The

Impact of Buyer-Supplier Relationships

on

Quality Practices and Quality Performance

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Abstract

The research questions addressed in this study are:
(a) to what extent do quality practices impact upon the various dimensions of quality performance and in turn, business performance?
(b) to what extent is the relationship between quality practices and quality performance contingent upon the nature of buyer-supplier relationships?

We undertook comprehensive reviews of the literature in the domains of both quality management and buyer-supplier relationships. The review of the quality management literature revealed that much of it is anecdotal, prescriptive and methodologically suspect, and that theory construction and rigorous empirical testing is a relatively recent development. On the other hand, the field of buyer-supplier relationship has evolved rather differently. This literature, which traditionally has attracted the attention of industrial and distribution channel marketing scholars, is more rigorous both in terms of theory construction and empirical testing.

Drawing on these reviews, we develop a theoretical model that integrates both the quality management and buyer-supplier relationship streams of research. The central proposition in our theoretical research model is that the strength of the relationship between buyer and supplier is a key intervening variable between quality practices and quality performance. This is operationalised as a path model incorporating quality practices, design quality, conformance quality, external quality-in-use, product cost, time-to-market, customer satisfaction and business performance. Fifteen hypotheses link these theoretical constructs.

The model was tested with data collected from 200 suppliers in the electronics sector in the Republic of Ireland. The analytical procedure used included reliability analysis, factor analysis, path (regression) analysis and sub-group analysis to test for the moderator effects of relationship strength. Data analysis of the data indicates that eleven of the hypotheses are supported. In particular, previously untested hypotheses incorporating design quality are supported. Similarly, the key hypothesis that buyer-supplier relationship strength moderated the quality practices-design relationship is also supported. An important contribution to knowledge of this study is that it provided the first empirical evidence that constructs from within the buyer-supplier

relational paradigm could explain the relationship between quality practices and design quality. In particular, the conceptualisation and measurement of design quality as a key dimension of quality performance, combined with the role of buyer-supplier relationships in product design and development, represents a new extension to theory development in this field. In addition, the study adds to existing theoretical development of the quality performance construct by including variables such as product cost and time-to-market. Methodologically, the study is amongst the first to use sub-group analysis to test for the moderating effects of a contingency variable in the field of quality management.

From a theoretical perspective, this study contributes to the development of quality management theory as well as the current debate on how the operations management discipline is broadening beyond its traditional functional remit to include concepts such as buyer-seller relationships. The results obtained also have practical implications for how supplier companies can consolidate customer relationships in the context of product quality. Likewise from a policy perspective, the results have implications for government agencies concerned with how linkages between indigenous suppliers and highly mobile multinational corporations can be enhanced, and thus contribute to industrial development and employment.

Introduction

The management of both quality and buyer-supplier relationships are issues that have attracted the attention of both academics and managers. From an academic perspective, theory development in quality management is of relatively recent vintage (e.g. Anderson *et al.*, 1994), while in contrast the area of buyer-supplier relationships has been the subject of rigorous theory building and testing for many years, particularly within the industrial marketing literature (Håkansson, 1982). From a management perspective, while many firms have invested substantial resources in adopting and implementing quality management programmes, the results have been mixed (The Economist, 1992). A key question then is under what circumstances will quality management practices impact on quality performance. The management of buyer-supplier relationships has also attracted the interest of managers. For instance, the Japanese concept of 'lean supply' based on close working relationships, transparency of information and devolution of design and engineering tasks further down the supply chain has implications for both buyers and

suppliers (Lamming, 1993). Buyers are concerned with getting the right quality product at the right price while suppliers are concerned with supplying the right quality product at a price that is profitable. Thus the interaction between quality and buyers-supplier relationships provides a fertile area for investigating *why* quality practices have an impact (or otherwise) on quality performance.

This paper aims to contribute to, and link the areas of quality management and buyer-supplier relationships. Indeed, Voss (1995) points out that the relationship between 'core' OM areas such as quality management and 'interface' disciplines such as networks and buyer-supplier relationships provides significant scope for further empirical research. However, with the exception of Forker (1997), there is little or no evidence of such empirical work. Accordingly, this study posits and tests an integrated theoretical framework based on both research areas. In doing so, we seek to address two broad research questions:

(a) to what extent do quality practices impact upon the various dimensions of quality performance, manufacturing performance, and in turn, business performance?
(b) to what extent is the relationship between quality practices and quality performance contingent upon the nature of buyer-supplier relationships?

In addressing these questions, we develop a conceptual framework, which draws on the contingency approach to research that is common in the strategy literature. The structure of such frameworks is that "when contingency theorists assert there is a relationship between two variables … which predicts a third variable … they are stating that an interaction exists between the first two variables" (Schoonhoven, 1981, p. 351).

The remainder of this paper is structured a s follows: firstly, we first review the literatures in both areas; secondly, we describe our methodology: thirdly we develop and test a model of quality practices, performance and buyer-supplier relationships; finally, we conclude with some reflections on the implications of our study.

Review of the Literature

Quality Management

While the academic literature on quality management can be traced back to the 1930s (Shewhart, 1931), much of the recent literature is anecdotal, prescriptive, methodologically suspect and atheoretical (Powell, 1995). In this context, one of the most problematic issues confronting the researcher in quality management is the search for an appropriate definition. Reeves and Bednar (1994) suggest a four-way classification of quality definitions that incorporates excellence, value, conformance to specifications and meeting and/or exceeding customer requirements. They argue that the diversity inherent in these definitions implies that the complexity and multiple perspectives historically associated with the concept have made theoretical and research advances difficult. What are the research implications of this complexity? Flynn et al. (1994) caution that a key issue in theory development is the "articulation of the distinction between quality management practices (input**)** and quality performance (output), which to date has been blurred under the broad heading of quality" (p. 340).

Empirical advances in the area initially focussed on the identification of core quality practices that included top management support, quality information, process management, product design, workforce management, supplier involvement and customer orientation (Flynn *et al.*, 1994; Black *et al.*, 1996). Subsequent empirical studies switched their focus to the quality practices - quality performance relationship and quality performance - business performance, relationship with significant support for the former but only mixed support for the latter (Ittner *et al.*, 1996; Adam *et al.*, 1997).

Whilst these studies are important in themselves, equally they prompt questions about the nature of quality performance and its various dimensions. In this regard, Flynn, et al. (1997) emphasised the need to distinguish between *internal* quality performance in the plant (conformance to specification) and *external* quality performance in the marketplace (quality-in-use and customer satisfaction). Internal quality performance incorporates both design quality and conformance quality while external quality performance incorporates quality-in-use and customer value and satisfaction (Fujimoto, 1989). Furthermore, while a number of studies have addressed the relationship between the various dimensions of quality performance (Choi *et al.*, 1998; Forza *et al.*, 1998), design quality in particular has received relatively scant attention in the literature with the exception of Garvin (1986) and

Clark (1987). This is somewhat surprising given that as much as 85 per cent of total product costs are committed by the time early product design is completed (Fleischer *et al.*, 1992). Furthermore, design is not only a cost driver; it is also recognised as a major determinant of quality because "quality is *designed into* the product … and good design contributes to a firm's ability to develop and produce new products more quickly by minimising engineering changes which delay production. Thus design makes major contributions to the three primary outcomes of cost, quality and timeliness" (Fleischer *et al.*, 1992, p. 254). Design quality incorporates elements of both engineering design (the development of a product from its technical conception through detail design and the design of the related manufacturing process and tooling) and industrial design (styling and aesthetics) (Dixon *et al.*, 1990). As such the negligible attention paid to design quality as a key construct in the domain of quality performance represents a significant gap in the literature.

Likewise, there have been very few empirical studies of the effects of contingency variables on the relationship between quality practices and quality performance. Forker (1997) investigated the impact of suppliers on the relationship between quality practices and quality performance. Significantly, she concluded that efficient quality management further up the supply chain was one of the most significant contributors to explaining variation in supplier quality performance underlines the importance of managing quality throughout the value chain. However this study is somewhat uni-dimensional in its definition and measurement of both buyer-seller relationships and quality performance. As such, the relationships between quality practices, quality performance (particularly design quality) and buyer-supplier relationships are worthy of further attention.

Buyer-Supplier Relationships

The study of buyer-seller relationships is grounded in some well-established frameworks in such as transaction cost theory, political economy theory, social exchange theory and resource dependence theory (Robicheaux *et al.*, 1994). In addition, empirical models, drawing on a variety of management disciplines have been proposed and tested in the literature. These include the IMP (Industrial Marketing and Purchasing Group) interaction model (Håkansson, 1982), network models (Jarillo, 1988), channel models (Heide *et al.*, 1992) and partnership models (Helper *et al.*, 1995). These studies differ somewhat in their

approach to purpose (descriptive versus theoretical), research design (cross-sectional versus longitudinal), unit of analysis (firm, dyad or network) and schools of thought (European and North American). Is there any evidence of convergence between these models? Wilson and Kristan Moller (1991, p. 103) conclude that a relational paradigm has emerged from the various research streams and note that "what becomes apparent is the number of constructs that are shared in the different models".

Empirical models of buyer-supplier relationships, while divergent in many respects, complement each other in terms of the relationship dimensions considered. In their review of seven of the most influential studies of the 'relational paradigm', Wilson and Moller (1991) identify trust as the most frequently used dimension. Other frequently cited dimensions were satisfaction, adaptation/transaction specific investments, power/dependence, communication, commitment and co-operation. We now consider each of these dimensions in more detail more detail.

Trust has been defined as "the firm's belief that that another company will perform actions that will result in positive actions for the firm, as well as not take unexpected actions that would result in negative outcomes for the firm" (Anderson *et al.*, 1990, p.45). This is because the presence of trust can reduce the specification and monitoring of contracts, provide material incentives for co-operation, and reduce uncertainty (Hill, 1990). *Adaptation* occurs when suppliers adapt to the needs of specific important customers and that customers adapt to the capabilities of specific suppliers (Hallén *et al.*, 1991). Such adaptation frequently occurs by way of investing in transaction specific assets such as product/process technology and human resources (Håkansson, 1982). *Satisfaction* is the positive feeling that results from an evaluation of all aspects of an exchange relationship (Wilson *et al.*, 1991). The domain of satisfaction includes all of the characteristics the relationship that a firm considers to be, on the one hand rewarding, profitable and of value, and on the other hand, costly, unfair or frustrating (Rukert *et al.*, 1984; Ping, 1993). *Communication* has been defined as "the formal as well as informal sharing of meaningful and timely information between firms" (Anderson *et al.*, 1990, p. 44). Frequent and timely communication is important because it assists in resolving disputes and aligning perceptions and expectations (Morgan *et al.*, 1994). Effective communication is therefore essential for successful collaboration. *Power/dependence* is also an important dimension of relationships. Power is a function of the extent to which two members in a channel are dependent on each other for satisfaction of

their goals and the relative sources/bases of each channel member's power (El-Ansary *et al.*, 1972). Dependence refers to a firm's need to maintain an exchange relationship to achieve desired goals (Frazier *et al.*, 1991). In exchange relationships, both parties may be, to some degree, dependent on each other (Gundlach *et al.*, 1994). The structure (magnitude and relative symmetry) of this 'reciprocal' dependence characterises the level of *interdependenc*e in the relationship and has important implications for interaction (Mohr *et al.*, 1994). *Commitment* has been defined as "an implicit or explicit pledge of relational continuity between exchange partners" (Dwyer *et al.*, 1987, p. 19). It refers to the willingness of trading partners to exert effort on behalf of the relationship and suggests a future orientation in which firms attempt to build a relationship that can be sustained in the face of unanticipated problems. There is thus a temporal dimension to commitment associated with the duration or age of the relationship. *Co-operation* refers to situations in which firms work together to achieve mutual goals (Anderson *et al.*, 1990). De Toni et al. (1994) argue that the form of co-operation that characterises the partnership model of buyer-supplier relationships does not necessarily mean harmonious collaboration, with unconditional faith in each party. They suggest that lean supply model's emphasis on efficient and transparent supplier evaluation and control systems with contractual obligations on the part of the supplier to reduce prices over time is evidence of a tightly controlled competitive discipline within an exchange relationship.

Do the dimensions complement each other? Mohr and Spekmans' (1994) empirical findings suggest significant positive correlation between the dimensions of buyer-supplier relationships. Likewise Monckza et al. (1995) found that such dimensions reinforce each other in terms of enhanced buyer-seller relationships. As such, the comprehensive measurement of buyer-supplier relationships should include these dimensions. However, while many empirical studies have tended to focus on individual relational dimensions, very few have incorporated an aggregate measure.

Accordingly, we propose therefore, that these dimensions are strong indicators of a higher order construct that we will refer to as *relationship strength.* We define relationship strength as the degree to which both parties in a relationship are engaged in an active, long-term working relationship and operationalise the construct using indicators of communication, trust, communication, commitment, interdependence, solidarity, satisfaction and co-operation (Figure 1). This definition is compatible with well-established approaches such as Sako's

(1992) obligational contract relations (OCR)-arm's length contract relations (ACR) framework and Ellram and Krause's (1994) partner-adversary framework. Relationships, which score positively on strength, would typically display OCR/partnership characteristics and *vice versa*.

Take in Figure 1

Our conceptualisation of research strength is intended to capture the dimensions of a given buyer-supplier relationship *at a given point in time*. Thus, while we acknowledge that all relationships may be influenced by past, present and future events, we believe that a comprehensive measure such as relationship strength substantially captures such temporal dimensions.

Research Hypotheses

The foregoing reviews identify gaps in both the quality management and buyer-supplier literatures that reinforce the importance of addressing the research questions posed at the beginning of this paper. We now restate these questions as a sequence of specific hypotheses and present our research model incorporating the contingency effects of buyer supplier relationships.

We argued in our review of the literature of the need to deconstruct quality performance into its constituent dimensions. We now posit that quality practices initially have a *direct* effect on both internal quality performance (design quality and conformance quality) which then in turn *indirectly* impacts upon external quality (quality-in-use and customer satisfaction). The empirical studies reviewed all support the relationship between quality practices and conformance quality. Furthermore, empirical evidence (see Hanson *et al.*, 1996) suggests that designing quality into a product can have a positive impact on conformance quality. This gives:

H1a: Quality practices have a positive effect on conformance quality.

H1b: Design quality has a positive effect on conformance quality.

Likewise, Fujimoto's (1989) work supports a hypothesised relationship between quality practices and design quality. Formally, this gives:

H2: Quality practices have a positive effect on design quality.

Voss and Blackmon (1994) found that internal conformance quality impacts upon external quality-in-use. We further posit that external quality-in-use is dependent on both design quality and conformance quality on the basis that the better the design specification and the better the manufacturing process, the better the quality of the product when it is in use. This gives:

H3a: Design quality has a positive effect on quality-in-use.

H3b: Conformance quality has a positive effect on quality-in-use.

The relationships between design quality, conformance quality and product cost have received considerable attention in the cost of quality literature. Juran (1986) has consistently argued that better quality practices can reduce the cost associated with quality prevention, inspection, appraisal and warranty returns. In addition, the adoption of techniques such as value engineering, DFM and quality function deployment (QFD) suggests that design quality also has an inverse relationship with product cost. Finally, the "80/20" rule, which posits that 80 per cent of manufacturing costs are committed at the design stage (Fleischer *et al.*, 1992) suggests that the effect of design quality on cost will be greater than the corresponding conformance quality effect. This gives:

H4a: Design quality has a negative effect on product cost.

H4b: Conformance quality has a negative effect on product cost.

H4c: Design quality has a stronger effect than conformance quality on product cost.

Voss and Blackmon (1994), in emphasising the importance of customer-driven definitions of quality, found a significant relationship between quality-in-use and customer satisfaction. We further posit that customer satisfaction is inversely related to product cost (or price from the customer's perspective) because measures of satisfaction can incorporate both quality and cost dimensions (Choi *et al.*, 1998). In addition, customer satisfaction may be enhanced through improved availability because the product is more quickly available in the marketplace. Formally, this gives:

H5a: Quality-in-use has a positive effect on customer satisfaction.

H5b: Product cost has a negative effect on customer satisfaction.

H5c: Time-to-market has a positive effect on customer satisfaction.

The impact of good design practices is not restricted to quality and cost dimensions; it can also significantly impact on time-to-market (De Meyer *et al.*, 1990). Accordingly, we hypothesise that:

H6: Design quality has a positive effect (i.e. reduces) on time-to-market.

A number of empirical studies in both the operations management literature have addressed the impact of quality performance on overall business performance (Dale *et al.*, 1992; Voss *et al.*, 1994). While there is mixed empirical support for this hypothesis, it is of particular significance to management given the effort and resources dedicated to quality improvement programmes. This gives:

H7: Customer satisfaction has a positive effect on business performance.

With the exception of Forker's (1997) study, there has been no major empirical study of the interaction between quality practices, quality performances and the strength of buyer-supplier relationships. We also observed that one of the major weaknesses of existing studies is their limited conceptualisation of the nature of buyer-supplier relationships. As a result, we posited relationship strength as a comprehensive construct that captured the critical dimensions of relationships. We now hypothesise that the relationships between quality practices and design quality, and quality practices and conformance quality are moderated by relationship strength. The rationale for this hypothesis is that strong partnership-type relationships, which score positively across all dimensions of a buyer-supplier relationship, will have a positive impact on the relationship between quality practices and design quality and conformance quality. We focus on the moderator effects specifically on these two relationships (rather than other quality performance constructs) because we believe that relational exchange with regard to product and process development can particularly impact upon design quality and conformance quality. Formally, this gives:

H8a: Relationship strength moderates the relationship between quality practices and design quality.

H8b: Relationship strength moderates the relationship between quality practices and conformance quality.

Figure 2 incorporates these hypotheses sequentially.

Take in Figure 2

Methodology

The population chosen for this study was manufacturing companies in the electronics sector in the Republic of Ireland. This sector was selected because it is not subject to the same level of regulation as other sectors such as pharmaceuticals while also being heterogeneous in terms of sub-sectors, relationship tiers and product/process complexity (Dicken, 1998). In order to establish the size of the survey population databases from the Irish Trade Board and Enterprise Ireland were consulted. This produced an initial listing of 821 companies. Plants with less than fifteen employees were excluded because the management of operations and quality practices is typically less structured at such sites (Voss *et al.,* 1995). Telephone contact was established with each of these companies and the key informant (i.e. the individual with a detailed knowledge of quality practices, quality performance, business performance and buyer-supplier relationships) was identified. From the initial frame of 821 companies, 283 were removed from the sample as they were inappropriate.

The instrument used to test the stated hypotheses was a mail survey. A questionnaire based on existing measurement scales for the research constructs (see Appendix 1) was initially drafted. This draft questionnaire then was pre-tested and piloted before mailing. Two repeat mailings of the instrument were carried out to improve the overall response rate. Each of the remaining 538 companies were then sent a copy of the questionnaire. A total of 202 questionnaires were returned, of which 200 were usable giving an overall response rate of 38%.

From a methodological perspective, buyer-supplier relationships can also be studied using different units of analysis such as a single party, both parties (the dyad) or multiple parties (the network). Measuring relationship strength is further confounded by the fact that many suppliers frequently supply their customers with different types of product, and these relationships differ according to product type. For the purposes of this study, we adopted the approach used by Sako, Lamming and Helper (1994), where respondents were asked to reply to questions with respect to the basis of the most important or *focal* customer-product relationship.

Analysis and Discussion

Descriptive and Focal Customer Characteristics

The degree to which the sample is representative of the population was addressed by carrying out a series of standard chi-square goodness-of-fit tests with respect to employee numbers, plant ownership and plant age. For each of the characteristics, we found no significant difference between the population percentages and the sample percentages. This suggests that the sample response profile is not significantly different from the population profile and that the sample is broadly representative on key variables.

The descriptive data collected (plant size, ownership) confirmed much of what is already known about the electronics sector in Ireland in terms of industry structure. On the one hand, the majority of companies are relatively small, independently owned indigenous operations, and, on the other, there are a smaller number of larger plants that are subsidiaries of overseas companies. With respect to the key informant, just over 90 per cent of respondents were either quality managers or operations/plant managers.

Reliability and Factor Analysis

Appendix 1 shows that the quality practice scales adapted from Flynn Schroeder and Sakakibara (1994) have Cronbach α values of 0.70 or greater. Only four items, QIR3, FB3, FB6 and NPQ2, displayed low item total correlation co-efficients, and were subsequently removed from the scale for purposes of analysis. With respect to the quality performance scales, all generate α values in excess of 0.70 with the exception of engineering design. However, given that this is a new scale and its α value is greater than 0.60, we have included it. Other scales dropped were TRT5, INDP1, INDP2, COMM7 and COMM8. Factor analysis using principal components with no rotation was performed separately for each construct; the factor analysis results supported the uni-dimensionality of the set of measurement statements for each construct.

Hypothesis Testing

The hypothesised relationships between the various constructs were tested using regression analysis. All variables were standardised to conform to a standard normal distribution, following the requirements of regression analysis (Heise, 1969). We also tested the model

for the control variables of size (number of employees), ownership (domestic or foreign) and markets served (domestic or foreign) and found no significant effects. In addition, residual and multicollinearity analysis indicated the model's robustness. The correlation/covariance matrix for the regression model is shown in Table I. The covariances are shown above the diagonal and the correlation coefficients below the diagonal. Correlation coefficients greater than 0.152 are significant at the 5 per cent level and greater than 0.182 are significant at the 1 per cent level. Correlation coefficients for hypothesised relationships are in bold. An examination of Table I provides preliminary support for the model, with the exception of the relationship between customer satisfaction and business performance.

Take in Table I

The standardised regression coefficients (betas) and coefficients of determination (R^2) are shown in Tables II and III. The significance of the hypotheses was tested using t-statistic, with beta estimates considered significantly different from zero when $t > 1.96$ ($p < 0.05$). For hypothesis H4c, which compares the relative strength of effects, a one-tailed test was used with $t > 1.65$ ($p < 0.05$). The analysis reveals that eleven of the fourteen hypotheses are supported at the 5 per cent level. The data thus provides broad support for the overall model with just a few exceptions.

Take in Tables II and III

Both hypotheses linking quality practices with conformance quality (H1a) and design quality with conformance quality (H1b) are supported. While the former has been tested and strongly supported in previous studies, the latter provides has not and thus provides an additional insight into the relationship between these two measures of internal quality performance. This finding thus provided strong support for the argument that the use of techniques such as design for manufacturability (DFM) and Taguchi methods impact strongly on conformance quality. Furthermore, as with H1a, the relationship between quality practices and design quality is significant (H2). While Clark *et al.* (1987) provided *prima facie* support for this finding using a ranking approach, the testing procedure used in this study was more rigorous in terms of statistical procedure and analysis. Furthermore, the hypothesis that quality practices related to new product development (e.g. the use of cross-functional teams, frequent design reviews) indirectly impact on time-to-market

through improved design quality (H6) is supported. However this effect is not carried through to customer satisfaction (H5c).

The effect of both conformance quality and design quality on quality-in-use is both significant and positive. As before, the former (H3b) has been previously found significant in the literature while the latter (H3a) represents a previously untested relationship. This finding further reinforces the contribution of design quality to other measures of quality performance. Thus the notion of "doing it right first time" reflects the value of designing quality into a product at the early stages of product design and development. Overall, 50.4% of the variation in quality-in-use is explained by design quality and conformance quality. This represents the strongest coefficient of determination in the model and may be explained by the fact that both the dependent and independent variables are all measures of quality performance.

Another important finding relates to the 'cost of quality' argument that appears in the quality literature. The basis of this argument is that higher levels of product quality can reduce unit manufacturing costs. While the conformance quality-cost relationship is supported (H4a), our study indicates that, additionally, design quality had a significant inverse effect on product cost (H4b). However, our hypothesis that the design quality effect on product cost would be greater than the conformance quality effect was not supported (H4c). This may possibly be explained by the relatively low usage of practices such as value analysis/engineering among our survey respondents

Turning to the impact of cost on quality performance, we found that low levels of product cost when coupled with higher levels of external quality-in-use, lead to higher levels of customer satisfaction (H5a and H5b). This extends the traditional 'improved conformance quality-lower manufacturing cost' argument to include customer-based measures of quality performance such as satisfaction which incorporates *both* price (which is based on manufacturing cost) and quality-in-use. Indeed our conceptualisation and measurement of customer satisfaction may be an indicator of value. This is an interesting insight because economists have traditionally ignored the role of quality in purchasing behaviour while researchers investigating quality have, to a considerable extent, ignored the role of price (Reeves *et al.*, 1994).

Likewise, our study did not produce any evidence to support the hypothesis that improved quality performance is positively related to improved overall business performance (H7). This may seem counterintuitive in the context of previous research such as the profit impact of market strategy (PIMS) studies which provide support for the relationship between product quality and firm performance (Buzzel *et al.*, 1981). However our findings are more consistent with the more recent work of Ittner and Larcker (1996) which indicated mixed results linking self-reported quality performance with financial performance. A possible explanation for such contrasting views lies the argument that the role of quality performance has changed from that of order-winner to order-qualifier, and as such is a necessary but not sufficient contributor to overall business performance. Alternatively, the explanation may lie in how quality performance and business performances are measured. In this regard Ittner and Larcker (1996) also found that quality and customer satisfaction measures, when estimated from consumers with actual product experience and computed using sophisticated econometric methods, are predictive of future changes in shareholder value. Accordingly, adopting objective rather than subjective measures of performance may ultimately provide more revealing insights.

Hypothesis Testing: Moderator Effects

The first step in testing for moderator effects was to calculate the construct means, standard deviations and the correlation/covariance matrix for the relationship constructs (Table IV). As with quality practices, the means were calculated as an equally weighted average of the item scores. Likewise, the mean for relationship strength is calculated as an equally weighted average of the individual relationship construct means. The mean relationship strength score was 2.34 with a standard deviation of 0.46. Coupled with the fact that the mean for four of the seven relationship constructs (commitment, communication, satisfaction and trust) had even smaller means than 2.34, and only co-operation (with a mean of 3.02), exceeded the median point of the scale, indicates that partnership forms of buyer-supplier relationships in the electronics may not be as sophisticated as it is sometimes claimed.

Take in Table IV

Correlations are shown below the diagonal and covariances above the diagonal in Table 4. With the sole exception of the association between satisfaction and interdependence, all correlation coefficients are significant at the 1 per cent level. This provides support for our

argument that the relationship strength construct incorporates the various relationship dimensions that have appeared in the literature.

Sub-group analysis was used to test the moderating effect of buyer-supplier relationship strength. A moderator effect implies that the moderator variable (relationship strength) modifies the form of the relationship (i.e. the slope of the regression line as represented by the regression coefficient) between the independent variable (quality practices) and the dependent variable (quality performance) (Sharma *et al.*, 1981). Accordingly, the sample was sorted in ascending order of the hypothesised moderator (relationship strength). Relationship strength scores were used to trichotomise the sample. The top and bottom terciles of cases were selected so as to obtain two subgroups reflecting high and low scores on the moderator. This procedure provided two subgroups, labelled 'high' relationship strength and 'low' relationship strength. A Chow test was then used to test whether or not both subgroups are significantly different with respect to the quality practices-design quality and quality practices-conformance quality relationships (Chow, 1960). Table V shows the results of the Chow test.

Take in Table V

The hypothesis (H8a) that relationship strength moderates the quality practices-design quality relationship is supported at the 5 per cent level as the observed F value of 7.88 exceeds the critical value of 3.05 (i.e. there is a significant difference between the regression coefficients). On the other hand, the hypothesis (H8b) that relationship strength moderates the quality practices-conformance quality relationship is not supported at the 5 per cent level as the observed F value of 2.69 is less than the critical value of 3.05 (i.e. there is not a significant difference between the regression coefficients).

Overall then, the results from the analysis of the moderator effects are somewhat mixed. On the one hand, our central proposition that companies that have developed strong relationships with their customers will see significant improvements in design quality is supported. This finding underpins the arguments developed in our model and points to the importance of addressing the potential effects of moderating variables. On the other hand, relationship strength does not moderate the quality practices-conformance quality relationship. A possible explanation for this finding is that conformance quality, while perhaps more critical

a decade ago, may be evolving from ‘order winner’ to ‘order qualifier’ status where high conformance to standards is a prerequisite for even being in the marketplace (Flynn *et al.*, 1997). Thus, achieving high levels of conformance quality is a fundamental competitive pre-requisite, irrespective of the nature and strength of a business-to-business relationship with a focal customer.

In contrast, design quality has more of the characteristics of an 'order-winner'. By developing and engaging in true partnership types of buyer-seller relationships, suppliers can become much more involved in the design and new product development process. As more and more of design responsibility devolves to such suppliers, customers will recognise their competitive edge with respect to design capability. Suppliers with such design capability can thus contribute much more than merely conforming to a manufacturing specification. Demonstrating more than just basic manufacturing competence, they can provide a significant contribution to the new product development processes of their customers and, in doing so, further consolidate such relationships. Such consolidation can lead to a virtuous circle of interdependence whereby even greater design responsibility is devolved in subsequent new product introductions.

Implications and Conclusion

This study adds to the emerging literature at the interface of quality management and buyer-supplier relationships. It is also one of the first studies to incorporate design quality as a pivotal dimension of quality performance. Previous studies, while considering this construct, have not addressed it as comprehensively (see Clark *et al.*, 1987; Forker *et al.*, 1996). Its inclusion in our research model, its operationalisation and measurement, and the study findings in relation to a number of key hypotheses represents an important extension of Voss and Blackmon's (1994) conceptualisation of quality performance. More specifically, its significant impact on conformance quality, product cost, external quality-in-use and time-to-market all support the arguments from the literature in support of the 'enabling' role of design quality.

What then are the implications for quality management theory? The first implication is the need to comprehensively address the various dimensions of quality performance. On the one hand, most studies to date have focussed on quality practices, and more recently, the

relationship between various quality practices. On the other hand, this study has identified critical relationships between various dimensions of quality performance. Ultimately however, if a theory of quality management is to emerge, it will be necessary to combine both approaches.

The relationship between quality performance and business performance also needs to be considered from a theoretical perspective. Neither this study nor previous empirical research has provided strong support for a quality performance-business performance relationship. While it is acknowledged that many factors outside of the domain of operations management influence business performance, theoretical conceptualisations of the relationships between quality performance, operational performance and business performance would further enhance our understanding of such phenomena.

This study also has implications for both operations and marketing managers. From the supplier's perspective, the first implication is the need to recognise the central role design quality plays in the overall spectrum of quality performance. Not only is it necessary to focus on quality practices which have a direct impact on design quality; in addition, firms must recognise the influential role of design quality on other measures of quality performance such as conformance quality and external quality-in-use. As we argued above, conformance quality is more likely to be an 'order-qualifier'. Design quality, however, has more the hallmarks of an 'order-winner'.

The second, and related, implication for suppliers is with respect to the development of buyer-seller relationships. The results suggest that one way suppliers can improve design quality and related measures of quality performance is through forging closer linkages with customers. By developing trust and commitment, adapting to each other's needs and improving communication and co-operation, a stronger relationship should emerge which ultimately will create a closer bonding between supplier and customer. This in itself could be self-perpetuating, because if stronger relationships ultimately improve customer satisfaction, it is also probable that the effect will be reciprocated.

The third implication for suppliers points to the need to consider other measures of manufacturing performance if overall business performance is to improve. The results of this, and other studies have indicated that quality performance alone does not explain

business performance. From a manufacturing perspective, firms must also consider other measures of manufacturing and operational performance such as flexibility, dependability and customer service. Thus, by focusing on improvements across a broader selection of measures of manufacturing performance, firms could possibly see improvements in 'bottom-line' results.

The study also has implications for the customers of supplier companies. There is considerable evidence in the literature that new product development is more and more becoming a boundary spanning process involving many companies. While this typically has taken the form of joint ventures, mergers and acquisitions or research consortia, partnership models of joint product development are becoming increasingly popular (Millson *et al.*, 1996). Increasingly, multinational enterprises also need to consider supplier linkages in product development. Although the process of relationship formation and development may be less critical in instances where a simple production task is subcontracted, nonetheless, in situations involving more complex product and process technology, customers of supplier companies will need to address how supplier relationships are managed.

There are also a number of limitations associated with this study. These relate to the currency of the sampling frame, the use of the focal or “most important” customer and relying on a single key informant’s perceptions. In addition, it can be argued that the perceptions of relationship in our study are somewhat one-sided in that they represent the views of just one party and ignore the views of customers. However, this limitation implicitly suggests a significantly different research design based on the relationship dyad (in itself, not without difficulties in terms of sample size, dyad access, confidentiality and accuracy of response). Finally, while it is probably true that quality managers would be familiar with measures of internal conformance, it can be argued that they would be less well informed with regard to measures of design quality, external quality-in-use and customer satisfaction and that objective measures of quality or customer perceptions of quality performance would be more appropriate in such instances.

Finally, this study also points to areas of potential future research. As is often the case, longitudinal research could provide valuable contributions to theory development and refinement in the fields of quality management. There is a considerable body of

knowledge in the quality management literature which suggests that best quality practices evolve over a considerable period of time within companies and that different challenges are faced at different points in time (see Wacker *et al.*, 1994). Research from the customer's perspective would complement and add to the findings of this study. Future research could examine issues such as customer perceptions of quality, and business performance. The impact of other contingency variables on the quality practices-quality performance relationship should also be considered given the findings of this study. Identifying the circumstances or variables that have an intervening effect on the quality practice-quality performance relationship could provide both the academic and practitioner communities with potentially compelling answers to the question of *why* quality improvement programmes sometimes fail.

Appendix A

Construct Items, Sources and Cronbach α Scores

Item	Quality Practices **(Flynn *et al.*, 1994)**
	Customer Involvement (α = 0. 70)
CI1	Our customers seldom visit our plant (R)
CI2	Our customers give us feedback on quality and delivery performance
CI3	We are frequently in close contact with our customers
	Feedback (α = 0. 74)
FB1	Charts plotting the frequency of machine breakdowns are posted on the shopfloor
FB2	Charts showing defect rates are posted on the shop floor
FB3*	Employees are never told whether or not they are doing a good job (R)
FB4	Information on quality performance is readily available to employees
FB5	Charts showing schedule compliance are posted on the shopfloor
FB6*	Management never comments about the quality of employees' work (R)
FB7	Information on productivity is readily available to employees
	Interfunctional Design Process (α = 0. 73)
IDP1	Direct labour employees are involved to a great extent (on teams, or consulted) before introducing new products or making product changes
IDP2	Manufacturing engineers are involved to a great extent before the introduction of new products
IDP3	There is little involvement of manufacturing and quality people in the early design of products, before they reach the plant (R)
IDP4	We work in teams, with members from a variety of areas (marketing, manufacturing etc.) involved in the introduction of new products
	New Product Quality (α = 0. 81*)*
NPQ1	Customer requirements are thoroughly analysed in the new product design process
NPQ2*	New product designs are thoroughly reviewed before the product is produced and sold
NPQ3	Reducing the cost of new products is a more important priority than new product quality (R)
NPQ4	In the new product development process, schedule concerns are more important than quality (R)
	Process Control (α = 0. 70)

PC1	A large percentage of the processes or equipment on the shopfloor are currently subject to statistical quality control procedures
PC2	Processes in our plant are designed to be robust
PC3	We make extensive use of statistical techniques to identify and reduce variance in processes
	Process Management (α = 0. 73)
PM1	Our plant is disorganised and dirty (R)
PM2	Our plant is kept clean at all times
PM3	Employees often have trouble finding the tools/equipment they need (R)
PM4	Our plant emphasises the importance of good housekeeping with tools and fixtures in their normal storage location
PM5	We take pride in keeping our plant neat and clean
	Quality Improvement Rewards (α = 0. 76)
QIR1	If an employee improves quality, management will reward him/her
QIR2	Non-financial incentives are used to reward quality improvement
QIR3*	Our plant has an annual bonus system based on plant productivity
QIR4	Supervisors are rewarded for quality improvement
QIR4	We pay a group incentive for quality improvement ideas
QIR6	Workers are rewarded for quality improvement
	Quality Leadership (α = 0. 72)
QL1	All managers within our plant accept their responsibility for quality
QL2	All managers within our plant work towards encouraging just-in-time production
QL3	At plant level, management provides personal leadership for quality products and quality improvement
QL4	The top priority in evaluating plant management is quality performance
QL5	Top management strongly encourages employee involvement in the production process
	Supplier Involvement (α = 0. 70)
SI1	Our suppliers are actively involved in our new product development process
SI2	Quality is our number one criterion in selecting suppliers
SI3	We rely on a small number of high quality suppliers
SI4	We strive to establish long-term relationships with suppliers
	Selection for Teamwork Potential (α = 0. 70*)*

STP1	We use ability to work in a team as a criterion in employee selection
STP2	We use problem-solving ability as a criterion in selecting employees
STP3	We use work values and ethics as a criterion in employee selection
	Teamwork (α = 0. 71*)*
TW1	During problem solving sessions, we make an effort to get all team members opinions and ideas before making a decision
TW2	In the past three years, many problems have been solved through small team sessions
TW3	Our plant forms teams in order to solve problems
TW4	Our plant is organised into permanent production teams
	Conformance Quality (α = 0. 82) **(Voss *et al.*, 1994)**
COQU1	Internal scrap and rework costs as a % of product cost
COQU2	Internal yield on new product introduction
COQU3	Defect rate for this product at final inspection
	Cost
COST	Unit cost of the product over its life cycle
	Customer Satisfaction (α = 0. 78) **(Voss *et al.*, 1994)**
CSAS1	Frequency of customer complaints
CSAS2	Adequacy of customer complaint tracking/feedback systems
	Design Quality: Engineering Design (α = 0. 69) *and Industrial Design* (α = 0. 71) **(Fleischer *et al.*, 1992)**, Pre-test interviews
EDQ1	Average number of engineering change orders in first year after product introduction due to production problems
EDQ2	Technical performance
EDQ3	Meets the customers criteria for material, design and cost
EDQ4	Meets the criteria for ease of production or assembly
IDQ1	Unique features to provide for special customer requirements
IDQ2	Matches the requirements of the customer's production process
	External Quality-in-Use (α = 0. 84) **(Voss *et al.*, 1994)**
QUSE1	Product failure rates in use
QUSE2	Frequency of product recalls
	Time-to-Market
TIME	Speed of new product development

Business Performance (α = 0. 86) **(Maani *et al.*, 1994)**

PERF1 Growth in return on investment

PERF2 Growth in sales

PERF3 Growth in earnings before tax

PERF4 Growth in market share

Adaptation (α = 0. 80) (Heide *et al.*, 1992), Pre-test interviews

ADPT1 Our technology and processes match those of this customer

ADPT2 Training to meet this customer's requirements has involved substantial commitments of time and money on our part

ADPT3 Gearing up to deal with this customer requires highly specialised tools and equipment

ADPT4 Our production system has been tailored to meet the requirement of this customer

ADPT5 We have made significant investments in tooling and equipment that are dedicated to our relationship with this customer

ADPT6 Our production system has been tailored to produce the items supplied to this customer

ADPT7 This customer has some unusual technological standards and norms that have required extensive adaptation on our part

Communication (α = 0. 72) **(Heide *et al.*, 1992)**, Pre-test interviews

COM1 Exchange of information in this relationship takes place frequently and informally, and not only according to a pre-specified agreement

COM2 This customer's personnel do not fully understand the capabilities of our production process (R)

COM3 In this relationship, any information that might help the other party will be provided for them

COM4 This customer operates inflexible signing-off procedures for new product designs (R)

COM5 Both parties in the relationship will provide proprietary information if it can help the other party

COM6 Both parties keep each other informed about events or changes that may affect the other party

COM7* The communication of new designs from this customer frequently causes us

	problems (R)
COM8*	This customer will ramp up its in-house production without consulting us (R)
	Commitment (α = 0. 74) **(Morgan *et al.*, 1994)**
COMT1	The relationship that our firm has with this customer deserves our maximum effort to maintain
COMT2	The relationship that we have with this customer is something we intend to maintain indefinitely
COMT3	The relationship that our firm has with this customer is something we are very committed to
	Interdependence (α = 0. 74) **(Heide *et al.*, 1988; Frazier *et al.*, 1991)**
INDP1*	What percentage of your sales of this product/component can be accounted for by this customer?
INDP2*	What percentage of this customer's total volume requirement of this product/component does your plant provide for?
INDP3	It would be difficult for our company to find a new customer for this product if we lost this business
INDP4	Our firm relies heavily on this customer to achieve our business objectives
INDP5	It would be difficult for this customer to find an alternative supplier to us
INDP6	This customer relies heavily on us to achieve its own business objectives
INDP7	Our firm and this customer are heavily reliant on each other for the success of our respective businesses
	Satisfaction (α = 0. 73) **(Anderson *et al.*, 1984)**
SAT1	In general, how satisfied are you with the working relationship between your firm and this customer?
SAT2	Our firm's relationship with this customer has been a happy one
	Co-operation (α = 0. 72) **(Morgan *et al.*, 1994)**
COOP1	We co-operate extensively with this customer with respect to product design
COOP2	We co-operate extensively with this customer with respect to process design
COOP3	We co-operate extensively with this customer with respect to joint cost analysis
COOP4	We co-operate extensively with this customer with respect to forecasting and production planning
COOP5	We co-operate extensively with this customer with respect to quality practices
COOP6	We co-operate extensively with this customer with respect to inventory holdings

COOP7	We co-operate extensively with this customer with respect to information and communication technologies
	Trust (α = 0. 87) **(Larzelere *et al.*, 1980)**
TRT1	Based on your past and present experience, how would you characterise the level of trust your firm has in its working relationship with this customer
TRT2	We feel that this customer can be counted on to help us
TRT3	We feel that we can trust this customer completely
TRT4	This customer has a high level of integrity
TRT5	There are times when this customer cannot be trusted (R)
TRT6	This customer is perfectly truthful and honest with us
TRT7	This customer treats us fairly and justly

*= Item/scale dropped; R = reverse coded

Figure 1

Relationship Strength

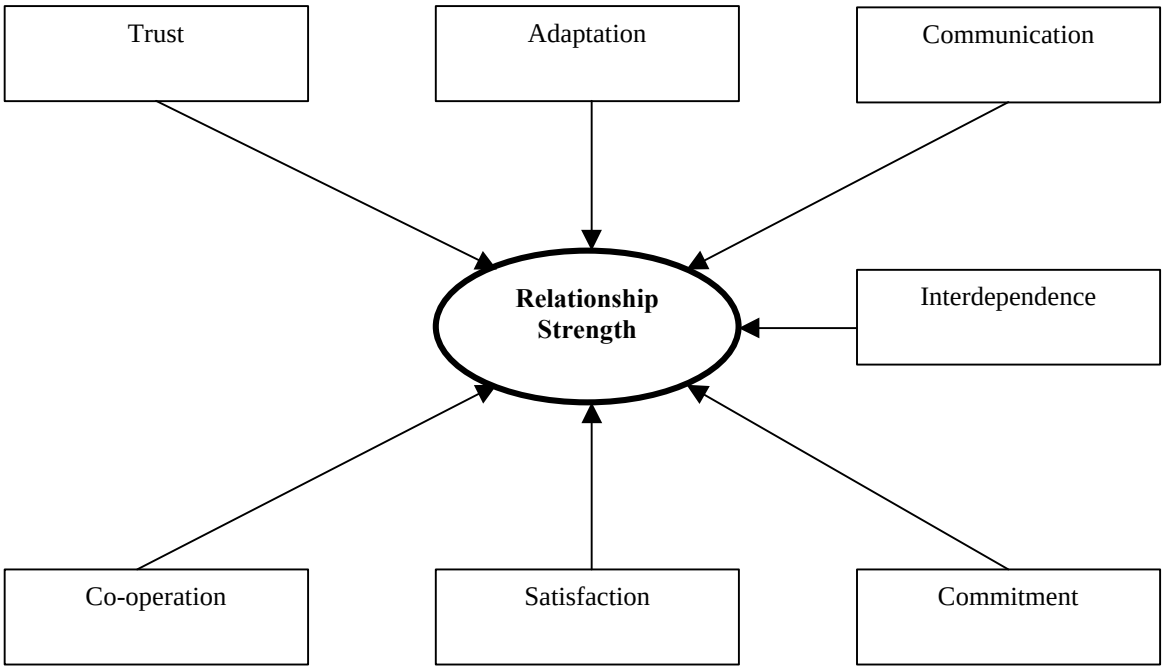
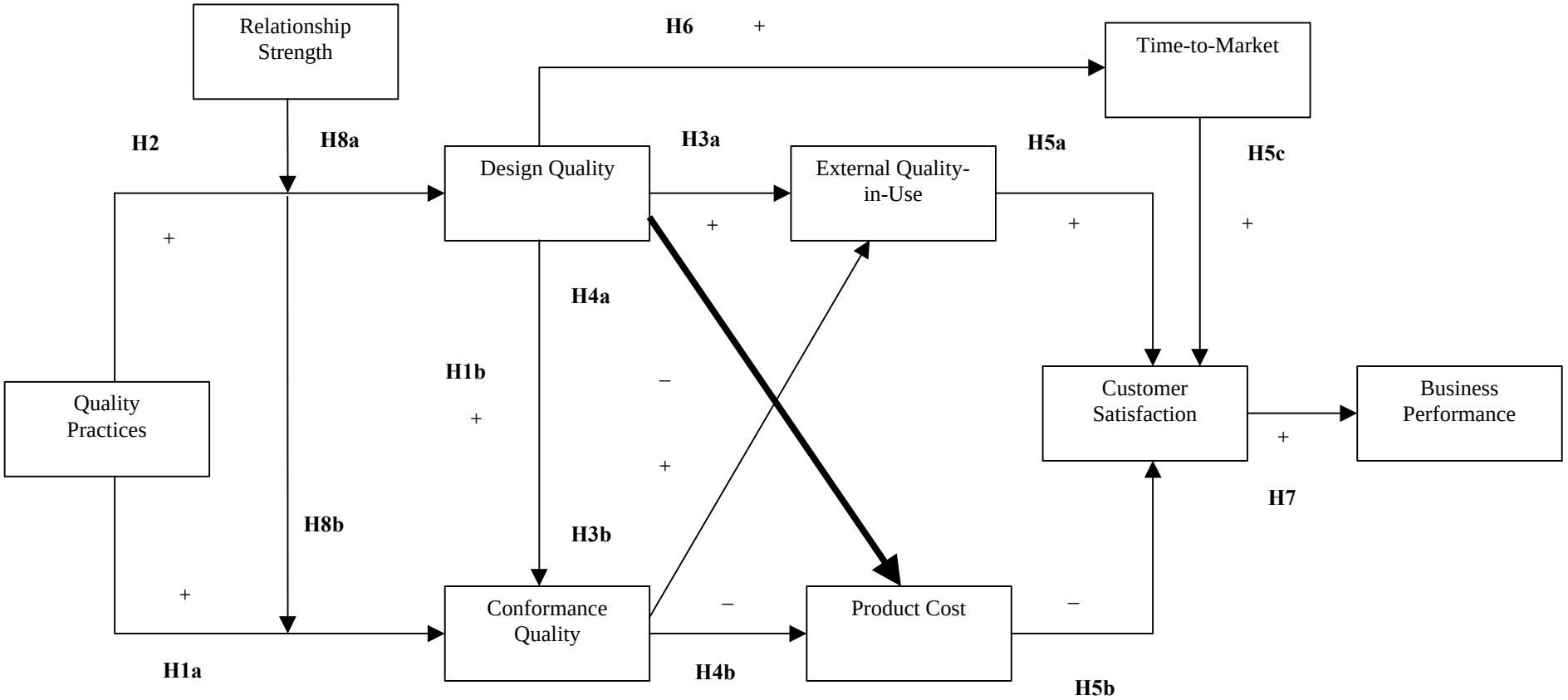


Figure 2

Research Model



Heavier lines indicate hypothesised stronger effect (H4c).

Table I

Regression Model: Construct Means, Standard Deviations and Correlation/Covariance Matrix

Construct	Mean	Std. Dev.	1	2	3	4	5	6	7	8
1. Conformance Quality	2.34	0.64	1.00	0.14	0.21	0.03	0.32	-0.15	0.11	0.09
2. Design Quality	2.17	0.46	**0.46**	1.00	0.17	0.07	0.18	-0.13	0.11	0.06
3. Customer Satisfaction	2.03	0.68	0.48	0.56	1.00	0.05	0.26	-0.16	0.16	0.11
4. Business Performance	2.38	0.71	0.07	0.21	**0.11**	1.00	0.05	-0.08	0.13	0.02
5. Quality-in-use	1.96	0.74	**0.67**	**0.52**	**0.51**	0.10	1.00	-0.15	0.16	0.09
6. Cost	3.65	0.69	**-0.35**	**-0.42**	**-0.35**	-0.17	-0.29	1.00	-0.210	-0.04
7. Time-to-market	2.30	0.76	0.23	**0.31**	**0.30**	0.24	0.29	-0.40	1.00	0.05
8. Quality Practices	2.32	0.44	**0.32**	**0.34**	0.37	0.08	0.27	-0.16	0.15	1.00

Table II

Model Coefficients

Hypothesis	Description	Estimate	t-value	Direction	Result
H1a	Quality Practices → Conformance Quality	0.189	2.888	+	+
H1b	Design Quality → Conformance Quality	0.397	6.064	+	+
H2	Quality Practices → Design Quality	0.337	5.055	+	+
H3a	Design Quality → Quality-in-Use	0.275	4.888	+	+
H3b	Conformance Quality → Quality-in-Use	0.540.	9.590	+	+
H4a	Design Quality → Product Cost	-0.325	-4.558	-	-
H4b	Conformance Quality → Product Cost	-0.196	-2.752	-	-
H4c	H4a effect > H4b effect	n.a.	1.321	>	NS*
H5a	Quality-in Use → Customer Satisfaction	0.428	6.798	+	+
H5b	Product Cost → Customer Satisfaction	-0.181	-2.886	-	-
H5c	Time-to-Market → Customer Satisfaction	0.106	1.748	+	NS
H6	Design Quality → Time-to-Market	0.306	4.535	+	+
H7	Customer Satisfaction → Business Performance	0.110	1.557	+	NS

NS = not significant

* = one-tailed test (t > 1.65)

Table III

Coefficients of Determination

Dependent Variable	Independent Variable (s)	R^2
Design Quality	Quality Practices	0.114
Conformance Quality	Quality Practices Design Quality	0.244
External Quality-in-Use	Design Quality Conformance Quality	0.504
Product Cost	**Design Quality** Conformance Quality	0.203
Time-to-Market	Design Quality	0.094
Customer Satisfaction	Product Cost External Quality-in-Use Time-to-Market	0.294
Business Performance	Customer Satisfaction	0.012

Table IV

Relationship Strength: Constructs Means, Standard Deviations and Correlation/Covariance Matrix

Construct	Mean	Std. Dev.	1	2	3	4	5	7	8
1. Adaptation	2.64	0.67	1.00	0.24	0.12	0.12	0.23	0.11	0.12
2. Co-operation	3.02	0.98	0.36	1.00	0.16	0.26	0.16	0.20	0.21
3. Commitment	1.64	0.55	0.31	0.29	1.00	0.15	0.11	0.17	0.17
4. Communication	2.14	0.55	0.33	0.47	0.48	1.00	0.13	0.15	0.21
5. Interdependence	2.70	0.73	0.46	0.22	0.26	0.32	1.00	0.06	0.11
6. Satisfaction	2.05	0.89	0.18	0.23	0.35	0.31	0.10	1.00	0.21
7. Trust	2.17	0.59	0.31	0.37	0.51	0.64	0.25	0.40	1.00

Table V

Chow Test (n=140)

Dependent Variable	**Moderator Variable**	**Moderator Level**	**Independent Variable**	**Chow**
Design Quality	Relationship Strength	High Low	Quality Practices	7.88
Conformance Quality	Relationship Strength	High Low	Quality practices	2.69

$F_{2, 136}$ at 5% level = 3.05

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