Winter 12-19-2001

Supplier Relationships in Quality Management

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Abstract

This paper investigates the relationship between supply chain strategy and TQM practices. We empirically test the relationships among strategic quality planning, supplier based relationships, product design, product innovation, dependable deliveries, and value to customer quality. The findings suggest that the success of some TQM practices, as reflected in the value-to-customer are influenced by supply chain principles such as developing appropriate supplier relationships. In addition, the present study verifies positive linkages between certain TQM practices like product design and innovation, and value to customers. Structural equation modeling is used for finding and testing relationships between the various constructs.

Introduction

Total quality management (TQM) is a management philosophy aimed at improving the quality of products and processes to achieve a competitive advantage. While the implementation varies from one organization to another there are major characteristics that provide a unifying theme to all programs. Agreement is apparent among the quality movement founders and principal spokesmen [20] [22] [47] [49] regarding fundamental philosophy, assumptions, and recommended practices [40]. Some of the fundamental characteristics of the TQM approach are: 1) prevention

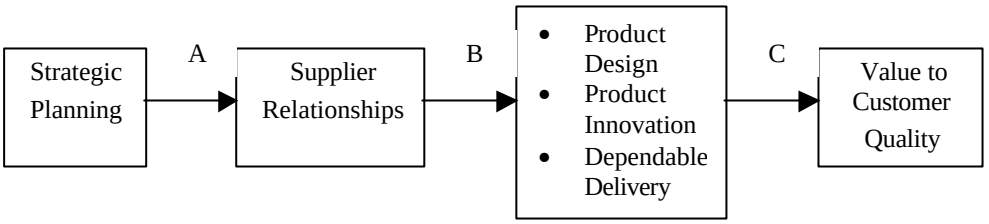
rather than detection [14] [101], 2) understanding that customer satisfaction is the driving force behind work processes [14], 3) continuous improvement, and 4) the underlying belief that people are naturally motivated to do a good job and improve quality [40]. A definition of TQM reflecting the above principles is provided by Flynn et al. [34]: " TQM is an integrated approach to achieving and sustaining high quality output, focusing on the maintenance and continuous improvement of processes and defect prevention at all levels and in all functions of the organization, in order to meet or exceed customer expectations."

The quality management literature exhibits different orientations: overview, conceptual, case study, and empirical. Overview articles present an integrative approach to managing quality, [2] [9] [19] [24] [25] [33] [37] [63] [96] and insights [103] into the Baldridge criteria [37] [25], international comparisons of quality practices [79] [26] [43] [33]. Conceptual articles include prescriptive models and methods for implementing TQM, [50] [80] [87] [91] [95] [102] [104] and case studies of a few organizations [17] [38] [60] [61] [66] [99].

Several empirical studies have examined TQM implementation in international organizations; countries and across countries [78] [10] [27] [36] [82] [83] [85] [32] [79] [89].

Current supply chain literature contains dozens of references to the importance of supplier relationships and its impact on product design [44], product innovation [7] and product delivery [16]. A firm' s abilities in product innovation and product design as well as its capabilities in terms of providing dependable on-time deliveries to its customers definitely create value to its customers. It is this creation of value to customers, as the customers perceive in terms of standards of performance, safety, and reliability, which, in the final analysis, can lead to customer retention and firm performance. Also it is to be noted that the firm' s product innovation, and design abilities, as well as its ability for affecting dependable deliveries are in turn linked to the firm' s suppliers, and their abilities. It is imperative that solid supplier relationships are built to sustain the firm' s design, innovation, and delivery capabilities to its customers. In this paper the strength of the relationship between supplier based relationships and product design, product innovation and dependable deliveries to the customer will be tested. The role of product design, product innovation and dependable delivery to value-to-customer quality will also be analyzed. The model, as well as the various relationships (A,B,C) that will be tested are shown in Figure 1.

Figure 1: Relationships tested by proposed Model



If these relationships are shown to be significant there are several implications that would result. Most significant of these are the relationships among the TQM construct involving supplier relationships and the constructs of product design, product innovation, and dependable delivery. While TQM would consider all of these constructs valuable, the suggestion that supplier relations may impact the effectiveness of these other constructs could change the way in which TQM is implemented in organizations.

Literature Review

The following sections review current literature for each of the constructs tested in our proposed model. Each section relates relevant literature leading to hypotheses to be investigated.

Strategic Quality Planning

Before discussing the linkage between strategic quality planning and supplier based relationships the strategy literature as it relates to the current topic is briefly reviewed. Prior literature discusses strategy from two different points of view. The strategy literature focuses on strategy types in which TQM is investigated as a type of strategy [1]. Various approaches have been utilized by researchers to assess different types of strategy. Porter [75] [76] proposes three competitive strategies: cost leadership, differentiation and focus. Cost leadership involves an attempt to achieve competitive advantage via economies of scale, controlling raw materials, proprietary technology and other cost reduction efforts. The differentiation strategy utilizes positioning techniques to present a winning combination of product and service mixes in the marketplace while a focus strategy chooses a market or product segment for specialization. According to Porter, a company cannot achieve cost leadership and differentiation simultaneously since differentiation is a costly strategy whereas cost leadership by definition involves very tight cost controls.

According to Kotha and Orne [57] there are eight unique manufacturing strategies that precipitate from combining Porters grid and the product-process matrix [46]. These eight strategies are comprised of three dimensions including organizational scope, process structure complexity, and product line complexity. This synthesis emphasizes cost cutting as a means to cost reduction and the creation of unique services or products to achieve differentiation leadership.

Parthasarthy and Sethi [70] proposed a different set of strategy options suggesting cost leadership, quality leadership and flexibility. Miller and Roth [65] further suggested yet another set of three strategy options for manufacturing environments including caretakers, marketers, and innovators. According to Miller and Roth, market differentiation and market scope are the primary means of classifying their proposed strategy types.

In summary, a firm's strategy is developed with the purpose of achieving some sort of advantage over a competitor. The strategy provides a basis for organizing the operations and alignment between the strategy and a company's operations is necessary for success. Ferdows and DeMeyer [32] suggest that synergy among manufacturing capabilities results in longer-term competitive advantage and that the first step in achieving this synergy is to focus on quality. Therefore, the adoption of TQM as a foundation to build superior capabilities results in enhanced product quality at reduced cost.

Improving quality is a long-term competitive strategy [8] [61] [72] [48] [22] [95]. It requires developing a quality culture, which is a lengthy process. Given the time factors, organizations must plan the process for achieving quality and integrating quality improvement planning into the overall business plan. Although organizations often seek immediate benefits from the start of a quality improvement process, a long-term focus is a greater objective. In a study, The American Quality Foundation found that in the United States, Canada, Germany and Japan strategic quality planning had significant effects on organizational performance measures. A strategic view of quality leads to: 1) the integration of quality management and customer satisfaction in the organizational strategic and operational plans, 2) long-term quality vision of the organization, and 3) the deployment and understanding of quality goals and policies throughout the entire organization. The strategic quality planning construct tested in our proposed model includes three items that tie in well with strategy literature. These areas include strategic plan supporting long-term quality improvement, strategic plan synergy with the firm's quality mission and policies, and strategic plan focus on quality as an integral part of the overall strategy.

Supplier based relationships

As in the case with a**l** other organizational processes, strategy plays a significant role with the

supplier based relationships as well. Our interest in this relationship is to highlight the importance of strategic quality planning in forming the framework as to how an organization deals with suppliers with respect to the supplier's role in the overall organizational operations and the influence that the strategy employed has on the ultimate performance outcomes associated with operations.

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

One great contribution of quality management is the recognition of suppliers as one of the most important resources organizations have [35]. This recognition grew out of the realization of three critical facts:

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

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

Leonard and Sasser [62] found a major source of quality product/process problems are defective incoming supplies. The impact of defective supplies on quality performance has raised the importance of quality procured materials, parts, and services, and elevated supplier relationships as a major component of quality management [3] [34]. Quality performance of suppliers is critical in many ways. For example, the quality of incoming material, parts, and components, determine the levels of SPC usage. Furthermore, quality of supplied parts impact the quality of the final product and therefore, the ability of a manufacturer to satisfy the needs and expectations of its customers. Additionally, knowledge and experience of the vendor has been found valuable during the initial design of new products and in the solution of problems to achieve high quality and faster response to market needs [22] [20] [47] [36] [31] [61] [90]. Supplier relationships with management have helped Japanese companies achieve world-class leadership. To obtain the best quality parts at a given price, Japanese managers promote long-term relationships and mutual cooperation with suppliers, extending from product development to manufacturing. In short, the vendor relationships in total quality management can be described as mutual trust and maximum cooperation within a long-term framework for the purpose of ensuring the greatest customer satisfaction.

Krause, Handfield, and Scannel [59] studied the importance of supplier development based on reactive and strategic processes and concluded that the strategic approach to these relationships provided significantly greater long-term benefits compared to the

reactive approach. Their work suggests that the approach to supplier relationships is a key component of organizational strategy. Additional research effort by Carr and Pearson [15] conclude that strategically managed long-term relationships with key suppliers can have a positive impact on a firm's performance. Further, that the investment made in these relationships may reduce transaction costs and result in higher levels of cooperation.

Investigation of the relationship between strategic quality planning and supplier based relationships therefore leads us to our first hypothesis:

H1: Strategic quality planning has a positive impact on supplier based relationships.

Impact of supplier relationship on product design

The importance of supplier relationships has also been studied in the context of its impact on product design, product innovation, and dependable product delivery capabilities [93] [84] [44]. In a study by Hartley, Zirger, and Lamath [44] management of the buyer-supplier interface lead to reduced supplier-related delays and over-all project related delays. In a generic new product design and development model proposed by Peters, Rooney, Rogerson, McQuarter, Spring, and Dale [71] supported the importance of common information and information management in the NPDD process. Research by Callahan and Moretton [12] concluded that supplier involvement in defining product requirements, system design and beta testing reduced development time. Furthermore, effective integration of suppliers into the product value/supply chain has been found to be a key for manufacturers in achieving the improvements necessary to remain competitive [42]. This work by Handfield, Ragatz, Petersen, and Monczka presented 17 case studies of manufacturing organizations. In 37.2% of these organizations supplier involvement as early as the concept development stage was reported.

The assurance of quality design of products affects internal quality performance and competitive capabilities through its effect on product manufacturability, product complexity, product reliability, product features, and product serviceability. Moreover, the efficiency of the manufacturing process is affected by considerations of producibility (materials, specifications, tolerances, etc.) at the product design stage. When the product components are designed in such way that they are easy to manufacture and assemble, the manufacturing process variance is reduced. As a consequence, the reduction in variance will be reflected on different measures of internal quality performance (waste, rework, cost, time, etc.). Furthermore, designs that reduce the complexity of the final product increase its reliability since fewer components typically lower failure rates. In addition, fewer components also

facilitate better coordination during the manufacturing process, reduce the manufacturing throughput time, and reduce the manufacturing cost. Of critical importance is the assurance of the incorporation of customer desired product features at the early design stage because it improves the quality, and enhances the value in the eyes of the customer, and minimizes changes during the production stage which affect the efficiency and productivity of the manufacturing process. The design of products' ease of use enhances the serviceability of the product, which is believed to impact the product's value perception by customers [45].

Brinton [11] reported supplier involvement as one of the keys to successful product development. Other important keys to success were top management support, strategic alignment, and focus on product definition. The importance of supplier involvement at the concept stage of product development was confirmed by Carbone [13] in an article on the development of medical technology. Research by Kessler [54] concluded that accessing external know-how is a key strategy for reducing or even eliminating costs at the development stage. This predominance of research supports the importance of suppliers in the product design process and leads us to our second hypothesis.

H2: Supplier based relationships have a positive impact on product design.

Supplier relationship and product innovation

Innovation has been defined as "the generation, acceptance and implementation of new ideas, processes, products or services for the first time within an organizational setting" [73] [94]. Other scholars have defined innovation as "the implementation of an internally generated or a borrowed idea whether pertaining to a product, service, system, process, policy, program, or service that is new to the organization at the time of adoption" [21]. In a manufacturing context product innovation may be summarized as the extent to which the manufacturing enterprise is capable of introducing new products and features in the market place [58] [18]. Knight [56] proposed a taxonomy based on four categories of innovation: product or service, production-process, organizational structure and people innovations while others propose a taxonomy classifying innovations as radical or incremental [23] [29] [30]. Radical innovations require fundamental changes in technology, where incremental innovations are small changes in existing technology. Product innovations fall into both categories. While existing products are incrementally improved with small changes and totally new products involve radical improvements or in some cases the creation of new technology.

The role of innovation in supporting the achievement of significant improvements in the capabilities of an organization were discussed by Schroeder, Scudder,

and Elm [86]. The research found that managers rely on quality improvement programs to help generate and implement new ideas to enhance the organization's competitive capabilities. In other research Bagchi-Sen [7] finds that small to medium-sized enterprises (SME's) with higher levels of product innovation use external service inputs for problem-solving and business development. This study examined the relationship between innovation and business performance in SME's and the competitive strategies and product innovation. It was reported that 63.7% of "high" innovators in the Niagara region of Canada regard quality, specialization, and delivery speed and after sales support as important competitive strategies. Annon [5] found that better supplier relationships create opportunities for both sides to innovate leading to improved performance. This study was based on an A.T. Kearney survey of 463 of the world's largest corporations. In a meeting of the Soap and Detergent Association [84] the SDA conference reported that association members rely on suppliers for help with innovation. The strong literature support for the connection between supplier based relationships to innovation brings us to the third hypothesis.

H3: Supplier based relationships have a positive impact on product innovation.

Importance of supplier relationship to delivery

The characteristics of dependable delivery includes the concepts of on-time, accurate quantity, and dependability. Hall [41] defines dependable delivery as "the extent (to which) a manufacturing enterprise is capable of providing on-time, the type and volume of products required by customer(s)". Dependability is viewed as the consistency of the company in performing at the time scheduled or promised. Hartley et al., [44] found that management of the buyer supplier relationship was effective at reducing supplier related delays. Supplier related delays effect the organizations internal customers by creating design, product introduction and production delays. For the same reasons the end (external) customers are also effected in a similar way. Other research reports that the delivery construct accounts for 21% of the variance underlying success factors for the JIT-P process [67]. Chamberlain [16] reports that supplier integration resulted in a 50% lead-time reduction with respect to "time to market" over three years in a study at Maytag. The strong literature support for the connection between supplier-based-relationships to dependable delivery brings us to the fourth hypotheses.

H4: Supplier based relationships have a positive impact on dependable deliveries.

Value to customer quality

The goal of any organization is to remain viable by providing its customers with products that are

competitive in every way with that of its competitors so as to insure survival of the organization. In this context TQM is viewed by many authors as a rational strategy to assure quality and customer value. As a construct value to customer quality may be defined as "the extent (to which) 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 [39] [6].

There is considerable literature support for the impact of product design, product innovation, and dependable delivery to value-to-customer quality. Rahman [77] concludes that quality is largely attributable to design. Product design has a direct effect on reliability, manufacturability, and cost therefore the effect on customer value is significant. Because of its relationship to manufacturability, design also effects delivery. Studies on Quality Function Deployment (QFD) techniques have also confirmed this relationship. Vonderembse and Raghunathan [98] report that QFD has a positive impact on developing product concepts and devising designs that meet customer quality and performance objectives. Studies have shown that while design cost may account for approximately 5 percent of product cost, 70 percent or more of the manufacturing process cost is determined in design [92]. In a study testing the links between TQM practices, customer satisfaction and organizational performance Agus, Krishman, and Kadir (2000) found customer satisfaction predicted by product quality, product features, product delivery, and product competitive pricing. These four predictor variables relate well to product design, product innovation, and dependable delivery. Product quality and cost is primarily driven by design, product features is determined by design and product innovation, and product delivery is a component of dependable delivery.

Kessler and Chakrabarti [53] concluded that high-level quality innovators often utilize a customer focus strategy. The study investigated the factors of strategic orientation and organizational capability that influence the quality of new product innovations. The customer focus strategy is consistent with the TQM goal of customer satisfaction. Both Deming [22] and Juran [48] promote customer satisfaction as the ultimate goal of TQM. Anderson and Sohal [4] in a study of the relationship between quality management practices and performance in small businesses found significant links between design, innovation, supplier relationships, management and process improvement and the quality of products and services to organizational performance. The literature support for the relationship between product design, product innovation, and dependable delivery to value-to-customer quality leads to hypotheses five, six, and seven.

H5: Product design has a positive impact on value to customer quality.

H6: Product innovation has a positive impact on value to customer quality.

H7: Dependable delivery has a positive impact on value to customer quality.

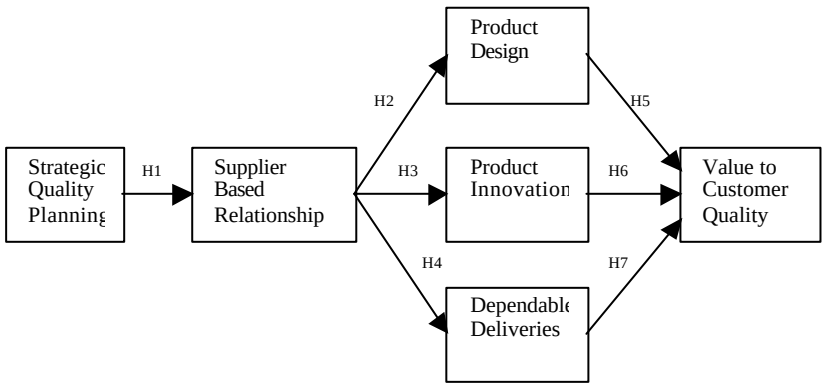
Hypotheses Summary

H1: *Strategic quality planning has a positive impact on supplier based relationships.*
H2: *Supplier based relationships have a positive impact on product design.*
H3*: Supplier based relationships have a positive impact on product innovation.*
H4*: Supplier based relationships have a positive impact on dependable deliveries.*
H5*: Product design has a positive impact on value to customer quality.*
H6*: Product innovation has a positive impact on value to customer quality.*
H7*: Dependable delivery has a positive impact on value to customer quality.*

The Model

While there have been several studies on the relationship between TQM practices and customer satisfaction, very little research has focused on the relationships among these TQM constructs. Our model hypothesizes that some TQM constructs may be important precedents and others are important antecedents of the overall relationship. The model is depicted in Figure 2 below.

Figure 2: Model and associated hypotheses



Data collection methodology and sample characteristics

The data collected here is from Solis [88] who used survey methodology. The survey was mailed to 2900 potential respondents from a mailing list provided by the Quality Management Division of American Society for Quality. The survey yielded 300 usable responses for a response rate of 10.4%. The majority of responses came from organizations with less than 500 employees (70.5%). Only 18% of the responses were from firms with more than 1000 employees. The respondent organizations covered SIC codes ranging between 2000 and 3900. Five manufacturing sectors accounted for 55.2% of the responses: chemicals, rubber and plastics, electronic products, food and kindred products and fabricated metal products. While the majority of respondents identified themselves as middle management level quality managers, 30% identified themselves as CEO' s, owners, presidents and vice-presidents.

Table 1: Survey Response by SIC Code

Respondents by SIC Code		
SIC Code	Name	Percent
3400	Fabricated metal products except machinery and transportation equipment	20.3
3600	Electric and other electronic equipment and components except computers	14.5
3000	Rubber and miscellaneous plastic products	11.6
2800	Chemical and allied products	9.1
2000	Food and kindred products	6.2
3900	Miscellaneous manufacturing industries	10.0
Others		24.7
Total		100.0

Table 2: Position

Respondents by Position	
Position	Percent
Top management	29.8
Middle management	61.8
Others	8.4
Total	100.0

Table 3: Firm Size

Firms by Size	
Number of employees	Percent
Up to 100	27.1
101 to 500	43.4
505 to 1000	11.1
1001 to 5000	10.8
Over 5000	7.6
Total	100.0

Analysis

The items used to measure each of the 6 constructs, and the data set for this research, are from prior research by Solis [88]. The construct validation process used in the prior research by Solis is summarized below. A five point Likert scale was utilized with the respondents indicating strong agreement (1) to strong disagreement (5) for each question. Organizational performance was evaluated based on the respondents perceived performance relative to their industry/competitors on the following scale: 1) much lower, 2) lower, 3) about the same, 4) higher, or 5) much higher. The items used to measure each of the seven

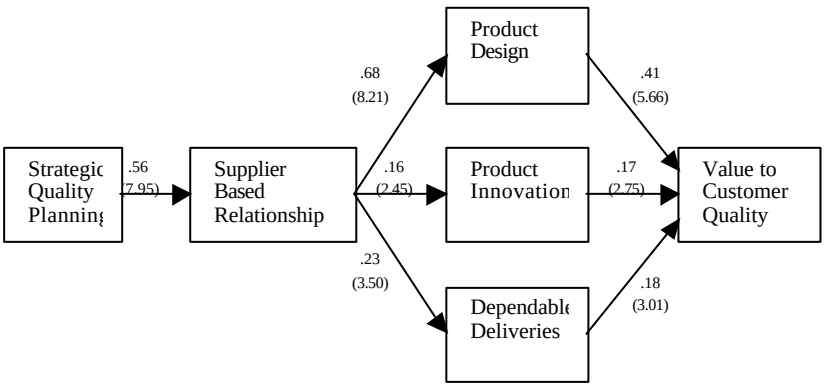
constructs are presented in appendix A.

Solis [88] tested each of the items in a pilot study using structured interviews and Q-sort methodology. The data were analyzed for simplicity of factor structure, purification, reliability, brevity, convergent validity, discriminent validity and predictive validity. Factor analysis was utilized to confirm the set of items for the seven constructs in the proposed model. Following Nunally' s [68] suggestion, eigenvalues greater than 1.0 was utilized as a general guideline for the number of factors to extract. Maximum likelihood was selected as the extraction procedure and the varimax method was utilized for factor rotation. Missing values in the data set were replaced with the variable mean for the item. Items which did not load at 0.60 or above or with cross-loadings greater than 0.40 were eliminated. Finally, the stability of the factors was analyzed by measuring the ratio of respondents to items, the Tinsley and Tinsley guideline of having a minimal ratio between 5 and 10 was followed.

Results and Discussion

To test the various hypotheses, the model proposed in Figure 2 was tested utilizing Structural Equation Modeling methodology. SEM is preferred over Factor Analysis methodology because of its ability to account for inter-item error correlations therefore enhancing the robustness and flexibility in establishing construct validity. The software employed was Lisrel 8.3 developed by Joreskog and Sorbom (1989). Detailed results for the model and all measurement items and constructs are summarized in Table 4. Overall, the results indicate significant relationships among all hypothesized relationships proposed by the model. Figure 3 shows the model with the structural path coefficients (ë) values and the corresponding t-values in parentheses.

Figure 3: Structural model with ë and t-values.



Tests for reliability and unidemensionality (convergent validity) are important in establishing construct validity. The reliability of the constructs was measured using Cronbach' s alpha. The values for the model constructs reported are; .89 for Strategic Quality Planning, .83 for Supplier Based Relationships, .85 for Product Design, .91 for Product Innovation, .92 for Dependable Deliveries, and .86 for Value to Customer Quality. All alpha values indicate good reliability.

Unidemsionality is indicated by the Goodness of Fit Index (GFI) and the Adjusted Goodness of Fit Index (AGFI). The GFI indicates the relative amount of variance and covariance jointly explained by the model: the AGFI differs form GFI in adjusting for the number of degrees of freedom. Analysis results indicate values of .89 and .87 for GFI and AGFI. Values approximating .9 or higher are considered evidence of good fit.

Table 4: Test results summary

Goodness-of-Fit Indices of the Model

Degrees of freedom	223
χ^2 Statistic	356.72
p-Value	0.00
χ^2 / df	1.60
Goodness of Fit Index (GFI)	0.90
Adjusted Goodness of Fit Index (AGFI)	0.88
RMSEA	0.045

Constructs and Items	Standardized loadings (ë)	Standard errors	Cronbach' s alpha (α)
a) Strategic quality planning			.89
SP1 long-term improvement efforts	.78	.39	
SP2 company policy support	.88	.22	
SP3 strategic plan integration	.90	.19	
b) Supplier based relationships			.83
SB1 quality based supplier selection	.66	.57	
SB2 long-term supplier focus	.77	.41	
SB3 confidence and trust	.80	.35	
SB4 supplier participation	.66	.57	
SB5 supplier continuous improvement	.67	.55	
c) Product design			.85
PD1 manufacturability	.68	.53	
PD2 supplier involvement	.75	.44	
PD3 customer-driven	.69	.52	
PD4 multi-disciplinary approach	.71	.50	
PD5 environmental and legal concerns	.57	.68	
d) Product Innovation			.91
PI1 new product features	.95	.09	

PI2 develop new products	.89	.20	
PI3 develop unique features	.80	.36	
e) Dependable deliveries			.92
DD1 provide dependable deliveries	.94	.12	
DD2 on-time deliveries	.95	.10	
DD3 correct quantity on-time	.81	.35	
f) Value to customer quality			.86
VCQ1 customer performance needs	.79	.36	
VCQ2 customer safe-to-use needs	.79	.36	
VCQ3 customer reliability needs	.78	.37	
VCQ4 meet pre-established standards	.70	.50	

The hypothesized relationship between strategic quality planning and supplier-based relationships was strongly supported by the model (ë=.56, t=7.95). We believed that this relationship existed based on the work of Krause et al., (1998), which suggests that the approach to supplier development is a key component of organizational strategy. We extended this to infer that supplier relationships are key to strategic quality planning as well. We also hypothesized that supplier relationships directly affected product design, product innovation and dependable deliveries. Support for these relationships were also confirmed by the results with strong support for the linkage from supplier relationships to product design (ë=.68, t=8.21). The support for the linkage to product innovation and dependable deliveries, while significant, were less strong.

The hypothesized relationship between supplier relationships and product design was based on prior work which linked successful product design and development to external suppliers that provide know-how [54], reduced supplier related delays [44] and reduced development time [12].

The hypothesized linkage between supplier relationships and product innovation, while significant (ë=.16, t=2.45) is only moderately supported by the results. One reason for this may be the differences between large organizations which internalize much of the innovation process and small to medium size enterprises (SMEs) which have been reported in literature to rely more heavily on external sources of innovation [7]. In our study we had a preponderance of SMEs, nearly 70%. Although other studies have reported reliance on suppliers by large organizations [84], only moderate support was found in our data.

Slightly stronger support is indicated for the linkage from supplier relationship to dependable delivery (ë=.23, t=3.50).

The linkages from product design, product innovation and dependable deliveries to value to customer quality are supported at similar levels as from supplier based relationships to these same three constructs. We found strong support for the linkage from product design to value-to-customer quality (ë=.41, t=5.66), weak support for product innovation to value-to-customer quality (ë=.17, t=2.75), and moderate support for dependable delivery to

value-to-customer quality (ë=.19, t=3.01).

Conclusion

In this study we developed and tested a model in which strategic quality planning was hypothesized to impact supplier-based relationships which in turn impacted product design, product innovation and dependable deliveries. We found these relationships supported by the data. We also tested the linkages from product design, product innovation, and dependable deliveries to value-to-customer quality. These linkages were also supported.

Significant managerial implications can be drawn from the study. First of all the strategic relevance of supplier relationships and its effect on processes within organizations implies that managers should actively be involved in the supplier selection process. Historically, the supplier selection has been performed by procurement and quality functions, which generally operate independently of internal process managers. This is not to say that internal managers have not been involved in this process but that their involvement has been largely reluctant and generally punitive in nature. Because of the impact that the suppliers have on the success of internal processes, which impact both the customer and the organizational performance, managers should be integrated into the supplier selection and relationship building process.

Future research should investigate the relationship between successful TQM and supply chain management practices including not only supplier relationships but other aspects of supply chain management. Another area of interest for future research is the connection between managers of internal processes (operational level managers) and their role in supplier selection and relationship building. This concept is important to organizational performance, which increasingly relies on the performance of suppliers.

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APPENDIX A

Strategic quality planning measurement items include responses to the following questions:

- SP1 Our strategic plan supports long-term (3 years of more) quality improvement efforts.
- SP2 Our strategic plan is supported by our company's quality mission and policies.
- SP3 In our strategic plan quality is an integral part.

Supplier based relationship items include responses to the following questions:

- SB1 Our primary criteria to select suppliers is quality not price.
- SB2 Our supplier relationships are focused on the long term.
- SB3 Our supplier relationships have achieved high levels of confidence and trust.
- SB4 Our suppliers readily participate in solving quality problems.
- SB5 Our suppliers are involved in our continuous improvement effort.

Product design items include responses to the following questions:

- PD1 Our product design process incorporates manufacturability as an important component.
- PD2 We involve external suppliers early in the product design.
- PD3 Our product design process applies customer-driven techniques (such as quality function deployment).
- PD4 Our product design process is supported by a multidisciplinary approach (marketing, manufacturing, R & D, etc.)
- PD5 Our product design process addresses environmental and legal concerns.

Product Innovation includes responses to the following questions:

- PI1 Our capability of developing a number of "new" product features is
- PI2 Our capability of developing a number of "new" products is
- PI3 Our capability of developing unique features is

Dependable Delivery items include responses to the following questions:

- DD1 Our capability of providing dependable deliveries is
- DD2 Our capability of providing on-time deliveries is
- DD3 Our capability of delivering the correct quantity of products needed on time is

Value to Customer Quality items include responses to the following questions:

- VCQ1 Our capability of offering products that perform according to customer needs is
- VCQ2 Our capability of offering products that meet customer's safe-to-use needs is
- VCQ3 Our capability of offering products that meet customer's reliability needs is
- VCQ4 Our capability of offering products that meet customer's pre-established standards is