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Journal of Operations Management 21 (2003) 405–435

JOURNAL OF OPERATIONS MANAGEMENT

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The relationship between total quality management practices and their effects on firm performance

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Received 6 June 2000; accepted 10 November 2002

Abstract

Recent research on total quality management (TQM) has examined the relationships between the practices of quality management and various levels of organizational performance. These studies have produced mixed results, probably because of the nature of the research designs used such as measuring TQM or performance as a single construct. Based on a comprehensive literature review, this study identifies the relationships among TQM practices and examines the direct and indirect effects of these practices on various performance levels. A proposed research model and hypotheses are tested by using cross-sectional mail survey data collected from firms operating in the US. The test of the structural model supports the proposed hypotheses. The implications of the findings for researchers and practitioners are discussed and further research directions are offered.

Keywords: Quality management; Performance; Structural equation modeling

1. Introduction

> The barnyard rooster Chanticleer had a theory. He crowed every morning, putting forth all his energy, flapped his wings. The sun came up. The connexion was clear: His crowing caused the sun to come up. There was no question about his importance. There came a snag. He forgot one morning to crow. The sun came up anyhow. Crestfallen, he saw his theory in need of revision.
>
> (Deming, 1993, p. 105)

In the late 1970s and early 1980s, previously unchallenged American industries lost substantial market share in both US and world markets. To regain the competitive edge, companies began to adopt productivity improvement programs which had proven themselves particularly successful in Japan. One of these "improvement programs" was the total quality management (TQM) system. In last two decades, both the popular press and academic journals have published a plethora of accounts describing both successful and unsuccessful efforts at implementing TQM. Like Chanticleer's theory, theories of quality management have been under revision ever since.

The early stages of empirical research in TQM have been almost exclusively limited to attempts at constructing instruments capable of measuring TQM practices as, for example, Saraph et al. (1989) have done, and with studies such as Garvin's (1983) that compare TQM practices in Japanese and US firms. More recently, scholars like Mohrman et al. (1995) have channeled their research efforts into analyzing

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doi:10.1016/S0272-6963(03)00004-4

the relationship between practices of quality management and organizational performance on various levels. Recent studies such as the one conducted by Das et al. (2000) have started investigating both the relationships among techniques of quality management systems and the effects they have on performance.

These studies have produced mixed results. This failure to obtain consistent results could be due to three significant differences among studies in terms of research design issues. First, in some studies such as the one conducted by Douglas and Judge (2001), TQM is operationalized as a single construct to analyze the relationship between TQM and firms' performance, while others, Samson and Terziovski (1999) for instance, operationalize TQM as a multidimensional construct. Second, the levels of performance measured vary among the studies. Some studies operationalize performance only at operating levels as Samson and Terziovski (1999) do, while others like Douglas and Judge (2001) measure only financial performance; and still others as do Das et al. (2000), measure performance at multiple levels. Third, the analytical framework used to investigate the relation between TQM and performance also differs among the studies. In other words, when the data analyses are based on a series of multiple regressions (Adam et al., 1997; Mohrman et al., 1995; Samson and Terziovski, 1999) or correlations (Powell, 1995), the studies fall short of investigating which TQM practices have direct and/or indirect effects on various levels of performance. In short, comprehensive studies trying to identify the direct and indirect effects of TQM practices on performance at multiple levels are rather limited and fail to respond conclusively to the following research questions:

- What are the relationships among TQM practices?
- Which TQM practices are directly related to operating, market and financial performance?
- Which TQM practices are indirectly related to operating, market and financial performance?

This study investigates these research questions by using the data from Kaynak's (1997) study. This research contributes to the development of TQM theory by investigating the relationships between seven quality management practices and their effects on operating, financial, and market performance. While this study does replicate some earlier research, it is unique in that the dimensions of the quality management practices investigated are extensive and firms' performance is measured at multiple levels. Replication research facilitates the goal of science, which is empirical generalization or knowledge development (Hubbard et al., 1998), and it is recommended in cases such as this "where different studies produced inconsistent results" (Amundson, 1998, p. 355). This research is relevant to practitioners because the findings may reveal patterns in the implementation of TQM practices, which may provide significant information managers can use to solve implementation challenges and perhaps to improve performance. Moreover, the results of this study may provide support for continued implementation of TQM. The unsuccessful attempts have prompted criticisms of TQM in the popular press and caused some managers who might otherwise have had an interest in implementing TQM to question the wisdom of utilizing this management approach. But this, to quote an old but still relevant cliché, is throwing out the baby with the bath water. The remainder of this paper is organized as follows. A research model and related hypotheses are offered based on the review of the literature in the next section. Section 3 describes the research methodology, including the construction of the instrument and measures, the survey procedure, the sample, and the tests for reliability and validity. Section 4 presents the results of testing the structural model. The implications of the results for researchers and practitioners are discussed and validity of findings is reevaluated in Section 5. The paper concludes with further research implications of this study.

2. Theoretical background

TQM can be defined as a holistic management philosophy that strives for continuous improvement in all functions of an organization, and it can be achieved only if the total quality concept is utilized from the acquisition of resources to customer service after the sale. TQM practices have been documented extensively in measurement studies as well as in the studies that have investigated the relation of TQM practices to various dependent variables. The TQM practices identified in measurement studies by Saraph et al. (1989) and those who have followed their example are summarized in Table 1.

Table 1
TQM Practices identified in measurement studies on TQM

Saraph et al. (1989)	Description by Saraph et al. (1989, p. 818)	Flynn et al. (1994)	Ahire et al. (1996)	Black and Porter (1996)	Malcolm Baldrige Award (Criteria for Performance Excellence, 2002)
Management leadership	Acceptance of quality responsibility by top management. Evaluation of top management on quality. Participation by top management in quality improvement efforts. Specificity of quality goals. Importance attached to quality in relation to cost and schedule. Comprehensive quality planning.	Top management support Quality leadership Quality improvement rewards	Top management commitment	Corporate quality culture Strategic quality management	Leadership Strategic planning
Role of the Quality Department	Visibility and autonomy of the quality department. The quality department's access to top management. Use of quality staff for consultation. Coordination between quality department and other departments. Effectiveness of the quality department.				
Training	Provision of statistical training, trade training, and quality-related training for all employees.		Employee training		Human resource focus
Employee relations	Implementation of employee involvement and quality circles. Open employee participation in quality decisions. Responsibility of employees for quality. Employee recognition for superior quality performance. Effectiveness of supervision in handling quality issues. Ongoing quality awareness of all employees.	Workforce management Selection for teamwork potential Teamwork	Employee empowerment Employee involvement	People and customer management Teamwork structures	Human resource focus
Quality data and reporting	Use of quality cost data. Feedback of quality data to employees and managers for problem solving. Timely quality measurement. Evaluation of managers and employees based on quality performance. Availability of quality data.	Quality information Process control Feedback	Internal quality information usage	Quality improvement measurement systems	Information and analysis
Supplier quality management	Fewer dependable suppliers. Reliance on supplier process control. Strong interdependence of supplier and customer. Purchasing policy emphasizing quality rather than price. Supplier quality control. Supplier assistance in product development.	Supplier involvement	Supplier quality management Supplier performance	Supplier partnerships	

Table 1 (*Continued*)

Saraph et al. (1989)	Description by Saraph et al. (1989, p. 818)	Flynn et al. (1994)	Ahire et al. (1996)	Black and Porter (1996)	Malcolm Baldrige Award (Criteria for Performance Excellence, 2002)
Product/service design	Thorough scrub-down process. Involvement of all affected departments in design reviews. Emphasis on producibility. Clarity of specifications. Emphasis on quality, not roll-out schedule. Avoidance of frequent redesigns.	Product design New product quality Interfunctional design process	Design quality management	External interface management	Process management
Process management	Clarity of process ownership, boundaries, and steps. Less reliance on inspection. Use of statistical process control. Selective automation. Fool-proof process design. Preventive maintenance. Employee self-inspection. Automated testing.	Process management	Statistical process control usage	Operational quality planning	Process management
		Customer involvement	Customer focus Benchmarking	Customer satisfaction orientation Communication of improvement information	Customer and market focus

A close examination of Table 1 shows that each instrument has some limitations and some strengths. As a part of her research, Kaynak (1997) used Saraph et al.'s (1989) survey instrument for most of the items to assess the implementation of TQM in 382 manufacturing and service firms operating in the United States because the nature of her study was closer to that of Saraph et al. (1989) than it was to the other TQM measurement studies available. The results of reliability tests and factor analysis showed the same pattern Saraph et al. (1989) found in their study. (The instrument will be discussed further in Section 3.) Because the data from Kaynak's (1997) study are used in this study, the seven TQM techniques investigated here are the same as in Saraph et al.'s (1989) study: management leadership, training, employee relations, quality data and reporting, supplier quality management, product/service design, and process management. These techniques are described in Table 1. The scale of Role of the Quality Department is not included in this study because 105 organizations of the 382 did not have a quality department. The summary of studies on the relationship between TQM techniques and firms' performance is presented in Table 2. A review of TQM techniques investigated in these studies shows that the seven techniques of TQM used in this study represent a wide domain of TQM.

Based on the strategic management, marketing, and operations management literature, Kaynak (1997) identified and validated three dimensions of firms' performance relevant to TQM. *Financial and market performance* indicators include return on investment (ROI), sales growth, profit growth, market share, and market share growth. The indicators for *quality performance* are product/service quality, productivity, cost of scrap and rework, delivery lead-time of purchased materials, and delivery lead-time of finished products/services to customers. Two indicators of *inventory management performance* are purchased material turnover and total inventory turnover. The same three dimensions of firms' performance Kaynak (1997) used in her previous study are used in this study, and these are consistent with the measurement of performance in the other studies on the relationship between quality management and firm performance, as presented in Table 2.

2.1. The research model and proposed hypotheses

Because of the inconsistent results, the main findings of the studies summarized in Table 2 do not really provide a plausible research model for identifying the direct and indirect effects of TQM practices on the dimensions of performance, though, as Mohrman et al. (1995) remind us, "Most of the TQM practices are related to one form of performance improvement or the other" (p. 39). However, the findings of the studies in which TQM has been operationalized as a multidimensional construct and in which indirect and direct effects of TQM practices on performance are investigated (e.g. Das et al., 2000; Flynn et al., 1995; Ho et al., 2001) indicate that the infrastructural TQM practices such as top management leadership, training, and employee relations affect performance through core TQM practices such as quality data and reporting, supplier quality management, product/service design, and process management.

Given the limited amount of literature on the research questions investigated in this study, the hypotheses pertaining to the relationships suggested in the research model (see Fig. 1) are drawn from studies in the literature on organizational change and operations management in addition to quality management literature. Each path in Fig. 1 is labeled with the associated hypothesis, and all are discussed in the following sections.

2.1.1. Management leadership

As documented by quality gurus (e.g. Deming, 1986; Juran, 1986), and the studies summarized in Tables 1 and 2, management leadership is an important factor in TQM implementation because it improves performance by influencing other TQM practices (Ahire and O'Shaughnessy, 1998; Anderson et al., 1995; Flynn et al., 1995; Wilson and Collier, 2000). Successful implementation of TQM requires effective change in an organization's culture, and it is almost impossible to change an organization without a concentrated effort by management aimed at continuous improvement, open communication, and cooperation throughout the value chain (Abraham et al., 1999; Adebanjo and Kehoe, 1999; Bell and Burnham, 1989; Choi, 1995; Daft, 1998; Ettkin et al., 1990; Goodstein and Burke, 1991; Hamlin et al., 1997; Handfield and Ghosh, 1994; Ho et al., 1999; Zeitz et al., 1997).

Table 2
Summary of studies on the relationship between total quality management (TQM) and firms' performance

Study	Operationalization of TQM	Sources of performance data and measurement level	Operational definition of performance	Data gathering technique and analysis	Main findings
Anderson et al. (1995)	Multidimensional construct[a] Visionary leadership Internal and external cooperation Learning Process management Continuous improvement Employee fulfillment Customer satisfaction	Secondary perceived performance (subjective) Operating performance	Customer satisfaction	Questionnaires from management and workers in each plant Path analysis	Employee fulfillment has a significant direct effect on customer satisfaction. No significant relationship exists between continuous improvement and customer satisfaction.
Flynn et al. (1995)	Multidimensional construct Core QM practices Process flow management Product design process Statistical control/feedback QM infrastructure practices Customer relationship Supplier relationship Work attitudes Workforce management Top management support	Perceived relative performance (subjective) and primary objective data Operating performance	Quality market outcomes, percent-passed final inspection with no rework, competitive advantage (unit cost, fast delivery, volume flexibility, inventory turnover, cycle time)	Same data base as in Anderson et al. (1995) Path analysis	Statistical control/feedback and the product design process have positive effects on perceived quality market outcomes while the process flow management and statistical control/feedback are significantly related to internal measure of the percent that passed final inspection without requiring rework. Both perceived quality market outcomes and percent-passed final inspection with no rework have significant effects on competitive advantage.
Mohrman et al. (1995)	Multidimensional construct Core practices Quality improvement teams Quality councils Cross-functional planning Process reengineering Work simplification Customer satisfaction monitoring Direct employee exposure to customers Production-oriented practices Self-inspection Statistical control methods used by front-line employees Just-in-time deliveries Work cells or manufacturing cells Other practices Cost-of-quality monitoring Collaboration with suppliers in quality efforts	Secondary data sources, perceived performance (subjective) Financial performance Market performance Operating performance	ROE, ROI, ROS, ROA, perceived profitability and competitiveness Market share Cost of manufacturing, inventory turnover, perceived productivity, customer satisfaction, quality and speed	Questionnaire Multiple regression analyses, hierarchical regression analyses	There is a significant and positive relation between the extent of TQM adoption and efficiency of employee and capital utilization. The relationship of TQM to manufacturing costs and inventory turnover is not significant. Although core TQM practices and market share are significantly related for manufacturing firms, no significant relationships are found between TQM adoption and financial performance.

Powell (1995)	Multidimensional construct Executive commitment Adopting the philosophy Closer to customers Closer to suppliers Benchmarking Training Open organization Employee empowerment Zero-defects mentality Flexible manufacturing Process improvement Measurement	Perceived performance (subjective) Financial performance (total performance) TQM program performance (measured as a mix of operating and financial performance)	 Sales growth, profitability, revenue growth Productivity, competitive position, profitability, revenues, overall performance	Questionnaire Partial correlations	Executive commitment, open organization, and employee empowerment produce significant partial correlations for both total performance and TQM program performance. A zero-defects mentality and closeness to suppliers correlate significantly with TQM performance, but with total performance only marginally.
Hendricks and Singhal (1996, 1997)	Single construct (winning of a quality award is a proxy for the effective implementation of TQM programs)	Secondary data source Financial performance	 Market returns, percentage changes in operating income, in sales, in the ratio of sales to assets, in the ratio of sales to number of employees, in the ratio of total cost to sales, in the ratio of capital expenditure to assets, in number of employees, in assets	Studies events in various publications Wilcoxon signed-rank test, Mann–Whitney test	Implementing an effective TQM program improves performance of firms.
Adam et al. (1997)	Multidimensional construct Employee involvement Senior executive involvement Employee satisfaction Compensation Customers Design and conformance Knowledge Employee selection and development Inventory reduction	Perceived performance (subjective) Financial performance Operating performance	 Net profit as percent of sales, ROA, sales growth Percent defectives, cost of quality, and customer satisfaction	Questionnaire Stepwise regression	Employee knowledge about quality improvement, what quality customers receive and perceive, employee compensation and recognition and management involvement are significantly and inversely correlated with total cost of quality and average per cent of items defective. Financial performance is positively correlated with senior management involvement and employee compensation and recognition.
Chenhall (1997)	Single construct	Perceived performance (subjective) Financial performance	 Growth in sales, in ROS, in ROA, overall growth in profitability	Questionnaire Regression, ANOVA	The relation between TQM and performance is stronger when manufacturing performance measures are used as a part of managerial evaluation.

Table 2 (*Continued*)

Study	Operationalization of TQM	Sources of performance data and measurement level	Operational definition of performance	Data gathering technique and analysis	Main findings
Grandzol and Gershon (1997)	Multidimensional construct Leadership Continuous improvement Internal/external cooperation Customer focus Learning Employee fulfillment Process management	Perceived performance (subjective) Financial performance Operating performance	 ROI, market share, capital investment ratio Product/service quality, productivity, scrap/waste, energy/efficiency, material usage	Questionnaire Structural equation modeling	Financial performance is a function of operating performance while operating performance is a function of continuous improvement. Customer focus has a significant effect on product/service quality. Employee fulfillment, cooperation and customer focus positively impact customer satisfaction.
Choi and Eboch (1998)	Single construct (in this study, various dimensions of TQM were examined; however, a single TQM construct is used to analyze the relationship between TQM and performance)	Perceived performance (subjective) Operating performance	 Quality (plant performance), customer satisfaction	Questionnaire Structural equation modeling	TQM practices have a stronger effect on customer satisfaction than they do on plant performance. The plant performance has no significant effect on customer satisfaction.
Ahire and O'Shaughnessy (1998)	Multidimensional construct Ten dimensions of TQM listed in Table 1 with the exclusion of supplier performance (Ahire et al., 1996)	Perceived performance (subjective) Operating performance	 Product quality	Questionnaire Stepwise regression, *t*-tests	Firms with high top management commitment produce higher quality products than those with low top management commitment. Customer focus, supplier quality management and empowerment emerge as significant predictors of product quality.
Easton and Jarrell (1998)	Single construct (in this study, various dimensions of TQM were examined; however, a single TQM construct is used to analyze the relationship between TQM and performance)	Secondary data source Financial performance	 Net income to sales and to assets, operating income to sales and to assets, sales to assets, net income and operating income per employee, sales per employee, total inventory to sales and to cost of goods sold, cumulative daily stock returns	Interviews Sign tests, Wilcoxon rank-sum test, Wilcoxon signed-rank test	For the firms adopting TQM, financial performance has increased.
Forza and Flippini (1998)	Multidimensional construct Orientation towards quality TQM link with suppliers Human resources TQM link with customers Process control	Perceived performance (subjective) and primary objective data Operating performance	 Quality conformance, customer satisfaction	Questionnaire Structural equation modeling	Process control has a significant effect on quality conformance, and TQM links with customers has a significant effect on customer satisfaction.

Rungtusanatham et al. (1998)	Multidimensional construct[b] The same dimensions as in Anderson et al. (1995) are used	Perceived performance (subjective) Operating performance	Customer satisfaction	Same data base as in Forza and Flippini (1998) Path analysis	Continuous improvement has a positive effect on customer satisfaction. Employee fulfillment seems to have no effect on customer satisfaction.
Dow et al. (1999), Samson and Terziovski (1999)	Multidimensional construct Leadership Workforce commitment Shared vision Customer focus Use of teams Personnel training Cooperative supplier relations Use of benchmarking Use of advanced manufacturing systems Use of just-in-time principles	Perceived performance (subjective) and self-reported objective data Operating performance	Product quality, customer satisfaction, employee morale, productivity, delivery performance	Questionnaire Structural equation modeling; multiple regression analysis	Employee commitment, shared vision, and customer focus in combination has a positive impact on quality outcomes. Leadership, human resources management and customer focus (soft factors) are significantly and positively related to operating performance.
Das et al. (2000)	Multidimensional construct High involvement work practices Quality practices	Perceived relative performance (subjective) Financial performance Operating performance	Market share, ROA, market share increase Customer satisfaction	Questionnaire Structural equation modeling	High involvement practices are positively correlated with quality practices; quality practices are positively correlated with customer satisfaction; customer satisfaction is positively correlated with firm performance.
Wilson and Collier (2000)	Multidimensional construct Leadership Information and analysis Strategic planning Human resource management Process management	Perceived performance (subjective) Financial performance Operating performance	Market share, market share growth, ROI, growth in ROI, ROS, growth in ROS Customer focus and satisfaction	Questionnaire Structural equation modeling	Process management, and information and analysis have significant and positive direct effects on financial performance.
Douglas and Judge (2001)	Single construct (in this study, various dimensions of TQM were examined; however, a single TQM construct is used to analyze the relationship between TQM and performance)	Perceived performance (subjective) and secondary data sources Financial performance	Growth in earnings, growth in revenue, changes in market share, return on assets, long-run level of profitability, industry expert ratings	Questionnaire Hierarchical regression analysis	The extent to which TQM practices are implemented is positively and significantly related to both the perceived financial performance and industry expert-rated performance.
Ho et al. (2001)	Multidimensional construct Supportive TQM factor (employee relations and training) Core TQM factor (quality data and reporting, supplier quality management)	Perceived performance (subjective) Operating performance	Product quality	Questionnaire Hierarchical regression analysis	Supportive TQM factor has an indirect effect on product quality through core TQM factor.

[a] Anderson et al. (1995) operationalized the constructs by using the questionnaire items in the World-Class Manufacturing (WCM) database (first round).
[b] Rungtusanatham et al. (1998) operationalized the constructs by selecting the questionnaire items from Round 2 of the WCM database for the plants operating in Italy.

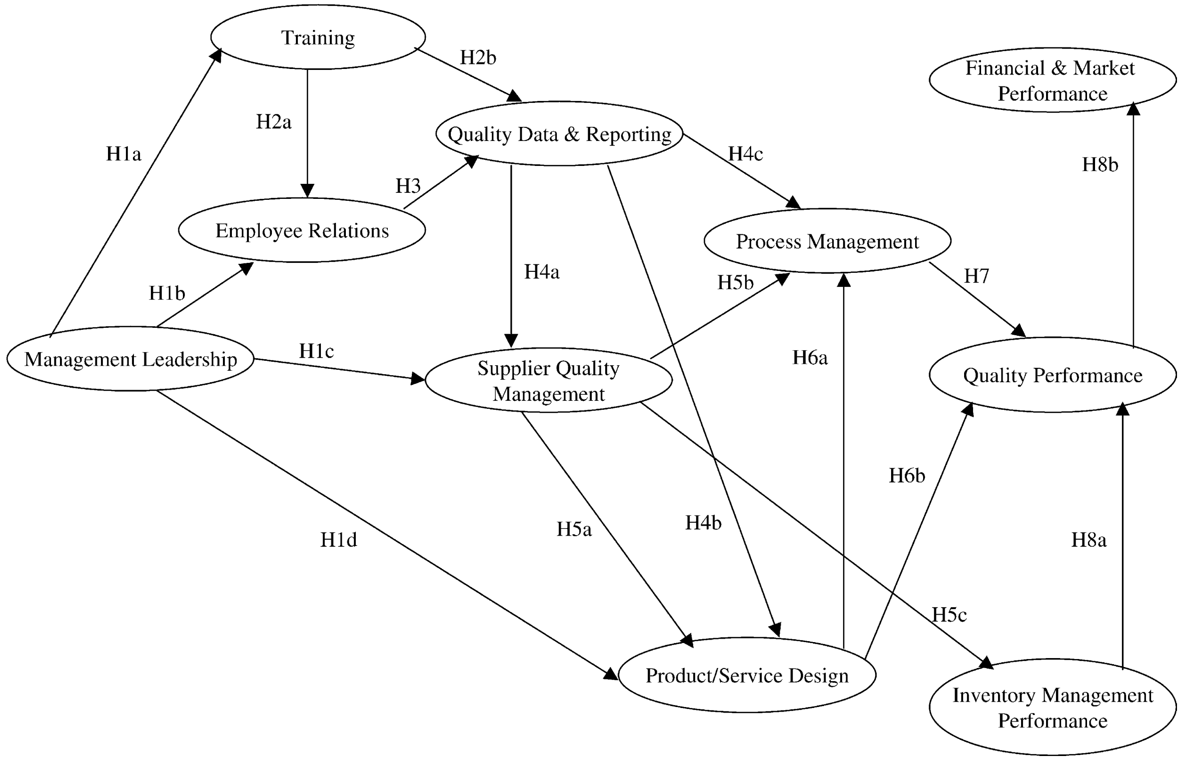

Fig. 1. Theoretical model of the relationship between TQM practices and performance measures.

Management has a complex leadership role when implementing TQM. It is impossible to improve any organization's operations without a well-trained workforce. It is management that provides the resources necessary for training employees in the use of new principles and tools, and creates a work environment conducive to employee involvement in the process of change (Ahire and O'Shaughnessy, 1998; Anderson et al., 1995; Bell and Burnham, 1989; Burack et al., 1994; Daft, 1998; Flynn et al., 1995; Hamlin et al., 1997; Handfield et al., 1998; Ho et al., 1999; Schroeder et al., 1989; Wilson and Collier, 2000). And top management must ensure that the necessary resources for quality-related training are available (Ahire and O'Shaughnessy, 1998; Anderson et al., 1995; Flynn et al., 1995; Handfield et al., 1998; Ho et al., 1999).

But it takes more than training to guarantee efficient and successful change. Employees must be involved in the process of change, a crucial factor according to Adebanjo and Kehoe (1999), and this involvement is effected by creating a work environment that encourages and facilitates open communication. In such an environment, workers are apt to work harder and contribute ideas that both facilitate and enhance the change process (Anderson et al., 1995; Burack et al., 1994; Das et al., 2000; Flynn et al., 1995; Handfield et al., 1998; Spector and Beer, 1994). Involving employees requires communicating a clear strategy for improving quality to them, and this function can be enhanced by instituting quality-based incentive and compensation procedures (Bonito, 1990; Flynn et al., 1995). Thus, the literature discussed above leads to the following hypotheses:

H1a. Management leadership is positively related to training.

H1b. Management leadership is positively related to employee relations.

Effective leadership is also critical to effecting organizational changes—especially in purchasing—that improve interactions with supply chain members (Cooper and Ellram, 1993). To promote mutually beneficial relations with suppliers, management can, and probably should, privilege quality and delivery performance over price when selecting suppliers and certifying suppliers for material quality (Flynn et al., 1995; Trent and Monczka, 1999). Managing supplier relationships strategically is essential to the success of organization–supplier relationships because these partnerships require both a high level of commitment and an exchange of proprietary and competitive information (Ellram, 1991). Consequently, the following hypothesis is proposed:

H1c. Management leadership is positively related to supplier quality management.

Last, but not the least, management must be responsible for focusing product design on market and consumer needs (Deming, 1986; Flynn et al., 1995; Garvin, 1987; Shetty, 1988). This sharp focus is crucial to developing products that are manufacturable and meet the needs of the customers (Flynn et al., 1995; Hackman and Wageman, 1995; Juran, 1981; Leonard and Sasser, 1982). Thus, we are led to the following hypothesis:

H1d. Management leadership is positively related to product design.

2.1.2. Training

In the literature (e.g. Bell and Burnham, 1989; Choi, 1995; Daft, 1998; Ettkin et al., 1990), employee training is clearly identified as a critical component of workforce management when implementing significant changes in an organization. If it is to be effective, i.e. transform employees into creative problem solvers, training in quality-related issues should emphasize problem solving in small groups, effective communication, and statistical process control (Flynn et al., 1994). Workforce training in the techniques necessary for improving processes must be continuous if the improvement effort is to be sustained, for an ongoing training program will help employees discover innovative ways to improve the organization (Choi, 1995) and shoulder more of the responsibility for effecting improvements (Adebanjo and Kehoe, 1999; Ho et al., 1999). The authors of several studies (Bonito, 1990; Daft, 1998; Easton and Jarrell, 1998; Forza and Flippini, 1998; Hackman and Wageman, 1995; Holpp, 1994) argue forcefully that the number of skills employees need to be productive workers is correlated positively with the level of engagement employees have with their jobs. It would seem reasonable, then, to expect that an increase in training will produce a corresponding increase in employee involvement with their jobs and in increased awareness of quality-related issues. Thus, we have the following hypothesis:

H2a. Training is positively related to employee relations.

To manage quality, employees must effectively measure and make use of quality data in a timely manner, and to do this they need to be trained in the use of quality improvement tools (Ahire and Dreyfus, 2000; Ho et al., 1999). Training and employee relations (the latter is discussed in the following section) has a positive effect on quality, which is mediated through quality data and reporting (Ho et al., 2001). Collecting and using quality data are impossible without training, but training alone will not sustain an improvement effort: employees must receive quality data in a timely manner and use it effectively. Thus, the following hypothesis is suggested:

H2b. Training is positively related to quality data and reporting.

2.1.3. Employee relations

The employee relations investigated in this study encompass a variety of organizational development (OD) techniques to facilitate changes such as employee participation in decisions (Bell and Burnham, 1989; Burack et al., 1994; Choi, 1995; Daft, 1998; Ford and Fottler, 1995; Holpp, 1994), employee recognition (Daft, 1998; Ford and Fottler, 1995), teamwork (Bell and Burnham, 1989; Daft, 1998; Ford and Fottler, 1995; Holpp, 1994), and the use of effective communications to create an awareness of organizational goals (Bell and Burnham, 1989; Daft, 1998; Ford and Fottler, 1995). These OD techniques, generally considered the most relevant human resource practices in organizations that make effective use of TQM techniques, are identified by the studies summarized in Tables 1 and 2.

Empirical results also support the assertion that employee relations are directly related to quality data and reporting (Flynn et al., 1995; Ho et al., 1999, 2001). This result is not surprising because effective measurement, availability, and use of quality data require continuous awareness of quality-related issues in employees who have a significant role in quality decisions. Generally speaking, these decisions contribute to improvement only when they are based on accurate quality data (Ho et al., 1999). Thus, we can suggest the following hypothesis:

H3. Employee relations is positively related to quality data and reporting.

2.1.4. Quality data and reporting

Quality data and reporting involve using costs of poor quality such as rework, scrap and warranty costs, and control charts to identify quality problems and provide information on areas of possible improvement (Choi, 1995; Ho et al., 1999; Lockamy, 1998). The positive effect of quality data and reporting on firm performance is through three other TQM techniques: supplier quality management, product/service design, and process management.

Managing supplier quality entails monitoring and assessing the performance of suppliers through the creation of a supplier performance measurement database, a tool crucial to enhancing material quality, reducing development costs, purchase prices, and improving supplier responsiveness (Krause et al., 1998). With this database companies can accurately track such quality measures as parts-per-million defective, reliability, process capability ratios, and percent parts rejected (Forza and Flippini, 1998; Krause et al., 1998; Trent and Monczka, 1999) as well as on-time delivery performance and percent of incoming materials acceptable (Tan et al., 1998). In conjunction with supplier performance databases, availability, costs of quality, and control charts help employees and managers identify and solve problems stemming from supplied materials and parts. Suppliers can be provided the information they need to improve their performance (Adebanjo and Kehoe, 1999). Thus, we can propose the following hypothesis:

H4a. Quality data and reporting is positively related to supplier quality management.

Companies implementing TQM emphasize building quality into the product rather than inspecting quality into the finished product and removing defective products (Ahire and O'Shaughnessy, 1998; Flynn et al., 1995; Handfield et al., 1999; Tan, 2001). Because product design requires such a wide range of information, design teams are comprised of people from purchasing, design, production, suppliers and customers (Flynn et al., 1995; Lockamy, 1998). Design management tools—design for manufacturability, concurrent engineering, quality function deployment, and design for experiments (Ahire and Dreyfus, 2000; Easton and Jarrell, 1998; Handfield et al., 1999; Ho et al., 1999)—can be used effectively only if quality data are collected and disseminated throughout the organization in a timely manner. Thus, the following hypothesis is proposed:

H4b. Quality data and reporting is positively related to product/service design.

Quality data directly affect process management by informing workers about changes in processes immediately so they can take corrective actions before defective products are produced and then check the results of their improvement efforts (Flynn et al., 1995; Ho et al., 1999). The effectiveness of using statistical process control charts and process capability studies in process improvement is well established in the literature (Ahire and O'Shaughnessy, 1998; Flynn et al., 1995; Handfield et al., 1999). Therefore, we can propose the following hypothesis:

H4c. Quality data and reporting is positively related to process management.

2.1.5. Supplier quality management

Effective supplier quality management is facilitated by long-term, cooperative relationships with as few suppliers as possible to obtain quality materials and/or services. Maintaining a small number of suppliers improves product quality and productivity of buyers by encouraging enhanced supplier commitment to product design and quality (Ansari and Modarress, 1990; Burt, 1989; Trent and Monczka, 1999). Additionally, dealing with a small number of suppliers facilitates the solution of quality and delivery problems because buyers can pay close attention to each supplier (Burt, 1989; Cooper and Ellram, 1993). Successful relationships encourage suppliers to become involved in the buying firm's design of products/services, and gives them a chance to offer suggestions regarding product and/or component simplification. They can also help purchasers procure the materials and parts that can be used most efficiently (Burt, 1989; Flynn et al., 1995; Forza and Flippini, 1998; Shin et al., 2000; Tan, 2001; Trent and Monczka, 1999). Thus, we can offer the following hypothesis:

H5a. Supplier quality management is positively related to product/service design.

A number of researchers have found that improved supplier relations enhance the performance of both suppliers and buyers, and this is especially true when quality and delivery are buyer priorities (Flynn et al., 1995; Ho et al., 1999; Shin et al., 2000). The production of quality products is necessarily dependent on the timely delivery of quality materials, so it is essential that materials supplied meet the buyer's specifications and standards for quality (Flynn et al., 1995; Forza and Flippini, 1998; Grieco and Gozzo, 1985; Trent and Monczka, 1999). Improving the quality of purchased materials and parts, a main source of process variability, will have a positive effect on process management (Flynn et al., 1995) by eliminating variance in materials and parts, which makes it possible to utilize internal controls over such other variables as machinery and the workforce (Forza and Flippini, 1998). Thus, we are led to the following hypothesis:

H5b. Supplier quality management is positively related to process management.

A direct contribution effective supplier management makes to firm performance is inventory reduction (Easton and Jarrell, 1998; Engelkemeyer, 1990; Levandoski, 1993; United States General Accounting Office, 1991), which enables firms to sustain efforts to reduce waste, eliminate safety stocks, and create a leaner operation (Choi, 1995; Krajewski and Ritzman, 2001). A study by Chapman and Carter (1990) shows that successful customer/supplier cooperation can result in inventory reduction benefits for both parties.

H5c. Supplier quality management is positively related to inventory management performance.

2.1.6. Product/service design

Under TQM systems, product/service design efforts have two objectives: designing manufacturable products and designing quality into the products (Flynn et al., 1995; Handfield et al., 1999). Designing to simplify manufacturing utilizes cross-functional teams to reduce the number of parts per product and standardize the parts (Chase et al., 2001), which results in more efficient process management by reducing process complexity and process variance (Ahire and Dreyfus, 2000; Flynn et al., 1995). The same cross-functional team that designed the product can also focus on improving manufacturing processes (Ahire and Dreyfus, 2000). Thus, we offer the following hypothesis:

H6a. Product design is positively related to process management.

Using as few parts as possible and standardizing as many of these parts per product as is feasible speeds up the learning curve effect on employees, thereby enhancing quality and reducing costs due to decreased variety and increased volume (Tan, 2001). As the number of components decreases, the failure rate of a product also decreases and its reliability increases (Ahire and Dreyfus, 2000; Flynn et al., 1995). Quality problems can be further reduced by including customers' requirements in new product/service design reviews prior to production (Forza and Flippini, 1998). Thus, the following hypothesis is proposed:

H6b. Product design is positively related to quality performance.

2.1.7. Process management

Process management entails taking a preventive approach to quality improvement such as designing processes that are fool-proof and that provide stable production schedules and work distribution (Flynn et al., 1995; Saraph et al., 1989) to reduce process variation (Flynn et al., 1995) by building quality into the product during the production stage (Handfield et al., 1999). Reducing process variation should result in increased output uniformity as well as reduced rework and waste (Anderson et al., 1994; Forza and Flippini, 1998) because quality problems are identified and corrected immediately (Ahire and Dreyfus, 2000). Regular preventive equipment maintenance positively contributes to product quality by improving machine reliability and reducing interruptions in production (Ho et al., 1999). Flynn et al. (1995) found that effective process management results in an increased percent-passed final inspection with no rework. This increased production quality leads to improved product quality and, in turn, other improvements in competitive priorities such as reduced costs and fast delivery. Additionally, the empirical findings by Ahire and Dreyfus (2000) and Forza and Flippini (1998) show that process management directly and positively affects product quality. Thus, the following hypothesis is offered:

H7. Process management is positively related to quality performance.

2.1.8. Firm performance

Companies implementing TQM experience high inventory turnover, a situation which enables the identification of scheduling and production problems (Krajewski and Ritzman, 2001; Tan, 2001) and encourages continuous improvement of processes and product quality (Adam et al., 1997). These improvements should result in lower scrap and rework costs as well as enhanced productivity and lead-time performance. Thus, we can expect that better inventory management will lead to increased quality performance.

H8a. Inventory management performance is positively related to quality performance.

Quality performance improves financial and market performance, and the literature offers several explanations for these effects. First, as a firm acquires a reputation for delivering high quality products and services, the elasticity of demand can decrease, which, in turn, can enable the firm to charge higher prices and earn higher profits (Shetty, 1988). Second, improving product quality by reducing waste and improving efficiency will increase the return on assets (Handfield et al., 1998), which will increase profitability. Third, reduced rework, less scrap, and improved productivity will lower the cost structure of a firm, which enables the firm to offer lower prices—if it is motivated to do so—for products and services without denting the profit margin. Low prices can increase market share and sales (Deming, 1986; Maani et al., 1994; Reed et al., 1996). Last, improvements in quality will result in more satisfied customers with greater loyalty, increased sales (Ahire and Dreyfus, 2000; Choi and Eboch, 1998; Handfield et al., 1998; Hendricks and Singhal, 1997), and an enhanced competitive position (Aaker and Jacobson, 1994; Fornell et al., 1996). The beneficial effect of product/service quality on market share (Buzzell et al., 1975; Craig and Douglas, 1982; Jacobson and Aaker, 1987; Phillips et al., 1983; Zeithaml and Fry, 1981) and profit when measured as return on investment (Craig and Douglas, 1982; Jacobson and Aaker, 1987; MacMillan et al., 1982; Phillips et al., 1983; Zeithaml and Fry, 1981) is a consistent finding of research published in marketing literature. Based on the reviewed literature, the following hypothesis is suggested:

H8b. Quality performance is positively related to financial and market performance.

3. Research methodology

The data for this research were drawn from a cross-sectional mail study conducted to investigate TQM, just-in-time purchasing (JITP) and the performance of firms operating in the 48 contiguous states of the US that have implemented TQM and JITP techniques. Using data collected through cross-sectional mail survey methodology is appropriate because the research questions posed in this study lend themselves to investigating the relationships between multiple variables. A large sample size is required to obtain reliable and valid research results. Moreover, it is relatively inexpensive and has the greatest potential for reaching a large number of respondents widely dispersed (Alreck and Settle, 1985). Issues pertaining to the construction of the instrument and measures, the survey procedure, the sample, and the tests for reliability and exploratory factor analysis are briefly reviewed in the following sections. The discussion of tests for reliability and validity also includes the results of the confirmatory factor analysis performed in the current study in order to refine the resulting scales in exploratory factor analysis and to establish unidimensionality, convergent validity, and discriminant validity of the measures used in this study.

3.1. Construction of the instrument and measures

Churchill's (1979) work provided the basis for the construction of the instrument and measures utilized in this study. The domains of constructs were identified via a thorough review of the literature. For most of the items of the TQM construct, Saraph et al.'s (1989) survey instrument was useful. Saraph et al. (1989) measured the factors of supplier cooperation and materials quality as one factor: supplier quality management. The measurement of these factors in this study, however, required a more in-depth examination. Therefore, to measure supplier cooperation and materials quality, the items pertaining to these two factors from Saraph et al.'s questionnaire were grouped based on content analysis. In addition, one item was adapted from Ettlie and Reza (1992) and the others were originated in the literature review. The list of scales, items, and their sources are presented in Appendix A.

Saraph et al.'s (1989) instrument uses a discrete, Likert-type scale. This study favored the use of a continuous scale because, as research shows, as the number of scaling points decreases, the amount of information lost increases (Martin, 1978; McClelland and Judd, 1993; Russell and Bobko, 1992). Therefore, a continuous scale 100 mm long was utilized. The polar points pertaining to TQM practices were none = 0 and very high = 100. The use of continuous scales for research (e.g. Taylor et al., 1992) has become acceptable in the social sciences. The wording of some borrowed items was changed to adapt them to a continuous scale format.

The items relating to performance variables were based on a review of the literature on strategic management, marketing, and operations management (see Appendix A). Three levels of performance measures were identified: financial, market, and operating. These performance measures are consistent with the performance measurement in the studies presented in Table 2. The values of the end poles measuring relative perceived performance are adapted from Venkatraman and Ramanujam (1987). We asked respondents to rate performance measures of their firms from "worse than competition" to "better than competition" on a continuous scale (worse than competition = 0, better than competition = 100) for the last fiscal year. The relative perceived performance is measured for 1 year because it is the common period for firms which have been using TQM practices.

This study was pilot tested at a joint dinner meeting of the American Production and Inventory Control Society (APICS) and the Institute for Supply Management (ISM, formerly the National Association of Purchasing Management). We tested the study there because the test sample was similar to our actual sample. Statistical analyses were performed on the data obtained from 11 respondents, but our statistical tests were restricted to Cronbach's alpha (α) and a few correlations because the sample was small. The values of Cronbach's α obtained for each factor were satisfactory, exceeding, as they did, the threshold value of 0.70 suggested by Nunnally and Bernstein (1994). Additional interviews with the ISM board members who participated in the pilot study showed that the questionnaire needed only a few minor changes in wording to clarify two questions that were to be used in the actual study.

3.2. Target population and survey procedure

The pilot study and power analysis determined a target sample of 1884 business units. The industries most likely to implement TQM and JITP were identified through a literature review. The SIC codes of the industries from which target respondents would be selected were submitted to the American Society for Quality (ASQ) and the ISM, which supplied addresses for chosen respondents. In addition to industry specifications, other criteria were relevant to the selection of target respondents. We preferred that respondents hold a high rank in their companies. Another concerned finding respondents who were likely to be familiar with the implementation of TQM and JITP in their companies and knowledgeable about their firm's performance. Job titles provided by ASQ and ISM such as quality manager, continuous improvement manager, and supplier and quality manager indicated that those organizations had implemented TQM techniques in some form.

Following the Total Design Methodology suggested by Dillman (1978), we mailed questionnaires; cover letters; and postage-paid, self-addressed return envelopes to the 1884 subjects. We followed his four-step procedure, although our response rate was sufficiently high after the second and third steps that the fourth step was not pursued. We received 383 replies. One was unusable, so we had 382 usable surveys, a 20.3% response rate, which is in line with that of other studies (e.g. Choi and Eboch, 1998; Das et al., 2000; Madu et al., 1995).

By testing the difference of the interest variables between early and late respondents, an estimate of non-response bias was calculated (Armstrong and Overton, 1977). To test the non-response bias, two sample *t*-test procedures were conducted for TQM, JITP, and three perceived performance factors. None of the *t*-test results indicated a significant difference between the two response waves on the means of these variables. The second test of non-response bias concerned the firms' demographics: number of employees, annual sales and ownership of the organization. χ^2tests were run to find out whether there was a significant difference in the three demographic variables between early and late respondents. Results indicated that no significant differences on demographics existed between the two waves of responses. Fifty-nine respondents either returned the blank questionnaire in the provided envelope or contacted the researcher by phone to explain why they chose not to participate in the study. The results of statistical tests and qualitative data indicate that non-respondents did not differ significantly from respondents.

3.3. Sample demographics

Missing values were neither calculated nor substituted for the performance measures, so the final sample used to test the research model was reduced to 214. Replies came from 42 states, although the target sample included firms from all 48 states. No firms in Delaware, Maine, Montana, North Dakota, Nevada and Wyoming answered the questionnaire. Moreover, the final sample also lacked responses from Mississippi, Oregon, Vermont, and West Virginia. Thus, the non-responses were not clustered geographically. The 38 states that comprised the sample did, however, provide a fair, representative coverage of geographical differences in the US.

The majority of respondents filled positions with titles such as president, vice president, director, manager, and coordinator. Additionally, the respondents' functions were concerned with quality practices, general management, engineering, and purchasing, thus, they were likely to pay careful attention to performance measures (Germain and Dröge, 1997). We concluded that the survey's respondents did possess the knowledge required to answer the questions appropriately.

Although the organizations that make up the sample represent various manufacturing industries (SIC codes 20–39) and service industries (e.g. transportation, wholesale, financial, and health care), the sample is skewed toward manufacturing firms. Fifteen percent of the sample is comprised of service firms. The most well-represented industries in the manufacturing sector are rubber and miscellaneous products (8.5%); fabricated metal (8.9%); machinery and computer (7.9%); electrical and electronic (11.2%); and measuring, analyzing and controlling instruments (9.8%). Our cross-industry sample is appropriate, as Pannirselvam and Ferguson (2001) suggest, because distinctions between manufacturing and service have become blurred as manufacturers have become more responsive to customers and service organizations more concerned about quality process and output.

Approximately 30.4% of the firms had 100 or fewer employees, 23.4% of the firms employed between 101 and 250 workers, 12.6% of the firms had 251–500 on the payroll, and 33.6% of the firms had more than 500 employees. About 28.5% of the firms reported annual sales of US$ 12.5 million or less, and 25% of the firms had annual sales between US$ 12.5 million and 50 million. The firms that had annual sales between US$ 51 million and 100 million comprised about 8% of the final sample. Companies with annual sales between US$ 101 million and 500 million accounted for 25.2% of the final sample, and approximately another 8% of the firms had annual sales of more than US$ 500 million.

3.4. Tests for reliability and validity

This section reports the results of tests for reliability and three components of construct validity—unidimensionality, convergent validity and discriminant validity. First, *reliability* of each scale of TQM and performance constructs was estimated by calculating Cronbach's α (Cronbach, 1951). Several items in the TQM factors that did not contribute to the α values of the scales were dropped (see Appendix A). None of the items in the performance construct was eliminated. All TQM and perceived performance scales had acceptable reliability levels, values of α equal to 0.70 or higher (Nunnally and Bernstein, 1994).

To establish the *unidimensionality* of factors, an exploratory factor analysis using principal component extraction with a varimax rotation was separately performed for TQM and perceived performance constructs. Because a significant number of the organizations did not have quality departments, the questions relating to a quality department were eliminated from the exploratory factor analysis of TQM. The examination of eigenvalues and screen test results revealed eight factors of TQM. What were proposed as separate scales—supplier cooperation and materials quality—actually formed a single factor; hence, the name of the factor "supplier quality management" in the study by Saraph et al. (1989) is retained. Process management emerged as two factors, showing the same pattern Saraph et al. (1989) found in their study. This study confirms the existence of two separate scales, which I have called "inspection" and "process management." The other items formed the expected factors. As a result of examining the loadings and communalities, several items were also dropped in this step (see Appendix A). The *inspection* scale was not included in the additional data analyses discussed in the following sections because it was deemed to add little value to the content of quality management.

In the case of the perceived performance construct, three factors emerged. They were not, however, the same as the proposed scales: financial and market performance, quality performance, and inventory management performance. The indicators of these performance factors are listed in Appendix A and described in Section 2. (For more details about the research method and the tests for reliability and factor analyses, see Kaynak, 1997.) Cronbach's α for each final scale pertaining to TQM and performance was recalculated, and the reliability values for each factor exceeded the threshold value.

Prior to evaluating the structural equation model (SEM), the validity of the measurement models was tested (Byrne, 1998; Jöreskog and Sörbom, 1993a). In other words, the resulting scales in exploratory factor analysis were evaluated and refined by a confirmatory factor analysis (CFA) before testing the full latent variable model (Gerbing and Anderson, 1988). The measurement model for each factor was estimated separately, then, after combining the factors into pairs, each pair was estimated separately. After estimating the measurement model for all factors without constraining the covariance matrix of the factors, the SEM for the factors together with the measurement models was estimated. At each step, whether or not the model fits the data was assessed. This assessment of the model was done by examining the standard errors, *t*-values, standardized residuals, modification indices, and a number of goodness-of-fit statistics (Jöreskog and Sörbom, 1993a).

LISREL 8.14 software (Jöreskog and Sörbom, 1993b) was employed to test the measurement models and the research model. The fit indices used in this study to estimate measurement models are the ratio of χ^2 to degree of freedom, Root Mean Square Error of Approximation (RMSEA), a consistent version of the Akaike's Information Criterion (CAIC), the Parsimony Goodness-of-Fit Index (PGFI), the Parsimony Normed Fit Index (PNFI), and the Comparative Fit Index (CFI). These fit indices, with the exception of RMSEA, were chosen because of their abilities to adjust for model complexity and degrees of freedom. Although RMSEA is sensitive to model complexity, it is one of the most informative criteria as to an absolute fit (see Byrne, 1998 for details). Recommended values of these fit indices for satisfactory fit of a model to data are presented in Table 3.

The assumptions of multivariate analysis—normality, linearity, and homoscedasticity—were tested for the variables used in the measurement models. Analyses for the assumptions of the multivariate model indicated no statistically significant violations.

During the estimation of the measurement models for TQM and perceived performance constructs, an examination of the modification indices and standardized residuals revealed redundant items in some scales. These redundant items were eliminated, which resulted in better-fitted models (Byrne, 1998). A comparison of goodness-of-fit statistics relating to each measurement model to the recommended values of these fit indices (see Table 3) reveals satisfactory fit of

Table 3
Test results of the measurement models and structural model

Goodness-of-fit statistics	Measurement model for TQM	Measurement model for firm performance	Structural model	Recommended values for satisfactory fit of a model to data
χ^2/df	657.16/383 = 1.72	52.03/24 = 2.17	1167.46/683 = 1.71	<3.0[a]
Root Mean Square Error of Approximation (RMSEA)	0.058	0.074	0.058	<0.08[b]
Akaike's Information Criterion (CAIC)	1179.17	185.72	1784.96	<Saturated model and
CAIC for Saturated Model	2960.18	286.47	4965.46	independence model[c]
CAIC for Independent Model	5383.51	1146.98	6992.04	
Parsimony Goodness-of-Fit Index (PGFI)	0.69	0.51	0.69	>0.50[d]
Parsimony Normed Fit Index (PNFI)	0.77	0.63	0.76	>0.50[d]
Comparative Fit Index (CFI)	0.94	0.97	0.92	>0.90[b]

[a] Bollen (1989), Carmines and McIver (1981), Hair et al. (1995).
[b] Byrne (1998), Jaccard and Wan (1996), Jöreskog and Sörbom (1993a).
[c] Byrne (1998), Jöreskog and Sörbom (1993a).
[d] Byrne (1998), Mulaik et al. (1989).

Table 4
Descriptive statistics, Cronbach's α, and bivariate correlations for the variables in research model[a]

Variables	1	2	3	4	5	6	7	8	9	10	Mean	S.D.	Cronbach's α
1. Management leadership	1.000										61.24	21.90	0.92
2. Training	0.651 (0.000)	1.000									53.43	24.72	0.92
3. Employee relations	0.715 (0.000)	0.643 (0.000)	1.000								53.00	23.25	0.89
4. Quality data and reporting	0.533 (0.000)	0.556 (0.000)	0.470 (0.000)	1.000							58.38	26.45	0.90
5. Supplier quality management	0.561 (0.000)	0.570 (0.000)	0.529 (0.000)	0.547 (0.000)	1.000						52.37	21.36	0.86
6. Product/service design	0.657 (0.000)	0.569 (0.000)	0.668 (0.000)	0.487 (0.000)	0.558 (0.000)	1.000					56.69	22.79	0.93
7. Process management	0.515 (0.000)	0.574 (0.000)	0.556 (0.000)	0.536 (0.000)	0.536 (0.000)	0.588 (0.000)	1.000				45.37	21.33	0.78
8. Inventory management performance	0.269 (0.000)	0.234 (0.001)	0.264 (0.000)	0.114 (0.095)	0.258 (0.000)	0.236 (0.000)	0.225 (0.001)	1.000			62.24	18.63	0.91
9. Quality performance	0.353 (0.000)	0.312 (0.000)	0.425 (0.000)	0.251 (0.000)	0.420 (0.000)	0.417 (0.000)	0.359 (0.000)	0.513 (0.000)	1.000		66.79	15.30	0.80
10. Financial and market performance	0.264 (0.000)	0.205 (0.003)	0.143 (0.037)	0.287 (0.000)	0.244 (0.000)	0.206 (0.002)	0.256 (0.000)	0.302 (0.000)	0.376 (0.000)	1.000	62.04	18.84	0.89

[a] Corresponding P values are in parentheses. $N = 214$.

the measurement models to the data. The remaining items in each scale are indicated in Appendix A as well as their standardized factor loadings on the respective factors. (See the first value in parenthesis next to remaining each item.) The mean values, standard deviations, bivariate correlations, and Cronbach's α for refined scales are presented in Table 4. The resulting values of Cronbach's α and factor loadings establish the reliability and unidimensionality of the measures used in this study.

The extent to which multiple attempts to measure the same constructs are in agreement is the issue in *convergent validity* (Bagozzi et al., 1991; Hoskisson et al., 1993). An instrument has convergent validity if the correlations between measures of the same construct using different methods are high (Crocker and Algina, 1986). In measurement studies, each item in the scale can be considered a different method for measuring the construct (Ahire et al., 1996). A test of each item's coefficient was used to assess convergent validity. If each item's coefficient is greater than twice its standard error (t-value), then measures indicate high convergent validity (cf. Krause, 1999). The t-value of each retained item is presented in Appendix A. All t-values are significant, indicating high convergence validity.

The concern with *discriminant validity* is the degree to which measures of different factors are discrete (Bagozzi et al., 1991; Hoskisson et al., 1993). An instrument has discriminant validity if the correlations between measures of different factors using the same method of measurement are lower than the reliability coefficients (Crocker and Algina, 1986). The bivariate correlations between seven TQM and three perceived performance factors are presented in Table 4. Significant correlations are expected because of the theoretical relation between them and the large size of the sample. Nevertheless, the correlation coefficients were lower than the reliability coefficients, suggesting that measures have discriminant validity.

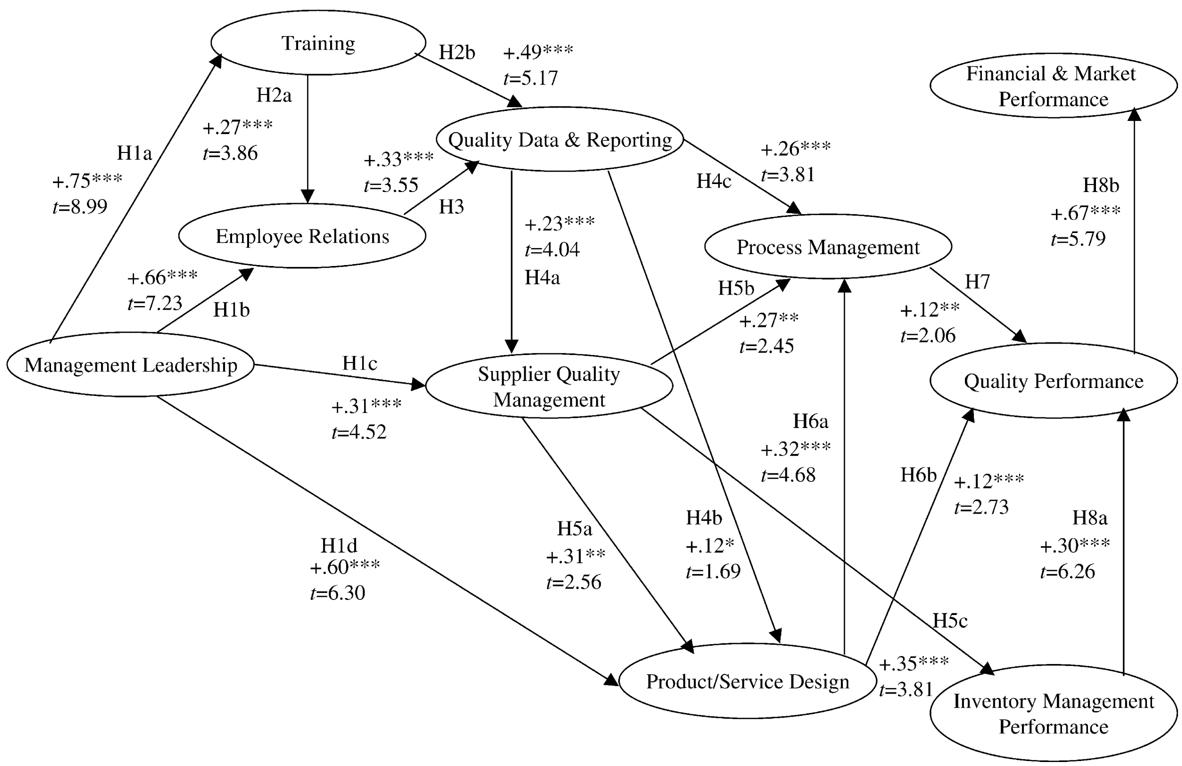

Fig. 2. Structural modeling of the relationship between TQM practices and performance measures. $^{***}P < 0.01$, $^{**}P < 0.05$, $^{*}P < 0.1$.

4. Test results of structural model

Fig. 2 depicts the SEM results of the relationship between TQM practices and factors of performance measures. Each path in the figure indicates the associated hypotheses as well as the estimated path coefficients and *t*-values. The goodness-of-fit statistics used to assess the fit of the data to the hypothesized model are the same as those used to test the measurement models and are presented in Table 3.

In the light of recommended values of fit indices, a review of the goodness-of-fit indices pertaining to the hypothesized model reveals a good fit of the model to the data. All of the paths in the model are supported (*t*-values for path coefficients greater than 1.65 are significant at $P < 0.10$; *t*-values greater than 1.96 are significant at $P < 0.05$; *t*-values greater than 2.58 are significant at $P < 0.01$).

5. Discussion

5.1. Discussion of results

The primary purposes of this study were to investigate the relationships among TQM practices and to identify the direct and indirect effects of TQM practices on the various dimensions of performance. Through testing the hypothesized structural model, which was developed based on a comprehensive literature review, these purposes were accomplished. The significant implications of the results of the structural model testing for researchers and practitioners, respectively, are discussed in the rest of this section.

The findings as a whole suggest that a positive relationship exists between the extent to which companies implement TQM and firm performance. This overall result corroborates the studies (Douglas and Judge, 2001; Easton and Jarrell, 1998; Hendricks and Singhal, 1996, 1997) in which TQM is operationalized as a single construct. This validation is important because, to investigate the relationship between TQM and performance, Easton and Jarrell (1998) and Hendricks and Singhal (1996, 1997) employed different research methodologies from that utilized in this study (see Table 2). As Palich et al. (2000) point out, it is important to obtain consistent research results among multiple studies using a variety of research methods to make strong statements "about the strength and generality of the findings" (p. 161).

Dow et al. (1999) argue that a fundamental weakness in the quality management literature is the assumption, without any empirical testing, of the interdependence of quality management practices. (It should be noted that the empirical findings supporting the interdependence of quality management practices were published by Anderson et al., 1995 and Flynn et al., 1995.) Thus, another significant finding of this study is the validation of the interdependence of TQM practices, which supports both the results of studies (e.g. Das et al., 2000; Flynn et al., 1995; Ho et al., 2001) referred to earlier in this research and the theory of TQM suggested by quality gurus (e.g. Deming, 1993).

The findings also show that assessment of management leadership is necessary when the effectiveness of TQM implementation is investigated. Management leadership is directly related to training, employee relations, supplier quality management, and product design, and indirectly related to quality data and reporting, and process management. Effective leadership by management also indirectly affects firm performance through the mediating effects of the other six practices of TQM. The results also demonstrate the importance of two other infrastructural practices—training and employee relations—to the assessment of TQM implementation. Training and employee relations are directly related to quality data and reporting, and they are indirectly related to supplier quality management, product/service design, and process management through quality data and reporting. As with management leadership, they indirectly affect firm performance.

Quality data and reporting, one of the core TQM practices, does not have any direct effects on any of the three performance dimensions; however, the scale of quality data and reporting has indirect influences on them through supplier quality management, product/service design, and process management. The confirmed indirect effect of training and direct effect of quality data and reporting on process management in this study explain the lack of significant relationships found between task-related training and process management in the studies by Anderson et al. (1995), Forza and Flippini (1998), and Rungtusanatham et al. (1998). Thus, future studies should evaluate availability and use of timely quality data when researchers investigate the relationships between TQM practices and assess the success of TQM implementation.

Supplier quality management emerges as an important component of TQM, directly and positively affecting product/service design, process management, and inventory management performance. Supplier quality management has an indirect effect on improved quality performance through product/service design and process management. It is important that when investigating the role of supplier quality management in the effectiveness of TQM implementation, researchers define inventory management performance as a relevant performance measure. It is also important that they recognize the indirect positive effects of supplier quality management on quality performance, and financial and market performance. The findings regarding the effects of supplier quality management also point to some limitations of the conclusions reached in several studies that investigated the relation between TQM and performance. One of the findings, among others, by Powell (1995), for example, is that closeness to suppliers only marginally correlates with financial performance. He concludes that the most critical factors of successful TQM implementation are executive commitment, open organization, and employee empowerment, but he overlooks a possible indirect effect of closeness to suppliers on financial performance. In another study, Mohrman et al. (1995) found that no significant relation existed between TQM (TQM is operationalized as two dimensions: core TQM practices and production-oriented practices) and inventory turnover. As the finding of this study shows, supplier quality management is the only TQM practice that has a direct effect on inventory turnover. Thus, in their study, the non-significant finding may have been due to the information lost by combining TQM practices.

Flynn et al. (1995) pointed out the missing link between product design process and process flow management scales and called for its future investigation. Thus, another notable result in this study is the significant direct effect of product/service design on process management. Product/service design positively contributes to quality performance directly as well as indirectly through process management. Process management is another core TQM practice that is directly and positively related to quality performance. This result confirms the findings in studies (Ahire and Dreyfus, 2000; Flynn et al., 1995; Forza and Flippini, 1998) that investigated the relation of process management to quality performance.

The direct relation of inventory management performance to quality performance shows that improvements in quality, productivity, and on-time delivery are partly due to reduced inventories. Both the indirect effect of inventory management and the direct effect of quality performance on financial and market performance validate the notion that the improvements in operating performance result in increased sales and market share, thereby providing a competitive edge to companies.

In summary, then, the three TQM practices which have direct effects on operating performance (inventory management and quality performance) are supplier quality management, product/service design, and process management. Management leadership, training, employee relations, and quality data and reporting affect operating performance through supplier quality management, product/service design, and process management. The positive effect of TQM practices on financial and market performance is mediated through operating performance. This finding is consistent with the results in the study by Grandzol and Gershon (1997).

Given the discussion above, it is apparent that scholars who engage in TQM research should pay attention to several research design issues if they wish to reach theoretically sound conclusions. First, the multidimensionality of the TQM construct should be recognized. Second, a broad set of performance variables—including operating, market, and financial measures—relevant to TQM practices should be measured. Third, researchers must be aware that the positive effect of each TQM practice on various levels of performance is different. Finally, data analyses more sophisticated than a series of multiple regression or correlations should be performed because it is important to be able to identify the direct and indirect effects of TQM practices. As the results of this study show, the relationships among TQM practices and the effects of these practices on firm performance are too complex to be identified by performing regression analysis or correlations.

The confirmed positive effects of TQM practices on firm performance in this study is encouraging for practitioners. The initiative in implementing TQM may originate at different levels of an organization. In companies that operate in highly global competitive environments and in quality-focused markets, the parent company may push divisions and/or strategic business units to adopt TQM practices (Handfield and Ghosh, 1994). In some instances, as expressed by some of this study's respondents, functional managers at local levels may recognize the need for TQM implementation to respond to competitive challenges. The empirically validated positive relation of TQM to firms' performance such as that documented in this study, can be very useful for the leaders who take the initiative in quality improvement to promote and obtain the resources needed for TQM implementation. TQM has, as this study shows, much to offer firms that wish to improve their performance. The accounts of specific and individual less-than-successful efforts to implement TQM should not be disheartening, for the problems might lie in the implementation of TQM rather than in TQM practices themselves.

This study's finding of the interdependent nature of TQM practices helps explain why TQM has not produced maximum benefits for every company that has implemented it. Management leadership clearly has a significant role to fill in a successful implementation of TQM practices. The more aggressive top management is in the implementation of TQM, the more training employees at all levels get. Moreover, management commitment to TQM empowers employees and makes them more conscious of the organization's goals. Management leadership is also important in forging strategic partnerships with suppliers and in creating products that are consumer focused and manufacturable. Too often, however, a serious commitment on the part of top management to TQM is weak or missing. Several respondents complained about management's lack of support, its resistance to change, and the failure of the organization's structure to change when TQM practices were implemented. Problems like these make it difficult to cultivate and take advantage of opportunities for TQM's potential benefits.

It is apparent that the practitioners as well as researchers cannot simply pick and choose a few techniques to implement. The structural model proposed and tested in this study may offer a flow chart to practitioners for effective TQM implementation. Companies first should secure a complete top management commitment to TQM implementation, and this commitment should motivate management to provide their employees quality-related training, institute teamwork, and employee involvement to lay the foundation for other practices of TQM.

Actually, it should do more. Establishing an effective system for collecting and disseminating quality data throughout the organization in a timely manner is necessary to realize improvements in supplier quality management, product/service design, and process management. Then, firms can focus on developing cooperative relationships with their suppliers to improve the quality of incoming materials and to involve them in the buyer firms' product/service design and process management activities. Coordination and cooperation among employees who participate in product/service design and process management are essential to improving quality performance of firms. All in all, a firm cannot simply select some of the TQM practices discussed above and expect to realize full benefits from implementing partial TQM.

5.2. Limitations of findings

Every effort was made at the design stage of this study to obtain reliable and valid findings as presented in Section 3. Nevertheless, several limitations of this study should be discussed in this section. Because it uses the same data for both exploratory and confirmatory factor analysis, this study has a major limitation. As the literature makes clear (Anderson and Gerbing, 1988; Kelloway, 1995), using the same data for both analyses is frequently done, probably because it streamlines research activities (Huber and Power, 1985). Research like that done for this study requires substantial investments of time and money, more so than in fields that allow researchers to collect data from one organization by studying the responses from a large sample comprised of respondents within it (Huber and Power, 1985). Because a cross-sectional survey method was utilized here, causal inferences were derived from existing theory and research only. This is, admittedly, a controversial approach, but Cook and Campbell (1979) say that it is acceptable to clarify theory and assess specific causal effects from correlational research data with structural and path analyses.

As far as construct validity is concerned, the use of self-reported data constitutes a major limitation, primarily because common method variance (CMV) is an acknowledged threat to studies that rely on self-reports for their data. A post hoc analysis of CMV—an evaluation of key informants, Harman's one-factor test, and multiple methods and sources—was performed in an earlier study by Kaynak (1997). The size of this study's sample, given the time and resource limitations that constrained it, made it impossible to use another method to gather data or corroborate what respondents reported about the extent to which their firms had implemented TQM. Likewise, the major problem when investigating performance at the business-unit level is the difficulty of obtaining objective performance measures. It is widely reported in the literature that managers are reluctant to share objective data with researchers (e.g. Choi and Liker, 1995; Swamidass and Newell, 1987). The same problem was also observed in this study.

Furthermore, because archival data are reported at the corporate rather than the business-unit level and so are unavailable for small and private businesses, it is difficult to find secondary data on financial performance. It was because of these difficulties that Choi and Eboch (1998) and Stanley and Wisner (2001) opted to use perceptual data to obtain a large sample. An attempt was made for this study to collect secondary objective data on the number of employees and the annual sales of firms from other sources. The high convergence between self-reported and archival data on number of employees ($r = 0.91$) and annual sales of firms ($r = 0.87$) indicates a high level of response consistency. Although analyses of key informants—Harman's one-factor test, and secondary data sources—do not completely eliminate the possibility of same source, self-report biases, the results indicated non-significant common method variance. Overall, validity and reliability in this study seem adequate.

6. Conclusion and further research

This study contributes to the TQM literature by validating the direct and indirect relations among TQM practices and the effects of these practices on firm performance. With the exception of Flynn et al. (1995), the TQM practices investigated in this study represent a wider domain of TQM than the other studies in which direct and indirect effects of TQM practices on performance are identified. In addition, measurement of performance at three levels in this research reveals more insights than the other studies do into the relation of TQM practices to firms' performance. It also sheds more light than they do on the relationships among three levels of performance: inventory management, quality, and financial and market performance.

A by-product of this study is a refined version of the questionnaire constructed by Saraph et al. (1989) that can be used to measure TQM implementation without making excessive demands on the time of both respondents and researchers. The final TQM measurement model includes 30 items, as indicated in Appendix A. In addition, a scale on customer relations can be added in future studies as one of the techniques of TQM. Evaluating customer relations as a technique of TQM is becoming more viable because TQM organizations are customer focused. Measurement studies on TQM discussed in this paper, as a part of the literature review, provide measurement items for the scale of customer focus. As pointed out by Amundson (1998), researchers should broaden their focus to include more complex issues regarding TQM implementation rather than simply replicating studies that identify TQM practices. Given that the response rate and the length of a questionnaire are inversely related, the shortened version of the questionnaire presented in this study allows researchers to investigate the relation of TQM to other variables of interest without seriously hurting response rate.

The findings of this study, as well as some of those reported in the literature reviewed in this paper, support the positive effects of TQM practices on firms' performance. A lack of top management commitment to the implementation of TQM has emerged as a possible reason for the failure of TQM systems in some organizations. Nevertheless, further empirical research should be conducted to assess the degree of effective organizational functioning under TQM systems to refine and sharpen our insights into the relationship between TQM practices and firms' performance. Having identified a number of gaps between TQM processes and outcomes in their conceptual study, Hackman and Wageman (1995) support the contention that the effectiveness of TQM should be measured in order to determine whether TQM changes the way people work together to meet customer requirements.

Effectiveness criteria such as organizational learning, employee satisfaction, decentralized structure, and resource acquisition should be assessed in the companies implementing TQM. Although TQM is learning-oriented, many learning failures in organizations that have implemented TQM have been reported (Hackman and Wageman, 1995). The effectiveness of the organizations that implement TQM depends on their ability to satisfy their employees, a necessary goal for companies that wish to realize benefits from employee involvement. Furthermore, employee participation in monitoring, detecting, and correcting quality problems requires decentralization and delegation in organizations implementing TQM. Decentralization, suggest Germain and Spears (1999), not only increases the number of minds searching for imaginative solutions to a firm's quality management problems, it also increases the number of internal groups that will support creative solutions once they are found. Finally, the effectiveness of TQM organizations should be measured by their degree of integration with their supplier bases because supplier quality management is a critical component of TQM.

Acknowledgements

Funding to collect the data was provided by the American Society for Quality and the Institute for Supply Management—National and Dallas Chapter. The author would like to thank Donald J. Newman, Charles F. Bimmerle, William A. Luker, and Victor Prybutok for their helpful comments and suggestions. She is also very grateful to the respondents who filled out the questionnaire for their cooperation.

Appendix A. Measurement scales, items and their sources

The items marked with the symbol (†) were retained after testing the measurement models. The first value in parenthesis for each retained item indicates the standardized factor loadings. The second value represents the *t*-value resulting from testing each item's coefficient. (The first item in each scale does not have an associated *t*-value because it has a fixed parameter in LISREL.) In her earlier study, Kaynak (1997) dropped these items (marked with symbol ‡) as a result of reliability tests and exploratory factor analysis. The ones marked with asterisk (*) belong to the scale of inspection.

A.1. Total quality management

A.1.1. Management leadership

All items in this scale were adapted from Saraph et al. (1989).

1. Extent to which the top business unit/organization executive (responsible for organization profit and loss) assumes responsibility for quality performance.
2. Acceptance of responsibility for quality by major department heads within the organization.
3. †Degree to which organization top management (top organization executive and major department heads) is evaluated for quality performance (0.74).
4. Extent to which the organization top management supports long-term quality improvement process.
5. †Degree of participation by major departments heads in the quality improvement process (0.79, t-value $= 11.83$).
6. †Extent to which the organizational top management has objectives for quality performance (0.86, t-value $= 12.96$).
7. Specificity of quality goals within the organization.
8. †Comprehensiveness of the goal-setting process for quality within the organization (0.78, t-value $= 11.62$).
9. Extent to which quality goals and policy are understood within the organization.
10. Importance attached to quality by the organizational top management in relation to cost and schedule objectives.
11. †Amount of review of quality issues in organizational top management meetings (0.84, t-value $=$ 12.53).
12. †Degree to which the organizational top management considers quality improvement as a way to increase profits (0.77, t-value $= 11.34$).
13. Degree of comprehensiveness of the quality plan within the organization.

A.1.2. Training

All items in this scale were adapted from Saraph et al. (1989).

1. †Specific work-skills training (technical and vocational) given to hourly employees throughout the organization (0.84).
2. †Quality-related training given to hourly employees throughout the organization (0.96, t-value = 19.02).
3. †Quality-related training given to managers and supervisors throughout the organization (0.89, t-value = 16.95).
4. Training in the "total quality concept" (i.e. philosophy of company-wide responsibility for quality) throughout the organization.
5. Training in the basic statistical techniques (such as histogram and control charts) in the organization as a whole.
6. Training in advanced statistical techniques (such as design of experiments and regression analysis) in the organization as a whole.
7. Commitment of the organizational top management to employee training.
8. Availability of resources for employee training in the organization.

A.1.3. Employee relations

All items in this scale were adapted from Saraph et al. (1989).

1. ‡Extent to which quality circles or employee involvement-type programs are implemented in the organization.
2. ‡Effectiveness of quality circles or employee involvement-type programs in the organization.
3. Extent to which employees are held responsible for error-free output.
4. †Amount of feedback provided to employees on their quality performance (0.79).
5. †Degree of participation in quality decisions by hourly/non-supervisory employees (0.84, t-value = 13.55).
6. †Extent to which building quality awareness among employees is ongoing (0.90, t-value = 14.76).
7. †Extent to which employees are recognized for superior quality performance (0.76, t-value = 11.93).
8. Effectiveness of supervisors in solving problems/issues.

A.1.4. Quality data and reporting

All items in this scale were adapted from Saraph et al. (1989).

1. Availability of cost of quality data in the organization.
2. †Availability of quality data (error rates, defect rates, scrap, defects, etc.) (0.75).
3. †Timeliness of the quality data (0.70, t-value = 17.96).
4. †Extent to which quality data (cost of quality, defects, errors, scrap, etc.) are used as tools to manage quality (1.00, t-value = 12.33).
5. Extent to which quality data are available to hourly employees.
6. Extent to which quality data are available to managers and supervisors.
7. Extent to which quality data are used to evaluate supervisor and managerial performance.
8. Extent to which quality data, control charts, etc. are displayed at employee work stations.

A.1.5. Supplier quality management

Items 1, 4–9 were adapted from Saraph et al. (1989); item 10 was adapted from Ettlie and Reza (1992); items 2, 3, and 11 were originated by Kaynak (1997).

1. †Extent to which long-term relationships are offered to suppliers (0.60).
2. †Reduction in the number of suppliers since implementing just-in-time purchasing and/or total quality management (0.61, t-value = 7.39).
3. †Extent to which suppliers are evaluated according to *quality*, *delivery performance*, and *price*, in that order (0.87, t-value = 9.36).
4. †Extent to which suppliers are selected based on quality rather than price or delivery schedule (0.82, t-value = 9.07).
5. Reliance on a reasonably few dependable suppliers.
6. †Thoroughness of your organization's supplier rating system (0.71, t-value = 8.24).
7. Amount of education provided for suppliers by your organization.
8. Technical assistance provided to the suppliers by your organization.
9. †Involvement of the supplier in your product/service development process (0.57, t-value = 6.96).

10. The extent to which the inspection of incoming parts has been reduced since you implemented just-in-time purchasing and/or total quality management.
11. Extent to which supplier conforms to the exact quality attributes required on your incoming parts.

A.1.6. Product/service design

All items in this scale were adapted from Saraph et al. (1989).

1. †Thoroughness of new product/service design reviews before the product/service is produced and marketed (0.90).
2. †Coordination among affected departments in the product/service development process (0.91, t-value = 20.79).
3. †Quality of new products/services emphasized in relation to cost or schedule objectives (0.84, t-value = 17.39).
4. Clarity of product/service specifications and procedures.
5. †Extent to which implementation/producibility is considered in the product/service design process (0.84, t-value = 17.08).
6. ‡Quality emphasis by sales, customer service, marketing, and public relations personnel.

A.1.7. Process management

All items in this scale were adapted from Saraph et al. (1989).

1. *Use of acceptance sampling to accept/reject lots or batches of work.
2. ‡Amount of preventive equipment maintenance.
3. †Extent to which inspection, review, or checking of work is automated (0.67).
4. *Amount of incoming inspection, review, or checking.
5. *Amount of in-process inspection, review, or checking.
6. *Amount of final inspection, review, or checking.
7. †Stability of production schedule/work distribution (0.57, t-value = 7.43).
8. †Degree of automation of the process (0.76, t-value = 9.48).
9. †Extent to which process design is "fool-proof" and minimizes the chances of employee errors (0.86, t-value = 10.32).
10. ‡Clarity of work or process instructions given to employees.

A.2. Relative perceived performance

A.2.1. Inventory management performance

All items in this scale were developed based on a literature review (e.g. Ansari and Modarress, 1990; Chapman and Carter, 1990; Deming, 1993; Engelkemeyer, 1990; Freeland, 1991; United States General Accounting Office, 1991).

1. †Purchase material turnover (0.97).
2. †Total inventory turnover (0.89, t-value = 13.93).

A.2.2. Quality performance

All items in this scale were developed based on a literature review (e.g. Ansari and Modarress, 1990; Deming, 1986, 1993; Engelkemeyer, 1990; Freeland, 1991; Garvin, 1983; Maani et al., 1994; Schonberger and Ansari, 1984; Shetty, 1988; United States General Accounting Office, 1991).

1. †Product/service quality (0.70).
2. †Productivity (0.87, t-value = 10.25).
3. †Cost of scrap and rework as a % of sales (0.65, t-value = 8.49).
4. Delivery lead-time of purchased materials.
5. †Delivery lead-time of finished products/services to customer (0.53, t-value = 7.00).

A.2.3. Financial and market performance

All items in this scale were developed based on a literature review (e.g. Buzzell et al., 1975; Cleveland et al., 1989; Craig and Douglas, 1982; Dess and Robinson, 1984; Dröge et al., 1994; Jacobson and Aaker, 1987; Keats, 1988; MacMillan et al., 1982; Parthasarthy and Sethi, 1993; Phillips et al., 1983; Swamidass and Newell, 1987; Venkatraman and Ramanujam, 1987; Vickery et al., 1993; Ward et al., 1994; Woo and Willard, 1983; Zeithaml and Fry, 1981).

1. Return on investment.
2. †Sales growth (0.78).

3. Profit growth.
4. †Market share (0.78, t-value = 12.70).
5. †Market share growth (0.99, t-value = 14.63).

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