A Study Of Manufacturing Competitive Capabilities: The Quality Management Practices Antecedents And The Mediating Role Of Internal Quality Performance

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Abstract

One important reason behind total quality management implementation failure has been attributed to the poor understanding of the interdependence between quality management practices and competitive capabilities. Despite, ample literature on total quality management (TQM) techniques, no comprehensive and systematic examination of TQM relating to manufacturing competitive capabilities has been conducted. The purpose of this study is to empirically assess the relationship between quality management practices and competitive capabilities. Data collected from 300 manufacturing companies were used to test the hypothesized relationships using structural equation modeling. The results confirmed that quality management practices play a significant role in building and supporting competitive capabilities. However, contrary to expectations, the relationships between product cost and lead time with competitive capabilities were not significant.

Keywords

Total quality management, internal quality performance factors, competitiveness of manufacturing firms, competitive capabilities typology.

Introduction

Despite, ample literature on total quality management (TQM) techniques, minimal research effort exist in investigating TQM in detail, in developing new theories, and testing existing ones. To date, no comprehensive and systematic examination of TQM relating to manufacturing competitive capabilities has been done or conducted. As Ahire, Landeros, and Golhar (1995) observed, no previous framework has provided a holistic perspective between these two critical variables. This issue is vital because, the poor understanding of the interdependence between quality management practices and competitive capabilities has been the one important reason behind total quality management implementation failures (Salegna and Fazel, 1995). In other words, more empirical studies that undertake creating hypothesis and theory testing the relationship between total quality management and manufacturing capabilities for competitive advantage are needed. A major objective of the present research is to fill this void by proposing, and extensively testing a research framework to explore the direct relationship between quality management practices and competitive capabilities, as well as the mediating role of internal quality performance factors. The importance of this research involves the possibility to improve the performance and competitiveness of manufacturing firms. The outcomes will help to increase the understanding of manufacturing managers about the interdependence between quality management practices and competitive capabilities and identify the quality factors critical for achieving and sustaining competitive advantage. For researchers, this study aids in developing and theory testing, and makes a significant contribution to the empirical quality literature by studying a segment of the manufacturing industry.

Theory Development

Quality Management

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

Table 1. Quality Management Taxonomy

Quality Management Categories	Quality Factors
Management Based Quality Practices	Top Management Support
	Strategic Quality Planning
Employee Based Quality Practices	Employee Training
	Employee Involvement
	Employee Empowerment

	Employee Recognition
Customer Based Quality Practices	Customer Orientation
	Customer Closeness
Information Based Quality Practices	Quality Information Availability
	Quality Information Usage
	Benchmarking
Product/Process Based Quality Practices	Product Design
	SPC Usage
Supplier Based Quality Practices	Supplier Quality Relationships

Internal Quality Performance

Internally, quality management practices are relevant in the context of improving product quality, reducing manufacturing costs, and improving operational performance. A wide arrange of performance measures for internal operational performance include: rework, scrap, productivity, throughput time, finished product defect rate, cost, and lead time among others (Garvin, 1984; Schonberger, 1983). In this research, the following internal quality performance measures were selected: (1) quality failures, (2) manufacturing cost, and (3) lead time. The reason for this selection is that these measures are implicitly considered as important antecedents to competitive capabilities (Koufteros, 1995).

Competitive Capabilities Concept and Typologies

Capabilities of manufacturers are those specific competencies that set the manufacturer apart from the competitors. In a recent empirical study, Koufteros (1995) identified and developed measurement scales for the following five distinctive competitive capabilities in manufacturing firms:

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

5. Product Innovation. It is the extent to which the manufacturing enterprise is capable of introducing new products and features in the market place (Koufteros, 1995; Clark and Fujimoto, 1991).

The Quality Management Practices-Competitive Capabilities Connection

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

Research Framework and Hypotheses Development

Model

The first-order level research framework (Figure 1) is based on a compilation of theory and empirical research on quality (Anderson, Rungtusanatham, and Schroeder, 1996; Ahire, Golhar, and Waller, 1996; 1989; Rao, Ragu-Nahan, Solis, 1996; Flynn, Schroeder, and Sakakibara, 1994; Saraph, Benson, and Schroeder, 1989); internal quality performance (Flynn, Schroeder, and Sakakibara, 1995a) and competitive capabilities (Koufteros, 1995; Hale, 1995).

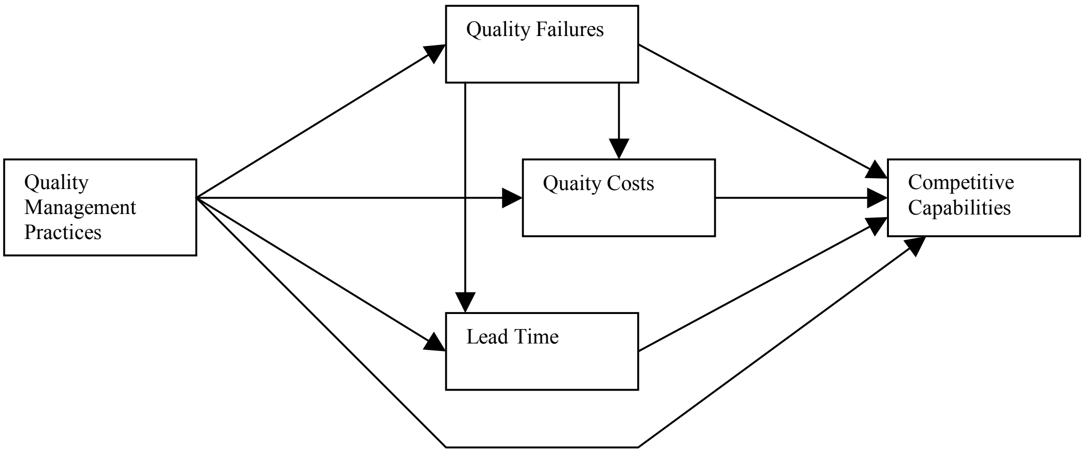

Figure 1. Quality Management Practices-Competitive Capabilities Framework

Hypotheses

This research examines relationships between quality management practices, and competitive capabilities. The model suggests that quality management practices predict and antecede both internal quality performance and competitive capabilities. For this study, the relationships will be tested at an aggregate level; the scores of all quality management practices, and competitive capabilities will be added into their respective categories and used in hypothesis testing. The relationships portrayed in Figure 1, give rise to the following hypotheses. The first set of five hypotheses deal with interrelationships among the endogenous variables (quality failures, product cost, lead time, and competitive capabilities).

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

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

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

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

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

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

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

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

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

Instrument Development

The development of the instrument was carried out in two stages. The first stage consisted of two steps. Respondents were asked to provide feedback about the clarity of the questions, instructions, the length of the questionnaire, and provide relevant comments meant to improve the questionnaire. Based on the feedback, items were modified or discarded to strengthen the constructs and content validity. The second step was scale development and testing. Items placed in a common pool were subjected to three sorting rounds by judges to establish which items should be in the various scales. The objective was to pre-assess the convergent and discriminant validity of the scales by examining how the items were sorted into various construct categories. Analysis of inter-judge agreement about item placement identified both bad items as well as weaknesses in the original definitions of the constructs. The various scales were then combined into an overall instrument for the next stage. The second stage included all the validity and reliability tests using the data from a large-scale sample. The resultant measurement instrument from the first stage showed a high potential for good construct validity.

The Quality Management Division of the American Society for Quality co-sponsored the second stage of the study and provided the mailing list. A stratified sample from the membership of the ASQ was deemed appropriate for the study, since ASQ members are top managers, quality managers, presidents, owners, etc.This letter was mailed to 2900 ASQ members. Moreover, the 2900 randomly selected respondents each represented a different discrete unit manufacturing firm. Five responses were returned undeliverable. Of the responses received, fourteen were evaluated as unsuitable for the large-scale analysis. In addition, all rejected responses were due to uncompleted surveys, leaving a total of 300 responses usable for a response rate of 10.4% [300 / (2900-5-14)]. The respondents came from companies with SIC codes between 2000 and 3900. Five manufacturing sectors accounted for 55.2 percent of the responses: <u>food and kindred products, chemicals, rubber and plastics, fabricated metal products, and electronic products</u>. Furthermore, the respondents identified their positions and size of the firms. The majority held positions as quality managers at a middle management position and 30 percent identified themselves as owners, presidents, vice-presidents, or CEOs. The majority of the responses came from firms with 500 employees or less (70.5%). Firms with more than 1000 employees accounted for 18% of the sample. The second stage in the instrument development process was the large-scale data analysis of the quality management constructs. The 300 responses from the large-scale survey were analyzed using the following criteria: *simplicity of factor structure, purification, reliability, brevity, convergent validity, discriminant validity, and predictive validity*. Overall, the resulting scales proposed to measure quality management practices, internal quality performance, and competitive capabilities were found to meet the criteria for validity and reliability. For brevity of space, the quantitative results are not included.

Exploratory Structural Analysis

To explore the antecedent role of quality management practices to internal quality performance and competitive capabilities, and the mediating role of internal quality performance, the linear structural equation modeling (LISREL) was used. For the present study, second order-constructs were used for exploratory hypothesis testing in lieu of the numerous first order factors. Thus, five variables are entered for hypothesis testing: quality management practices, quality failures, manufacturing cost, lead time, and competitive capabilities. To further assess the proposed relationships, the LISREL methodology was used to conduct an exploratory path analysis. The chi-square value (185.45) was nonsignificant indicating that the model had a good fit. Furthermore, the chi/square/degrees of freedom index value (1.67) also indicated that the model had a good fit. The values for the goodness-of-fit-index (GFI), the adjusted-goodness-fit-index (AGFI), the comparative-fit-index (CFI), the normated-fit-index (NFI), the non-normated-fit-index (NNFI), and the root mean-square-residual (RMR) were 0,93, 0.91, 0.90, 0.95, 0.96, and 0.047 respectively. Table 70 depicts a summary of the above model fit measures observed for the model. Overall, all measures surpassed the recommended acceptable levels giving evidence of the appropriateness of the model to the data. Since the model in Figure 1 fits the data, we now will analyze the magnitudes and t-values of the gamma and beta coefficients to test the research hypotheses.

Table 2. Fit Statistics for the Structural Equation Model

Goodness-of-fit Measure	**Value**	**Recommended Value***
Chi-square	185.45	No significant
Chi-square/degrees of freedom	1.67	□ 3.0
Goodness-of-fit Index (GFI)	0.93	□ 0.90
Adjusted Goodness-of-fit Index (AGFI	0.91	□ 0.80
Normed Fit Index (NFI)	0.90	□ 0.90
Non-Normed Fit Index (NNFI)	0.95	□ 0.90
Comparative Fit Index (CFI)	0.96	□ 0.90
Root Mean Square Residual (RMR)	0.047	□ 0.10

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

Hypotheses Testing Results

Total effects can be divided into direct, indirect, and noncausal effects (Table 3), and to examine the total effects, the coefficients for indirect effects were also calculated (Jorsekog and Sorbom, 1993).

Endogenous to Endogenous Relationships

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

Table 3: Decomposition of Effects

Relationship	**Total Effects**	**Direct Effect**	**Indirect Effects***	**Noncausal Effects**
Quality Management Practices to Quality Failures ($\square_1$ to $\square_1$)	-0.47 (-6.62)**	-0.47 (-6.62)**	----------	----------
Quality Management Practices to Product Cost ($\square_1$ to $\square_2$)	-0.20 (-3.14)**	-0.10 (-1.34)	-0.10 (-2.67)**	----------
Quality Management Practices to Lead Time ($\square_1$ to $\square_3$)	-0.15 (-2.01)*	0.08 (0.91)	-0.23 (-3.99)**	----------
Quality Management Practices to Competitive Capabilities ($\square_1$ to $\square_4$)	0.61 (5.26)**	0.36 (3.94)**	0.25 (3.80)**	----------
Quality Failures to Product Cost ($\square_1$ to $\square_2$)	0.21 (2.86)**	0.21 (2.86)**	----------	----------
Quality Failures to Lead Time ($\square_1$ to $\square_3$)	0.49 (4.79)**	0.49 (4.79)**	----------	----------
Quality Failures to Competitive Capabilities ($\square_1$ to $\square_4$)	-0.57 (-4.78)**	-0.55 (-4.26)**	-0.02 (-.37)	----------
Product Cost to Competitive Capabilities ($\square_2$ to $\square_4$)	0.11 (1.74)	0.11 (1.74)	----------	----------
Lead Time to Competitive Capabilities ($\square_3$ to $\square_4$)	-0.08 (-0.95)	-0.08 (-0.95)	----------	----------

** Significant at 0.01

- Significant at 0.05

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

The structural coefficient Beta for the direct relationship indicates a negative and very significant direct effect (t=-4.26). The indirect relationship between quality failures and competitive capabilities which was proposed to works itself through lead time and unit manufacturing cost proved insignificant (t=-0.37). Therefore, Improvement (reduction) in quality failures will improve competitive capabilities directly but will not improve competitive capabilities indirectly through unit manufacturing cost and lead time.

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

The Beta coefficient for the competitive capabilities-manufacturing cost relationships was found to be non significant (t=1.74). No indirect relationships were hypothesized and noncausal effects were not present. Improvements in manufacturing cost due to improvements in quality failures will not improve competitive capabilities.

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

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

Hypothesis 4: Quality failures have a positive relationship with unit anufacturing cost

It was proposed that quality failures would have a significant impact on manufacturing cost. Indeed, the Beta coefficient is positive and very significant (t=2.86) indicating that reducing quality failures reduces manufacturing cost. No indirect relationships were hypothesized and noncausal effects were not present.

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

The theory proposes that quality failures have a direct effect on lead time, and the results supported this hypothesis. The structural coefficient Beta that related the two variables indicates that the direct effect is positive and very significant (t=4.79). Reduction in quality failures reduces lead time. No indirect relationships were hypothesized and noncausal effects were not present.

Exogenous to Endogenous Relationships

In the exogenous to endogenous relationships, quality management practices were hypothesized to be an antecedent for quality failures as expressed by hypothesis 6.

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

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

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

The structural coefficient for quality management practices and manufacturing cost was non-significant (t=-1.34). However, the data shows the indirect relationship (t=-2.67) was negative and very significant. The indirect relationship works itself through quality failures. Quality management practices reduce quality failures which reduce unit manufacturing cost, and non causal effects were not present.

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

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

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

Quality management practices to competitive capabilities demonstrated a significant positive direct and indirect relationship with competitive capabilities. In fact, the direct relationship (t=3.94) was stronger than the indirect relationship (t=3.80). Improvements in quality management practices directly improved competitive capabilities, and indirectly improved quality competitive capabilities through reducing quality failures. Non causal effects were not present

Conclusion

Overall, the data indicates that quality management practices lead to improvements in competitive capabilities. Quality management practices lead to reductions in quality failures too. In addition, improvements of quality failures have a direct effect on the improvement of competitive capabilities. Also, quality management practices do not affect lead time and unit manufacturing cost. Further, reductions in unit manufacturing cost and lead time do no lead to improvement in competitive capabilities. However, these conclusions should remain cautionary because the applicability of the results may pertain to the particular sample of this research. Moreover, it is possible that a measurement problem with the unit manufacturing cost and lead time variables exist. Therefore, additional efforts should be expended in future research to establish valid and reliable measures of unit manufacturing cost and lead time.

A full version of the paper with tables and references is available upon request from the author.