the suggested value of .08. The proportion of the variance that is explained in the dependent variable, business performance, is reduced to .69 which is substantially smaller than .83. Also, the proportion of the variance that is explained in the dependent variable, customer satisfaction, is reduced to .27 from .65. Such a large drop in the R-square values suggests that competitiveness is a vital construct to explain both customer satisfaction and business performance.

Figure 5-5 shows the constrained model leaving out paths linked with customer satisfaction. For this model, the chi-square value is 801.1 and the degrees of freedom are 203, resulting in a ratio of 3.95 which is not considered a good fit. The CFI for this model is .979 which satisfies the criterion that the CFI index value be at least .95. However, the RMSEA value of .082 is higher than the suggested value of being less than .08 to be considered an adequate model fit. The proportion of the variance that is explained in the dependent variable, business performance, is reduced to .79 from .83.

The chi-square value for the unconstrained model is compared to the chi-square values for the other four constrained models. In this case, the chi-square value for the unconstrained model was significantly less (at .001 level) than the chi-square values for each of the four constrained models as shown in Table 5-23. This implies that each construct is a necessary component of the full model.

However, to examine the discriminant validity, particularly for Competitiveness, Customer Satisfaction, and Business Performance, which are highly correlated, another constrained model is introduced. This constrained model fixes three of the ten pairs to 1.0 as shown in Figure 5-6. If the chi-square value for the unconstrained model is significantly lower than the chi-square value for the constrained model, then, each correlation between three pairs is less than 1.0

(Bagozzi et al., 1991). This implies that the three constructs are empirically distinct, rendering support for the discriminant validity of constructs.

For this model, the chi-square value is 747.3 and the degrees of freedom are 202 resulting in a ratio of 3.70. The CFI for this model is .981 which satisfies the criterion that the CFI index value be at least .95. However, the RMSEA value of .078 is much higher than RMSEA value of the unconstrained model. The proportion of the variance that is explained in the dependent variable, business performance, is reduced to .79 from .83.

The chi-square value for the unconstrained model (Figure 5-1) is compared to the chi-square value for the constrained model (Figure 5-6). The chi-square value for the unconstrained model is significantly less (at .001 level) than the chi-square value of the constrained model. The result supports that the three constructs, competitiveness, customer satisfaction, and business performance, are empirically distinct.

Testing the Hypotheses

Taking out the paths that are not significant leads to a model shown in Figure 5-7. For this model, the chi-square value is 413.6 and the degrees of freedom are 202 resulting in a ratio of 2.05 which is considered acceptable. The CFI for this model is .993 which again satisfies the criterion that the CFI index value be at least .95. Also, the RMSEA value of .049 implies a good model fit. The proportion of the variance that is explained in the dependent variable, business performance, is .83 indicating a large effect size.

Comparing this parsimonious model to the unconstrained model indicates that the difference in chi-square values between the two models is not significant. Since there is no difference between the two models, the parsimonious model is chosen.

The analysis supports six out of the ten hypotheses being tested. This empirical study supports the following hypotheses:

H1: ISO 9000 registration efforts enhance TQM practices.

H2: ISO 9000 registration efforts enhance competitiveness.

H5: TQM practices enhance competitiveness.

H8: Competitiveness enhances customer satisfaction.

H9: Competitiveness enhances business performance.

H10: Customer satisfaction enhances business performance.

It does not, however, support the following hypotheses:

H3: ISO 9000 registration efforts enhance customer satisfaction.

H4: ISO 9000 registration efforts enhance business performance.

H6: TQM practices enhance customer satisfaction.

H7: TQM practices enhance business performance.

Cross-Validation Analyses

Follow up with a detailed non-response analysis as a means of testing for biased results was not possible due to the anonymity and confidentiality aspect of the survey. It can be argued that the respondents who answer less readily to a questionnaire are more like non-respondents than those who answer more readily. Cross-validation is performed by splitting the sample into the first half and second half of responses. The goodness of fit indices relative to the full model proved to be equivalent between the two sets of responses (see Figures 5-8 and 5-9). This shows an evidence of a lack of non-response bias. Moreover, the response distribution was consistent with their ISO 9000 registration distribution by industry.

Multiple Group Analyses

Finally, multiple group analyses are performed on the full model (see Figure 3-1) by splitting the data set by industry type, U.S. owned and foreign owned firms, firm sizes in terms of the number of employees, as well as by firm's quality orientation (i.e. TQM vs non-TQM). TQM firms are the companies that have implemented TQM in their plants. Non-TQM firms are the companies that have not yet implemented TQM in their plants. These findings are summarized in Table 5-24. As can be seen from Table 5-24, all eight models indicate adequate model fit. Due to an encounter of a standardized coefficient exceeding 1.0 between competitiveness and business performance in chemical industry, the model fixes the offending estimate to 1.0. This results in an extra degree of freedom.

Four hypotheses (H2, H5, H8, and H9) are consistently supported at the .01 significance level across industry, firm type, firm size, and quality orientation. Also, four hypotheses (H3, H4, H6, and H7) are consistently not supported. The comparisons show that industry type, firm type, firm size, and quality orientation have a significant effect on the hypotheses H1 and H10 that are being tested. H1 is supported by firms belong to the electronic industry, U.S. owned firms, large size firms, and non-TQM firms. In this study, large size firms are firms with one hundred or more employees and small size firms are firms with less than one hundred employees. H1 is not, however, supported by firms in the chemical industry, foreign owned firms, small size firms, and TQM firms. H10 is supported by firms belong to the electronic industry, foreign owned firms, large size firms, and TQM firms and is not supported by firms in the chemical industry, U.S. owned firms, small size firms, and non-TQM firms.

The statistical results support the claim that a large sample size inflates the power of the chi-square test (Marsh, Balla, and McDonald, 1988; Bearden, Sharma, and Teel, 1982; Tanaka, 1987). The statistical findings agree with the assertion of Bentler (1990) and Brown and Cudek (1993) that Structural Equation Models should be evaluated not only by chi-square significance tests but also with adjunctive fit indices such as Comparative Fit Index (CFI) and the root mean square error of approximation (RMSEA). As can be seen from Table 5-24, sample size seems to have little influence on the CFI and RMSEA indices (Fan and Wang, 1998) even though it has a direct effect on the size of chi-square test statistic.

Table 5-1

Demographics

Industry	**Number**	**Percentage**
Chemicals (SIC 2800)	119	28.7
Electronics (SIC 3600)	295	71.3
Firm Size		
Small (< 100 employees)	142	32.4
Medium (100 - 499)	205	46.8
Large (> 500 employees)	91	20.8
Firm Type		
U.S. owned	206	66.5
Foreign owned	104	33.5
Quality Orientation		
TQM	193	43.8
Non-TQM	236	53.5

Table 5-2

ISO 9000 registration efforts - Construct

Correlation Matrix

		X1	X2	X3	X4	X5	X6	X7
Correlation	X1	1.000	.440	.426	.432	.496	.460	.329
	X2	.440	1.000	.407	.440	.516	.486	.355
	X3	.426	.407	1.000	.520	.387	.393	.349
	X4	.432	.440	.520	1.000	.413	.446	.444
	X5	.496	.516	.387	.413	1.000	.524	.432
	X6	.460	.486	.393	.446	.524	1.000	.459
	X7	.329	.355	.349	.444	.432	.459	1.000

Factor Matrix[a]

	Factor
	1
X1	.655
X2	.675
X3	.616
X4	.670
X5	.709
X6	.707
X7	.591

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 4 iterations required.

Cronbach's Alpha = .8434

Table 5-3

Competitiveness

Pattern Matrix[a]

	Component			
	1	2	3	4
V33	4.708E-02	9.250E-03	.870	7.698E-02
V34	3.656E-02	-.101	.767	-.135
V35	2.175E-02	-6.14E-02	.818	-.119
V36	4.504E-02	.122	.772	2.031E-02
V37	-8.91E-02	.204	.757	-2.19E-03
V38	-3.09E-02	.832	-5.39E-03	1.248E-02
V39	-4.36E-02	.856	1.266E-02	-.149
V40	.178	.687	2.090E-02	-.130
V41	5.781E-02	.741	5.915E-02	-.158
V42	.172	.586	.185	.155
V43	.677	.247	2.234E-02	-4.10E-03
V44	.117	1.889E-02	9.776E-02	-.796
V45	4.906E-02	.146	-8.00E-03	-.858
V46	5.252E-03	4.506E-02	7.962E-02	-.859
V47	.764	2.843E-02	-8.39E-02	-.120
V48	.786	-7.86E-02	.119	-9.14E-02
V49	.797	2.741E-02	2.275E-02	7.100E-02
V50	.417	-9.41E-02	.305	-.261

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 13 iterations.

Table 5-4

Competitiveness

Cost

Correlation Matrix

		V33	V34	V35	V36	V37
Correlation	V33	1.000	.600	.645	.686	.634
	V34	.600	1.000	.722	.575	.542
	V35	.645	.722	1.000	.694	.584
	V36	.686	.575	.694	1.000	.650
	V37	.634	.542	.584	.650	1.000
Sig. (1-tailed)	V33		.000	.000	.000	.000
	V34	.000		.000	.000	.000
	V35	.000	.000		.000	.000
	V36	.000	.000	.000		.000
	V37	.000	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
V33	.804
V34	.765
V35	.841
V36	.826
V37	.744

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 4 iterations required.

Cronbach's Alpha = .8946

Table 5-5

Competitiveness

Quality

Correlation Matrix

		V38	V39	V40	V41	V42
Correlation	V38	1.000	.659	.532	.560	.520
	V39	.659	1.000	.761	.779	.536
	V40	.532	.761	1.000	.840	.525
	V41	.560	.779	.840	1.000	.536
	V42	.520	.536	.525	.536	1.000
Sig. (1-tailed)	V38		.000	.000	.000	.000
	V39	.000		.000	.000	.000
	V40	.000	.000		.000	.000
	V41	.000	.000	.000		.000
	V42	.000	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
V38	.653
V39	.864
V40	.896
V41	.914
V42	.606

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Cronbach's Alpha = .8942

Table 5-6

Competitiveness

Delivery

Correlation Matrix

		V44	V45	V46
Correlation	V44	1.000	.857	.819
	V45	.857	1.000	.845
	V46	.819	.845	1.000
Sig. (1-tailed)	V44		.000	.000
	V45	.000		.000
	V46	.000	.000	

Factor Matrix[a]

	Factor
	1
V44	.911
V45	.940
V46	.899

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Cronbach's Alpha = .9403

Table 5-7

Competitiveness

Flexibility

Correlation Matrix

		V43	V47	V48	V49
Correlation	V43	1.000	.595	.628	.553
	V47	.595	1.000	.690	.413
	V48	.628	.690	1.000	.554
	V49	.553	.413	.554	1.000
Sig. (1-tailed)	V43		.000	.000	.000
	V47	.000		.000	.000
	V48	.000	.000		.000
	V49	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
V43	.759
V47	.775
V48	.864
V49	.634

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Cronbach's Alpha = .8416

Table 5-8

Competitiveness - Construct

Correlation Matrix

		Y1	Y2	Y3	Y4
Correlation	Y1	1.000	.632	.660	.665
	Y2	.632	1.000	.566	.639
	Y3	.660	.566	1.000	.684
	Y4	.665	.639	.684	1.000
Sig. (1-tailed)	Y1		.000	.000	.000
	Y2	.000		.000	.000
	Y3	.000	.000		.000
	Y4	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
Y1	.815
Y2	.751
Y3	.799
Y4	.839

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Goodness-of-fit Test

Chi-Square	df	Sig.
7.578	2	.023

Cronbach's Alpha = .8678

Table 5-9

Customer Satisfaction - Construct

Correlation Matrix

		S1	S2	S3	S4
Correlation	S1	1.000	.683	.681	.684
	S2	.683	1.000	.844	.750
	S3	.681	.844	1.000	.776
	S4	.684	.750	.776	1.000
Sig. (1-tailed)	S1		.000	.000	.000
	S2	.000		.000	.000
	S3	.000	.000		.000
	S4	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
S1	.758
S2	.906
S3	.923
S4	.843

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Goodness-of-fit Test

Chi-Square	df	Sig.
12.311	2	.002

Cronbach's Alpha = .9176

Table 5-10

Business Performance

Pattern Matrix[a]

	Component	
	1	2
V57	.883	-4.62E-02
V58	1.000	-6.91E-02
V59	.906	7.224E-02
V60	.944	4.405E-03
V61	.606	.387
V62	.505	.491
V63	-7.49E-02	.965
V64	.119	.791

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Table 5-11

Business Performance

Profit

Correlation Matrix

		V57	V58	V59	V60
Correlation	V57	1.000	.777	.739	.740
	V58	.777	1.000	.908	.884
	V59	.739	.908	1.000	.897
	V60	.740	.884	.897	1.000
Sig. (1-tailed)	V57		.000	.000	.000
	V58	.000		.000	.000
	V59	.000	.000		.000
	V60	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
V57	.794
V58	.952
V59	.954
V60	.934

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Cronbach's Alpha = .9492

Table 5-12

TQM Practices

Pattern Matrix[a]

	Component					
	1	2	3	4	5	6
V65	.176	.153	.645	-.151	3.172E-02	4.892E-02
V66	4.606E-02	-9.92E-02	.881	-5.77E-02	-3.61E-02	1.337E-02
V67	2.005E-02	-9.63E-03	.731	1.034E-02	9.555E-02	-3.60E-02
V68	-.135	.137	.619	.387	1.293E-02	4.930E-02
V69	.158	.755	5.291E-02	-.201	2.053E-02	.103
V70	.108	.758	3.921E-02	-.101	2.341E-02	.158
V71	-7.42E-02	.733	3.358E-02	3.879E-02	5.450E-02	8.054E-02
V72	7.623E-04	.695	-3.48E-02	.261	1.931E-02	-.215
V79	-3.84E-02	-6.59E-03	1.804E-02	-4.80E-03	.977	1.991E-02
V80	3.506E-02	-8.37E-03	5.606E-03	-3.55E-02	.946	9.417E-03
V82	.257	.142	1.312E-02	.575	.165	-.124
V83	.107	-4.40E-02	1.228E-02	.784	-3.46E-02	.186
V85	.739	8.523E-03	.126	5.542E-02	-6.38E-02	1.000E-04
V86	.786	3.379E-02	4.232E-02	-8.10E-02	1.285E-02	3.264E-02
V87	.830	6.165E-02	-1.49E-02	3.659E-02	5.167E-02	-6.43E-02
V88	.832	-2.47E-02	-5.46E-02	5.138E-02	3.216E-02	4.356E-02
V91	.656	-3.67E-02	3.586E-03	.108	.129	.137
V92	9.276E-02	-7.85E-02	2.726E-03	9.280E-02	8.800E-02	.841
V93	2.841E-02	.311	4.887E-02	5.215E-02	3.411E-02	.735

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Table 5-13

TQM Practices

Supplier Relationship

Correlation Matrix

		V65	V66	V67	V68
Correlation	V65	1.000	.576	.443	.404
	V66	.576	1.000	.471	.458
	V67	.443	.471	1.000	.426
	V68	.404	.458	.426	1.000
Sig. (1-tailed)	V65		.000	.000	.000
	V66	.000		.000	.000
	V67	.000	.000		.000
	V68	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
V65	.719
V66	.778
V67	.628
V68	.598

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Cronbach's Alpha = .7755

Table 5-14

TQM Practices
Customer Involvement

Correlation Matrix

		V69	V70	V71
Correlation	V69	1.000	.755	.478
	V70	.755	1.000	.486
	V71	.478	.486	1.000
Sig. (1-tailed)	V69		.000	.000
	V70	.000		.000
	V71	.000	.000	

Factor Matrix[a]

	Factor
	1
V69	.861
V70	.877
V71	.555

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Cronbach's Alpha = .8033

Table 5-15

TQM Practices

Top Management Commitment

Correlation Matrix

		V85	V86	V87	V88	V91
Correlation	V85	1.000	.613	.517	.530	.542
	V86	.613	1.000	.627	.573	.562
	V87	.517	.627	1.000	.730	.635
	V88	.530	.573	.730	1.000	.656
	V91	.542	.562	.635	.656	1.000
Sig. (1-tailed)	V85		.000	.000	.000	.000
	V86	.000		.000	.000	.000
	V87	.000	.000		.000	.000
	V88	.000	.000	.000		.000
	V91	.000	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
V85	.675
V86	.743
V87	.840
V88	.832
V91	.773

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Cronbach's Alpha = .8811

Table 5-16

TQM Practices - Construct

Correlation Matrix

		T1	T2	T3	T4	T5
Correlation	T1	1.000	.460	.466	.424	.353
	T2	.460	1.000	.481	.483	.401
	T3	.466	.481	1.000	.574	.553
	T4	.424	.483	.574	1.000	.404
	T5	.353	.401	.553	.404	1.000
Sig. (1-tailed)	T1		.000	.000	.000	.000
	T2	.000		.000	.000	.000
	T3	.000	.000		.000	.000
	T4	.000	.000	.000		.000
	T5	.000	.000	.000	.000	

Factor Matrix[a]

	Factor
	1
T1	.605
T2	.650
T3	.800
T4	.705
T5	.634

Extraction Method: Maximum Likelihood.

a. 1 factors extracted. 5 iterations required.

Goodness-of-fit Test

Chi-Square	df	Sig.
18.315	5	.003

Cronbach's Alpha = .7793

Table 5-17

Constructs - Pattern Matrix

Pattern Matrix[a]

	Component		
	1	2	3
X1	2.843E-02	.703	1.619E-02
X2	7.684E-03	.737	-3.93E-02
X3	4.128E-02	.686	-4.40E-02
X4	7.746E-02	.744	-.133
X5	-2.31E-02	.765	-9.80E-03
X6	-9.88E-02	.765	.100
X7	3.173E-03	.628	.117
T1	.134	3.702E-02	.622
T2	1.252E-02	-2.44E-02	.748
T3	4.446E-02	-4.45E-02	.807
T4	-8.19E-02	8.483E-04	.812
T5	2.747E-02	3.960E-02	.704
Y1	.736	2.392E-02	.147
Y2	.741	.178	-4.36E-03
Y3	.657	9.079E-02	8.169E-02
Y4	.721	6.894E-02	7.953E-02
S1	.797	-2.77E-02	-2.91E-03
S2	.889	-2.89E-02	-6.73E-02
S3	.893	-5.76E-02	-4.93E-02
S4	.846	-2.34E-02	3.686E-02
P1	.849	-5.35E-03	3.307E-02
P2	.786	-6.22E-02	-5.09E-02

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 4 iterations.

Table 5-18

Three Component Pattern Matrix I

Pattern Matrix[a]

	Component		
	1	2	3
X1	4.221E-02	.694	1.257E-02
X2	-5.42E-04	.737	-3.40E-02
X3	9.258E-02	.661	-6.57E-02
X4	8.778E-02	.724	-.121
X5	6.155E-03	.759	-2.73E-02
X6	-.157	.792	.129
X7	-9.92E-03	.634	.127
T1	.174	3.335E-02	.595
T2	9.821E-03	-1.94E-02	.746
T3	2.204E-02	-2.53E-02	.817
T4	-9.35E-02	1.344E-02	.817
T5	7.269E-02	3.134E-02	.676
Y1	.821	-3.55E-02	.119
Y2	.765	.139	2.331E-03
Y3	.858	-8.39E-03	-1.39E-03
Y4	.878	-1.95E-02	1.568E-02

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 10 iterations.

Table 5-19

Three Component Pattern Matrix II

Pattern Matrix[a]

	Component		
	1	2	3
X1	1.116E-02	.708	2.842E-02
X2	-4.36E-03	.741	-3.11E-02
X3	2.097E-02	.692	-3.26E-02
X4	.107	.741	-.141
X5	-4.55E-02	.768	-1.89E-03
X6	-8.51E-02	.761	9.321E-02
X7	2.268E-02	.625	.108
T1	6.747E-02	5.806E-02	.658
T2	4.037E-02	-3.22E-02	.736
T3	4.107E-02	-4.05E-02	.813
T4	-7.37E-02	-7.35E-03	.807
T5	6.336E-03	4.399E-02	.712
S1	.836	4.845E-03	2.684E-02
S2	.927	1.056E-02	-2.85E-02
S3	.936	-2.00E-02	-1.23E-02
S4	.857	1.615E-02	7.938E-02

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 7 iterations.

Table 5-20

Three Component Pattern Matrix III

Pattern Matrix[a]

	Component		
	1	2	3
X1	.696	2.963E-03	5.990E-02
X2	.732	-4.98E-02	2.566E-02
X3	.676	-5.55E-02	8.331E-02
X4	.754	-7.69E-02	-4.46E-03
X5	.765	-2.37E-02	-1.92E-02
X6	.755	7.701E-02	-6.63E-02
X7	.644	.148	-6.63E-02
T1	3.341E-02	.563	.280
T2	-9.81E-03	.775	-5.37E-02
T3	-3.55E-02	.800	7.049E-02
T4	-5.30E-03	.813	-9.06E-02
T5	4.658E-02	.699	3.014E-02
P1	6.100E-02	.102	.848
P2	-2.16E-02	-3.81E-02	.939

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Table 5-21

Three Factor Pattern Matrix

Pattern Matrix[a]

	Component		
	1	2	3
Y1	8.306E-02	.695	.193
Y2	.374	.471	7.322E-02
Y3	3.263E-03	.966	-.142
Y4	-2.21E-02	.809	.155
S1	.863	9.200E-02	-.130
S2	.911	-8.09E-02	.100
S3	.942	-6.60E-02	4.662E-02
S4	.811	8.316E-02	4.739E-02
P1	.161	.433	.472
P2	5.752E-02	3.189E-02	.912

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Table 5-22

Correlation Matrix - Constructs

	ISO	TQM	Comp.	C. Sat.	B. Perf.
ISO	1.000				
TQM	0.258	1.000			
Comp.	0.448	0.566	1.000		
C. Sat.	0.329	0.471	0.805	1.000	
B. Perf.	0.331	0.485	0.899	0.801	1.000

Table 5-23

Nested Models

Models	Chi-Square	d.f.	Ratio	CFI	RMSEA
Unconstrained (Fig. 5-1)	411.5	199	2.07	.993	.049
Constrained #1(Fig. 5-2)	484.1	203	2.38	.990	.056
Constrained #2(Fig. 5-3)	531.0	203	2.62	.988	.061
Constrained #3(Fig. 5-4)	943.3	203	4.66	.974	.091
Constrained #4(Fig. 5-5)	801.1	203	3.95	.979	.082
Constrained #5(Fig. 5-6)	747.3	202	3.70	.981	.078
Parsimonious (Fig. 5-7)	413.6	202	2.05	.993	.049

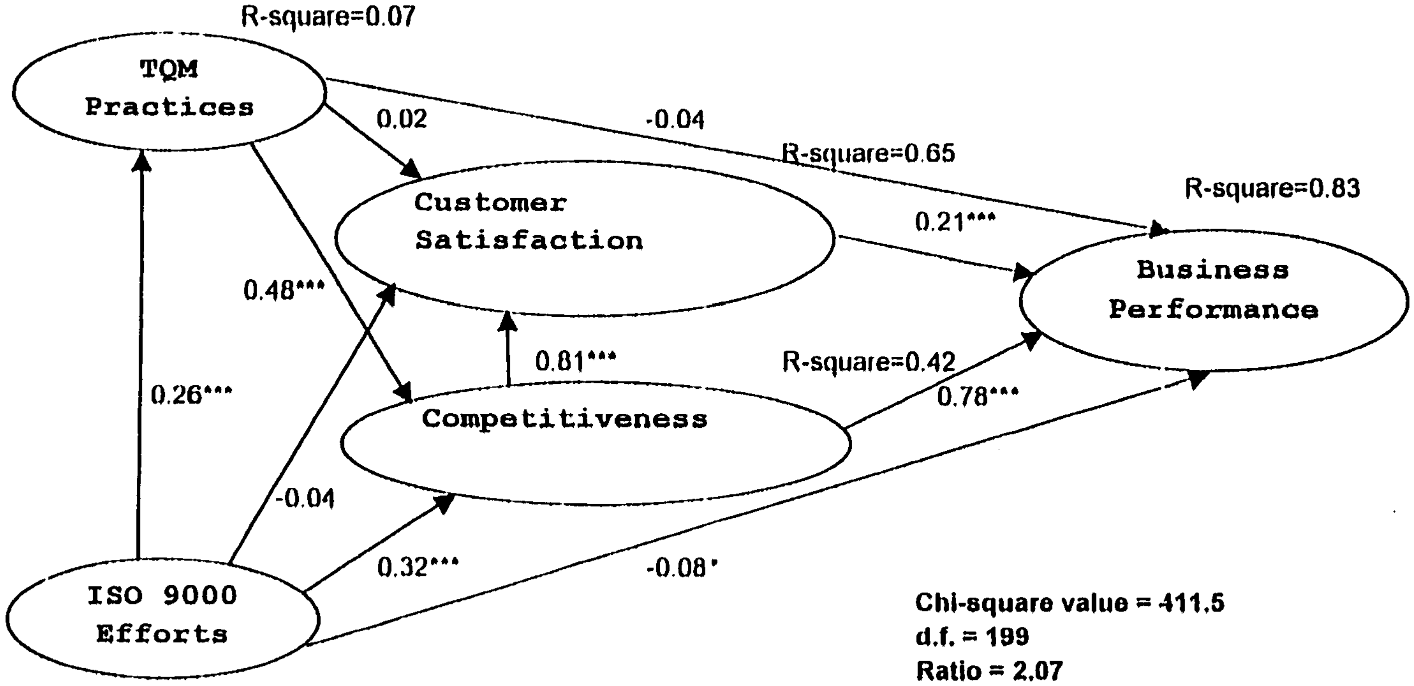
Table 5-24

Multiple Group Analyses

	INDUSTRY		FIRM TYPE		FIRM SIZE		QUALITY	
Hypotheses	Chemical	Electronic	USA	Foreign	Small	Large	TQM	Non-TQM
H1:	.06NS	.29***	.23**	.10NS	.14NS	.32***	.15NS	.45***
H2:	.37***	.27***	.34***	.36***	.33***	.32***	.36***	.26**
H3:	.04NS	-.02NS	-.07NS	.07NS	-.02NS	-.06NS	-.12NS	.05NS
H4:	-.23**	-.03NS	-.11NS	-.10NS	-.11NS	-.06NS	-.10NS	-.06NS
H5:	.51***	.49***	.44***	.50***	.49***	.49***	.44***	.51***
H6:	.09NS	.00NS	.00NS	.07NS	-.04NS	.06NS	.08NS	-.07NS
H7:	-.08NS	.01NS	-.09NS	-.06NS	-.04NS	-.04NS	-.03NS	-.06NS
H8:	.76***	.77***	.86***	.70***	.86***	.77***	.78***	.88***
H9:	1.00***	.66***	.89***	.79***	.83***	.74***	.77***	.85***
H10:	-.01NS	.28***	.14NS	.28**	.17NS	.27***	.21**	.17NS
Chi-Sq.:	221.1	396.6	314.3	282.3	256.2	349.9	300.2	317.4
df:	200	199	199	199	199	199	199	199
Ratio:	1.11	1.99	1.58	1.42	1.29	1.76	1.51	1.60
CFI:	.997	.990	.991	.988	.994	.992	.994	.990
RMSEA:	.030	.058	.053	.064	.045	.051	.047	.056
n:	119	295	206	104	142	296	236	193

Note: NS = Not Significant
*: p<.05; **: p<.01; ***: p<.001
n = Sample Size

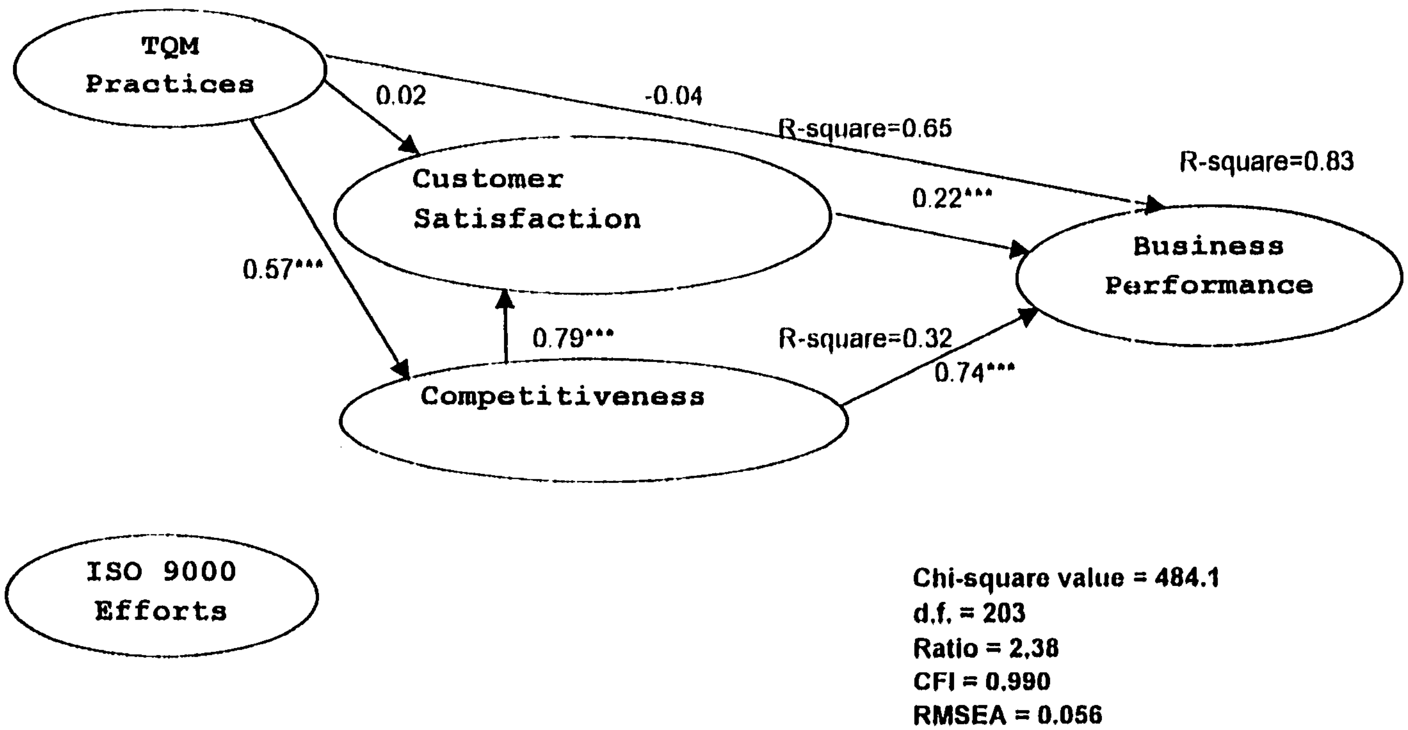
Figure 5-1
Unconstrained Model



Chi-square value = 411.5
d.f. = 199
Ratio = 2.07
CFI = 0.993
RMSEA = 0.049

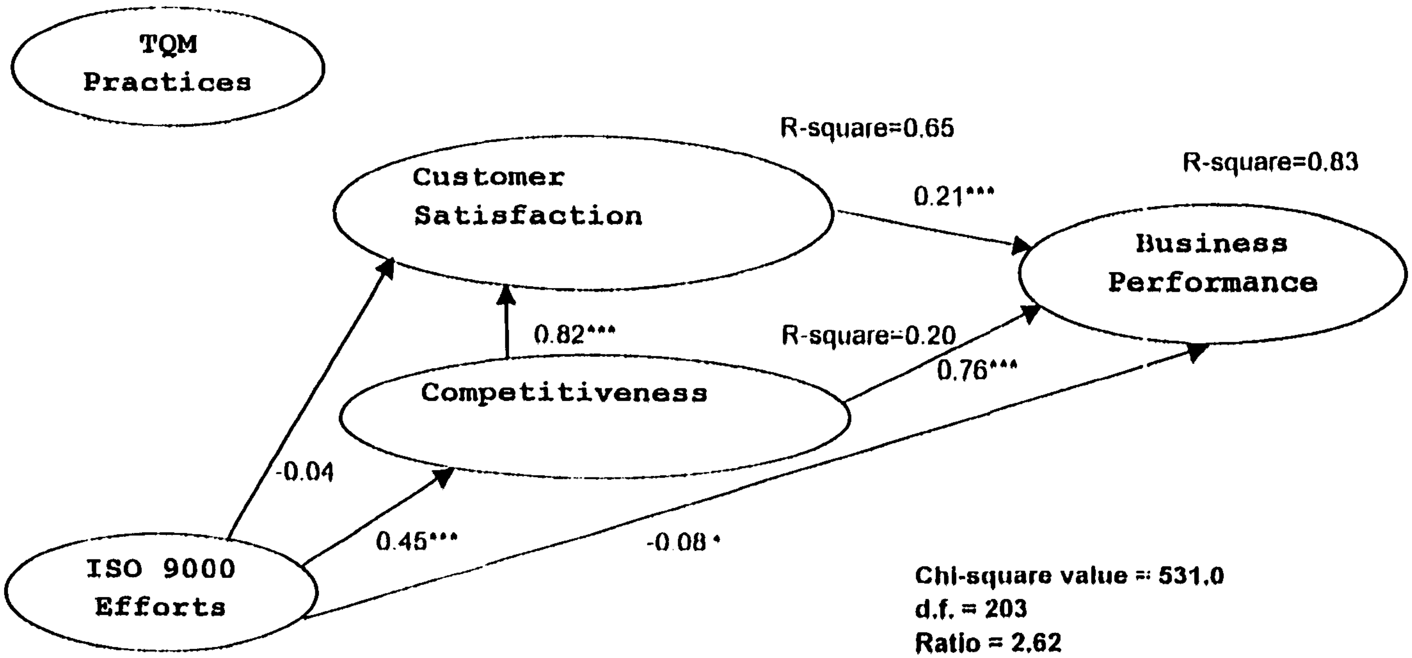
Note: *: $p<0.05$; **: $p<0.01$ ***: $p<0.001$

Figure 5-2
Constrained Model #1



Note: *: $p<0.05$; **: $p<0.01$ ***: $p<0.001$

Figure 5-3
Constrained Model #2

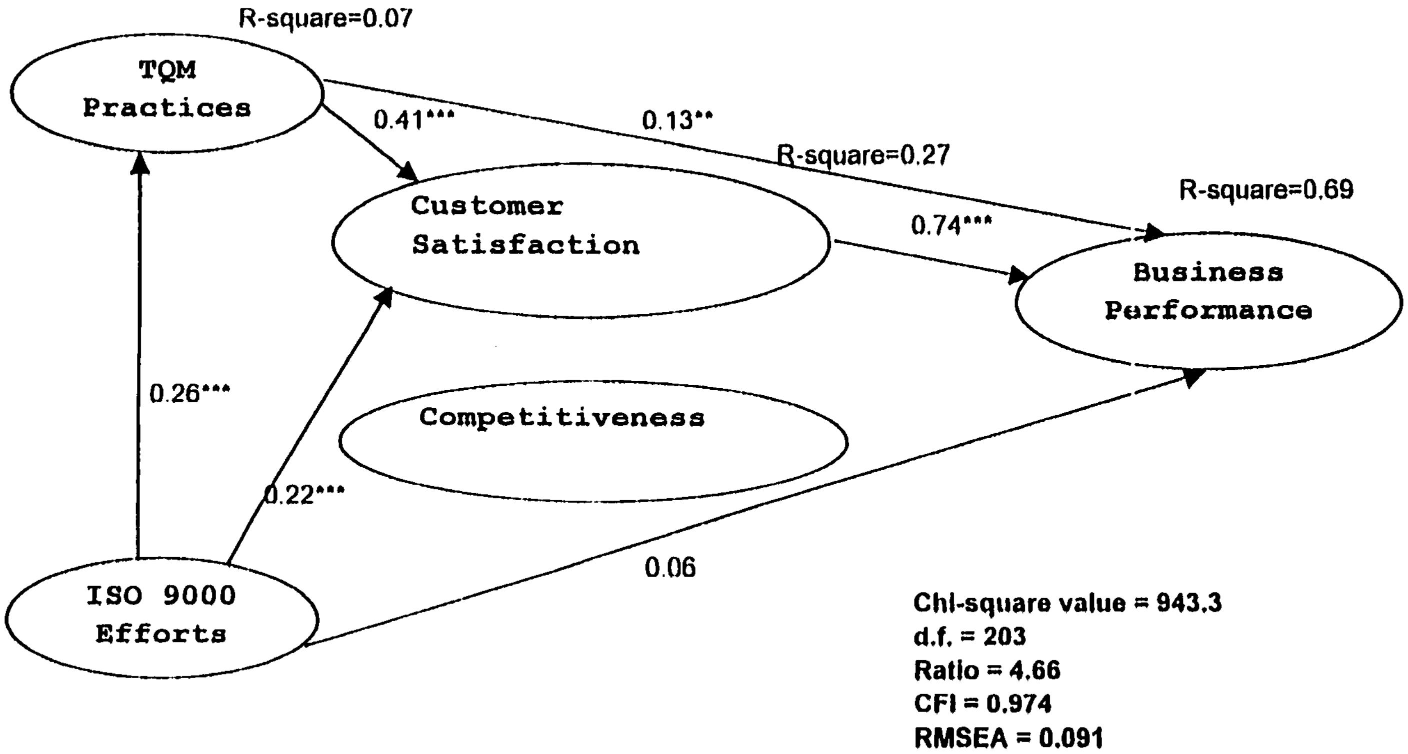


Chi-square value = 531.0
d.f. = 203
Ratio = 2.62
CFI = 0.988
RMSEA = 0.061

Note: *: p<0.05; **: p<0.01 ***: p<0.001

Figure 5-4

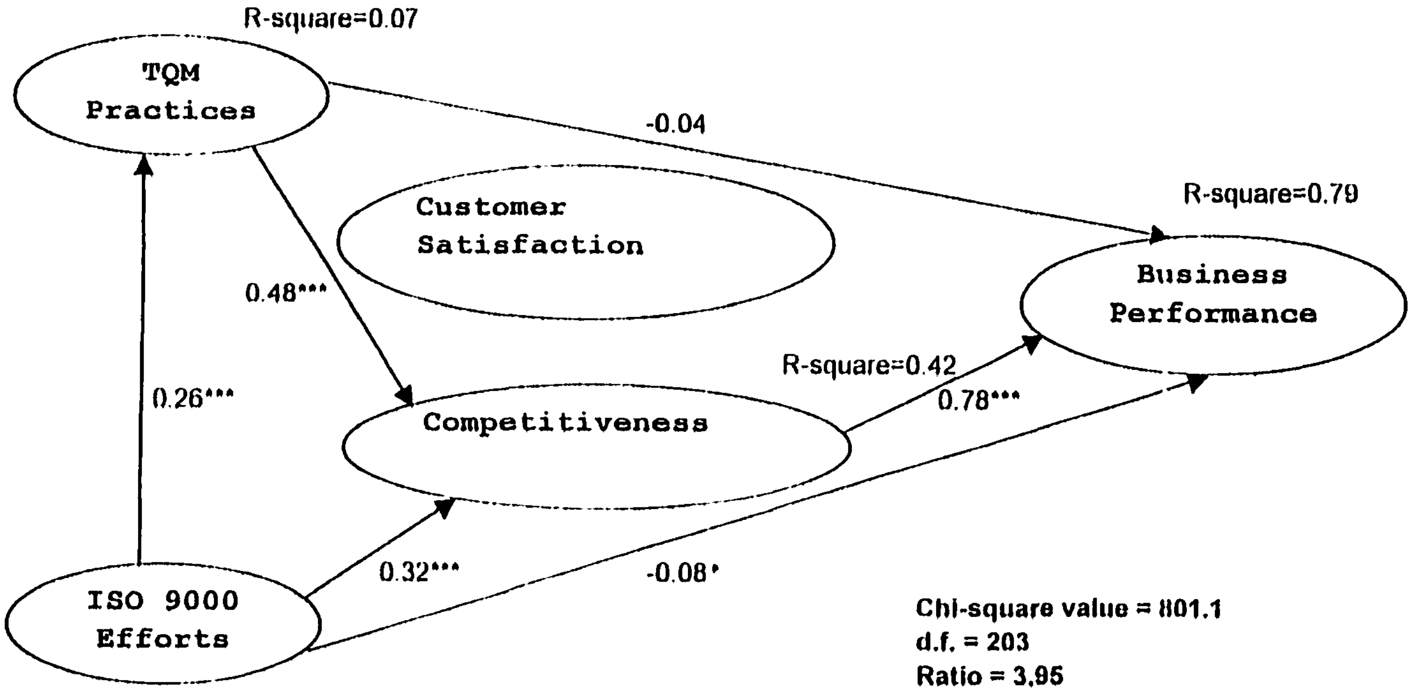
Constrained Model #3



Note: *: $p<0.05$; **: $p<0.01$ ***: $p<0.001$

Figure 5-5

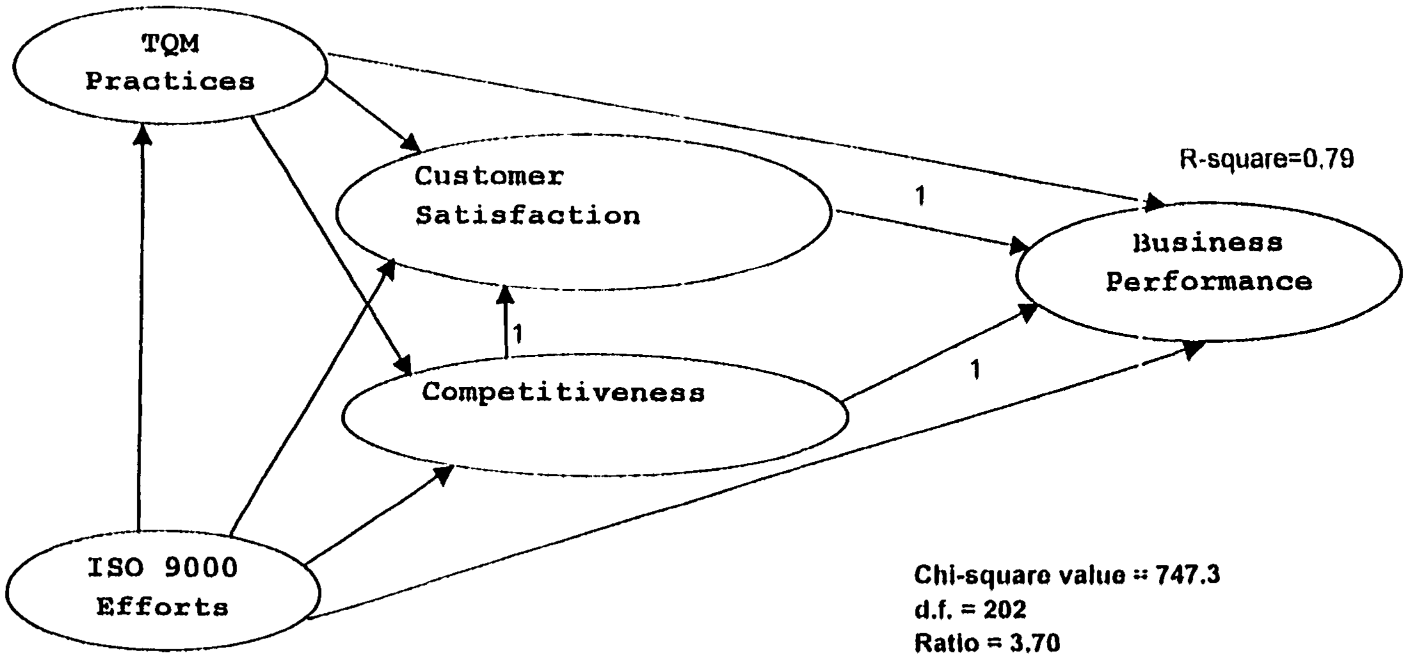
Constrained Model #4



Chi-square value = 801.1
d.f. = 203
Ratio = 3.95
CFI = 0.979
RMSEA = 0.082

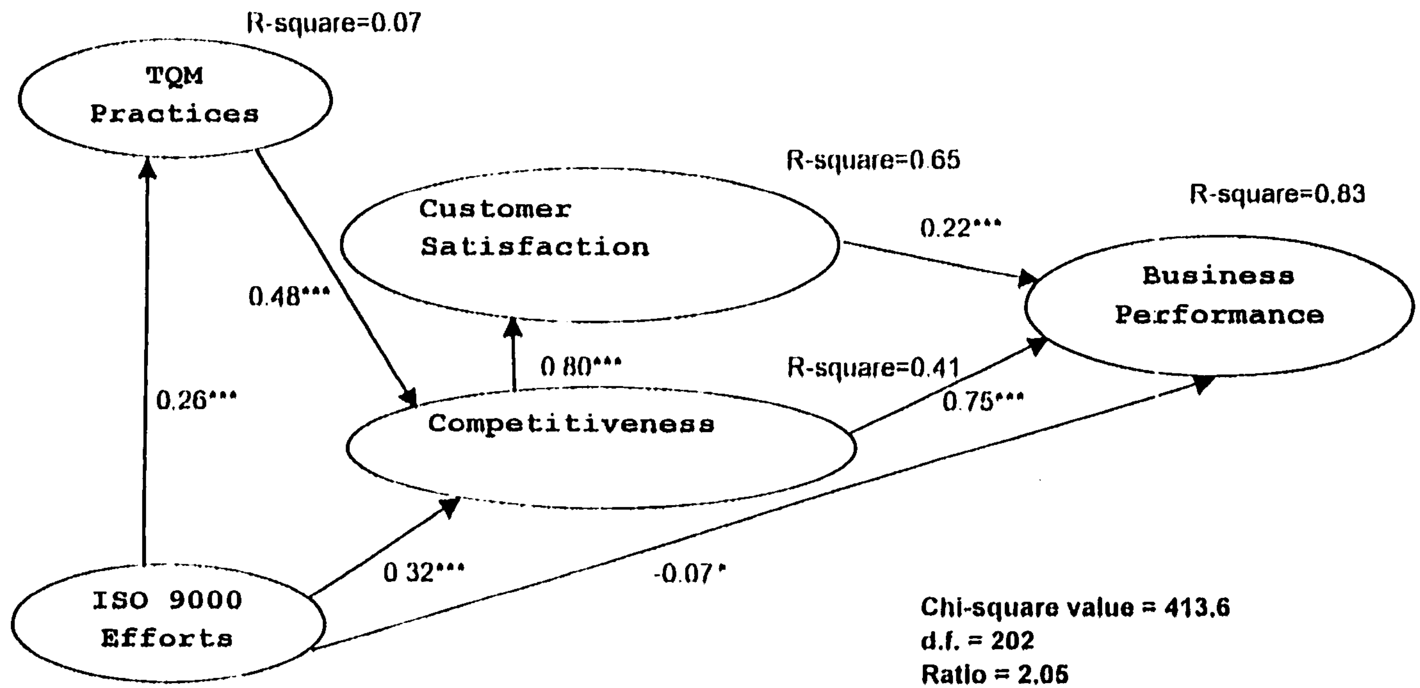
Note: *: p<0.05; **: p<0.01 ***: p<0.001

Figure 5-6
Constrained Model #5



Chi-square value = 747.3
d.f. = 202
Ratio = 3.70
CFI = 0.981
RMSEA = 0.078

Figure 5-7
Parsimonious Model

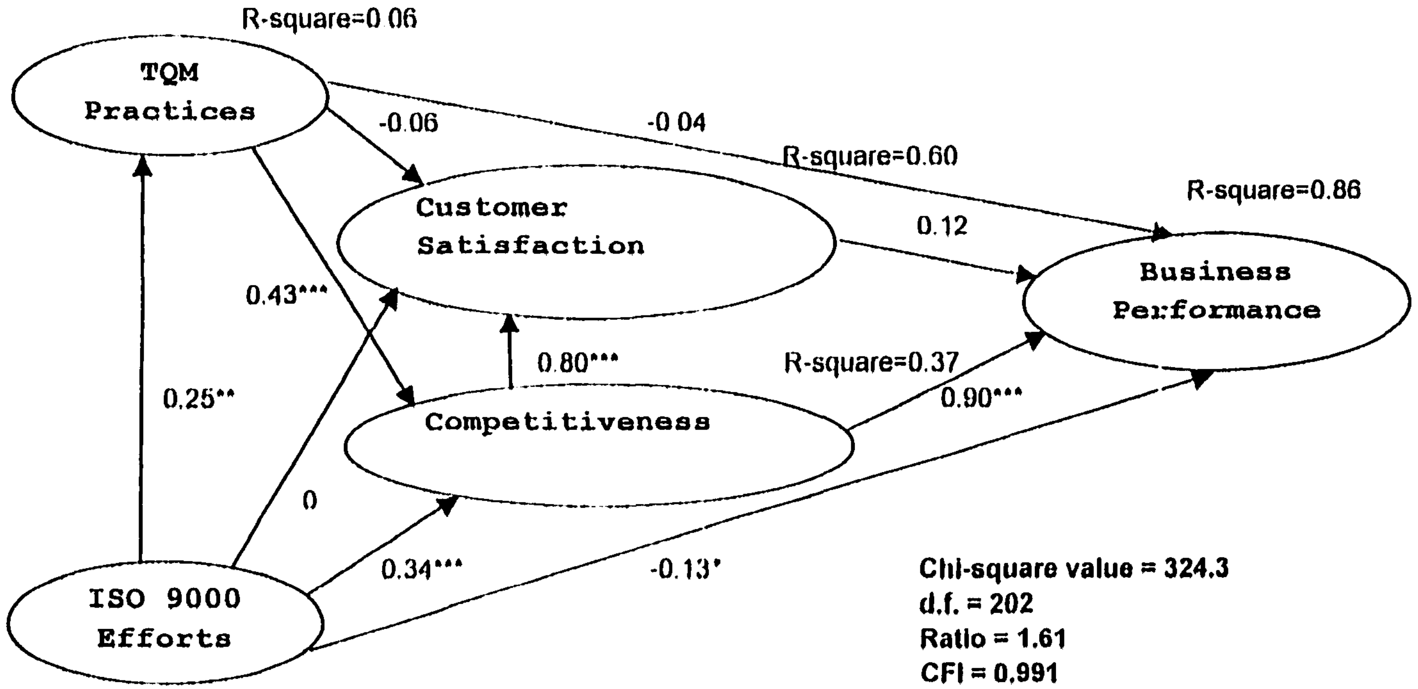


Chi-square value = 413.6
d.f. = 202
Ratio = 2.06
CFI = 0.993
RMSEA = 0.049

Note: *: $p<0.05$; **: $p<0.01$ ***: $p<0.001$

Figure 5-8

First-Half

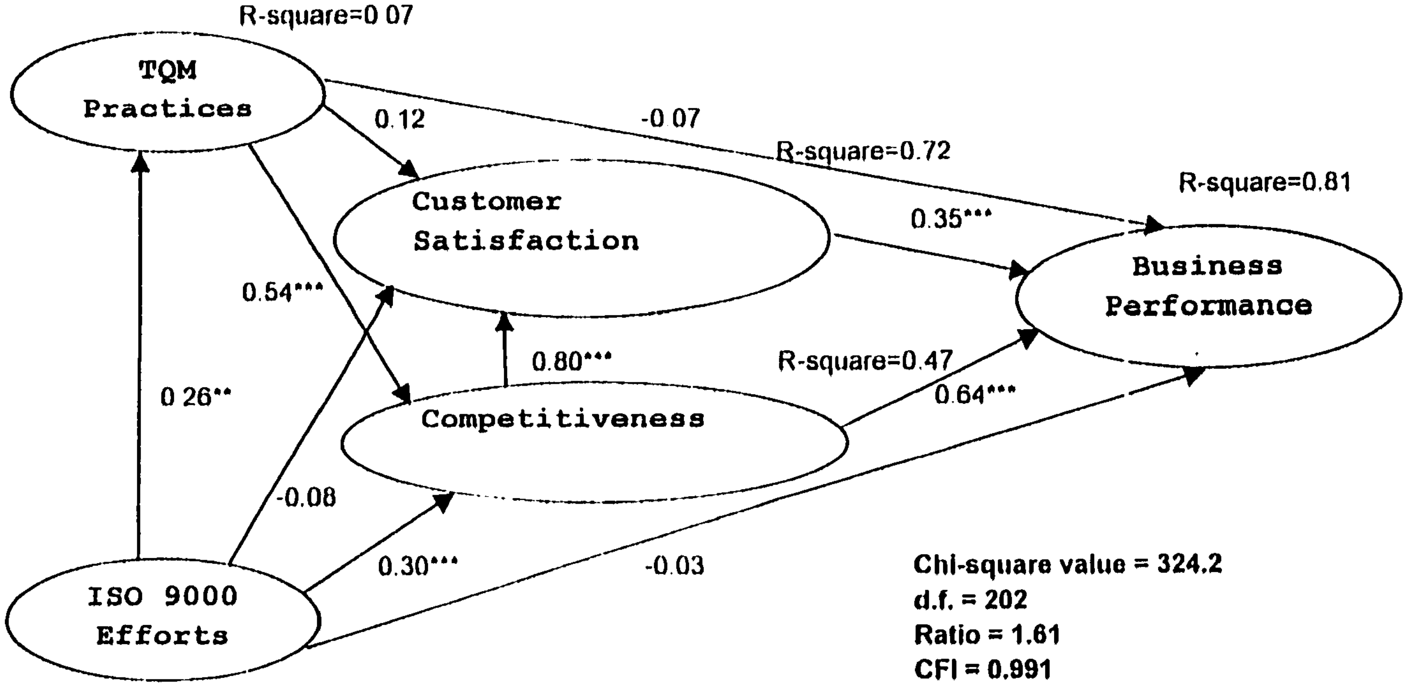


Chi-square value = 324.3
d.f. = 202
Ratio = 1.61
CFI = 0.991
TLI = 0.989
RMSEA = 0.052
n = 221

Note: *: $p<0.05$; **: $p<0.01$ ***: $p<0.001$

Figure 5-9

Second-Half



Chi-square value = 324.2
d.f. = 202
Ratio = 1.61
CFI = 0.991
TLI = 0.989
RMSEA = 0.053
n = 220

Note: *: $p<0.05$; **: $p<0.01$ ***: $p<0.001$

CHAPTER SIX

DISCUSSION

This study was developed from a theoretical foundation and provides a deeper insight into fundamental theories in operations management. The results of this study raise as many questions as they answer. One important result in this research is that there is strong evidence that the ISO 9000 registration efforts enhance organizational competitiveness. This is a significant contribution due to the fact that there is substantial disagreement in the literature over the relationship between the two constructs (Miller, 1993; Brecka, 1994; Stratton, 1994; Sissell, 1996; Tsiotras and Gotsamani, 1996; Terziovski et al., 1997; Anderson et al., 1999). It is also interesting to note, from Figure 5-1, that at the same time, ISO 9000 registration efforts have a negative relationship with the business performance at the .05 significance level. This finding seems contradictory at first and might be a source for confusion. It does make sense, however, since the organizations might perceive that the expenses outweigh the benefits at first. What the results indicate is that ISO 9000 registration efforts enhance competitiveness, which in turn enhances customer satisfaction as well as business performance.

This study supports the finding of Terziovski et al. (1997) that ISO 9000 certification does not have a significant positive relationship with organizational performance by itself. Furthermore, the R-square value for business performance does not change (.83) when the construct, ISO 9000 registration efforts, is left out from the model (see Figure 5-2). This shows that the construct, ISO 9000 registration efforts, is not directly linked with performance. However, the large amount of decrease (from .42 to .32) in the proportion of the variance that is explained in competitiveness suggests that ISO 9000 registration is an important construct in explaining competitiveness. The results of this study also agree with Anderson et al. (1999) who indicated that customer and regulatory compliance are not the only reasons for the widespread adoption of ISO 9000 in North American manufacturing companies. They found that managers adopt ISO 9000 as a means of achieving quality improvement and global competitiveness.

It is surprising to find that TQM practices do not have a direct positive relationship with customer satisfaction, as the literature suggests (Anderson et al., 1994; Reimann and Hertz, 1994; Forza and Filippini, 1998). It does, however, imply that TQM practices enhance competitiveness, which in turn enhances customer satisfaction. The study reveals that customer satisfaction can be enhanced through achieving the improvement in quality, reduction in cost, on-time delivery, and flexibility (customization). In other words, organizational competitiveness is a mediating variable between TQM practices and customer satisfaction. The implementation of TQM will not by itself guarantee customer satisfaction. This study also suggests that TQM practices do not enhance business performance directly. The R-square value for business performance does not change (.83) when the construct, TQM practices, is left out from the model (see Figure 5-3). This indicates that the construct, TQM practices, is not directly linked with performance. Also, no change in the proportion of the variance that is explained in customer satisfaction suggests that the construct, TQM practices, is not critical in explaining customer satisfaction. This may explain why some companies that did not see the expected results immediately, questioned the effectiveness of TQM programs, thus terminating them.

It is not surprising to find from the study that ISO 9000 registration efforts do not affect customer satisfaction directly. The literature was not very explanatory in regards to the relationship of these two constructs. The R-square value for customer satisfaction is reduced to .27 from .65 when the construct, competitiveness, is left out from the model (see Figure 5-4). This explains that competitiveness is critical in explaining customer satisfaction. The results indicate that customer satisfaction can be achieved by attaining organizational competitiveness.

The results of the analysis support the belief that TQM contributes to competitiveness, which in turn helps to gain greater market share and profitability (Reimann and Hertz, 1994; Hendricks and Singhal, 1997; Schonberger and Knod, Jr., 1997). It is also interesting to note that the results support the claim that ISO 9000 registration covers less than ten percent of the scope of the Baldrige Award criteria, which measures TQM practices (Reimann and Hertz, 1994). This is demonstrated in Figure 5-1 where R-square value is .07 for the dependent variable, TQM practices. This means that only 7% of the variances in TQM practices are explained by the independent variable, ISO 9000 registration efforts.

ISO 9000 registration efforts and TQM practices have a significant, positive relationship when the model is tested based on all 441 responses. The overall result supports the claim that ISO 9000 might be a good first step to total quality and is a meaningful component of TQM. Conflicting conclusions, however, can be drawn, depending on the industry type, firm type, firm size, and quality orientation. Even though firms in the electronic industry suggest that there is a strong positive relationship between the two constructs, firms in the chemical industry do not support that claim. This could be one of the reasons why the electronic industry was the first industry to embrace ISO 9000 and was best represented in terms of number of companies registered in the United States. In addition, small firms, foreign owned firms, and TQM firms seem to side with critics who claim that ISO 9000 has little relation to TQM. As a matter of fact, our findings support the claim of McAdam and McKeown (1999) which states, although many small businesses in Northern Ireland are benefiting from ISO 9000, the majority of firms are not progressing towards TQM. On the other hand, larger firms, U.S. owned firms, and non-TQM firms tend to side with proponents who see ISO 9000 as a starting point for TQM and as an ongoing integral part of TQM.

Customer satisfaction and business performance have a significant, positive relationship when the model is tested based on all 441 responses. The overall result supports the findings of Anderson et al. (1994), Rust and Zahorik (1993), and Babich (1992) that customer satisfaction has a positive impact on a firm's market share and profitability. Conflicting conclusions, however, can be drawn depending on the industry type, firm type, firm size, and quality orientation. Firms in the electronic industry, large firms, foreign owned firms, and TQM firms do support this claim. On the other hand, firms in the chemical industry, small firms, U.S. owned firms, and non-TQM firms do not support that claim.

Four hypotheses (H2, H5, H8, and H9) are consistently supported and four hypotheses (H3, H4, H6, and H7) are consistently not supported across industry, firm type, firm size, and quality orientation.

Given these findings, it becomes clear why the term ISO 9000 has become more widely used than TQM in discussions of quality improvement and global competitiveness. Since ISO 9000 is much smaller in scale than TQM, it is more manageable and achievable, and yet, ISO 9000 registration efforts can give similar benefits to the organization even though they are not in the same scale. This is why the automotive and telecommunications industries began on two new sets of quality systems requirements known as QS 9000 and TL 9000 respectively. Both QS 9000 and TL 9000 are more comprehensive than ISO 9000, but not as extensive as TQM. The goal was to create a consistent, worldwide set of quality system requirements that would apply to their respective industries. It is evident that industries are already moving towards the total quality. Furthermore, companies that are ISO 9000 certified receive acknowledgement and recognition from a third party as well as their customers. However, this is not the case for TQM in general (exception: the recipients of Malcolm Baldridge National Quality Award).

The analysis indicates that each construct added significantly to the model. Simply, all constructs were important in explaining the model. Particularly, organizational competitiveness plays a critical role as a mediating variable between ISO 9000 registration efforts and business performance, as well as TQM practices and business performance. In addition, large R-square values for competitiveness, customer satisfaction, and business performance can be used as evidence that the observed data are consistent with the proposed model shown in Figure 5-7. As can be seen from Figure 5-7, 41% of the variances in competitiveness are explained by ISO 9000 registration efforts and TQM practices. It is also interesting to note that 65% of the variances in customer satisfaction are explained by competitiveness and 83% of the variances in business performance are explained by competitiveness and customer satisfaction.

CHAPTER SEVEN

SUMMARY AND CONCLUSIONS

In this study, SEM was applied to help explain and predict the relationships between and among ISO 9000 registration efforts, TQM practices, competitiveness, customer satisfaction, and business performance. A model framework was formulated based on the existing literature. Ten hypotheses were proposed and tested based on the empirical data collected from ISO 9000 registered companies in the United States. Findings show support for 6 of the 10 hypotheses. In spite of the positive methodological aspects of the study, there are still limitations that must be addressed.

Limitations

Due to the nature of this study, a number of limitations should be considered in interpreting the results presented and conclusions drawn from this work. This survey is based on a cross-sectional sample at one specific point in time. To establish causal relationships, a longitudinal research design is necessary. However, a longitudinal study would not only take a long time but also would be difficult to carry out with such a large sample. Another limitation is that ISO 9000 champions had answered all of the survey questions. Although, under the given circumstances, ISO 9000 champions were the best available respondents, it would have been preferable to have multiple respondents and more objective sources for the question. Customer satisfaction data, for example, would have been more reliable if it had come from the customers rather than ISO 9000 champions. Another source of potential weakness of this paper is the perceptual measures of all the variables. This study lacks more objective measures from plants. Even with the stated limitations, this study provides a clearer understanding of the relationships among constructs that the current literature has failed to do.

The results of this study may not be used to explain the dynamics beyond the two manufacturing industries in the United States in which the survey was conducted. Although the findings may prove useful in other industries and in other parts of the world, that usefulness needs to be determined by future research and cannot be assessed here.

Future Directions

The data obtained from the survey contains a wealth of information. The model developed here can be further evaluated by subgroups to test what effects these groupings have on the relationships among different constructs. For example, the data set can be divided into different regions in the U.S. to see whether the geographic location of the plants would have any effect on the hypotheses that are being tested. These comparisons would show interesting and meaningful insights.

Another interesting research question might be which elements of TQM practices contribute to superior quality outcomes and which elements of competitiveness have a greater influence on firm's profitability.

The data was collected exclusively from manufacturing companies in the United States. Similar studies can be extended to service organizations in the United States to test the proposition made by Madu et al. (1996). They claim that managers of manufacturing firms tend to think more widely that there is a positive relationship between quality dimensions, such as customer satisfaction and product quality, and business performance than managers in service firms. Today, Kaye (2000) estimates that 13,000 U.S. service organizations, law firms, health care providers, and insurance companies have ISO 9000 certification. Kaye (2000) expects this figure to grow to 40,000 in the next two years.

The sample used in this study represented only two industries from the United States. One way to strengthen this research is to repeat the survey in other industries in the United States or even in other countries. The inclusion of other countries might add new insight and value to the research.

Conclusions

This study has contributed to the existing literature on quality management in several ways. First, it identified significant research issues and addressed previously unanswered questions. Second, it evaluated current operations theories by applying existing constructs to real problem settings and provided new and significant research insights. Third, a comprehensive model was formulated and introduced based on the existing literature. Fourth, this empirical study supported or refuted existing beliefs and propositions, as well as fostered development of new theories and concepts in quality and operations management. For example, this study supports that there is a significant, positive relationship between ISO 9000 registration efforts and organizational competitiveness. Furthermore, this study supports that ISO 9000 registration efforts do not have a direct, significant, positive relationship with business performance. However, this study does refute the claim that there is a direct, significant, positive relationship between TQM practices and customer satisfaction. Instead, this study suggests that TQM practices enhance organizational competitiveness which in turn enhances customer satisfaction. Fifth, this study extended the boundaries of the quality management literature. This study examined the relationships between and among five constructs, namely ISO 9000 registration efforts, TQM practices, organizational competitiveness, customer satisfaction, and business performance. Sixth, the study was forthright as to its methodology, its key measures and limitations, and included pertinent references and relationships to existing literature.

Appropriate statistical methods were used to analyze survey data. Lastly, the findings were relevant and important to practicing managers as well as operations management researchers.

APPENDIX A

Quality Management Research Questionnaire

Please specify your title or position: ________________________________

What is your Standard Industrial Classification (SIC) code or plant's line of business?
____2800 Chemicals and Allied Products
____3600 Electronic and Other Electrical Equipment and Components

In which region in the U. S. is your plant located?
____East ____West ____Mid-West ____South ____Other (specify) __________

Part 1

Please respond to the following questions by placing a check mark in the underlined area. Feel free to write comments at any point. Thank you in advance for your help.

1) Is your company a multi-national corporation?
No______ Yes______

If yes. your parent company's headquarters is in:
___USA ___Asia ___Europe ___Other (specify) ______________

2) Please estimate how much of your plant's total annual ($) sales are from exporting goods.
___0% ___1 to 49% ___50 to 99% ___100% ___Don't Know

3) Please estimate the total number of full-time employees at your plant?
___0 – 99 ___100 – 499 ___Over 500

4) Has Total Quality Management (TQM) been implemented in your plant?
___No ___Yes ___In process of being implemented ___Don't Know

If yes, approximately how long has TQM been implemented? ______years

5) How important is ISO 9000 registration to your plant?
___Not important
___Moderately important
___Very important/Required

Approximately how long has your plant been registered to ISO 9000 standard? ______years

6) Is your competition registered to ISO 9000 standard?
___No ___Yes ___In process of being implemented ___Don't Know

Part 2

Based on your experience, please rate the level of effort that was needed in each of the following Quality System Requirements to achieve your plant's ISO 9000 registration.

	Not Applicable/Low				High
Management Responsibility	1	2	3	4	5
Quality System	1	2	3	4	5
Contract Review	1	2	3	4	5
Design Control	1	2	3	4	5
Document and Data Control	1	2	3	4	5
Purchasing/Supplier Quality	1	2	3	4	5
Control of Customer Supplied Product	1	2	3	4	5
Product Identification and Traceability	1	2	3	4	5
Process Control	1	2	3	4	5
Inspection and Testing	1	2	3	4	5
Calibration, Measuring, and Test Equipment	1	2	3	4	5
Inspection and Test Status	1	2	3	4	5
Control of Nonconforming Product	1	2	3	4	5
Corrective and Preventive Action	1	2	3	4	5
Handling, Storage, Packaging and Delivery	1	2	3	4	5
Quality Records	1	2	3	4	5
Internal Quality Auditing	1	2	3	4	5
Training	1	2	3	4	5
Servicing	1	2	3	4	5
Statistical Techniques	1	2	3	4	5

Part 3

To what extent has your organization experienced improvement in the following areas, as a result of the ISO 9000 registration efforts, at your plant?

	Not at All		To Some Extent		To a Great Extent
Unit Production Cost	1	2	3	4	5
Inventory Level	1	2	3	4	5
Capacity Utilization	1	2	3	4	5
Productivity	1	2	3	4	5
Waste	1	2	3	4	5
Conformance to Design Specification	1	2	3	4	5
Product Performance	1	2	3	4	5
Product Durability	1	2	3	4	5
Product Reliability	1	2	3	4	5
Perceived Product Quality	1	2	3	4	5
Technical Innovation	1	2	3	4	5
Delivery Speed	1	2	3	4	5
Delivery Reliability	1	2	3	4	5
On-Time Delivery	1	2	3	4	5
Customization (large number of product features or options)	1	2	3	4	5
Rapid Capacity Adjustment	1	2	3	4	5
Product Design Time	1	2	3	4	5
Set Up Time	1	2	3	4	5
Number of Customer Complaints	1	2	3	4	5
Number of Warranty Claims	1	2	3	4	5
Number of Customer Compliments	1	2	3	4	5
Number of Repeat Customers	1	2	3	4	5
Customer Retention Rate	1	2	3	4	5
Level of Customer Satisfaction	1	2	3	4	5
Return on Investment	1	2	3	4	5
Net Income	1	2	3	4	5
Revenue	1	2	3	4	5
Financial Performance	1	2	3	4	5
Total Sales	1	2	3	4	5
Sales Growth Rate	1	2	3	4	5
Export Growth Rate	1	2	3	4	5
Number of New Customers	1	2	3	4	5

Part 4

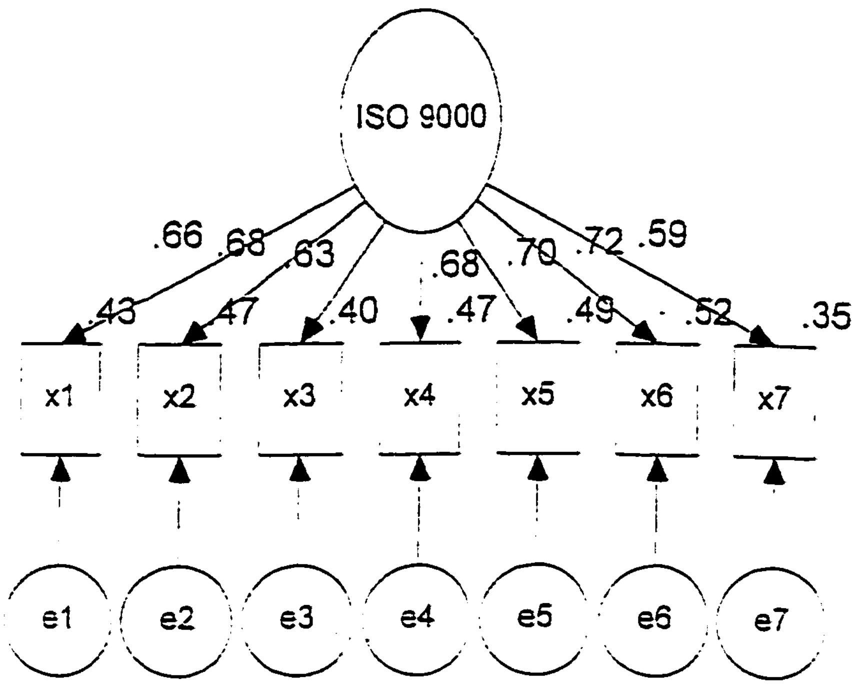
Based on your observations, how accurate are the following statements concerning your organization as a result of the ISO 9000 registration efforts.

	Not Very Accurate		Somewhat Accurate		Very Accurate
We strive to establish long-term relationships with suppliers.	1	2	3	4	5
We rely on a small number of high quality suppliers.	1	2	3	4	5
Our suppliers are certified or qualified for quality.	1	2	3	4	5
Our suppliers are involved in our new product development process.	1	2	3	4	5
We actively seek customers' input to determine their requirements.	1	2	3	4	5
We involve customers in product design.	1	2	3	4	5
Our customers give us feedback on quality and delivery performance.	1	2	3	4	5
Our customers often visit our plant.	1	2	3	4	5
We have quality circle or employee involvement type programs.	1	2	3	4	5
All employee suggestions are evaluated.	1	2	3	4	5
Feedback is provided to employees on their quality performance.	1	2	3	4	5
Employees are held responsible for error-free output.	1	2	3	4	5
We have employee training in problem-solving skills.	1	2	3	4	5
Training in the basic statistical techniques is given in the plant.	1	2	3	4	5
Quality-related training is given to hourly employees.	1	2	3	4	5
Quality-related training is given to managers and supervisors.	1	2	3	4	5
Quality information is displayed at most of the workstations.	1	2	3	4	5
Progress toward quality-related goals is displayed in our plant.	1	2	3	4	5
Cost of quality data concerning our major product is readily available.	1	2	3	4	5
We have an active competitive benchmarking program.	1	2	3	4	5
There's an effective system for employee/management communication.	1	2	3	4	5
Adequate resources are provided for quality improvement.	1	2	3	4	5
We have clear quality goals identified by our top management.	1	2	3	4	5
Our top-level managers actively champion our Quality program.	1	2	3	4	5
We use SPC extensively in our plant.	1	2	3	4	5
We have preventive maintenance program in place.	1	2	3	4	5
Management promotes the use of quality tools and methods.	1	2	3	4	5
New product designs are thoroughly reviewed.	1	2	3	4	5
Customer requirements are analyzed in the product design process.	1	2	3	4	5

APPENDIX B

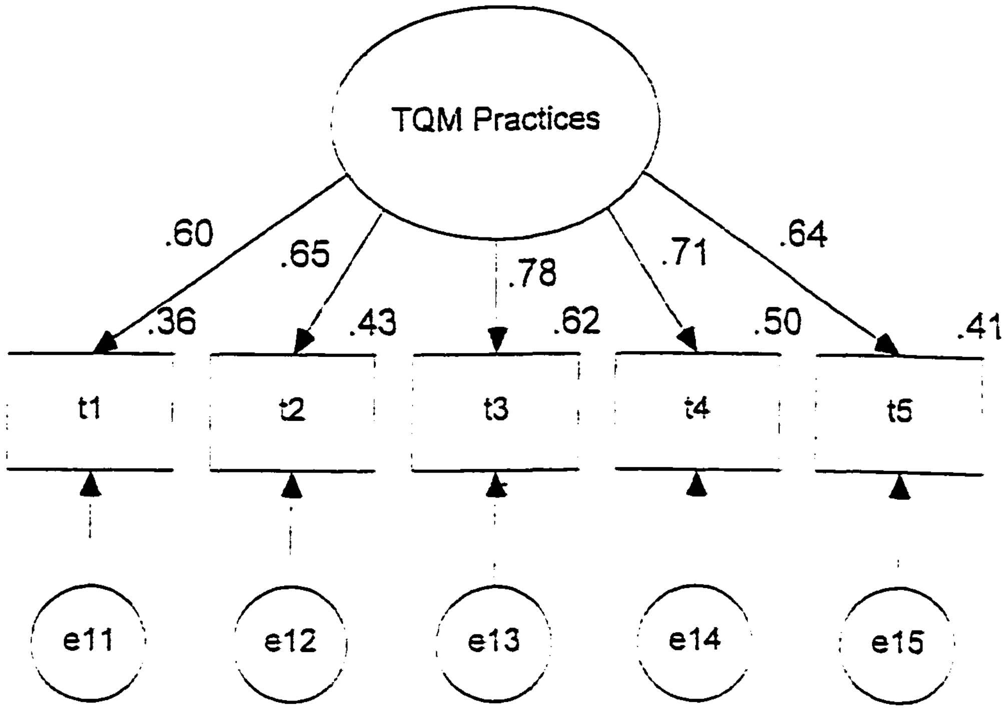
Confirmatory Factor Analyses

ISO 9000 Registration Efforts



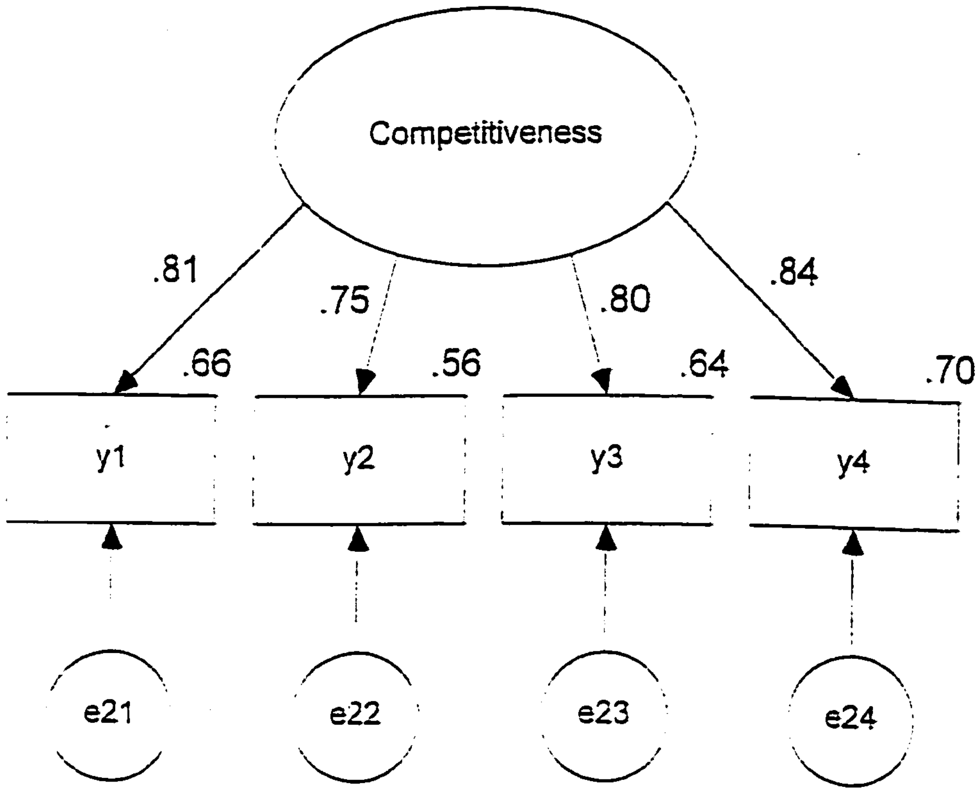
Range of t-values: 10.691 - 11.318
Chi-square = 42.336
Degrees of freedom = 14
Ratio = 3.024
CFI = 0.997
TLI = 0.994
RMSEA = 0.068

TQM Practices



Range of t-values: 10.192 - 12.218
Chi-square = 20.324
Degrees of freedom = 5
Ratio = 4.065
CFI = 0.976
TLI = 0.953
RMSEA = 0.083

Competitiveness



Range of t-values: 17.092 - 18.919
Chi-square = 7.627
Degrees of freedom = 2
Ratio = 3.813
CFI = 0.999
TLI = 0.999
RMSEA = 0.080

Customer Satisfaction

Range of t-values: 16.525 - 25.529
Chi-square = 13.088
Degrees of freedom = 2
Ratio = 6.544
CFI = 0.998
TLI = 0.998
RMSEA = 0.112

Appendix C

Correlation Matrix of Measured Variables

Correlation Matrix

Correlation	A1	A2	A3	A4	A5	A6	A7	T1	T2	T3	T4	T5	Y1	Y2	Y3	Y4	S1	S2	S3	S4	P1	P2
A1	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A2	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A3	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A4	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A5	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
A7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
T1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
T2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
T3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
T4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
T5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Y1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Y2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Y3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Y4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
S1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
S2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]	[illegible]
S3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]	[illegible]
S4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]	[illegible]
P1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000	[illegible]
P2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.000

BIBLIOGRAPHY

Adam, E. E., Jr. (1994), "Alternative Quality Improvement Practices and Organization Performance," *Journal of Operations management*, 12, 1, 27-44.

Adam, E. E., Jr. and P. M. Swamidass (1989), "Assessing Operations Management from a Strategic Perspective." *Journal of Management*, 15, 2, 181-203.

Ahire, S. L., Golhar, D.Y. and M.A. Waller (1996), "Development and Validation of TQM Implementation Constructs," *Decision Sciences*, 27, 1, 23-56.

Ahire, S. L., Landeros, R. and D. Y. Golhar (1995), "Total Quality Management: A Literature Review and an Agenda for Future Research," *Production and Operations Management*, 4, 3, 277-306.

Ahmed, N. U., Montagno, R. V., and R. J. Firenze (1996), "Operations Strategy and Organizational Performance: An Empirical Study," *International Journal of Operations Production Management*, 16, 5, 41-53.

Alreck, P. L. and R. B. Settle (1995), The Survey Research Handbook, Second Edition, Irwin/McGraw-Hill.

Anastasi, A (1968), Psychological Testing, Third Edition, The Macmillan Company.

Anderson, E. W., Fornell, C. and D. R. Lehmann (1994), "Customer satisfaction, Market Share, and Profitability: Findings From Sweden," *Journal of Marketing*, 58, 53-66.

Anderson, J. C., Cleveland, G., and R.G. Schroeder (1989), "Operations Strategy: a Literature Review," *Journal of Operations Management*, 8, 2, 133-158.

Anderson, J. C. and D. W. Gerbing (1988), "Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach," *Psychological*

Bulletin, 103, 3, 411-423.

Anderson, J. C., M. Rungtusanatham, Schroeder, R. G. and S. Devaraj (1995), "A Patn Analytical Model of a Theory of Quality Management Underlying the Deming Management Method: Preliminary Empirical Finding," *Decision Sciences*, 26, 5, 637-658.

Anderson, J. C., M. Rungtusanatham and R. G., Schroeder (1994), "A Theory of Quality Management Underlying the Deming Management Method," *Academy of Management Review*, 19, 3, 472-509.

Anderson, S. W., Daly, J. D. and M. F. Johnson (1999), "Why Firms Seek ISO 9000 Certification: Regulatory Compliance or Competitive Advantage?," *Production and Operations Management*, 8, 1, 28-43.

Arbuckle, J. L. and W. Wothke (1999), Amos User's Guide: Version 4.0, Smallwaters Corp., Chicago.

Armstrong, J. S. and T. S. Overton (1977), "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research*, 14, 392-402.

Arter, D. R. (1992), "Demystifying the ISO 9000/Q90 Series Standards," *Quality Progress*, November, 65-67.

Askey, J. M. and B. G. Dale (1994), "From ISO 9000 Series Registration to Total Quality Management: An Examination," *Quality Management Journal*, July, 67-76.

Babich, P. (1992), "Customer Satisfaction: How Good is Good Enough?," *Quality Progress*, 25, 12, 65-67.

Bagozzi, R. P. and Y. Yi (1988), "On the Evaluation of Structural Equation Models," *Journal of Academy of Marketing Science*, 16, 1, 74-94.

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

Bearden, W. O., Sharma, S. and J. R. Teel (1982), "Sample Size Effects on Chi-Square and Other Statistics Used in Evaluating Causal Models," *Journal of Marketing Research*, 19, 425-530.

Benson, P. G., Saraph, J. V. and R. G. Schroeder (1991), "The Effects of Organizational Context on Quality Management: An Empirical Investigation," *Management Science*, 37, 9, 1107-1124.

Bentler, P. M. (1990), "Comparative Fit Indexes in Structural Models," *Psychological Bulletin*, 107, 2, 238-246.

Bentler, P. M. (1995), EQS Structural Equations Program Manual, Encino, CA: Multivariate Software, Inc.

Bergquist, T. M. and K. D. Ramsing (1999), "Measuring Performance After Winning Award Criteria," *Quality Progress*, September, 66-72.

Black, S. A. and L. J. Porter (1996), "Identification of the Critical Factors of TQM," *Decision Sciences*, 27, 1, 1-21.

Brecka, J. (1994), "Study Finds Gains with ISO 9000 Registration Increase Over Time, *Quality Progress*, 27, 5, 18-20.

Bullock, H. E., Harlow, L. L. and S. A. Mulaik (1994), "Causation Issues in Structural Equation Modeling Research," *Structural Equation Modeling*, 1, 3, 253-267.

Campbell, D. T. and D. W. Fiske (1959), "Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix," *Psychological Bulletin*, 58, 81-105.

Carmines, E. G. and R. A. Zeller (1979), "Reliability and Validity Assessment," Sage University Paper series on Quantitative Apllications in the Social sciences, Series No. 07-017, Sage Publications, Beverly Hills.

Choi, T. Y. and K. Eboch (1998), "The TQM Paradox:

Relations Among TQM Practices, Plant Performance, and Customer Satisfaction," *Journal of Operations Management*, 17, 59-75.

Choi, T. Y. and M. Rungtusanatham (1999), "Comparison of Quality Management Practices: Across the Supply Chain and Industries," *The Journal of Supply Chain Management*, Winter, 20-27.

Churchill, G. A. and C. Suprenant (1982), "An Investigation into the Determinants of Customer Satisfaction," *Journal of Marketing Research*, 19, November, 491-504.

Cohen, J. (1988), Statistical Power Analysis for the Behavioral Sciences, Second Edition, Hillsdale, NJ:Erlbaum.

Conti, T. (1999), "Vision 2000: Positioning the New ISO 9000 Standards with Respect to Total Quality Management Models," *Total Quality Management*, 10, 4/5, 454-464.

Cook, T. D. and D. T. Campbell (1979), Quasi-Experimentation: Design & Analysis Issues for Field Settings, Houghton Mifflin Company.

Cronbach, L. J. (1951), "Coefficient Alpha and the Internal Structure of Tests," *Psychometrika*, 16, 297-334.

Corrigan, J. P. (1994), "Is ISO 9000 the Path to TQM?," *Quality Progress*, May, 33-36.

Curkovic, S., Melnyk, S., Calantone, R. and R. Handfield (2000), "Validating the Malcolm Baldrige National Quality Award Framework through Structural Equation Modeling," *International Journal of Production Research*, 38, 4, 765-791.

Dean, Jr., J. W. and D. E. Bowen (1994), "Management Theory and Total Quality: Improving research and Practice Through theory Development," *Academy of Management Review*, 19, 3, 392-418.

Dillman, D. A. (1978), Mail and Telephone Surveys: The

Total Design Method, John Wiley & Sons, Inc.

Doll, W. J., Hendrickson, A. and X. Deng (1998), "Using Davis's Perceived usefulness and Ease-of-use Instruments for Decision Making: A Confirmatory and Multigroup Invariance Analysis," *Decision Sciences*, 29, 4, 839-869.

Doll, W. J., Xia, W. and G. Torkzadeh (1994), "A Confirmatory Factor Analysis of the End-User Computing Satisfaction Instrument," MIS Quarterly, December, 453-461.

Douglas A., Kirk, D., Brennan, C. and A. Ingram (1999), "Maximizing the Benefits of ISO 9000 Implementation," *Total Quality Management*, 10, 4/5, 507-513.

Dow, D., Samson, D. and S. Ford (1999), "Exploding the Myth: Do All Quality Management Practices Contribute to Superior Quality Performance?," *Production and Operations Management*, 8, 1, 1-27.

Duffy, J. (2000), "ISO 9000: Alive and Well," *Industrial Distribution*, 89, 3, 108.

Durand, I. G., Marquardt, D. W., Peach, R. W. and J. C. Pyle (1993), "Updating the ISO 9000 Quality Standards: Responding to Marketplace Needs," *Quality Progress*, July, 23-28.

Easton, G. S. and S. L. Jarrell (1998), "The Effects of Total Quality management on Corporate Performance: An Empirical Investigation," *Journal of Business*, 71, 2, 253-307.

Ebrahimpour, M. (1985), "An Examination of Quality Management in Japan: Implications for Management in the United States," *Journal of Operations Management*, 5, 419-431.

Ebrahimpour, M. and J. L. Johnson (1992), "Quality, Vendor Evaluation and Organizational Performance: A Comparison of U. S. and Japanese Firms," *Journal of Business Research*, 25, 129-142.

Ebrahimpour, M., Withers, B. and N. Hikmet (1997), "Experiences of U.S. and Foreign Owned Firms: A New Perspective on ISO 9000 Implementation," International Journal of Production Research, 35, 2, 569-576.

Economist, (1992), April 18, p.67.

Fan, X. and L. Wang (1998), "Effects of Potential Confounding Factors on Fit Indices and Parameter Estimates for True and Misspecified SEM Models," *Educational and Psychological Measurement*, 58, 5, 701-735.

Fine, C. H. and A. C. Hax (1985), "Manufacturing Strategy: A Methodology and Illustration," *Interfaces*, 15, 6, 28-46.

Fisher, T. J. (1992), "The Impact of Quality Management on Productivity," *International Journal of Quality and Reliability Management*, 9, 44-52.

Flynn, B. B., Sakakibara, S, and R. G. Schroeder (1995), "Relationship Between JIT and TQM: Practices and Performance," *Academy of management journal*, 38, 5, 1325-1360.

Flynn, B. B., Sakakibara, S, Schroeder, R. G., Bates, K. A. and E. J. Flynn (1990), "Empirical Research Methods in Operations Management," *Journal of Operations Management*, 9, 2, 250-284.

Flynn, B. B., Schroeder, R. G. and E. J. Flynn (1999), "World Class Manufacturing: An Investigation of Hayes and Wheelwright's foundation," *Journal of Operations Management*, 17, 249-269.

Flynn, B. B., Schroeder, R. G. and S. Sakakibara (1994), "A Framework for Management Quality Research and an Associated Measurement Instrument," *Journal of Operations Management*, 11, 339-366.

Flynn, B. B., Schroeder, R. G. and S. Sakakibara (1995), "The Impact of Quality Management Practices on Performance and Competitive Advantage," *Decision Sciences*, 26, 5, 659-691.

Fonell, C. (1992), "A National Customer Satisfaction Barometer: The Swedish Experience," *Journal of Marketing*, 55, January, 1-21.

Forza, C. and R. Filippini (1998), "TQM impact on Quality Conformance and Customer Satisfaction: A Causal Model," *International Journal of Production economics*, 55, 1-20.

Frehr, H. U. (1997), "From ISO 9000 to Total Quality Management, a Rough Road," *Human Systems Management*, 16, 185-193.

Garvin, D. A. (1987), "Competing on the Eight Dimensions of Quality," *Harvard Business Review*, 65, 6, 101-109.

Grandzol, J. R. and M. Gershon (1997), "Which TQM Practices Really Matter: An Empirical Investigation," *Quality Management Journal*, 4, 4, 43-59.

Gupta, Y. P. and T. M. Somers (1996), "Business Strategy, Manufacturing Flexibility, and Organizational Performance Relationships: A Path Analysis Approach," *Production and Operations Management*, 5, 3, 204-233.

Hackman, J. R. and R. Wageman (1995), "Total Quality Management: Empirical, Conceptual, and Practical Issues," *Administrative Science Quarterly*, 40, 309-342.

Hair, Jr., J., Anderson, R., Tatham, R. and W. Black (1998), Multivariate Data Analysis with Readings, Fourth Edition, Prentice Hall, Englewood Cliffs, New Jersey.

Handfield, R. B. and S.A. Melnyk (1998), "The Scientific Theory-Building Process: A Primer Using the Case of TQM," *Journal of Operations Management*, 16, 321-339.

Hayes, R. H. and G. P. Pisano (1994), "Beyond World Class: The New Manufacturing Strategy," *Harvard*

Business Review, January-February, 77-85.

Hayes, R. H. and S. C. Wheelwright (1984), Restoring Our Competitive Edge: Competing Through Manufacturing, Wiley, New York.

Hendricks, K. B. and V. R. Singhal (1997), "Does Implementing an Effective TQM Program Actually Improve Operating Performance? Empirical Evidence from Firms That Have Won Quality Awards. *Management Science*, 43, 9, 1258-1273.

Hendricks, K. B. and V. R. Singhal (1996), "Quality Awards and the Market Value of the Firm; An Empirical Investigation, *Management Science*, 42, 3, 415-436.

Hoelter, J. W. (1983), "The Analysis of Covariance Structures: Goodness-of-Fit Indices," *Sociological Methods and Research*, 11, 325-344.

Jasinowski, J. (1995), "How We Made America Work," *Manufacturing Engineering*, 114, 6, 112.

Joseph, I. N., Rajendran, C., Kamalanabhan, T. J. and R. N. Anantharaman (1999), "Organizational Factors and Total Quality Management-An Empirical Study," *International Journal of Production Research*, 37, 6, 1337-1353.

Kathuria, R. and F. Y. Partovi (1999), "Workforce Management Practices for Manufacturing Flexibility," *Journal of Operations Management*, 18, 21-39.

Kaye, P. J. (2000), "ISO 9000: Should Your Company Seek Certification?," *Pennsylvania CPA Journal*, 70, 4, 7-20.

Kettinger, W. J., Lee, C. C. and S. Lee (1995), "Global Measures of Information Service Quality: A Cross-National Study," *Decision sciences*, 26,5, 569-588.

Kim, K. Y. and D. R. Chang (1995), "Global Quality Management: A Research Focus," *Decision Sciences*, 26, 5, 561-568.

Leong, G. K., Snyder, D. L. and P. T. Ward (1990), "Research in the Process and Content of Manufacturing Strategy," *OMEGA*, 18, 2, 109-122.

Madu, C. N., Kuei, C. and R. A. Jacob (1996), "An Empirical Assessment of the Influence of Quality Dimensions on Organizational Performance," *International Journal of Production Research*, 34, 7, 1943-1962.

Madu, C. N., Kuei, C. and C. Lin (1995), "A Comparative Analysis of Quality Practice in Manufacturing Firms in the U.S. and Taiwan," *Decision Sciences*, 26, 5, 621-635.

Malhotra, M. K. and V. Grover (1998), "An Assessment of Survey Research in POM: From Constructs to Theory," *Journal of Operations Management*, 16, 407-425.

Mann, R. and D. Kehoe (1994), "An Evaluation of the Effects of Quality Improvement Activities on Business Performance," *International Journal of Quality and Reliability Management*, 11, 4, 29-44.

Marsh, H. W., Balla, J. R. and R. P. McDonald (1988), "Goodness-of-Fit Indexes in 3, Confirmatory factor analysis: The Effects of Sample Size," *Psychological Bulletin*, 103, 391-410.

Maruchek, A., Pannesi, R. and C. Anderson (1990), "An Exploratory Study of the Manufacturing Strategy Process in Practice," *Journal of Operations Management*, 9, 1, 101-123.

McAdam, R. and M. McKeown (1999), "Life After ISO 9000: An Analysis of the Impact of ISO 9000 and Total Quality Management on Small Businesses in Northern Ireland," *Total Quality Management*, 10, 2, 229-241.

McHaney, R. and T. P. Cronan (1998), "Computer Simulation Success: On the Use of the End-User Computing Satisfaction Instrument: A Comment," *Decision Sciences*, 29, 2, 525-536.

Merrill, P. (1995), "ISO 9000 on the Road to Total

Quality," *CMA Magazine*, May, 21-24.

Mirani, R. and A. L. Lederer (1998), "An Instrument for Assessing the Organizational Benefits of IS Projects," *Decision sciences*, 29, 4, 803-838.

Mueller, R. O. (1996), Basic Principles of Structural Equation Modeling: An Introduction to LISREL and EQS, New York: Springer-Verlag.

Monczka, R. M., Petersen, K. J., Handfield, R. B. and G. L. Ragatz (1998), "Success Factors in Strategic Supplier Alliances: The Buying Company Perspective," *Decision Sciences*, 29, 3, 553-578.

Narasimhan, R. and J. Jayaram (1998), "Causal linkages in Supply Chain Management: An Exploratory Study of North American Manufacturing Firms," *Decision Sciences*, 29, 3, 579-605.

Netemeyer, R. G., Boles, J. S., McKee, D. O. and R. McMurrian (1997), "An Investigation Into the Antecedents of Organizational Citizenship Behaviors in a Personal Selling Context," *Journal of Marketing*, July, 85-98.

Nunnally, J. (1967), Psychometric Theory, McGraw-Hill, New York.

O'Leary-Kelly, S. W. and R. J. Vokurka (1998), "The Empirical Assessment of Construct Validity," *Journal of Operations Management*, 16, 387-405.

Pagell, R. A. and Halperin, M. (1998), International Business Information: How to Find IT, How to Use It, Second Edition, The Oryx Press.

Pannirselvam, G. P., Siferd, S. P. and W. A. Ruch (1998), "Validation of the Arizona Governor's Quality award Criteria: A Test of the Baldrige Criteria," *Journal of Operations Management*, 16, 529-550.

Parr, G. L. (1999), "ISO 9000 Drives TQM," *Quality*, 38, 7, 6

Porter, L. J. and S. J. Tanner (1996), Assessing Business Excellence, Butterworth-Heinemann.

Powell, T. C. (1995), "Total Quality Management as Competitive Advantage: A Review and Empirical Study," Strategic Management Journal, 16, 15-37.

Ramasesh, R. V. and M. D. Jayakumar (1991), "Measurement of Manufacturing Flexibility: A Value Based Approach," *Journal of Operations Management*, 10, 4, 446-468.

Reeves, C. A. and D. A. Bednar (1994), " Defining Quality: Alternatives and implications," *Academy of Management Review*, 19, 3, 419-445.

Reid, R. D. (2000), "Why QS 9000 Was Developed And What's in It's Future," *Quality Progress*, 33, 4, 115-117.

Reimann, C. W. and H. S. Hertz (1994), "Understanding the Important Differences Between the Malcolm Baldridge National Quality Award and ISO 9000 Registration," *Production and Operations Management*, 3, 3, 171-185.

Rosenthal, R. and R. L. Rosnow (1991), Essentials of Behavioral Research: Methods and Data Analysis, Second Edition, McGraw-Hill, Inc.

Rust, R. T. and A. J. Zahorik (1993), "Customer Satisfaction, Customer Retention, and Market Share," *Journal of Retailing*, 69, 193-215.

Sakakibara, S., Flynn, B. B. and R. G. Schroeder (1993), "A Framework and Measurement Instrument for Just-In-Time Manufacturing," *Production and Operations Management*, 2, 3, 177-194.

Salant, P. and D. A. Dillman (1994), How to Conduct Your Own Survey, John Wiley & Sons, Inc.

Samson, D. and M. Terziovski (1999), "The Relationship Between Total Quality Management Practices and Operational Performance," *Journal of Operations Management*, 17, 4, 393-409.

Saraph, J. V., Benson, P. G. and R. G. Schroeder (1989), "An Instrument for Measuring the Critical Factors of Quality Management," *Decision Sciences*, 20, 4, 810-829.

Schonberger, R. J. and E. M. Knod, Jr. (1997), Operations Management: Continuous Improvement, Sixth Edition, Irwin Inc.

Schwab, D. P. (1980), "Construct Validity in Organizational Behavior," *Research Organizational Behavior*, 2, 1, 3- 43.

Segars, A. H., Grover, V. and J. T. C. Teng (1998), "Strategic Information Systems Planning: Planning System Dimensions, Internal Coalignment, and Implications for Planning Effectiveness," *Decision Sciences*, 29, 2, 303-345.

Sissel, K. (1996), "Survey rates ISO 9000 success," *Chemical Week*, 158, 33.

Shiba, S., Graham, A. and D. Walden (1993), A New American TQM, Productivity Press, Portland, Oregon.

Skinner, W. (1985), Manufacturing: The Formidable Competitive Weapon, New York: John Wiley and Sons.

Smith, T. M. and J. S. Reece (1999), "The Relationship of Strategy, Fit, Productivity, and Business Performance in a Services Setting," *Journal of Operations Management*, 17, 145-161.

Steeples, M. M. (1994), " The Baldridge Award and ISO 9000 in the Quality Management Processes," *IEEE Communications Magazine*, October, 52-56.

Stratton, B. (1994), "Goodbye, ISO 9000: Welcome back Baldrige Award," *Quality Progress*, 27, 8, 5.

Swamidass, P. M. (1986), "Manufacturing Strategy: Its Assessment and Practice," *Journal of Operations Management*, 6, 4, 471-484.

Tabachnick, B. G. and L. S. Fidell (1996), Using

Multivariate Statistics, Third Edition, Harper Collins.

Tanaka, J. (1987), "'How Big is Enough?' Sample Size and Goodness-of-Fit in Structural Equation Models with Latent Variables," *Child Development*, 58, 134-146.

Terziovski, M., Samson, D. and D. Dow (1997), "The Business value of Quality Management Systems Certification Evidence from Australia and New Zealand," *Journal of Operations Management*, 15, 1-18.

Tsiotras, G. and K. Gotsamani (1996), "ISO 9000 as an entry key to TQM: The Case of Greek Industry," *International Journal of Quality and Reliability Management*, 13, 4, 64-76.

Vloeberghs, D. and J. Bellens (1996), "Implementing the ISO 9000 Standards in Belgium," *Quality progress*, 29,6, 43-48.

Ward, P. T. and R. Duray (2000), "Manufacturing Strategy in Context: Environment, Competitive Strategy and Manufacturing Strategy," *Journal of Operations Management*, 18, 123-138.

Ward, P. T., McCreery, J. K., Ritzman, L. P. and D. Sharma (1998), "Competitive Priorities in Operations Management," *Decision Sciences*, 29, 4, 1035-1046.

West, J., Cianfrani, C. A. and J. J. Tsiakais (1999), "ISO 9000:2000: A Shift in Focus," *Quality Progress*, November, 100-102.

Wheelwright, S. C. and R. H. Hayes (1985), "Competing through Manufacturing," *Harvard Business Review*, 63, 99-109.

Wheelwright, S. C. (1984), "Manufacturing Strategy: Defining the Missing Link," *Strategic Management Journal*, 5, 1, 77-91.

Withers, B. E., Ebrahimpour, M. and N. Hikmet (1997), "An Exploration of the Impact of TQM and JIT on ISO

9000 Registered Companies," *International Journal of Production Economics*, 53, 209-216.

Wood, C. H., Ritzman, L. P. and D. Sharma (1990),"Intended and Achieved Competitive Priorities: Measures, Frequencies and Financial Impact," In J. E. Ettlie, M.C. Burstein & A. Fiegenbaum (Eds.), Manufacturing Strategy, Norwell, MA: Kluwer Academic Publishers.

Woodruff, R. B. and S. F. Gardial (1996), Know Your Customer: New Approaches to Understanding Customer Value and Satisfaction, Blackwell Publishers, Inc.

Yusof, S. M. (1995), "A Quality System Assessment of an Electrical Contracting Company Based on BS 5750," *International Journal of Quality and Reliability Management*, 12, 8, 64-73.

Zairi, M., Letza, S. R. and J. S. Oakland (1994), "Does TQM Impact on Bottom-Line Results?," *TQM Magazine*, 6, 38-43.

Zhang, Z. (2000), "Developing a Model of Quality Management Methods and Evaluating Their Effects on Business Performance," *Total Quality Management*, 11, 1, 129-137.

Zhu, Z. and L. Scheuermann (1999), "A Comparison of Quality Programmes: Total Quality Management and ISO 9000," *Total Quality Management*, 10, 2, 291-297.

Zikmund, W. G. (1997), Exploring Marketing Research, Sixth Edition, The Dryden Press.

Zuckerman, A. (2000), "Gaining Added Value from the Year 2000 ISO 9000 Revisions," *World Trade*, 13,2, 60-62.

ISO 9000 Registered Company Directory, 1994, CEEM Information Services, Fairfax, VA.

The ISO Survey of ISO 9000 and ISO 14000 Certificates, 1997, International Organization for Standardization.

The Mobil Survey of ISO 9000 Certificates Awarded
Worldwide, 1994, Mobil Europe
Limited 1994, London, October 18.

1997 Annual Report of the International Organization for
Standards, May 1998, Geneva.