The Influence of Supply Chain Quality Management Practices on Quality Performance: An Empirical Investigation

Purpose

The extant literature highlights the notable lack of a consensus among operations and supply chain management scholars regarding the theoretical underpinnings and associated empirical evidence for the performance impact of supply chain quality management (SCQM) practices on quality. The aim of this study is to redress this imbalance in the literature through empirical examination of the relationship between SCQM practices and quality performance outcomes.

Design/methodology/approach

In accordance with the research aim, a quantitative approach was adopted, and a multi-item scale web-based survey was designed to collect primary data. A total number of 325 questionnaires were collected from a sample of UK-based manufacturing companies. Factor analysis, internal consistency and multivariate regressions were employed to validate the multi-item scale and test the hypotheses.

Findings

The findings confirm the proposed hypotheses and reveal statistically significant results for the performance impact of SCQM practices on quality at an aggregate level. However, the results of the individual level analysis of SCQM practices appear to vary from practice to practice. Of various SCQM practices, customer focus with the highest beta value (i.e. $\beta = 0.303$; t-value= 6.120; p=0.000) was found to have the greatest impact on quality performance.

Practical implications

The findings encourage managers to place high priority on both inter-firm and intra-firm relationships as prerequisites for achieving superior quality performance. The propositions and the results of the study provide managers with some guidelines about effective management of upstream, midstream and downstream supply chain networks and awareness of the potential synergies arising from the combined effects of SCQM practices that could bring about desired quality performance outcomes across the entire supply chain network.

Originality/value

Real and sustainable quality performance often requires an equal focus on both intra- and inter-firm relationships among supply chain partners. So effective management of quality across the entire supply chain is deemed essential if a

firm is to smoothly supply high quality products and services to customers. But, little research has been devoted to understanding conceptual underpinnings of SCQM as well as empirical support and validation for the conceptualisation and measurement of SCQM practices. Based on the insights gained from social network theory (SNT), this paper makes an attempt to address this gap and examine the impact of SCQM practices on quality performance.

Keywords: supply chain quality management (SCQM); social network theory, quality performance, individual/aggregate-level analysis, survey, UK manufacturing sector.

Type: Research paper

1. Introduction

The current globalised business environment has forced businesses to shift their intra-firm focus on quality improvement to encompass the globalization of their quality strategy (Li, Su and Chen, 2011; Soltani et al., 2011; Wiengarten, Fynes and Onofrei, 2013; Lin, Kuei and Chai, 2013). This has encouraged operations and supply chain management scholars to discuss the need for implementing quality across the entire supply chain (see Kaynak and Hartley, 2008; Foster, Wallin and Ogden, 2011). Such revisit of internal quality strategy to take account of the dynamic nature of external supply chain network has proved to be core to a firm's competitive standing and deemed essential to achieve desired quality and supply chain performance outcomes (see Vanichchinchai and Igel, 2011). Hence, quality is now viewed as a common supply chain goal and perceived to be the responsibility of all levels and actors in the supply chain, particularly in a context where business models show increasing trends to adopt servitization, IoT and circular economy models. Drawing on in-depth industrial interviews and extensive literature review, Lo and Yeung's (2006) study suggests the application of supply quality management practices throughout the entire supply chain based on the understanding that a function has to view its upstream function as its supplier – if quality is to be managed effectively in supply chain. In the extant literature, such focus on the interface between

quality and supply chain has been referred to as 'Supply Chain Quality Management' (SCQM hereinafter) (Lo and Yeung, 2006; Sila, Ebrahimpour and Birkholz, 2006; Foster, Wallin and Ogden, 2011; Kuei, Madu and Lin, 2011; Uluskan, Joines and Godfrey, 2016; Tsai and Hung, 2016).

Since its initial conceptualisation by Ross (1998), the notion of SCQM has been increasingly gaining recognition as a vastly important topic for theorisation and research. However, it can be argued that much of the debate in this area has been relied on the theoretical inferences from either quality management (QM), supply chain management (SCM) practices or in very few cases on the interface between the two concepts rather than direct empirical scrutiny of SCQM practices as fully stand-alone theme and field of study. While existing studies of SCQM have laudably increased the interest of both academics and managers in the field of operations and supply chain management, they typically do not delve deeply into whether SCQM practices can influence and improve the quality of products and services produced. As our review of several most influential and frequently cited operations and supply chain management journals (e.g. SCMIJ, IJOPM, JOM, IJPE, IJPR) indicates (see Appendix 1), SCQM has not yet received a similar level of detail as exists in the operations-related supply chain and quality literature. Thus, there is the lack of a coherent theory and a consensual theoretical framework of fundamental principles underpinning SCQM coupled with the abundance of interpretations of what characterises SCQM. In addition, a review of the extant literature shows that while previous studies have identified performance effects of SCQM practices on quality at an aggregate level, the aggregate measure of SCQM impact on quality performance is unlikely to yield accurate measures of differences in quality performance across a broad and heterogeneous range of products and suppliers. Such dearth of attempts has led us to argue that an enhanced understanding of the individual-level associations between each

of SCQM practices and quality performance could assist managers to evaluate and prioritise critical success factors of SCQM and formulate strategies for SCQM successful implementation. Of particular significance is the dearth of empirically validated scales for SCQM construct. Similarly, the absence of recent empirical assessments suggests that many studies of SCQM fail to collect data from industries which are characterised by global production chains, multiple domestic and foreign locations for production facilities, multi-tier domestic and foreign supply networks, and overreliance on rigorous quality standards.

Based on insights gained from Social Network Theory (SNT) and building upon prior research on SCQM practices (e.g. Sila, Ebrahimpour and Birkholz, 2006; Foster, Wallin and Ogden, 2011; Lo and Yeung, 2006; Wiengarten, Fynes and Onofrei, 2013; Quang et al., 2016), the current study makes an attempt to respond to these shortcomings with both theoretical and empirical contributions. Specifically, this study heeds the suggestions offered by several researchers (e.g. Foster, Wallin and Ogden, 2011; Kuei and Madu, 2001; Kuei, Madu and Lin, 2011; Sila, Ebrahimpour and Birkholz, 2006; Zhong et al., 2016; Kaynak and Hartley, 2008; Flyn and Flyn, 2005; Quang et al., 2016) who commonly argue that SCQM is still in the definitional stage and that it requires empirically validated SCQM measures (Foster, Wallin and Ogden, 2011, p. 2286). Furthermore, we argue that having only validated SCQM measures makes it hard to justify an investment decision in an update of existing quality systems throughout the entire supply chain. Rather, we argue that the performance impact of quality-related implementation efforts across the supply chain needs to be measured – if improved SCQM practices are to enhance product quality and organisational performance (see Uluskan, Joines and Godfrey, 2016; Theodorakioglou, Gotzamani and Tsiolvas, 2006; Prajogo, Huo and Han, 2012). Our aim is thus to empirically develop a richer account of SCQM practices and

assess their performance impact on product quality. To test this argument, we used data from a sample of 325 UK-based manufacturing firms with multiple manufacturing sites and multi-tier domestic and foreign suppliers.

The paper is organised as follows. It starts with a review of the literature pertinent to SCQM and quality performance. The literature review lays a foundation for developing the conceptual framework as well as deriving a set of research hypotheses. The next section discusses the adopted quantitative methodology followed by an analysis of the data. The final section discusses the theoretical and practical implications of the study.

2. Theoretical background

Social network theory (SNT henceforth) argues that organisations should not be studied in isolation because they are ultimately influenced by the network to which they belong to (Williams and Durrance, 2008). Key SNT principles include graph hierarchy, graph efficiency, least upper boundedness, centralisation index, density, clique, n-cliques, clique overlap, clique multiplexity, simmelian ties, homophily, multiplexity, heterophily, structural holes, strength of ties, strength of weak ties, weak ties, influence, propinquity, mutuality (reciprocity or symmetry), distance, 'small world', degree of connectedness, embeddedness, and transitivity (Scott, 2000, p. 7).

Even though the network approach has been frequently adopted in organisational research since the 1930's (Jack, 2010), it still offers opportunities for further research, especially in the field of operations and supply chain management (Kim et al., 2011; Braziotis et al., 2013). SNT endorses the idea of looking at supply chains as networks and explains how the structure of the interactions between firms affects outcomes (Kilduff and Tsai, 2003; Kim et al., 2011). There has been a growing awareness of the relevancy and benefits of network perspective in the SCQM context – largely based on the premise that SCQM connotes the management of inter-organizational (supplier-customer) relations

and that maintaining quality across the entire supply chain requires firms to form collaborative inter-firm relationships in terms of sharing information, coordinating schedules, and developing high quality products and services together (Humphries and Gibbs, 2010; Soares, Soltani and Liao, 2012). With the emphasis on inter-firm relationship as an important avenue for creating value, differential advantages and bilateral dependence between buyers and suppliers, the network perspective has become a lingua franca for operations and supply chain management scholars. As evidence of the importance of social network theory in a supply chain context, several researchers have presented evidence to argue that the assumptions underpinning SNT can be utilised as a generic explanatory platform to relate network variables to performance outcomes of interest and more specifically to shorten the large distance between buyer and supplier (see Borgatti and Li, 2009; Choi, Dooley and Rungtusanatham, 2001;, Ellram, Tate and Carter, 2006; Carter, Ellram and Tate, 2007; Autry and Griffis, 2008; Fletcher et al., 2016; Pomponi, Fratocchi and Tafuri, 2015). In light of the aforementioned discussion, we gain insights from SNT as an appropriate lens to highlight the importance attached to the linkages between internal processes with upstream and downstream firms' externalisation – if quality is to be maintained as a core identity for all parties across the entire supply chain (Foster, Wallin and Ogden, 2011, 2011, p. 2286). The principles underpinning SNT allow us to adopt a holistic approach, apply network concepts to "soft" types of intra- and inter-firm ties, and consequently to interpret the dynamics of upstream, midstream and downstream supply chain relationships and effectively tap SCQM implementation and performance outcomes (see Kilduff and Tsai, 2003; Borgatti and Li, 2009).

3. Supply chain quality management (SCQM): a review

The renewed emphasis on harmonization of the needs and interests of various supply chain

partners and on the importance attached to alignment of these needs with those of diverse customer requirements (at both intra- and inter-firm levels) are deemed essential for manufacturing firms (see Zhang et al., 2011; Kamal and Irani, 2014). One explanation for such renewed emphasis on supply chain management integration arises from the fact that it is viewed as a prerequisite for boosting operational efficiency, rendering superior quality products/services, maintaining organisational performance, and keeping abreast of customers' ever-rising and changing expectations (see Sila, Ebrahimpour and Birkholz, 2006; Foster, Wallin and Ogden, 2011; Prajogo, Huo and Han, 2012; Tsai and Hung, 2016). These operational and organisational priorities and the need to further advance from a traditional firm-centric and product-based mindset to an inter-organisational supply chain orientation have paved the way for operations and supply chain management scholars to make concerted efforts to theorize and operationalise the interface between QM and SCM practices into a unified and coherent whole as 'SCQM' (see Ross, 1998; Sila, Ebrahimpour and Birkholz, 2006; Lo and Yeung, 2006; Foster, 2008; Foster, Wallin and Ogden, 2011; Kuei, Madu and Lin, 2011; Prajogo, Huo and Han, 2012; Tsai and Hung, 2016; Uluskan, Joines and Godfrey, 2016). For the sake of parsimony, a summary of these studies is shown in Table 1.

'INSERT TABLE 1 ABOUT HERE'

As Table 1 suggests, existing studies of SCQM can be categorized into three broad strands, namely, (i) definitional aspects of SCQM concept, (ii) SCQM practices, and (iii) individual and aggregate performance impact of SCQM practices on quality and organizational performance. While these and a number of other studies (e.g. Kannan and Tan, 2005; Prakash, 2011; Zhang et al., 2011; Jraisat and Sawalha, 2013; Kamal and Irani, 2014) have consistently pointed to the synergies arising from the relatedness of internal quality processes with upstream and downstream processes and dynamics, they have

often inferred and indirectly explored the nature and peculiarities of SCQM from either an internal quality perspective or an external perspective of suppliers. Each of these areas will be briefly covered below.

3.1. SCQM Definition

As with all scholarly endeavours in other fields, a range of different definitions of SCQM have so far been offered by different authors. These definitions reflect different theoretical, empirical and more importantly the focus and scope of the scholars' own research interests. For example, Ross (1998, p.284) views SCQM as 'the latest stage in the total quality movement' and considers all supply chain actors responsible for processes and products/services improvement. Kuei and Madu (2001, p.411) adopt a relational approach to the definition of SCQM and argue in favour of the need for trust in buyer-supplier relationships as a prerequisite for sustained quality performance across the entire supply chain (see also Fynes et al., 2005). Robinson and Malhotra (2005, p.319) advocate a coordinative and cooperative approach to managing supply chain relationships and related business processes for effective integration of quality and supply chain management practices. In a more recent definition of SCQM, Foster (2008, p. 461) views the term to signal a more 'systems-based and holistic approach to performance improvement which capture not only internal processes but also upstream and downstream processes and dynamics'.

Whilst these definitions implicitly take different stances of the essence of SCQM and highlight the intricacies of the two concepts, a key tendency appears to be the increased emphasis upon the broadest network of supply chain participants and their knock-on effect on quality performance. Although getting the right quality product at the

right price and at the right time is perceived to be the primary concerns for buyers, supplying the right quality product at the right time and at a profitable price is regarded as the ultimate goal of suppliers (Fynes et al., 2005). Thus, understanding and finding the optimal balance in the buyer-supplier relationship and the nature of inter-firm interactions and consequences for product quality performance provides a fertile ground for utilising SNT assumptions to examine the management of quality processes throughout the entire supply chain (see Wee and Wu, 2009; Fletcher et al., 2016; Tsanos and Zografos, 2016; Kähkönen, Lintukangas and Hallikas, 2015; Sancha, Longoni and Giménez, 2015).

3.2. SCQM practices

Another important debate in the literature on SCQM has centred on a set of practices and critical factors that characterise the nature of SCQM. A number of recent studies have pointed to the potential synergies between QM and SCM (e.g., Foster, Wallin and Ogden, 2011; Soltani et al., 2011; Quang, et al., 2016; Sampaio, Carvalho and Fernandes, 2016; Fernandes et al., 2017) and provided a fertile area for elucidating SCQM practices. For example, Lin et al. (2005) suggested nine SCQM constructs as follows: top management leadership, training, product/service design, supplier QM, process management, quality data reporting, employee relations, customer relations and benchmarking learning. In a similar vein, Kaynak and Hartley (2008) conceptualise SCQM through the following eight practices: management leadership, training, employee relations, customer focus, quality data and reporting, supplier QM, product/service design, and process management. Several other researchers (e.g. Kuei, Madu and Lin, 2008:1132) developed a SCQM framework based upon five categories, namely, customer focus, quality of the IT system, supplier relationships, externally focused process integration, and supply chain quality leadership. In other study, Lin, Kuei and Chai (2013) identified the enabler criteria of SCQM as supplier relationship, information technology, process management, top

management support, human resource management, QM, strategic planning, and knowledge management. Taken together, these bodies of literature have theorized a set of shared practices that can be summarized into the following five practices:

(1) Quality leadership: it refers to managerial actions and choices with regard to establishing a working environment conducive to continuous improvement at both inter- and intra-firm levels (Ahire and O'Shaughnessy, 1998; Prajogo and Sohal, 2003; Kaynak and Hartley, 2008).

(2) Customer focus: it requires viewing both internal and external customers as the ultimate arbiter of quality, long-term business value driver and a prime source of business success. It also connotes a prompt response and proactive approach to customer needs and concerns (Deming, 1986; Lai, 2003; Sroufe and Curkovic, 2008).

(3) Supplier focus: it requires organisations to view suppliers as invaluable members of their value chain creation and that organisations should establish a business environment which enable joint quality focus and development through collaborative relationships. It should be noted that the ability and willingness of supply chain partners to promptly respond to the quality concerns of the buying organisation rely, in the main, upon the level of trust between all the parties and at all levels of supply chain (Lin et al., 2005; Lo and Yeung, 2006).

(4) IT-enabled organisations: It views communication and information sharing through the use of IT as a prerequisite for optimising quality performance of multi-echelon supply chain networks. If managed and maintained appropriately, IT can result in operational efficiency and yield competitive advantage for all members of supply chain network (Xu, 2011).

(5) Integration: it refers to close alignment and coordination within a supply chain which is deemed essential to the coherent implementation of SCM activities and the

achievement of improved performance (Yeung, 2008; Huo, Zhao and Lai, 2014).

3.3. Performance impact of SCQM practices

In general, prior work on quality management (QM) practices and performance has primarily attempted to measure the impact of quality practices separately. As Table 2 seeks to suggest, much existing research on QM practices are frequently devoid of critical analysis of the performance impact of QM practices altogether and their aggregate impact on product/service quality and organisational performance (e.g., Cua, Mckone, and Schroeder, 2001; Flynn, Schroeder and Sakakibara, 1994, 1995; Tan et al., 1999). The results of such individual-level (as opposed to aggregate level) analysis of performance impact of quality management practices at operational and organisational levels showed that different QM practices had different effects on quality performance (e.g. Dow, Samson and Ford, 1999; Samson and Terziovski, 1999; Baird, Hu and Reeve, 2011).

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In terms of the performance impact of SCQM practices (see Table 1), research has provided evidence in support of a positive relationship between SCQM practices and overall organisational performance (see Lin et al., 2005; Kahnali and Taghavi, 2010). With the exception of Sila, Ebrahimpour and Birkholz's (2006) study of the performance impact of SCQM on product quality and design quality, the extant empirical studies of the performance impact of SCQM have failed to capture the performance effects of SCQM practices at the individual level of analysis. In most of these studies, research scholars have typically measured the performance impact of SCQM at the aggregate level. For example, Kuei, Madu and Lin (2001) report on the managers' positive perceptions toward the impact of SCQM on overall organisational performance. In their study of the synergies between quality and supply chain management, Flynn and Flynn (2005, p.3424) present evidence in favour of the positive impact of QM practices on a

firm's operational (supply chain) performance such as 'inventory and time-related metrics – e.g. cycle time and delivery dependability' (see also Flynn, Schroeder and Sakakibara, 1995). In a study involving 200 suppliers in the electronics sector in the Republic of Ireland, Fynes, Búrca and Voss (2005) reported the positive impact of supply chain relationship quality (SCRQ) on supply chain performance quality. Similarly, Lo, Yeung and Yeung's (2007) study provided evidence for the positive impact of SCQM on organisational/quality performance in Chinese manufacturing firms.

Whilst these studies have made significant contribution to the conceptualisation and theorization of SCQM, the existing SCQM research seems to be weakened by the assumption of unidimensional nature of SCQM. In other words, the analysis of SCQM empirical data has often been carried out at an aggregate level (i.e. viewing SCQM as a single construct), thereby concealing variation between individual practices of SCQM (see Nair, 2006; Johnson, Rosen and Chang, 2011; Kim, Kumar and Kumar 2012). In this regard and given the multidimensionality of SCQM, we argue that the literature could be enriched by analysing the individual performance impact of each SCQM practice on product quality. Such individual level of analysis of SCQM practices not only supplements the existing dominant aggregate level analysis of SCQM, but also provides a platform for quality, supply chain and operations managers to identify the relative importance weight of individual SCQM practices and to plan their operational and strategic priorities accordingly. Finally, another limitation of existing theorization of SCQM is that they often explore the impact of SCQM practices on overall organisational performance. This implies that few studies have provided (mixed) accounts of the performance impact of SCQM practices on quality and that the impact of SCQM practices on quality performance has remained ambiguous and controversial – to say the least (see Lin et al., 2005; Kaynak and Hartley, 2008; Kahnali and Taghavi, 2010).

The study reported in this article is designed to contribute to the existing SCQM research by identifying SCQM practices and exploring their impacts on quality performance at individual level of analysis. In the context of this article, quality performance connotes the quality of the final product (which incorporates design, conformance and more importantly quality attributes). A review of quality performance is given in the next section.

3.4. Quality performance

'Quality' or 'quality performance' is a controversial construct for a variety of conceptual and empirical reasons. From a conceptual point of view, quality has been viewed as a 'seductive' (Wilkinson and Willmott, 1995) and 'an unusually slippery concept of management which is easy to visualize but exasperatingly difficult to define' (Garvin, 1991). From an empirical standpoint, the existing research evidence provides mixed results at both micro- and macro-level impact of QM practices on individual and organisational performance (see Table 2). While some studies reported little or no performance improvements as a result of QM implementation (e.g. Adam Jr. et al., 1997), others provided evidence in support of the significant impact of QM practices on quality performance outcomes (e.g., Forker, Mendez and Hershauer, 1997). As a result of the mixed findings concerning the performance impact of QM programmes, the debate on quality performance measurement systems has been equally diverse and illusive (see De Toni, Nassimbeni and Tonchia, 1995; Flynn, Schroeder and Sakakibara, 1995; Lee, Rho and Lee, 2003). In most of these studies, scholars have tended to focus on the positive association between internal quality practices with operational (including quality) and financial performance outcomes (e.g., Kaynak, 2003; Goldstein and Iossifova, 2012; Jayaram, Oke and Prajogo 2013), thereby leading to a relative neglect of operationalization of quality performance as a construct.

A review of the extant literature highlights three key issues that might explain the variety and vagaries of research findings relevant to performance impact of quality practices: (1) the use of different measurement instruments to assess both quality implementation and the resulting performance impact, (2) the use of quality and performance as single and/or multi-dimensional constructs (Kim, Kumar and Kumar, 2012:296) which implies individual and/or aggregate level measurement of quality performance, and (3) the existence of additional interacting/contextual variables (e.g., Sousa and Voss, 2001). Consequently, the ambiguity and existing mixed results of the definitions and operationalization of quality performance calls for further research on the individual impact of each of the quality practices on quality performance outcomes.

In the light of these limitations and absence of a consensual definition of quality performance, more recent research suggests to study quality and its performance impact as a multidimensional construct. This usage is essentially that of Garvin (1987) who defines product quality in terms of the following eight mutually exclusive attributes: product performance, product features, reliability, conformance, technical durability, serviceability, aesthetics and perceived quality (see also Neely, 2007 that adds value for money to these attributes). Sousa and Voss (2002, p.94) consequently highlighted the need to differentiate between quality performance and operational performance and urged operations and supply chain scholars to study the multi-dimensional nature of 'quality performance' in future research. However, very few studies have empirically examined the multidimensional performance attributes of product quality in the context of SCQM. This vital issue (i.e. examination of the individual level impact of SCQM practices on quality outcomes) constitutes the primary focus of the current study.

4. Research framework and hypotheses

Figure 1 presents the adopted research framework and hypotheses. As depicted in Figure

1, four SCQM practices were considered for the purpose of the current study. These four categories are based on the literature previously presented, namely, Kuei, Madu and Lin's (2008) SCQM practices (i.e. customer focus, quality of the IT system, supplier relationships, externally focused process integration and supply chain quality leadership). To avoid item repetition, the items representing the quality of the IT system dimension (i.e. the information sharing items adopted in the current study) were included in the survey with the questions referring to the 'customer focus' and 'supplier focus' practices. As a result, SCQM practices were examined in the form of four (see Kuei, Madu and Lin, 2008) SCQM practices in the current study. In order to conceptualise and operationalise quality performance, we employed product quality features recommended by Garvin (1987) and Neely (2007).

'INSERT FIGURE 1 ABOUT HERE'

In the light of the aforementioned research framework (Figure 1), the related hypotheses are elaborated as follows.

4.1. Customer focus and quality performance

The existing research pertinent to the relationship between customer focus and quality performance tends to support the positive effect of customer-focused practices on quality performance at both individual and aggregate levels (Tan et al., 1999; Chen and Paulraj, 2004). For example, Flynn, Schroeder and Sakakibara (1994) supported the role of customers' involvement in the product design and development process not least because it had the potential to reduce quality problems at the production stage. Adam Jr. et al. (1997) found that actual quality was influenced by QM knowledge, its degree of customer focus, and management involvement. Kaynak and Hartley's (2008) study provided evidence for the direct relationship between customer focus, management leadership,

supplier QM and quality performance, as well as the need for implementing QM as an integrated system. In short, we make the following hypothesis:

H1: Customer focus positively contributes to the achievement of superior quality performance.

4.2. Supplier focus and quality performance

The extant literature (see Table 2) indicates that suppliers' quality and involvement has a positive, but not always direct, impact on operational and financial performance. For example, Forker, Mendez and Hershauer (1997) reported that suppliers' relative efficiency moderated the relationship between QM practices and quality performance. Kaynak (2003) demonstrated the importance of supplier QM in effective QM implementation through its direct relationships with product/service design and process management. Baird, Hu and Reeve (2011) found that while all QM practices were interrelated, supplier QM, process management, and quality data and reporting were reported to facilitate the achievement of operational performance goals. Thus, we suggest the following hypothesis:

H2: Supplier focus positively contributes to the achievement of superior quality performance.

4.3. Supply chain integration and quality performance

The relationship between supply chain integration and business and operational performance has also been fairly established in the literature (see Table 2). For example, Rosenzweig, Roth and Dean's (2003) study of the effects of an integration strategy on competitive capabilities and business performance supported the influence of supply chain integration intensity on product quality and delivery reliability. Yeung's (2008)

study of the organizational impacts of strategic supply management on quality and organisational performance found that supply chain integration improved on-time shipments, reduces operational costs, and consequently led to customer satisfaction and improved business performance. Based on the insights gained from the contingency and configuration approaches, Flynn, Huo and Zhao's (2010) study revealed that supply chain integration was related to both operational and business performance. Similarly, Huo, Zhao and Lai's (2014, p. 38) study of antecedents and consequences of supply chain quality integration found how different types of supply chain quality integration were related to quality-related performance. In particular, Huo et al.'s (2010, 2014) findings highlighted internal quality integration as a core strategic resource for quality improvement. Restated as a proposition, we offer the following statement:

> *H3: Supply chain integration positively contributes towards the achievement of superior quality performance.*

4.4. Quality leadership and performance

The extant literature has provided evidence in support of the impact of quality leadership on performance. For example, Rodgers and Hunter's (1991) study showed that when top management commitment to specific performance objectives was high, firms experienced an average gain in productivity of up to 56%. Powell (1995) reported that top management commitment to quality significantly influenced quality performance. In a similar vein, Ahire and O'Shaughnessy (1998) showed that high top management commitment resulted in higher quality products. In another study, Samson and Terziovski (1999) found that QM practices were not equally predictors of operational performance. Of various QM practices, their study confirmed only a significant positive correlation between leadership and customer focus with the firm performance. As such, we argue

that leadership is expected to substantially impact on quality performance. In formal terms:

H4: Quality leadership positively contributes towards the achievement of superior quality performance.

4.5. The overall performance impact of SCQM practices on quality

As our review of the literature indicates (see Table 1), much discussion of SCQM is based on the examination of the aggregate impact of SCQM practices on overall organisational performance. As a result, there is the dearth of research into the quality performance impact of SCQM practices and empirically validated scales for SCQM. In this regard and in concordance with the existing research pertinent to the potential impact of SCQM practices on quality performance (e.g., Sila, Ebrahimpour and Birkholz, 2006; Lin et al., 2005; Kahnali and Taghavi, 2010), we argue that SCQM implementation (i.e. the combined effect of the four SCQM practices on quality performance) is positively related to the achievement of superior quality performance. Therefore, it is hypothesized that:

H5: Supply Chain Quality Management (SCQM) has a positive effect on quality performance.

5. Methodology

The aim of the present study was to investigate the performance impact of SCQM practices on quality. Drawing on positivist ontologies, a quantitative research strategy was adopted (see Burns, 2000). Simple linear regression and multivariate analysis were employed to test the research hypotheses. Specifically, simple regression analysis was undertaken to examine H1-H5. The results of multivariate regression were provided for

further discussion about the relationship between variables at an aggregate level.

5.1. Questionnaire development

In order to collect the quantitative data and test the research hypotheses a web-based survey was adopted. Of various modes of survey data collection (e.g. postal-mail, telephone, face to face survey), this method was chosen for two main reasons: to enable the collection of data in an efficient and cost-effective manner, and more importantly to maximize response rate (Griffis, Goldsby and Cooper, 2003). In line with De Vaus' (2002) recommendations, the elaboration and refinement phase of questionnaire design involved a three-stage pre-test analysis. The outcomes of the analysis led to some changes in the layout and content of the final draft of survey questionnaire. The final version of the web-based self-completion questionnaire adopted a seven-point Likert scale (Likert, 1932). The final version of the questionnaire survey was composed of the following four main sections: introduction, SCQM items, quality performance items, and background information questions.

5.2. Sample

In an attempt to broaden distribution and dissemination of the questionnaires, extensive collaborative efforts were undertaken with several professional manufacturing and quality associations. As a result of our joint efforts, a total number of 2000 questionnaires were distributed to leading membership organizations for these associations in the UK, of which 527 were received but only 325 were usable. This yielded a 16.3% response rate which was comparable to similar studies of quality and supply chain management (e.g. Sila, Ebrahimpour and Birkholz, 2006; Kaynak and Hartley, 2008; Dellana and Kros, 2014). The demographic profile of responding companies included mainly large

manufacturing companies with operations in the metals and engineered metal products sector (14.46%), food and drinks (12.92%), electronics (12%), process manufacturing (9.85%), pharmaceutical (8.31%), aerospace (8%), automotive (8%) and other manufacturing sectors (26.46%). They were located all over the UK with the highest percentage of companies operating in the South-East region (23.69%). The majority of the companies (75.4%) were in operations for more than 20 years and varied in size (no. of employees), ranging from small and medium sized (42.4%) to large enterprises (56.3%). They were ISO 9000 certified and adopted different business excellence models (mainly European Foundation for Quality Management or EFQM Business Excellence Model) and improvement methodologies and techniques (e.g. lean manufacturing tools, six sigma, business process reengineering) to aid in execution of operations strategy and improve the effectiveness and efficiency of quality management activities.

5.3. Measurement

As our proposed conceptual framework indicates (see Figure 1), four SCQM practices were selected for the purpose of the current study. These practices included customer focus, supplier focus, supply chain integration, and quality leadership. Given the absence of a thorough measurement scale for all SCQM practices, several validated items utilised in previous studies were adopted and adapted accordingly (e.g. Zhang, Waszink and Wijngaard 2000; Kannan and Tan, 2010). In order to measure the dependent variable of the proposed conceptual framework (i.e. quality performance), Neely's (2007, p.69) nine attributes of quality (i.e. product performance, features, reliability, conformance, technical durability, serviceability, aesthetics, perceived quality and value for money) were adopted.

6. Results

6.1. Validity and reliability

Cronbach's alpha and factor analysis under the extraction method of principal component analysis with the rotation method of Varimax were employed to assess the reliability and validity of the adopted scales. Overall, factor loadings greater than 0.4 (cut-off point at ≥ +0.4 or ≤ –0.4) and internal consistency/reliability higher than 0.7 ($\alpha > 0.7$) are needed for practical significance (see Tabachnick and Fidell, 2001; Hair et al., 2006) and retaining an item in a scale (Nunnally, 1978), respectively. The results from these analyses suggested that all measures were both valid and reliable which implied that they could be safely used for testing the research hypothesis. Table 3 shows the results for factor analysis as well as the reliability analysis of the variables.

'INSERT TABLE 3 ABOUT HERE'

In line with the extant literature, the results of the factor analysis produced four SCQM factors with high loadings for all communalities (> 0.4) and a KMO of 0.94 (see Tabachnick and Fidell, 2001; Hair et al., 2006). These four factors which cumulatively explained 63.7% of the total variance were labelled as follows: (1) SC activities/integration, (2) customer focus, (3) supplier focus and (4) quality leadership. Individually, each of these factors explained 42.8%, 9.8%, 6.4% and 4.8% of the data variance, respectively. These factors were further used to conduct multiple regression analysis.

6.2. Hypotheses testing

The correlation between variables was then tested and significant correlations at the 0.01 level (2-tailed) were found among the variables – an indication of low and medium correlation levels. Table 4 presents the correlation analysis of the research variables.

‘INSERT TABLE 4 ABOUT HERE’

Regression assumptions were also considered to ensure that the data was normally distributed, with no heteroscedasticity, singularity or multicollinearity and that a linear association could be inferred (Tabachnick and Fidell, 2001; Hair et al., 2006). Upon fulfilling all these conditions, multiple regression analyses were conducted to analyse the impact of SCQM practices on quality performance outcomes. In this respect, summed scales for each of the independent and dependent variables were created and included in the regression analysis. The four practices and an aggregate SCQM variable for testing their impact as a whole were used as independent variables in a series of regressions with quality performance as the dependent variable.

After analysing the results of correlation analysis and regression conditions, we conducted two regression analyses: simple and multiple regression analysis. Simple regression was used to test the performance effect of each independent variable (i.e. each of SCQM practices separately including SCQM as an independent variable) on dependent variable (i.e. quality performance) – i.e. addressed by H1 to H5. Table 5 presents a simple regression model for explaining the individual effect of SCQM practices on quality performance.

‘INSERT TABLE 5 ABOUT HERE’

As shown in Table 5, the results of simple linear regression lend support for all the hypotheses (H1 to H5). The results of the individual performance impact of SCQM practices (including SCQM as an independent variable) indicate that customer focus (β =0.465, t-value =7.935, $p<0.001$), supplier focus (β =0.448, t-value =8.201, $p<0.001$), supply chain activities/integration (β =0.285, t-value =5.503, $p<0.001$), quality leadership (β =0.307, t-value =6.211, $p<0.001$) and SCQM (β =0.533, t-value =8.549, $p<0.001$) all have a positive impact on quality performance (addressed by H1 to H5).

While the results of simple regression are suggestive of a positive linear relationship between SCQM and quality performance (addressed by H5), they do not show how much of the variation in product quality performance can be explained by customer focus, supplier focus, supply chain integration and quality leadership 'as a whole' – the aggregate performance impact of SCQM. Thus, we used multiple regression to further examine H5 and analyse the 'relative contribution' of each SCQM practice in explaining the variance in quality performance. The use of multiple regression analysis allowed us to determine the overall fit (variance explained) of the model and the relative contribution of each of the predictors to the total variance explained. Table 6 shows the multiple regression analysis for the four explanatory variables of SCQM. A discussion of data analysis is given in the next section.

'INSERT TABLE 6 ABOUT HERE'

Although the aggregate effect of SCQM on quality performance is statistically significant (with the highest R-squared, 18.5% - see Table 5), the results of multiple regression (see Table 6) show how much variance in product quality performance can be attributed to each of the four SCQM practices (i.e. aggregate performance impact of SCQM as the sum of all four practices). The analysis reveals the proportions of variance explained by SCQM practices to vary from 0.8% (supply chain integration), 4% (quality leadership), and 7.6% (supplier focus) to 9.2% (customer focus).

These results not only support the extant literature that argues in favour of the individual effects of SCQM practices on quality performance (e.g., Flynn, Schroeder, and Sakakibara 1994; 1995; Cua, Mckone, and Schroeder 2001), but also they support the potential aggregate effect of SCQM practices 'as a whole' on quality performance (e.g., Sila, Ebrahimpour and Birkholz 2006; Lin, Kuei, and Chai 2013**).**

7. Discussion

7.1. Main findings

The results of the present study provide a response to the notable lack of research regarding the theoretical underpinnings and associated empirical evidence for the effects of SCQM practices on product quality. Overall, the findings reveal that different SCQM practices significantly affect product quality and that the effects of each of SCQM practices on product quality measures differ. A summary of the main findings is detailed as follows.

The findings support the significance of definitional dimensions of SCQM as a coordinated effort of all parties involved in the company's supply chain to improve product quality. A SCQM or end-to-end approach to managing quality is even deemed more essential for the entire supply chain network than merely paying lip service to quality by each individual firm (i.e. the buying organisation's or supplier's) through their internal system of quality control. This finding not only confirms the paramount importance of all SCQM practices in enhancing product quality outcomes but also indicates that some of the SCQM practices are strong enablers of product quality improvement across the entire supply chain network. This echoes Huo, Zhao and Lai's (2014, p. 47) observation who argue that the organisation-wide approach to managing quality across the entire supply chain can signal supply chain members to understand each other well, to learn from each other, and to achieve high quality performance in a competitive environment.

An end-to-end or supply chain approach to managing quality not only demonstrates a proven way to enhance product quality performance, but also and more importantly, it lays stress on the need to improve the entire supply chain network and associated processes that must work together to ensure high quality products. This finding

echoes assumptions underpinning SNT in a sense that effective management of quality across the entire supply chain requires supply chain members to thoroughly understand the nature and peculiarities of a broader network of ties, their multiple interdependencies, non-linear feedback and hidden consequences (Humphries and Gibbs, 2010; Soares, Soltani and Liao, 2012), if a SCQM network is to be established effectively and product quality is to exceed customer expectations. In practice, these findings indicate that members of supply chain network need to have awareness of complexities arising from multi-party supply chain peculiarities and adopt a multi-tiered approach to effectively manage product quality across the entire supply chain. One explanation is that the failure of one logistics partner in a supply chain network has unwelcome repercussions for its fellow members and consequently impact on the product quality performance (see Scott, 2000; Braziotis et al., 2013).

Whereas most of previous studies were largely theoretical and involved proposing models to analyse SCQM practices or enablers (e.g. Lin et al., 2005; Kaynak and Hartley, 2008; Kuei, Madu and Lin, 2008; Lin, Kuei and Chai, 2013), our empirical findings support previously identified SCQM constructs. As our results showed, these practices were grouped into four broad categories, namely, customer focus, supplier focus, supply chain activities/integration and quality leadership. Overall, the findings support previous research documenting the direct positive effect of all four SCQM practices on quality performance (e.g. Kaynak and Hartley, 2008; Collin, Eloranta and Holmström, 2009; Baird, Hu and Reeve, 2011; Prajogo, Huo and Han, 2012; Hu, Zhao and Lai, 2014; Huang, Yen and Liu, 2014; Huo, Han and Prajogo, 2016; Uluskan, Joines and Godfrey, 2016). Although prior research findings have yielded mixed results for the individual effect of SCQM practices on quality performance (e.g. Lin et al., 2005), our findings are

consistent with those of Sila, Ebrahimpour and Birkholz (2006), who observed a strong and positive relations between each of SCQM practices and quality performance.

Whereas previous studies have tended to conceptualise SCQM largely as a stand-alone construct and activity and in terms of its aggregate effect on operational and organisational performance, our findings also highlight the relative importance of individual SCQM practices and related operational and strategic effects. To help understand and realise the potential performance impact of SCQM, our findings offer an individual level analysis of the performance impact of each of SCQM practices on product quality. Overall, the findings lend support for the direct positive effect of all SCQM practices on quality performance. But, the results of the aggregate level analysis of SCQM practices suggest that the performance impact of each SCQM practice varies and that customer and supplier orientation are stronger predictors of quality performance than other SCQM practices. In contrast to most of previous research findings on the primacy of leadership role in managing quality (e.g. Deming, 1986; Juran, 2003; Rahman, 2006; Soltani and Wilkinson, 2010; Uluskan, Joines and Godfrey, 2016), our results reveal that quality leadership is less important than some of SCQM practices (see Soltani, 2005). This finding suggests that managing quality in an increasingly global supply chain brings many challenges and consequently the relative importance of SCQM practices does change to some degree as products move through a series of tiers and organisations.

7.2. Implications for research

This study contributes to supply chain and quality management literature by examining the interlinking of the two perspectives and their resulting combined effects (i.e. SCQM) on product quality outcomes. Our focus on SCQM heeds the suggestion offered by Robinson and Malhotra (2005, p. 315) who have highlighted the "need for more focused

approach in evaluating quality management issues within the internal and external supply chain context". Given the notable lack of consensus among operations and supply chain management scholars regarding conceptualization of SCQM, our study examines SCQM in terms of both its theoretical underpinnings and associated empirical evidence for their performance impact on quality. Theoretically, our proposed SCQM conceptual model is a response to the absence of multivariate scales that allow replication and measurement of SCQM critical factors (e.g. Kuei, Madu and Lin, 2008, 2011). We also empirically test our SCQM model using data collected from 325 UK-based manufacturing companies with global and regional operations. Our focus on the UK-based manufacturing sector is attributed to the fact that empirical scrutiny of SCQM has largely relied on leading manufacturing firms and lead OEM and ODM suppliers operating in East Asian economies – an indication of a potential limitation of existing conceptualization of SCQM from the perspectives of Western business economies which have become major recipients of substantial East Asian Manufacturing outputs.

Our study also contributes insights into the appropriateness of SNT as a theoretical lens for the study of quality management issues within the internal and external supply chain contexts. Our findings lend support to the view that the interlinking nature of SCQM practices could have knock-on effects on the degree of quality performance as products move through a series of tiers and organizations at both intra- and inter-firm levels. Although the performance effects of QM practices on operational and organizational performance have been examined in the literature, very little has focused on the key predictors or enablers of SCQM and their performance impact on product quality. Our study enriches the SNT literature by identifying the relative importance of customer orientation and supplier focus than other SCQM practices. SNT has the potential to become the foundation for the systematic study of intra- and inter-firm

supplier-buyer relationships. In fact, the uncertainties and challenges of global supply chain and in particular language, trust, communication and cultural issues inherent in multiple buyer-supplier relationships coupled with inter-connected supply chain networks with profound interdependencies have made the network perspective to become 'a lingua franca' (Borgatti and Li, 2009; Wichmann and Kaufmann, 2016). While supporting evidence is found that concords with some theories' call for additional empirical research into the application of social network perspective (see Kembro, Selviaridis and Näslund, 2014; Halldórsson, Hsuan and Kotzab, 2015), the SNT literature can be enriched by exploring how and to what extent the nature and peculiarities of a broader network of ties at both intra- and inter-frim levels can influence product quality performance (see Scott, 2000; Braziotis et al., 2013; Håkansson and Persson, 2004; Choi et al., 2015). We argue that real and sustainable quality performance requires firms to advance from traditional firm centric and product-based mindsets to an inter-organizational supply chain orientation with equal focus on both intra- and inter-firm relationships (see Huo, Zhao and Lai, 2014).

In a manner similar to that of previous SCQM research (e.g. Nair, 2006; Johnson, Rosen and Chang, 2011), we analyzed the aggregate impact of SCQM on quality performance. Our study also extends this literature by providing an individual level analysis of SCQM practices. In this respect, customer orientation and supplier focus emerged as main predictors of SCQM effectiveness. These findings appear somewhat contradictory to those initially reported by the proponents of quality management and their followers (e.g. Deming, 1986; Juran, 2003; Garvin, 1991) who consider leadership as the most important ingredient for successful implementation of quality and continuous improvement initiatives and in fact the glue that holds the TQM organization together through cementing the importance of quality in the minds of everyone from top to shop

floor (see also Prajogo and Sohal, 2003; Sila, Ebrahimpour and Birkholz, 2006; Rahman, 2006; Kaynak and Hartley, 2008; Soltani and Wilkinson, 2010; Uluskan, Joines and Godfrey, 2016). Rather, strong evidence emerged to support the view that customer focus and supplier orientation were the 'raison d'etre' of effective SCQM. This finding echoes Robinson and Malhotra (2005, p. 315) who observed that effective implementation of quality initiatives from an (internal and external) supply chain perspective necessitates a shift in focus "from traditional firm centric and product based mindsets to an inter-organizational supplier chain orientation involving customers, suppliers and other partners". Taken together, the results of individual level analysis and relative importance of SCQM practices contribute to extant conceptualization and theories of SCQM – i.e. research that lies at the interface of quality and external supply chain management (see Flynn, 2005; Foster, 2008; Fish, 2011; Soltani et al., 2011). Our findings improve the clarity of SCQM definition and practices and ensure that the relative importance of SCQM practices on product quality performance is not overlooked in future SCQM research.

7.3. Implications for practice

The study contributes insights into the effective management of quality from the supply chain perspective. The findings encourage practicing managers to adopt both an internal quality and external supply chain perspectives to managing quality and place high priority on effective intra- and inter-firm relationships as prerequisites for achieving superior product quality performance (see Halldórsson, Hsuan and Kotzab, 2015). The propositions and the results of the study provide managers with some guidelines about effective management of upstream, midstream and downstream supply chain networks and awareness of the potential synergies arising from the combined effects of SCQM

practices that could bring about desired quality performance outcomes across the entire supply chain network (see Kuei and Madu, 2001; Robinson and Malhotra, 2005; Foster, 2008). To develop an organisational environment that is conducive to produce a quality product for the end customer and meet the requirements of global market competition in the long run, managers should not rely solely on developing internal quality integration capabilities. Rather, they should adopt a supply chain perspective to managing quality in a sense that they should extend the concept of a customer to include both stakeholders within the organisation as well as suppliers and other partners who at any time are dependent on anyone else within or between the organization(s). As such, managers need to convince internal customers about the benefits of adopting an appropriate approach and behaviour in their working relationships with suppliers and other members of supply chain network particularly end customers (see Ross, 1998). In an era where competitors are considering and developing servitized solutions and incorporating IoT and big data in their business models (Tachizawa, Alvarez-Gil and Montes-Sancho, 2015), it is mandatory for manufacturing companies to consider the extended links of their networks and ensure the implementation of consistent quality throughout their supply chain.

To remain competitive in the aftermath of the "post-Brexit", practicing quality and supply chain managers in the UK should be reminded that a business-as-usual approach will not deliver desired quality attributes for the global market. Rather, the quality of end product specifically and the future competitiveness of UK manufacturing generally is influenced by all parties involved in the entire supply chain network. Given the numerous linkages between all members of supply chain network and their (in) direct effects on product quality throughout the supply chain, any UK government policy design will also need to address the entire supply chain at both strategic and more detailed levels (Foresight, 2013, p. 6).

8. Limitations and suggestions for future research

Despite the contributions of the current study to both the theory and practice of SCQM, it has several limitations that establish avenues for future research. Our focus in the current study was on UK-based manufacturing sector operating in different industries and involving processing of a wide range of products. Given the differences in manufacturing environment of firms and today's manufacturing industry's reliance on supply base (as opposed to the historical practices of vertically integrated manufacturing firms) and the resulting implications for product quality outcomes, future research could explore the performance impact of SCQM practices on quality in a single industry. In addition to providing depth to the study, focusing on a single industry not only controls for quality performance variance due to industry-specific conditions and characteristics but also enhances the generalisability of the findings.

Given that we limit our study to survey data coupled with the recent call for strengthening the theoretical base of operations and supply chain management research (Seuring, 2008; Singhal and Singhal, 2012; Jraisat and Sawalha, 2013; Soltani et al., 2014), future studies could include theory-informed qualitative approach to the study of quality performance throughout the supply chain network. Relatedly, in the current study, we analysed the performance effects of SCQM practices on quality performance at both individual and aggregate level of analyses in a sample of UK-based manufacturing sector. The increased importance of the servitization of products and inherent challenges of managing service quality in the manufacturing supply chain could also extend the current study to collect data from the service side of supply chain as well as the service industries (see Prakash, 2011).

In the light of globalization, geographically scattered suppliers and greater supply chain interdependence, future studies could involve examining the cross-national/cultural differences in supply chain relationships, identifying context- and culture-dependant effects on SCQM performance, and challenging SCQM theories that are generally valid and universally applicable (see Sousa and Voss, 2001; Cao et al., 2015; Davis et al., 2014; Jia et al., 2016; Cadden et al., 2013; Uluskan, Joines and Godfrey, 2016; Wiengarten et al., 2015).

Finally, given that the adopted survey method in the current study was cross-sectional in nature and assessed the performance effects of SCQM practices on quality performance at just one point in time, future studies of SCQM could test the research model in a longitudinal manner. It is argued that longitudinal data has the potential to identify the improvement or otherwise in quality across the entire supply chain over time and locate the associated causes and sleeper effects that might not be apparent until later in the course long-term supply chain relations (See Hakim, 1987; Menard, 2002; Yeniyurt et al., 2014).

9. Concluding remarks

This study offers a review of the extant literature on SCQM in terms of its definitional dimensions, underlying practices and their performance effects on product quality. While our review indicates that SCQM has so far remained a relatively new construct in operations and supply chain management field (e.g., Quang et al., 2016; Fernandes et al., 2017), it is increasingly gaining recognition as a promising topic of research and theorising – largely owing to the strategic role of global sourcing and widespread product quality failure of supply chain at global level (see Li et al., 2002; Theodorakioglou, Gotzamani and Tsiolvas, 2006; Rahman, 2006; Prajogo, Huo and Han, 2012; Huang, Yen

and Liu, 2014; Huo, Han and Prajogo, 2016; Tsanos and Zografos, 2016; Uluskan, Joines and Godfrey, 2016). In addition, our study offers an empirical test of SCQM practices and their effects on product quality performance. The findings confirm the underlying practices of SCQM and present their performance effects on quality at both individual and aggregate level of analyses. While the findings reveal statistically significant results for the overall performance impact of SCQM, the results of the individual level analysis of SCQM practices appear to vary from practice to practice.

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Table 1. SCQM literature: summary.

Authors (Year)	Sample	Methodology	Main findings
Kuei, Madu and Lin (2001)	N=81 Taiwan	Email surveys; Reliability & validity; Cluster analysis; Stepwise discriminant analysis; Means analysis.	Organisational performance could be enhanced through improved SCQM. Impact on cost savings, productivity, sales and earnings growth.
Flynn and Flynn (2005)	N=164 USA, Japan, Italy, England and Germany.	Survey; Stepwise and hierarchical regression analyses.	Evidence to support the need for integration of QM and SCM. Organisations with stronger QM practices achieve better supply chain performance.
Fynes, Búrca and Voss (2005)	N=200 Republic of Ireland	Mail survey; Confirmatory factor analysis and structural Path model (AMOS).	Supply chain relationship quality (SCRQ) has a positive impact on supply chain performance. Competitive environment moderates this relationship.
Fynes, Voss and Búrca (2005)	N=200 Republic of Ireland	Mail survey; Confirmatory factor analysis and structural path model (AMOS).	Conceptual framework incorporating dimensions of supply chain relationships and quality performance. SCRQ has a positive impact on design quality, but not on conformance quality.
Lin *et al.* (2005)	N1 = 109 Hong Kong N2 = 103 Taiwan	Postal mail surveys; Structural equation modelling (LISREL).	QM practices have no direct influence on organisational performance. Indirect effect through supplier participation.

Authors (Year)	Sample	Methodology	Main findings
Robinson and Malhotra (2005)	1 Case study USA	Literature review; Interviews.	SCQM literature taxonomy. Illustration of SCQM themes with a case study.
Lo and Yeung (2006)	N=90 Hong Kong	Postal mail surveys; reliability and validity analysis	10 critical SCQM practices clustered into three major groups: supplier selection, supplier development and supplier integration. Reliable and valid research instrument.
Sila, Ebrahimpour and Birkholz (2006)	N = 89 USA	Mail surveys; Mean comparison	SCQM can improve the quality of the final product Acknowledgement of SCQM importance but lack of implementation in companies considered.
Foster Jr. (2008)		Literature review	SCQM definition and operationalisation. Areas for future SCQM research.
Kuei, Madu and Lin (2008)	1 Case study Taiwan	Case study survey; Analytic Hierarchy Process; Two management levels comparison.	SCQM main dimensions: SC competence, critical success factors, strategic components and SCQM practices. Differentiating perspectives between company and suppliers. Commonalities: supplier participation and buyer-supplier quality
Kuei, Madu and Winch (2008)		Statistical experimental design methods and simulation meta-modeling.	Links between critical SCQ factors and their influences performance (response lead times and cost of non-conformance).

Authors (Year)	Sample	Methodology	Main findings
Kahnali and Taghavi (2010)	N=130 Iran	Mail surveys; Validity & reliability; Path analysis.	Organisational performance could be enhanced through improved SCQM; Support for the interdependence of QM practices in SC and their implementation as a whole system.
Hung (2011)	Case study	Optimal quality modeling; Sensitivity analysis	Combines activity-based costing (ABC) with economic incentive schemes (EISs) to develop a system of optimal incentive planning for global SCQM;
Kuei, Madu & Lin (2011)	Taiwan	Executive MBA students; Corporate executive interviews; Analytic hierarchy process.	Theoretical framework; Four major SCQM themes: design for six-sigma, international standards, SCM, global leadership and human resource management.
Foster Jr., Wallin and Ogden (2011)	N=102 USA	Web-based survey; Rankings and mean differences (Kruskal Wallis).	Differentiating perspectives of operations and supply chain managers on SCQM. Commonalities: job training, data analysis, supply chain management, project management and surveys.
Soltani et *al.* (2011)	N=148 China, Indonesia, United Arab Emirates, China, and UK	Face-to-face interviews; Two case studies; Secondary data analysis.	Dynamics of SCM and QM practices; Implications to end customers in terms of product/service quality at a global level; Collaborative mode of inter-firm relations;
Xu (2011)		Literature review	SCQM information architecture; Key technologies that have the potential to significantly improve the performance.

Authors (Year)	Sample	Methodology	Main findings
Zu and Kaynak (2012)		Literature review.	Conceptual framework (outcome-based and behaviour-based); No generic approach; Different management mechanisms for different suppliers.
Jraisat, L. and Sawalha, I. (2013)	Case study 5 firms (Jordan)	Observation; questionnaires.	High-order factors of quality control (QC) are identified, The role of QC in SCM is demonstrated, QC acts as the main strategy to improve supply chains.
Lin, Kuei and Chai (2013)	N=17 Taiwan	Interviews; Content analysis and formal concept analysis.	SCQM enablers: supplier relationship, information technology, process management, top management support, human resource management, quality management, strategic planning, and knowledge management; Pathways towards high performance SCQM (training programs, ISO and supplier quality audit programs).
Quang, et al. (2016)		Literature review Semi-structure interviews; Q-sort method;	Conceptual framework developed that identifies direct and indirect relationships between SCQM and firm performance.

Authors (Year)	Sample	Methodology	Main findings
Fernandes et al. (2017)		Literature review	QM and SCM synergies; Identification of critical factors for an effective integration of SCQM; Conceptual model.

Table 2. A review of the literature on the association of quality practices and performance

Studies	Customer Focus	Supplier Focus	Supply chain integration	Leadership
Adam Jr. et al. (1997)	X			X
Ahire and O'Shaughnessy (1998)	X	X		X
Ahire and Ravichandran (2001)	X			
Ahire, Golhar and Waller (1996)	X	X	X	X
Anderson et al. (1995)		X	X	X
Baird, Hu, and Reeve (2011)		X		
Black and Porter (1996)	X	X	X	X
Cagliano, Caniato, and Spina (2004)			X	
Chen and Paulraj (2004)	X			X
Choi (1995)		X		
Choi and Eboch (1998)				X
Collin, Eloranta and Holmström (2009)	X			
Cua, Mckone, and Schroeder (2001)	X	X	X	X
Douglas and Judge (2001)	X			X
Dow, Samson, and Ford (1999)	X	X		X
Easton and Jarrell (1998)	X	X		
Flynn, Huo, and Zhao (2010)			X	
Flynn, Schroeder, and Sakakibara (1994)	X	X	X	X
Flynn, Schroeder, and Sakakibara (1995)	X	X	X	X
Forker, Mendez, and Hershauer (1997)		X		
Forza and Filippini (1998)	X	X		
Frohlich and Westbrook (2001)	X	X		
Grandzol and Gershon (1997)	X			X
Hackman and Wageman (1995)	X			
Handfield et al. (2009)			X	
Ho, Duffy, and Shih (2001)		X		
Huang, Yen and Liu (2014)			X	
Huo (2012)			X	
Huo, Han and Prajogo, 2016			X	

Studies	Customer Focus	Supplier Focus	Supply chain integration	Leadership
Huo, Zhao, and Lai (2014)			X	
Kannan and Tan (2005)	X			
Kaynak (2003)		X	X	X
Kaynak and Hartley (2008)	X	X		X
Koufteros, Vonderembse, and Jayaram (2005)			X	
Lai (2003)	X			X
Li et al., (2002)	X			
Levandoski (1993)		X		
Meyer and Collier (2001)	X		X	X
Mohrman et al. (1995)	X	X		
Nair (2006)	X	X		
Powell (1995)	X	X	X	X
Prajogo and Sohal (2003)	X			X
Prajogo, Huo and Han (2012)		X		
Rahman (2006)				X
Robinson and Malhotra (2005)	X			
Rodgers and Hunter (1991)				X
Rosenzweig, Roth, and Dean (2003)			X	
Rungtusanatham et al. (1998)				X
Samson and Terziovski (1999)	X		X	X
Sánchez-Rodríguez and Martínez-Lorente (2004)		X		X
Saraph, Benson, and Schroeder (1989)		X	X	X
Sila and Ebrahimpour (2003)	X			
Sila, Ebrahimpour, and Birkholz (2006)	X			
Soteriou and Chase (1998)	X			
Sousa (2003)	X			
Sroufe and Curkovic (2008)	X	X		
Tan et al. (1999)	X	X	X	X
Theodorakioglou, Gotzamani and Tsiolvas (2006)		X		
Uluskan, Joines and Godfrey (2016)				X
Wilson and Collier (2000)	X		X	X
Yeung (2008)		X	X	

Table 3. Factor loadings.

Variable items	Factor loadings	Cronbach's alpha (α)
SCQM		**0.96**
Supply Chain Integration (Regarding your company's supply chain activities, please indicate on a scale from 1 to 7, the degree to which you agree or disagree with the following statements, with 1 = Strongly disagree and 7 = Strongly Agree.)		**0.93**
Our company creates supply chain teams that include members from different companies.	.836	
Our company extends the supply chain to include members beyond immediate suppliers.	.809	
Our company extends the supply chain to include members beyond our direct customers.	.807	
Our company improves the integration of activities across the supply chain.	.797	
Our company creates a greater level of trust among supply chain members.	.762	
Our company involves all members of the supply chain in product/service/marketing plans.	.703	
Our company participates in sourcing decisions of suppliers.	.639	
Our company seeks new ways to integrate supply chain activities.	.605	
Our company aids suppliers in increasing their capabilities.	.567	
There is a compatible communication/information system with suppliers.	.519	
Customer Focus (Regarding your company's attitudes towards customers and information sharing, please indicate on a scale from 1 to 7, the degree to which you agree or disagree with the following statements, with 1 = Strongly disagree and 7 = Strongly Agree)		**0.92**
Determination of key factors for building and maintaining customer relationships.	.827	
Enhancement of customers' ability to seek assistance.	.812	
Determination of future customer expectations.	.799	
Evaluation of formal and informal complaints.	.769	
Follow-up with customers for quality/service feedback.	.751	
Measurement and evaluation of customer satisfaction factors.	.741	
Interaction with customers to set reliability, responsiveness, and other standards.	.736	
Communicating customers' future strategic needs throughout the supply chain.	.595	
Use of informal information sharing with customers.	.565	
Supplier Focus (Regarding your company's attitudes towards suppliers, please indicate on a scale from 1 to 7, the degree to which you agree or disagree with the following statements, with 1 = Strongly disagree and 7 = Strongly Agree.)		**0.92**
Our company regularly conducts supplier quality audit.	.802	
Our company has detailed information about supplier performance.	.765	
Our company always gives feedback on the performance of suppliers' products.	.639	
Our company always participates in supplier activities related to quality.	.639	
Our company has a formal programme for evaluating and recognising suppliers.	.633	

Variable items	Factor loadings	Cronbach's alpha (α)
Our company has very frequent face-to-face planning/communication with key suppliers.	.608	
Our company can influence 1st tier/Main supplier's responsiveness to our requirements.	.520	
Our company enters into special agreements with suppliers who have improved performance.	.496	
Our company regards product quality as the most important factor for selecting suppliers.	.446	
Quality Leadership (Regarding your company's top management positions, please indicate on a scale from 1 to 7, the degree to which you agree or disagree with the following statements, with 1 = Strongly disagree and 7 = Strongly Agree.)		**0.92**
Top management strongly encourages employee involvement in quality management and improvement activities.	.832	
Top management learns quality-related concepts and skills.	.809	
Top management actively participates in quality management and improvement process.	.804	
Top management empowers employees to solve quality problems.	.788	
Top management empowers suppliers to solve quality problems.	.693	
Top management strongly encourages supplier involvement in quality management and improvement activities.	.662	
Quality performance (Considering the performance of the products provided by your company in comparison with the industry competitors, please indicate the degree to which you agree or disagree with the following sentences, with 1 = Strongly disagree and 7 = Strongly Agree.)		**0.86**
The product has distinctive features/characteristics when compared to competitors.	.810	
Our company implements frequent quality improvements.	.807	
The product has higher technical durability than competitors.	.782	
The product provided conforms to prearranged specifications.	.778	
The product functions above average when compared to competitors.	.743	
The product has higher value for money than competitors.	.720	
Our company implements frequent cost reduction measures.	.661	

Table 4. Correlations, means and standard deviations.

	CF	SF	SCI	QL	QP
Customer focus (CF)	1	.598**	.496**	.526**	.404**
Supplier focus (SF)	.598**	1	.723**	.588**	.415**
Supply Chain Integration (SCI)	.496**	.723**	1	.559**	.293**
Quality leadership (QL)	.526**	.588**	.559**	1	.327**
Quality performance (QP)	.404**	.415**	.293**	.327**	1
Mean	5.4472	5.2451	4.5622	5.3169	5.3429
SD	.89414	.95476	1.05806	1.09451	1.02942

Note: Correlation is significant at the 0.01 level (2-tailed).

Table 5. Results for individual simple linear regressions.

Hypotheses	R^2	Beta	t value	F
H1: Customer focus→Quality performance	0.163	0.465	t=7.935****	F(1,323)=62.969, p=0.000
H2: Supplier focus→Quality performance	0.172	0.448	t=8.201****	F(1,323)=67.251, p=0.000
H3: Supply chain integration→Quality performance	0.086	0.285	t=5.503****	F(1,323)=30.285, p=0.000
H4: Quality leadership→Quality performance	0.107	0.307	t=6.211****	F(1,323)=38.572, p=0.000
H5: SCQM→Quality performance	0.185	0.533	t=8.549****	F(1,323)=73.090, p=0.000

Notes: Statistical significance: *p <0.1; **p<0.05, ***p<0.01, ****p≤0.001

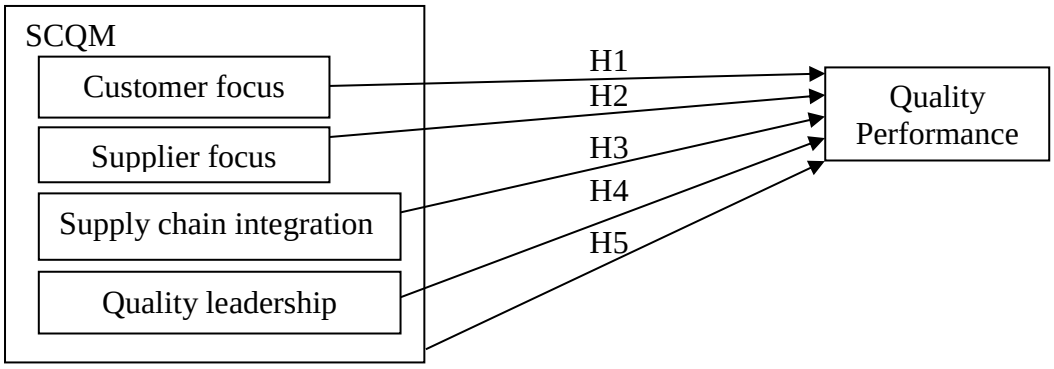
Table 6. The influence of Supply Chain Quality Management (SCQM) practices on quality performance.

Independent variables:	**R^2**	**ΔR^2** (ΔR^2 to the overall model)	**Beta (β)**	**SE**	**t-value**	**F**
Customer focus (CF)	12.5%	(0.092)	0.303	0.049	6.120****	F(3,321) = 15.235, p=0.000
Supplier focus (SF)	14%	(0.076)	0.276	0.049	5.582****	F(3,321) = 17.426, p=0.000
Supply Chain Integration (SCI)	20.8%	(0.008)	0.091	0.049	1.834*	F(3,321) = 28.122, p=0.000
Quality leadership (QL)	17.6%	(0.040)	0.200	0.049	4.046****	F(3,321) = 22.898, p=0.000

Notes: Statistical significance: *p <0.1; **p<0.05, ***p<0.01, ****p≤0.001

Dependent Variable: Quality Performance (QP)

Figure 1. Conceptual framework



Appendix 1. Summary of research published on SCQM: timeline.

Journal	2001	2002	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017
The Int. J. of Quality & Reliability Management	(1) Kuei, Madu & Lin	(2) Kuei et al.								(30) Mellat-Parast	(34) Madu & Kuei		(40) Quang et al.	(42) Fernandes et al.
IJPE			(3) Lin et al. (4) Robinson & Malhotra								(35) Chen, Zhang & Delaurentis		(41) Huo et al.	
IJPR			(5) Flynn & Flynn		(9) Batson & McGough (10) Lo, Yeung & Yeung	(11) Foster & Ogden		(18) Foster, Wallin & Ogden (19) Hung (20) Kuei, Madu & Lin						

Journal	2001	2002	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017
								(21) Li, Su & Chen (22) Soltani et al. (23) Vanichchinchai & Igel (24) Xu (25) Zhang et al.						
Multinational Business Review			(6) Kuei et al.											
SCMIJ				(7) Lo & Yeung (8) Sila, Ebrahimpour & Birkholz						(31) Jraisat & Sawalha				

Journal	2001	2002	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017
JOM						(12) Das et al. (13) Foster (14) Kaynak & Hartley (15) Sroufe & Curkovic								
TQM						(16) Kuei, Madu & Lin								
Singapore Management Review							(17) Kahnali & Taghavi							
The QM Journal								(26) Foster				(39) Ford		
IJOPM									(27) Zu & Kaynak	(32) Lin, Kuei & Chai	(36) Dellana & Kros			

Journal	2001	2002	2005	2006	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017
Int. J. of Business & Economics									(28) Echazu & Frascatore					
Asian Journal on Quality									(29) Rashid & Aslam					
Operations Management Research										(33) Zeng, Phan & Matsui				
Int. J. of Organizational Analysis											(37) Vanichchinchai			
IEEE Transactions on Engineering Management											(38) Huo, Zhao & Lai			