

Developing Supply Chain Management Focus through ISO 9000: An Empirical Assessment

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Abstract

The ISO 9000 quality management (QM) standard, a key approach to implementing QM in organizations, also has many supply chain management (SCM) concepts associated with it. In this paper, we assess the extent to which organizations can use the standard to develop a SCM focus. Specifically, we extracted the relevant SCM practices from the ISO 9000 standard (internal organizational processes, relationships with suppliers and relationships with customers), and related these to business performance of firms through a direct effects model. The empirical data to test this model was obtained from a sample of 416 manufacturing plants in Australia that are registered to the standard. The results of this study provide evidence to suggest that firms do derive significant benefits from SCM related practices contained within ISO 9000, and that these practices affect performance by acting through internal organizational processes. The relationships were subjected to tests for sensitivity to several moderating factors. From these analyses, it is apparent that unfavorable business environmental conditions make it difficult to realize such benefits. We also found that the length of temporal experience (with the standard) did not appear to make a difference in terms of benefits obtained. Finally, it appears that smaller plants find it easier to realize the benefits of these practices than their larger counterparts. These sensitivity test results suggest that the utility of the standard is not universal. We see these results as a reality check for managers in modifying their expectations from certification and application of the standard. In sum, the findings indicate an important potential role for the use of the ISO 9000 standard beyond that of just promoting quality assurance at the plant level.

1. Introduction

Christopher's [1] observation that "competition is between supply chains, not firms" is generally well understood by managers of organizations that operate in tough competitive markets. However, the difficulty for most is *how* to develop the required supply chain management (SCM) focus that not only results in effective relationships with suppliers and customers alike, but also is transparent, tangible, definable, demonstrable, and communicable to interested parties.

To date, organizations have used an eclectic collection of methods, programs, tools and techniques for their SCM purposes. These include the use of: process mapping methodologies such as the SCOR model to represent the linkages both between and within firms [2]; technology based solutions for better integration with trading partners [3]; socio-political approaches that focus on improvements in relationships between firms and their trading partners [4]; and, strategically changed roles in supply chains in order for firms to better co-align their activities with trading partners [5].

The effectiveness of these myriad of approaches is mixed, especially if they are pursued singularly and in isolation. Several multi-organization studies that have examined SCM practices – performance relationships show mixed results. Some studies show that both supplier and customer related practices are strongly related to firm performance [6, 7]. In contrast, other studies demonstrate that neither supplier nor customer related practices directly affect firm performance [8, 9]. Further still, some studies show that only supplier related upstream activities (and not customer related practices) are positively associated with firm performance [10, 11]. Not surprisingly, these mixed findings have led to doubts being expressed about the value of SCM efforts, and calls made for more sustained research [8, 12].

We therefore address this issue in this paper. A major objective is to examine the relationship between SCM practices and performance. We have chosen to use concepts developed in the allied area of quality management (QM) to represent these SCM practices. The rationale for this approach is that it has been shown that there is strong overlap between QM and SCM bodies of knowledge [13-19]. While the main difference between them appear to be in terms of focus (QM is mostly about internal aspects of organizations whilst SCM is about inter-organizational aspects [13, 18]), they both address issues that enable organizations to develop competitive capabilities through enhanced process capability.

Of particular interest is the potential use of the ISO 9000 QM standard by firms to practice effective SCM. ISO 9000 is by far the most popular approach taken by organizations to operationalizing QM, with close to 600,000 plants registered to the standard globally. A review of the standard and the extant literature suggests that, *prima facie*, it may be possible for firms to use it for SCM purposes [13, 15]. This is because the standard explicitly prescribes that registered organizations should not only focus on internal functions, but also, simultaneously, on upstream supplier and downstream customer activities. Together, these are fundamental SCM practices [9].

If it can be shown that the ISO 9000 standard is a suitable vehicle that firms can use for SCM purposes, then there are several potential beneficial implications. Firstly, firms would be able to achieve multiple positive benefits from the standard, thereby deriving greater utility from their investments in this standard than anticipated. Secondly, as has been the case with QM, registration will be a verifiable signal to interested parties of a firm's capabilities relating to SCM. Finally, the implementation process is a lot more structured, enabling organizations to achieve a supply chain orientation in a more systematic and defined manner.

In this paper, we examine the relationship between ISO 9000 inspired SCM practices and performance via a direct effects model. Further, we test the sensitivity and generalizability of the relationships within this model by examining the moderating influence of several contingent/contextual factors. Data for this study is taken from a study involving 416 manufacturing plants from Australia, all of which are registered to the standard.

The next section provides a review of the literature focusing on how the ISO 9000 QM standard could provide firms with SCM capability. This is followed by a description of how the empirical data was collected and analyzed. The results of the study are provided next. These results are then discussed in detail. The paper concludes with a discussion of the implications of the findings of this study for practitioners and researchers.

2. Literature Review

2.1 Aspects of ISO 9000 that are Suggestive of Supply Chain Orientation

The standard defines a supply chain as: "supplier → organization → customer" [20, p.1]. This is a classic pipeline representation and takes the flow of products into account. Whilst this conceptualization of supply chains could be criticized for being limited and not fully reflecting the complex issues involved in end-to-end supply chains, this 'link in the chain' representation provides the opportunity to analyze issues in considerable detail and from the organization's immediate frame of reference.

As a first step towards analyzing the SCM practices – performance relationships, the standard and associated literature were reviewed and relevant SCM aspects extracted. The results are classed into three groups, which will later be converted to psychometric constructs. The three categories are: internal organizational processes; relationships with suppliers; and relationships with customers.

2.1.1 Internal Organizational Processes

The ISO 9000 standard has a very strong focus on internal processes of implementing organizations. Indeed, the philosophy underlying much of the standard is that organizations with solid operations and processes will be in the best position to influence the quality of their products and services [21]. For those organizations that successfully implement and utilize ISO 9000, the main benefit is that it produces an effective system that assists in eliminating errors and thereby saves money that is spent on rework and scrap [22]. According to Conti [23], effectiveness of the ISO 9000 based quality system goes beyond conformance to specification, which traditionally has been the focus of the standard [24]. Conforming to ISO 9000 requires that all processes and procedures that affect quality be documented [25]. This makes ISO 9000 a highly documentation oriented system [21, 26, 27]. Taking this in a positive light, ISO 9000 can assist organizations to develop sound communication systems by carefully documenting procedures, process performance and failures [11, 21, 28]. In sum, processes and activities affecting quality must be planned, controlled and documented [11, 29].

2.1.2 Relationships with Suppliers

ISO 9000 describes 'mutually beneficial supplier relationships' as one of the eight principles of QM, stating that "an organization and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value" [30, p.5]. In practice, organizations frequently require suppliers to be ISO 9000 registered because they need assurance that products or services supplied are of consistent quality [27]. ISO 9000 provides a universally agreed upon, minimum quality assurance system [31, 32]. It requires an organization to "select suppliers based on their ability to supply product in accordance with the organization's requirements" (clause 7.4.1, Purchasing process, ISO 9001:2000). It also stipulates that corrective actions need to be taken should mistakes be made.

2.1.3 Relationships with Customers

ISO 9000 recognizes the contemporary reality of understanding and meeting customer preferences in order for organizations to compete effectively [23, 27]. As such, the standard has declared ‘customer focus’ as one of the key principles of QM, stating that “organizations depend on their customers and therefore should understand current and future customer needs, should meet customer requirements and strive to exceed customer expectations” (clause 4.3(a), Customer focus, ISO 9004:2000). An important objective of the standard is therefore to give customers an assurance about the quality of products or services supplied [33]. In pursuit of this, organizations need processes that produce products/services that speedily and consistently meet customer expectations [26]. A well-designed, well-implemented and carefully managed ISO 9000 QM system would provide confidence to implementing organizations that the output of the processes meet customer expectations and requirements [29]. In practice, this would require organizations to carefully and systematically determine customer requirements [34, 35] to the extent that mistakes are not made in interpreting them (clause 7.2, contract review process, ISO 9000:2000). Should mistakes occur, organizations need to have appropriate processes to resolve them.

These discussions show that ISO 9000 does focus on aspects that can provide registered firms with some level of SCM capability and orientation.

2.2 ISO 9000 Management Practices – Performance Relationships

A review of the extant literature shows that, surprisingly, there is a paucity of research that has focused on how ISO 9000 related management practices impact upon performance. A number of researchers have commented on this state of knowledge. For example, Simmons and White [36, p.340] observe that the “relationships between ISO 9000 and business performance are complex and our understanding of these relationships is underdeveloped”. Further, they claim that “while there has been much published work on various issues associated with ISO 9000, research in this area has lacked systematic measurement and multi-organization comparisons” (ibid, p.331). Similarly, Corbett et al. [37, p.328] states that “[t]here is little evidence on how ISO 9000 certification affects quality or business performance”. Likewise, Naveh and Marcus [38, pp.4-5] comment that “[i]mplementation of ISO 9000 should make an organization’s operating performance go up, but consistent results that could verify this proposition are not found in the literature”.

Notwithstanding the above sentiments, the few studies that have examined whether ISO 9000 registration makes a difference to organizations’ performance show no clear-cut evidence of the standard’s effectiveness. These studies show mixed results: some show that there is little difference in operational and financial performance between registered and non-registered organizations [36, 39-41], whilst others show that ISO 9000 registered organizations perform better than non-registered organizations [33, 34, 42]. In some cases, ISO 9000 appears to selectively affect certain types of performance. For example, registration to the ISO 9000 standard appears to improve operating performance, but not business performance [38].

For our purposes where the interest is in understanding how ISO 9000 based SCM practices affect firm performance, the studies mentioned above were re-appraised to uncover, where possible, the specific instances where SCM related issues were discussed. This provided some interesting insights. In terms of relationships with customers, Rahman [40] shows that firms without ISO 9000 registration rate higher than non-registered firms as far as ‘customer management’ practices are concerned. Carr et al. [33] found similar outcomes for customer focus, and further found that there was no difference between these groups in the area of supplier linkages. Naveh and Marcus [43] have shown that external coordination with suppliers and customers during the design and implementation of the ISO 9000 system does not have a significant effect on either operating or business performance outcomes. Naveh and Marcus [38] further found that the extent to which ISO 9000 is internally integrated and externally coordinated did not significantly relate to various measures of operating and financial performance.

2.3 Contingent/Contextual Factors Affecting ISO 9000’s SCM Capability

A parallel debate within QM generally, and ISO 9000 specifically, is whether the elements are universally applicable, or affected by contingent and contextual factors such as country and national context, organization size, business environmental conditions, experiential and temporal issues, and company culture.

Some studies allude to universalism. For example, Rungtusanatham et al. [44] conclude that QM practices appear to be more similar than different across several countries. Similarly, Ebrahimpour et al. [45] and Taylor [46] show that country-of-ownership of registered plants does not appear to have an impact when explaining differences and similarities in ISO 9000 related management practices. Further, Peyrat [47] claims that the “2000 version of the ISO 9000 is truly generic” (p.46). Kirchenstein and Blake [25] claim that the “great strengths of ISO 9000 are to be found in its generic and non-prescriptive approach and its ability to be used by all: industry sectors including manufacturing, process and service; sizes of companies, and type of business activities” (p.362). In contrast, in other studies where

contingent factors such as business environmental conditions, organization size and time since registration were taken as control variables [26, 33, 34, 36, 38, 39, 41, 43, 46, 48, 49], the findings are mixed or inconclusive.

Given this situation, calls have been made for clarification. For example, Robinson and Malhotra [13] ask: “Is the mere presence of ISO 9001 sufficient to achieve higher supply chain integration, or do some other contingent factors also have to be in place to achieve this outcome? If so, what are these factors?” (p.333). Corbett and Kirsch [37] similarly state that little is known about how registration to ISO 9000 is affected by contingent factors such as organization size, ownership structure, national business climate, and business cycles.

To develop a better understanding of ISO 9000’s ability to generate supply chain orientation in firms, we selected three factors and tested their moderating effect on the SCM practices – performance relationships. These factors are business environmental conditions, length of time since registration was obtained and organization size.

2.3.1 Business Environmental Conditions

It has long been recognized that there is a link between the external environment in which firms operate and their behaviors and actions. This link is particularly strong in the use of ISO 9000. Many studies have shown that firms register to the standard as a reaction to events in their environments: to meet the requirements of regulators, accede to the pressure from usually large and powerful customers, to isomorphically deal with competitors, or to simply be part of supply chains of large businesses and public sector organizations [11, 37, 50-52]. This reaction has been described as being “extrinsically motivated” [30], “compliance-related” [11] and “market-related” [53].

The interest for us, however, is to assess if business environmental conditions affect the decisions of firms to develop intrinsically motivated supply chain orientation involving alignment of internal practices with relationships with suppliers and customers. When the environment is a tough one to operate in, one would expect that firms would develop strong supply chain orientations to deal with the vagaries of the market, and generate stability and certainty for themselves. However, it could just as well be argued that in tough operating environments the type of intra- and inter-organizational practices expected as part of a strong supply chain focus could inhibit flexibility and responsiveness of organizations by making it difficult to terminate, realign and reconfigure relationships.

When the business environment is a conducive one, firms may find that ISO 9000 does not provide any utility. On the other hand, the stability of the business environment could be a result of practices such as ISO 9000. Therefore, the effects of business environmental conditions on practices associated with the standard, including those pertaining to SCM, are not clear.

2.3.2 Temporal Experience with the Standard

Does length of time that organizations are registered to the standard have an impact on their ability to maintain and sustain the SCM practices developed through ISO 9000 implementation? Naveh and Marcus [38] and Simmons and White [36] postulate, based on experiential learning grounds, that the longer a firm is registered, the better its performance would be. Naveh et al. [26] and Boiral [51] use institutional theory to suggest that firms that have been registered for a longer time period (first movers) would derive greater intrinsic benefits than those that register later (second mover). However, it is just as likely that firms would not benefit from the standard with time. If organizations registered for purely externally motivated reasons (and therefore made no fundamental changes to their practices), then as Lawrence [54] has suggested, their practices would revert to normality once registration was achieved.

The empirical evidence on the effect of time since registration on practices and performance associated with ISO 9000 is mixed. Some studies have shown that time since registration does have a significant positive effect [26, 34, 38, 43, 49], while other studies have shown that there is no such temporal effect [36, 41, 55]. Therefore, it is not clear how the length of time that organizations are registered affects their SCM practices.

2.3.3 Organization Size

It is generally acknowledged that large and small organizations are ‘different’ to each other in the way that they behave and act toward internal and external stimuli. However, it is not clear if size is a significant factor in explaining differences in the practices and performance of ISO 9000 organizations. Adam [56] uses agency theory to suggest that large organizations can more beneficially employ ISO 9000 to alleviate contracting incentive problems and reduce agency costs such as information processing and monitoring expenditures. Further, commitment to ISO 9000 can be expensive so large firms are more likely to realize economies of scale from their investment in the standard than small firms. This is particularly evident in terms of reducing transaction and search costs in procurement [11]. These factors have led some to conclude that ISO 9000 may inherently be unsuitable for small firms [57]. Others have concluded that small organizations need to conceptualize and consider the standard in a different way when compared to large organizations [48, 58]. ISO 9000 can assist small organizations to deal with the negative aspects of characteristics such as informal communication, flexible behavior and simple operating systems [48] by adding

structure, discipline, control and traceability [50]. One would therefore conclude that both large and small firms would find ISO 9000 to be useful, albeit for different reasons.

The empirical research of effect of organization size on ISO 9000 related practices and performance appears to be generally supportive of this. Most studies that have incorporated organization size as a control variable show that this does not influence practices or performance [26, 34, 36, 43]. However, the specific role that organization size plays in affecting the relationships between an organization’s practices within and across its customers and suppliers, and its performance is not clear, and therefore warrants further clarification.

2.4 Research Questions, Model and Hypotheses

As stated earlier, the higher level objective of this paper is to develop an understanding of whether ISO 9000 elements related to SCM are indeed capable of providing firms with an SCM orientation. This objective is reduced to two specific research questions. These are: (1) *How do the ISO 9000 based SCM practices affect the business performance of firms?*; and, (2) *Are these relationships affected by contingent/contextual factors such as business environmental conditions, time since registration to the standard and organization size?*

These questions are conceptually represented in Figure 1. The relationships postulated are in the form of a direct effects model where the three exogenous constructs (internal organizational processes, relationships with suppliers and relationships with customers) are directly related to the single endogenous construct of business performance of the firm. The three exogenous constructs are inter-correlated. Conceptually, this indicates that these constructs have a shared influence on the business performance construct. Statistically, these inter-correlations cover the undefined theory prior to the exogenous constructs.

The direct effects relationships can be expressed in formal hypothetical form as:

H1a: The ISO 9000 inspired SCM internal organizational processes that firms develop affect business performance.

H1b: The ISO 9000 inspired SCM relationships with customers that firms develop affect business performance.

H1c: The ISO 9000 inspired SCM relationships with suppliers that firms develop affect business performance.

As for the impact of the contingent/contextual factors, these are shown in Figure 1 as affecting the hypothesized relationships in the model. Since the effects of the three chosen factors are *a priori* uncertain, these are presented in null form as follows:

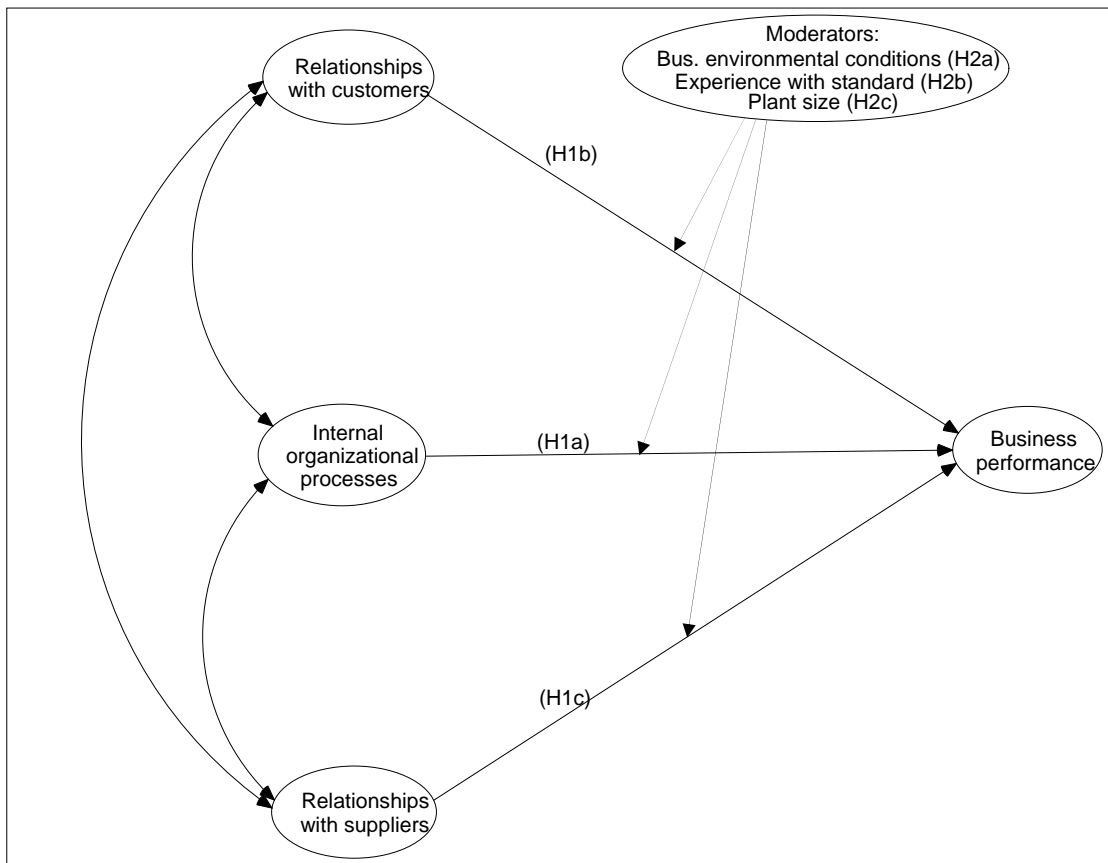


Figure 1 Hypothesized model

- H2a: The business environmental conditions that firms operate in do not moderate the relationships between ISO 9000 inspired SCM practices and business performance.
- H2b: The length of experience that firms have with the standard does not moderate the relationships between ISO 9000 inspired SCM practices and business performance.
- H2c: The size of firms does not moderate the relationships between ISO 9000 inspired SCM practices and business performance.

3. METHOD

3.1 Study Participants

The empirical data to test the above hypotheses was collected through a postal questionnaire targeting ISO 9000-registered organizations in the manufacturing industry in Australia. This industry was one of the first to embrace the ISO 9000 standard on a large-scale basis during the 1980s and 1990s. As a result, it has a relatively long experience and accumulated knowledge of the standard.

Since ISO 9000 certificates are predominantly issued at the plant level, this level of analysis was chosen for this study. Corbett et al. [49] and Ahire and Golhar [59] argue that the plant is the most suitable level for such studies. The JAS-ANZ Register [60] was used for the purpose of selecting the sample of plants. This register is a database of all plants registered to various standards, including ISO 9000. The standard industrial classification code ‘2xxx’ was used to select the plants from the manufacturing sector. An initial list of 1,300 plants was compiled. After checking to ensure that large companies did not have multiple plants included in the sample, a final target sample size of 1,053 plants was obtained. The survey was carried out in two phases. The first phase involved a mailout to the whole sample. This was followed up by a repeat mailout to non-respondents a month later. The final response rate was 41.3 percent (n = 418). However, two respondents had excessive levels of missing information. These were excluded. The final usable sample size was 416 plants.

For this study, the key informant approach in which the person in charge of quality (quality/production/operations manager) was selected because this person was best able to provide the quality-related operational information at the specific plant. The potential for non-response bias was assessed by testing for differences between respondents to the two phases of the survey. It was assumed that organizations that responded in the second phase were reacting to reminder notices sent to them, and they would otherwise have been non-respondents. Statistical analysis of responses between respondents to the first and second phases showed little difference. Further assessment of non-response bias was through telephone interviews of a randomly selected group of twenty non-responding organizations. The main reasons for non-response included: ‘lack of time’, ‘company policy of not disclosing information’ and ‘not interested’. None of these reasons suggested that these organizations would have answered the questions in the questionnaire significantly differently to responding organizations. Hence, the two approaches independently suggested that the level of non-response bias was low.

Table 1 provides demographic details on the participating plants. As this table shows, the survey respondents represented predominantly small plants with almost half the plants having less than 100 employees and \$A10 million in annual revenue. These plants were mainly from the machinery and equipment manufacturing (26 percent) and metal products (17 percent) manufacturing industry sub-categories. About a third of all plants had TQM programs formally implemented in the past. Further, just over half the plants (57 percent) were registered for less than three years. Exactly half the sample of respondents indicated that business environmental conditions were ‘positive’, with the other half considering them to be generally ‘negative’.

Table 1 Demographic characteristics of plants participating in the study

Characteristic	Number
<u>Plant size:</u>	
Micro to small (less than 100 employees or less than \$Aus10m in revenue p.a.)	224
Medium to large (greater than 100 employees or greater than \$ Aus10m in revenue p.a.)	192
<u>Time since registration to standard:</u>	
Less than 3 years	239
Greater than 3 years	177
<u>Business environmental conditions</u>	
Those that consider effect to be ‘favorable’	208
Those that consider effect to be ‘unfavorable’	208

3.2 Measurement Instrument

The measurement instrument used in this study was developed for a broader QM study and included items associated with ISO 9000. Since this instrument was original in many respects, steps were taken to ensure that various types of errors [61] were within acceptable levels. These included pretest with eight practitioners and academicians, and a pilot test within 21 organizations. The instrument consisted of six management practices sections (top management leadership, customer focus, employee relations, interaction with suppliers, communication and information system, product and process management) as well as one section each for performance and business environment. A total of 146 items were involved. For this paper, a subset of the items relevant to SCM aspects of ISO 9000 was used. These items and associated constructs are shown in Table 2.

Table 2 Constructs and associated items of theoretical model

Construct	Item label and description*
1. Internal organizational processes	<p>IOP1: The quality assurance processes ensure that the organization’s own output requirements are consistently met.</p> <p>IOP2: The actual manufactured products are checked against customer orders before they are delivered.</p> <p>IOP3: The equipment to carry out tests and inspections are available when needed.</p> <p>IOP4: Products and processes are inspected and/or tested.</p> <p>IOP5: Processes that produce products that cannot be tested or inspected are continuously monitored.</p> <p>IOP6: Everyone is aware of what needs to be done with raw materials, work-in-progress and finished products that fail inspections.</p> <p>IOP7: The handling, storage, packaging and delivery methods help to minimize quality-related problems.</p> <p>IOP8: It is possible to identify clearly when a raw material, work-in-progress or finished product has been inspected.</p> <p>IOP9: It is possible to establish relevant details (such as parts suppliers, place and date of manufacture, persons-in-charge) of all finished products.</p>
2. Relationships with customers	<p>RC1: The organization is aware of the requirements of its customers.</p> <p>RC2: Processes and activities of the organization are designed to increase customer satisfaction levels.</p> <p>RC3: Misunderstandings between customers and the organization about customer orders are rare.</p> <p>RC4: All contracts are systematically reviewed before acceptance, even if they are routine ones.</p> <p>RC5: The organization has systematic processes for handling complaints.</p> <p>RC6: Changes made to contracts lead to confusion in the organization. (Reverse coded)</p>
3. Relationships with suppliers	<p>RS1: The organization seeks assurance of quality from suppliers.</p> <p>RS2: The main criterion for choosing suppliers is the quality of their products.</p> <p>RS3: Misunderstandings between suppliers and the organization about orders placed with them are rare.</p> <p>RS4: The quality of supplied products and services are assessed.</p> <p>RS5: Materials provided by the customer for incorporation into products are treated the same as materials from any other suppliers.</p>
4. Business performance	<p>BP1: Profits.</p> <p>BP2: Cashflow.</p> <p>BP3: Demand for products made at the registered site.</p> <p>BP4: Market share.</p>

*Survey respondents were asked to express their agreement with statements associated with constructs 1 to 3, on a five point scale with 1 representing ‘strongly agree’ and 5 representing ‘strongly disagree’. For items associated with construct 4, survey respondents were asked to express the satisfaction of the organizations with respect to the various measures of performance, using a five point scale with 1 representing ‘very satisfactory’ and 5 representing ‘very dissatisfactory’.

Perceptual measures were used throughout. The management practice items were measured on a five-point Likert scale with “strongly agree” and “strongly disagree” as the end-point descriptors. Similarly, performance items were measured on a five-point scale with “very satisfied/very dissatisfied” as end-point descriptors.

Using managerial perceptions to measure performance related items can be problematic due to the inherent subjectivity involved and the possibility of introducing common methods bias. However, using direct objective measures is not without problems either. Corbett et al. [49], Naveh and Marcus [43] and Ahire and Golhar [59] demonstrate the difficulties of obtaining and using objective plant level data. Further, Taylor and Wright [62] discuss

the problems associated with publicly reported indices of performance such as market share, share price and profitability. In favor of perceptual measures, Venkataraman and Ramanujam [63] show that senior executives' perceptions of their companies financial performance correspond closely to objective measures of performance. Further, Meredith [64] argues that the information compiled from the perceptions of key participants is often better than limited collections of incomplete objective data gathered independently by researchers themselves. As for common-methods bias, this was assessed using the confirmatory approach to Harman's single factor test [65].

4. RESULTS & ANALYSIS

4.1 Psychometric Properties of Constructs

A series of tests were performed to determine if the SCM management practices relating to the ISO 9000 and business performance constructs had sound psychometric properties. These tests were for content validity, multicollinearity, reliability, convergent and discriminant validity, and common methods bias.

4.1.1 Content Validity

The lists of SCM related practice and business performance items assigned to the constructs were arrived at through a review of the standard and the research literature. This is summarized in section 2.1. This review suggests that the constructs and their associated items have sufficient grounding in the literature and therefore possess sufficient content validity.

4.1.2 Multicollinearity

If inter-item correlations are greater than 0.9, the possibility that multicollinearity (i.e., two or more items measure the same entity) exists is high [66]. The correlation coefficients for items in this study are not shown in this paper, but is available from the first listed author. None of the inter-item Pearson correlation coefficients is greater than 0.9. Hence multicollinearity related problems did not appear to be present.

4.1.3 Reliability

Cronbach's alpha reliability coefficients were calculated. These coefficients were 0.830 for internal organizational processes, 0.654 for relationships with customers, 0.634 for relationships with suppliers and 0.769 for business performance. For all the constructs, the coefficients exceeded the minimum threshold level of 0.6 [66]. The constructs were therefore measured with reasonably reliable items.

4.1.4 Convergent and Discriminant Validity

Convergent validity (assessing whether the measurement items of constructs yield roughly the same results) and discriminant validity (checking whether the items estimate only the assigned construct and not any others) were both tested using a Confirmatory Factor Analysis (CFA) model – a structural equation model (SEM) where the constructs are all co-varied with each other [67]. Evaluation of the CFA, using the maximum likelihood estimation technique, showed acceptable fit of the model with the data. The $\chi^2_{(246)} = 649$ and had a p-value < 0.001 , suggesting poor fit; however, this was not unexpected as this fit measure has a tendency to produce negative results with sample sizes greater than 200. Applying the cutoff criteria suggested by Marsh et al. [68], other measures suggested acceptable fit: normed $\chi^2 = 2.640$; goodness-of-fit index (GFI) = 0.884; adjusted goodness-of-fit index (AGFI) = 0.859; Tucker-Lewis index (TLI) = 0.836; comparative fit index (CFI) = 0.852; root mean square residual (RMR) = 0.032; and, root mean square error of approximation (RMSEA) = 0.063.

The convergent validity of the constructs was generally supported: all the estimated factor loadings of items on constructs were significant (at p-values < 0.001), the signs were all positive and only one standardized loading was below 0.4 (+0.238). Further, from the squared multiple correlation values, the variances of the items explained by their constructs were reasonably high (with the average being 35 percent). As for discriminant validity, correlations between the constructs were mostly moderate (with average correlation coefficient being +0.502), suggesting that items assigned to one construct were not significantly highly loading on others.

4.1.5 Common Methods Bias

Harmon's one factor test using a confirmatory approach [65] indicated that common methods bias was not present, with the goodness-of-fit indices for this model indicating much poorer fit with data, being worse than the CFA and hypothesized models. (Results for the hypothesized model are provided in the next section.) The indices for Harmon's one factor model were: $\chi^2_{(252)} = 1134$, p-value < 0.001 ; normed $\chi^2 = 4.501$; GFI = 0.798; AGFI = 0.760; TLI

= 0.649; CFI = 0.679; RMR = 0.061; and, RMSEA = 0.092. These results suggest that common methods bias does not appear to distort the results of this study.

4.2 SEM Results for Hypothesized Model

A two-step procedure was applied to test the hypothesized model because the theoretical model shown in Figure 1 is drawn tentatively and the constructs are operationalized with items that have not been validated in prior studies. This two-step procedure controlled for within-construct versus between-construct effects [67]. A simplified form of the two-step procedure proposed by Anderson and Gerbing [67] was used. This required conducting confirmatory factor analysis in the first step. In the second step, the hypothesized model was tested. Then the χ^2 difference test between these models was evaluated, with the hypothesized model accepted as having empirical support if the χ^2 difference was significant.

The fit indices suggest acceptable fit of the hypothesized model with the data. The $\chi^2_{(246)} = 649$ had p-value < 0.001 (ignored due to sample size sensitivity). Other fit measures suggested reasonable fit (normed $\chi^2 = 2.640$; GFI = 0.884; AGFI = 0.859; TLI = 0.836; CFI = 0.853; RMR = 0.032; and, RMSEA = 0.063).

Since the number of relationships specified in the hypothesized model is the same as that in the CFA, the fit indices are therefore the same for the two models. Therefore, it was not possible to perform a χ^2 difference test. Based on the fit indices alone, it can be concluded that the hypothesized model has empirical support.

Figure 2 presents all the structural model parameters. These are in standardized form (regression, relevant squared multiple correlation, and correlation coefficients). The results have several noteworthy aspects. In terms of the magnitude and sign of the relationships, as Figure 2 shows, two out of the three relationships are statistically insignificant in magnitude, having p-values greater than 0.05. The other relationship is statistically significant in magnitude and positive in sign, as hypothesized. Also, the inter-correlations between the three exogenous constructs are positive, statistically significant and moderate in magnitude.

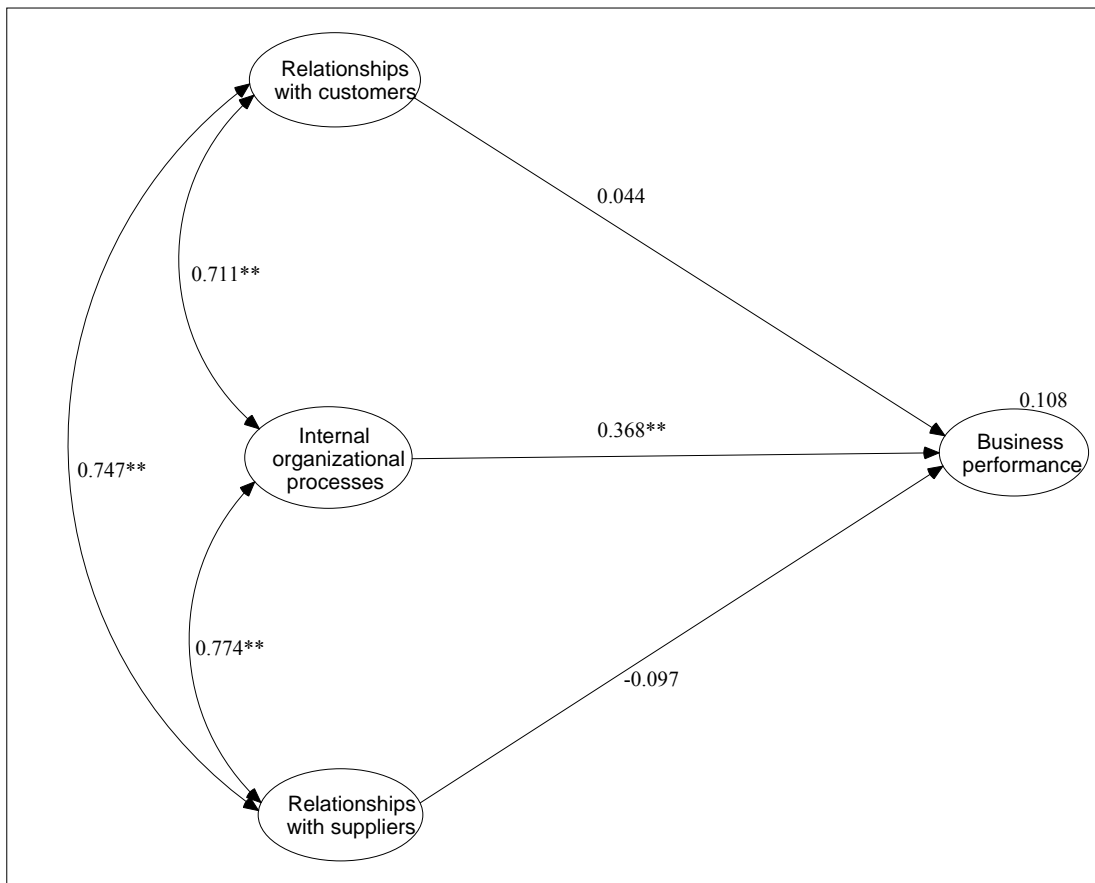


Figure 2 Hypothesized model, showing maximum likelihood estimates of standardized regression coefficients (on straight lines single-arrowheads), squared multiple correlation coefficients (on constructs) and correlation coefficients (on curved lines with double-arrowheads). ** p-value < 0.05.

4.3 SEM Results for Moderating Effects on Relationships in Hypothesized Model

4.3.1 Business Environmental Conditions

In order to assess whether the business environmental conditions had moderated the effect of SCM related ISO 9000 practices on business performance, the hypothesized model was subjected to a two-stage multigroup analysis (MGA) similar to that used by Froehle [69]. In the first stage, the hypothesized model was tested in which all the structural model parameters were freely estimated in the presence of the moderator groups (firms that believed that their business environment was favorable and those that believed that it was unfavorable). The second step was to determine if the MGA showed a significant change in fit when the structural parameters being influenced by the moderator were constrained to be equal across the two groups. If a significant reduction in fit occurs, then this would suggest that the moderator is acting.

The first stage of the MGA exhibited good fit ($\chi^2_{(492)} = 986$, p-value < 0.001; normed $\chi^2 = 2.005$; GFI = 0.838; AGFI = 0.803; TLI = 0.796; CFI = 0.818; RMR = 0.041; and, RMSEA = 0.049). The second stage of MGA, where the model is constrained, also shows good fit ($\chi^2_{(495)} = 994$, p-value < 0.001; normed $\chi^2 = 2.008$; GFI = 0.837; AGFI = 0.802; TLI = 0.795; CFI = 0.816; RMR = 0.044; and, RMSEA = 0.049). The inflation in χ^2 statistic is 7.807 with 3 degrees of freedom. The p-value associated with this is 0.050. Since this p-value is at the cut-off level for significance, it can be concluded that the pattern of structural relationships varies for the two groups. In other words, relationships in the hypothesized theoretical model are sensitive to the moderating impact of business environment. Figure 3 shows the results for the two groups.

4.3.2 Length of Experience with the Standard

A similar two-stage MGA to that described above was used to assess if length of experience moderated the relationships between the SCM related ISO 9000 practices and business performance. The first-stage fit results for the model where the moderator was allowed to act freely showed good fit ($\chi^2_{(492)} = 1016$, p-value < 0.001; normed $\chi^2 = 2.066$; GFI = 0.832; AGFI = 0.795; TLI = 0.794; CFI = 0.817; RMR = 0.041; and, RMSEA = 0.051). For the constrained model, the fit was equally good ($\chi^2_{(495)} = 1018$, p-value < 0.001; normed $\chi^2 = 2.057$; GFI = 0.832; AGFI = 0.795; TLI = 0.794; CFI = 0.817; RMR = 0.041; and, RMSEA = 0.051). The inflation in the χ^2 statistic is 1.764 with 3 degrees of freedom. This has a p-value of 0.623, suggesting that the structural parameters did not vary in the presence of the moderator, i.e., the length of experience is not a significant moderator of the relationships between the three ISO 9000 inspired SCM practices and business performance. Figure 4 shows the results for the two groups.

4.3.3 Plant Size

Again, as above, a two-stage MGA was used to assess if the size of the plant moderated the relationships in the hypothesized model. The first-stage fit results showed good fit ($\chi^2_{(492)} = 980$, p-value < 0.001; normed $\chi^2 = 1.992$; GFI = 0.843; AGFI = 0.808; TLI = 0.807; CFI = 0.828; RMR = 0.040; and, RMSEA = 0.049). Fit was equally good for the constrained model ($\chi^2_{(495)} = 988$, p-value < 0.001; normed $\chi^2 = 1.998$; GFI = 0.843; AGFI = 0.808; TLI = 0.805; CFI = 0.826; RMR = 0.043; and, RMSEA = 0.049). The χ^2 statistic increased by 8.835 (3 d.f.), which has a p-value of 0.032, suggesting that the structural parameters do vary with plant size. In other words, the size of the plant is a significant moderator of the relationships between the ISO 9000 based SCM practices and business performance. Figure 5 shows the results for the two groups.

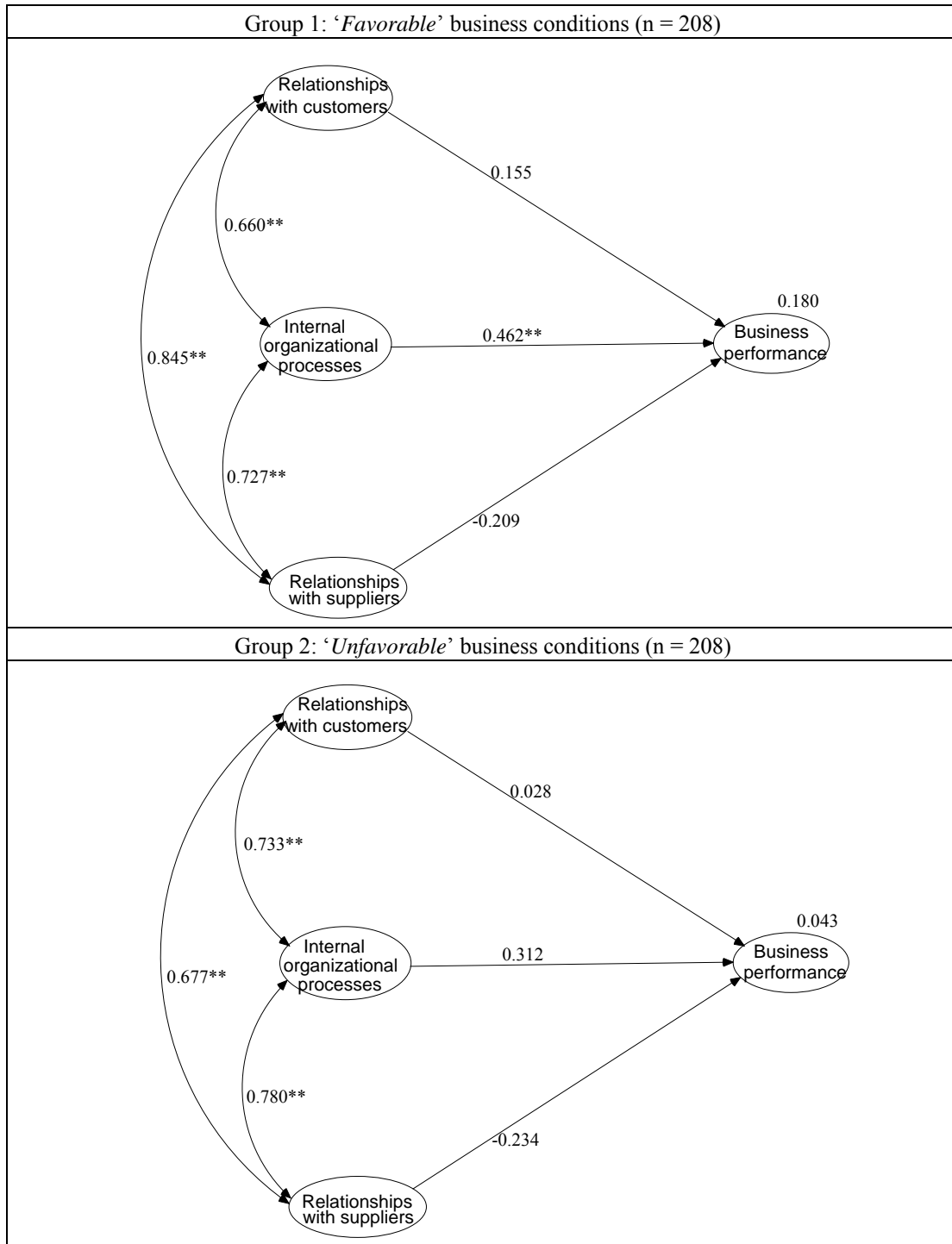


Figure 3 Comparison between firms that consider business environmental conditions to be favorable and unfavorable. Hypothesized model, showing maximum likelihood estimates of standardized regression coefficients (on straight lines single-arrowheads), squared multiple correlation coefficients (on constructs) and correlation coefficients (on curved lines with double-arrowheads). ** p-value < 0.05

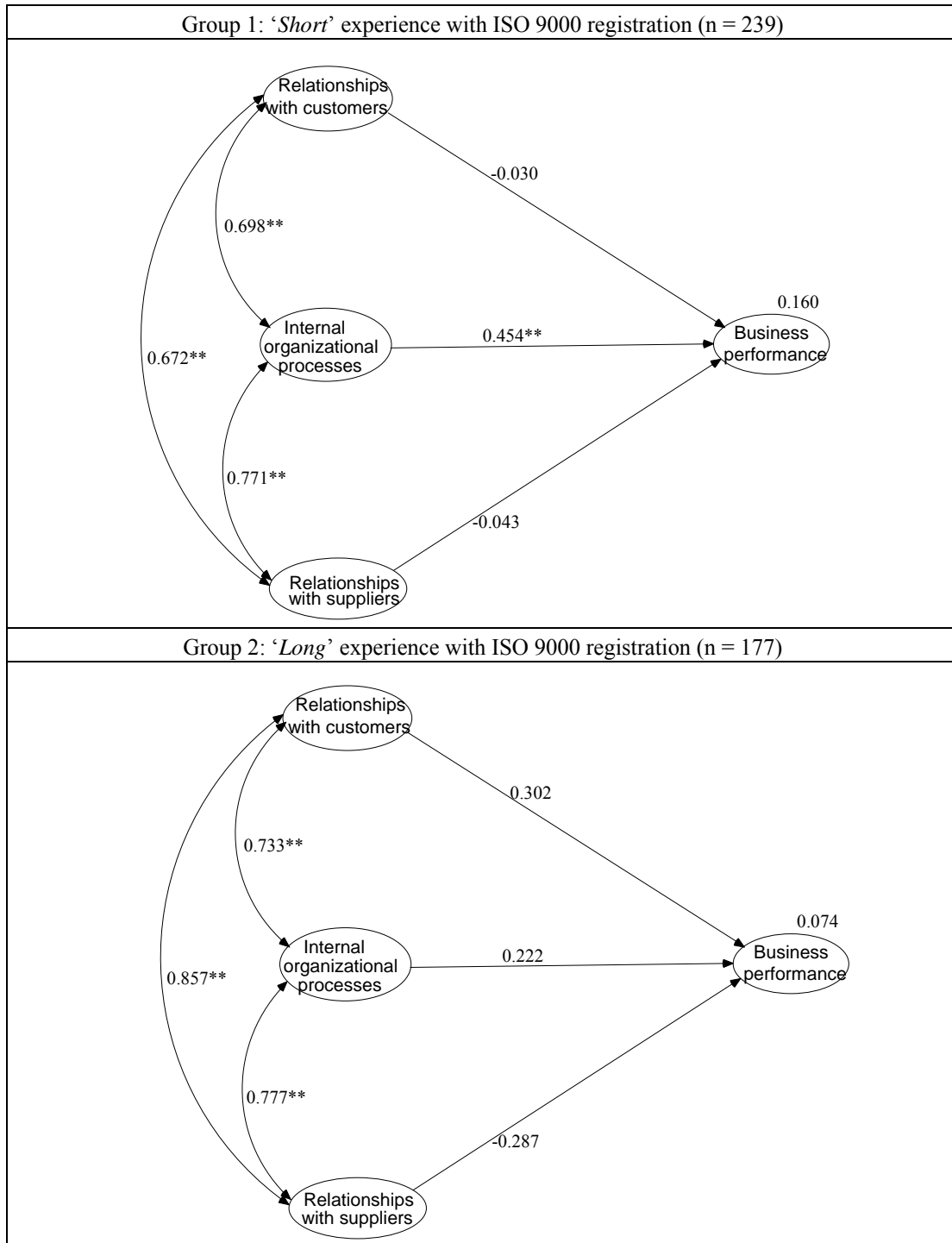


Figure 4 Comparison between firms that have long experience with ISO 9000 registration and those that have short experience. Hypothesized model, showing maximum likelihood estimates of standardized regression coefficients (on straight lines single-arrowheads), squared multiple correlation coefficients (on constructs) and correlation coefficients (on curved lines with double-arrowheads). ** p-value < 0.05.

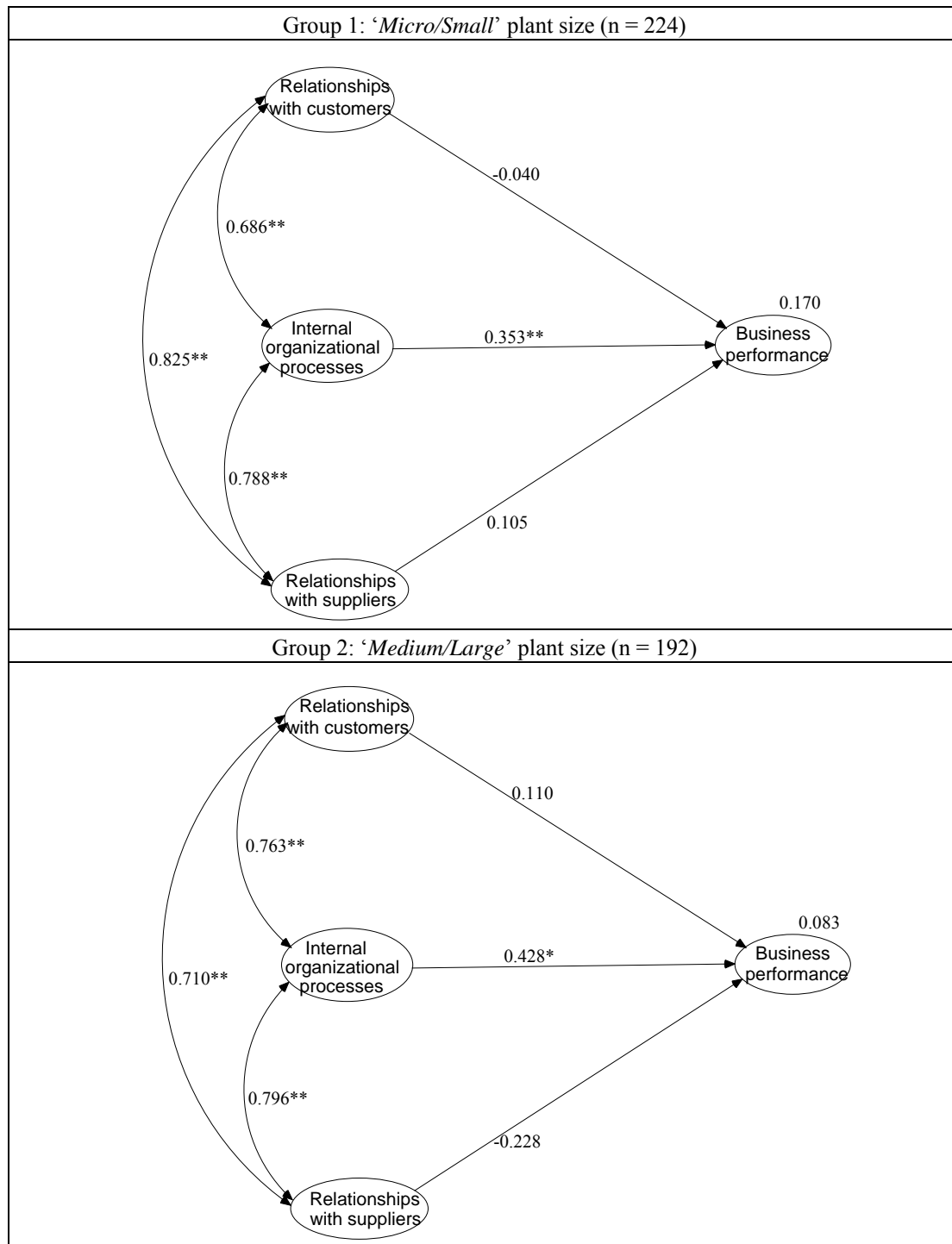


Figure 5 Comparison between plants that are micro/small with those that are large in size. Hypothesized model, showing maximum likelihood estimates of standardized regression coefficients (on straight lines single-arrowheads), squared multiple correlation coefficients (on constructs) and correlation coefficients (on curved lines with double-arrowheads). ** p-value < 0.05. * p-value < 0.1.

5. DISCUSSION

5.1 Psychometric Properties of Constructs and Relationships between Exogenous Constructs

Results presented in section 4.1 show that the psychometric properties of the constructs were reasonably sound. The tests for validity and reliability indicate that each construct could be assessed as being reasonably reliable and valid independent measures. Further, common methods bias did not appear to distort the results of this study.

Overall, it can be concluded that in the manner in which the constructs have been described, all four of them accurately represent the SCM related practices and performance aspects of ISO 9000.

The results of testing of the CFA model and hypothesized model as reported in Figure 2 shows that all three exogenous constructs have moderate to strong levels of inter-correlation. This indicates that they are each strongly and significantly associated with each other. Given that these measures are derived from the wordings used in the ISO 9000 standard, the results provide strong support for the three “elements” of a process based pipeline view of SCM, and that these relationships should be assessed as a “package” rather than as individual elements. This is also consistent with the administration of the standard where all three are measured and assessed. Beyond this, however, there is support for the notion that relationships in a SCM sense are better addressed holistically and systemically. That is, that SCM is generally enabled through combinations of relationships with supply and demand based trading partners [6]. Such an approach is also consistent with internal process improvement. In this sense, the standard can be seen to be promoting such a systemic approach to the development and management of supply chain based relationships.

5.2 Relationships within Hypothesized Model

The results relating to the hypothesized model presented in Figure 2 show that H1a (*ISO 9000 inspired SCM internal organizational processes that firms develop affect business performance*) is supported, with the internal organizational processes construct found to be a moderately strong, positive and significant predictor of plant business performance. On the other hand, the results in Figure 2 show that H1b (*ISO 9000 inspired SCM relationships with customers that firms develop affect business performance*) and H1c (*ISO 9000 inspired SCM relationships with suppliers that firms develop affect business performance*) are both not supported, with the regression coefficients being statistically insignificant. Further, all three exogenous constructs account for 10.8 percent of the variance in plant business performance.

These hypotheses test results show that only one factor (internal organizational processes) has a strong effect on plants’ business performance. The lack of significant direct paths from either relationships with customers or relationships with suppliers appears to indicate that these are not important factors in determining performance. Further, the three constructs together explain a relatively small proportion of variance in performance. These findings could be seen as refuting the central thesis of the paper, this being that the ISO 9000 is able to provide SCM focus to firms and this is demonstrable through linkages of such practices to performance outcomes. However, we believe that closer examination of the results, plus some practical considerations would lead us to conclude otherwise.

The standardized regression and correlation coefficients shown in Figure 2 were converted into direct, indirect and total effects between the three exogenous and one endogenous constructs using the decompositional procedure for path analysis described by Kline [70]. Results of these path analyses shown in Table 3 indicate that whilst the direct effects of relationships with customers and relationships with suppliers on performance are weak, the indirect effects are strong and positive in sign. These strong indirect effects more than compensate the weak direct effects. The total effects of all three exogenous constructs on the endogenous construct are similar in magnitude. Also, the strong correlational interrelationships between the three exogenous constructs (as reported in Figure 2 and discussed above) provide support for their importance to each other. Further still, we contend that the ability of this model to explain more than ten percent of the variance of the performance construct is not insignificant or inconsequential. As Samson and Terziowski [71] state, ignoring this level of performance prediction would not be wise for most organizations that operate in very competitive markets.

Table 3: Effects decomposition of paths in the hypothesized model

Exogenous construct:	Endogenous construct: Business performance		
	Direct effect	Indirect effect	Total effect
Internal organizational processes	0.368	-0.071	0.297
Relationships with customers	0.044	0.350	0.394
Relationships with suppliers	-0.097	0.366	0.269

Notwithstanding these findings, the two insignificant direct effects could be explained in practical terms. Firstly, the unit of analysis is important. The ISO 9000 standard is developed specifically to provide formal structures and process controls at the *plant* level. At this level of operation it is unlikely that the nature and practice of managing relationships with trading partners could influence performance of the plant at any other level than through better management of internal processes. The fact that the model shows no direct link with plant performance is consistent with the practical problems of management at the plant level. In particular, it suggests that at this level of operation, the only way relationships with trading partners in the supply chain can alter the performance of the plant is through the

effect they have on operational processes within the plant – whether these be related to better planning, scheduling, processing systems or inventory management practices.

Secondly, insignificant direct effects could be due to the mismatch in measurement metrics. The business performance construct involves mostly financial metrics. These most closely reflect measures of performance within the plant and best captures aspects related to internal organizational practices. Relationships with external entities such as customers and suppliers cannot be easily measured with financial metrics. These are frequently measured in the form of socio-psychological states that take a long-term strategic form. This mismatch in metrics is well recognized, has been a source of frustration to many and has led to calls for more holistic assessment of organizations' performance through methods such as the balanced scorecard, triple-bottom line, and other multi-criteria approaches [72].

5.3 Moderating Effects on Relationships in Hypothesized Model

5.3.1 Business Environmental Conditions

H2a (*business environmental conditions that firms operate in do not moderate the relationships between ISO 9000 inspired SCM practices and business performance*), which is presented in null form, is not supported. Figure 3 shows that there is evidence of a significant difference in the structural model parameters of interest when controlled for business related environmental conditions. The results indicate that for plants which face favorable environmental conditions, the pattern of relationships between the constructs is similar to the non-moderated hypothesized model (Figure 2). For this group, the magnitude of direct effects, proportion of variance of performance construct explained, and the indirect and total effects (not shown) is similar and in some instances, better than those for the whole group. Conversely, for the plants that have indicated as facing unfavorable business environmental conditions, none of the hypothesized relationships hold.

In explaining this moderating effect, it appears that the disciplined approach to managing internal and external aspects of an organization's operations promoted by ISO 9000 is particularly suitable when the environment is a conducive and stable one. When the environment is unfavorable, ISO 9000 with its facilitative and transactional capabilities, may not be enough. These organizations may need to use tools, methods, and initiatives that are more transformational and regenerative in nature, those that enable radical restructure, and more vigorous pursuit of inter-organizational relationships than ISO 9000 currently support.

We interpret this moderating effect as a reality check for plant managers in terms of the relative importance of the SCM relationship elements contained in the ISO 9000 standard. In other words, if the fundamental conditions of business are unfavorable, performance in terms of profit and demand for products is unlikely to be impacted as strongly by relationships with trading partners, particularly at the plant level. The importance of environmental factors outside of the control of the plant manager is therefore reinforced by this result.

5.3.2 Length of Experience with the Standard

H2b (*length of experience that firms have with the standard does not moderate the relationship between ISO 9000 inspired SCM practices and business performance*) is supported. Figure 4 shows that there is some change in the parameters of the model on the basis of length of time certified, but the statistical significance of this difference is such that it does not meet the conventional minimums to provide adequate levels of confidence in the result. As such the results confirm some other studies in showing that the period of certification does not appear to be an important factor in determining outcomes [36, 41, 55]. At the plant level, this result reinforces the possibility that if certification is driven by purely externally motivated reasons, then as Lawrence [54] has suggested, their practices may not change beyond a basic level once registration has been achieved.

The time since registration of three years was used to differentiate between short and long temporal experience. This time period was chosen because studies on the diffusion of organizational innovations such as QM show that it takes about three years for successful implementation [73]. Further, ISO 9000 registration certificates are valid for three years. It could be argued that if a cut-off time was set to a shorter time period (say one year), then the differences between short and long registration groups would be easier to capture. This aspect could be investigated in future studies.

5.3.3 Plant Size

H2c (*size of firms does not moderate the relationships between ISO 9000 inspired SCM practices and business performance*) is not supported. Figure 5 shows that plant size does alter the strength and significance of the relationships in the model. The relationship between internal organizational processes and business performance is more significant for smaller plants than for larger ones, and the proportion of variance in performance explained by the three SCM relationship constructs is 17 percent for smaller plants compared to 8 percent for larger ones.

We interpret this result in a couple of ways: in terms of how organizations of different sizes view the standard, and relatedly, how the complexity of processes affects its utility. For small organizations, registration to the standard would involve a significant investment of resources for the purposes of developing systems. As such, these organizations are likely to view the standard in strategic terms, and could be expected to be more directly focused on strategic outcomes. For large organizations, ISO 9000 would probably be part of a much larger and sophisticated administrative system. The standard would be used as a tool for deriving transactional efficiency. Since the hypothesized model consists of relationships that involve not only internal organizational issues but also relationships with trading partners that are strategic in nature, it can be expected that these relationships would hold better in small firms than the large ones.

The complexity of processes found in plants of different sizes and the consequent impediments to change and improvement can also provide an explanation for the difference between small and large plants. Though it may not always be the case, generally larger plants are faced with either more complex processes, or more capital intensive processes, or both. As such, translating the effects of trading partner relationships into better ways of doing things (i.e., by improving internal processes), may be more a function of inertia than of will. In other words, managers of larger plants may not find it as easy to leverage relationships with trading partners due to constraints related to the cost implications of changes to operating methods. Alternatively, the complexity of operating practices may also constrain realization of the benefits of closer trading partner relationships. Smaller plants, however, may benefit from being able to implement elements of the standard related to internal process organization more readily if processes are less complex, creating a more direct effect on performance. It is interesting to note, however, that other studies of SCM have found that although smaller firms may be more nimble in development of SCM practices, larger firms are able to develop greater depth of adoption through greater capability for investment [74, 75].

6. CONCLUSIONS

In answer to the first research question (*how do the ISO 9000 based SCM practices affect the business performance of firms?*), we have established through a direct effects model that internal organizational processes are most significant, and that relationships with customers and suppliers indirectly affect business performance. As for the second research question (*are these relationships affected by contingent/contextual factors such as business environmental conditions, time since registration to the standard and organization size?*), we have found that the hypothesized model holds when business environmental conditions are generally favorable, is more applicable to smaller firms than large ones, and that temporal experience does not significantly moderate these relationships. These findings have implications for theory and knowledge development, as well as practice.

6.1 Implications for Theory and Knowledge Development

Much of the knowledge relating to the standard which has involved formal theory is intra-organizational in nature, with little focus on inter-organizational relationships. For example, Boiral [51] uses critical theory to argue against isomorphic tendencies (as a result of institutional pressures) and shows that the standard is reinterpreted, renegotiated and modified in organizations. Likewise, Adams [56] uses, *inter alia*, agency theory to assemble a set of factors that explain why firms decide to seek registration. Naveh et al. [26] use institutional and organizational learning theories to demonstrate that learning is a more important factor than timing (in terms of being a first or second mover) for firms to realize benefits from registration. Naveh and Marcus [38, 43] utilize innovation adoption, diffusion and implementation theories to explain the factors that contribute to the successful use of the standard in organizations. In all these instances, the foci is squarely on intra-organizational aspects.

There are some studies that have taken a cross-organization focus, but these concentrate on macro level issues. For example, Guler, et al. [52] use neo-institutional and social network theories to show that a complex combination of coercive, normative and mimetic forces are resulting in the spread of ISO 9000 across organizations and industries, even internationally. Similarly, Corbett and Kirsch [37] use national economic data to explain trends in the international diffusion of ISO 14 000, a standard very similar to ISO 9000.

The strong focus of this study is on inter-organizational aspects. As such, the findings from this study can be viewed from a number of inter-organizational relationship theoretical perspectives, all of which improve our understanding in novel ways of the nature of the standard and the role it places in organizations. For example, from a transaction cost economics perspective, it is evident that ISO 9000 is an important facilitator of boundary spanning activities, particularly by enabling organizations to reduce search, monitoring and transaction costs. Further, the standard fits with the resource dependency theory view (which postulates that organizations must engage with its environment to obtain resources) since it provides a reasonably smooth framework for facilitating inter-organizational relationships. From a 'stakeholder theory of the firm' perspective, one could visualize whole networks of related entities

with all registered to ISO 9000, deriving strong value from the 'link in the chain' conceptualization of supply chains in the standard. Finally, this study provides evidence to suggest that application of the standard may not be universal, showing that the utility of the standard is affected by contextual and contingent factors such as business environmental conditions and plant size. All these insights extend knowledge relating to the standard in novel ways.

6.2 Implications for Practice

There are a number of implications for practitioners and managers. The results of this study suggest that a relatively simple and effective framework (in the form of the ISO 9000 standard) exists that can be used for SCM purposes. In playing a facilitative role through QM, the standard, perhaps serendipitously, also enables a SCM focus to develop. This is not surprising, as there are many other organizational intentions that have more than one level of utility. For managers, these findings suggest that plants can derive potentially significant benefits from implementation of ISO 9000. As such, the ISO 9000 standard provides a template that managers at the plant level can apply when confronted with decisions in terms of the nature and extent to which they should pursue relationships with customers and suppliers. Managers at this level need also to recognize that the best means by which they can translate such relationships into improved plant performance is through their own internal processes. In other words, the efforts going into developing relationships with customers and suppliers will not impact on the bottom line directly, rather they would affect internal processes, and these in turn would impact on business performance. This is an important point when justifying investment into the standard as the inter-organizational outcomes are indirect in nature.

It is also apparent that the applicability of the standard is limited in several ways. Firstly, the standard has a strong focus on activities related to immediate trading partners. It is not a tool for end-to-end supply chains or large networks of firms (unless all players are registered to the standard). As a result, the standard is best suited for developing strong, intense and enduring relationships with important immediate upstream suppliers and downstream customers.

Secondly, the sensitivity test results show that the standard is not relevant in every context. Results show that the inter-organizational model represented in the standard applies to organizations whose business environmental conditions are favorable. If underlying business conditions are unfavorable, management at the plant level will find it increasingly difficult to realize benefits. The implication here is that management of an individual plant is often directly affected by environmental conditions (e.g., significant price changes for basic inputs). As such, they cannot expect to be insulated from such factors based on use of supply chain practices incorporated in an ISO 9000 standard. In this sense, we see this as a reality check for managers in modifying their expectations from the standard. Further, micro/small organizations appear to find the approach more applicable than their larger counterparts. This is probably because small organizations view the standard in strategic terms and place greater value in their investment in the standard. Larger organizations, on the other hand, are more likely to view the standard in functional terms for the purposes of facilitating transactional activities. As against the two moderating effects, the study further found that time based experience with the standard does not appear to affect its utility. The greater message for managers as a result of the discovery of the two moderators is that the standard is not universally applicable in all contexts, and that care needs to be taken as to when and how the standard could be utilized for SCM purposes.

In sum, the findings indicate an important potential role for the ongoing use of the ISO 9000 standard beyond that of just promoting quality assurance at the plant level. Through the use of the SCM focused elements of the standard, the evidence suggests managers can use these as a template for developing a more externally focused SCM perspective. Importantly, the real benefits appear to lie in how they then use these relationships with trading partners to enable more effective process development and management at the plant level. As such, the ISO standard provides managers with a template on which they could build more effective supply chain practices.

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