



Defining the concept of supply chain quality management and its relevance to academic and industrial practice

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Abstract

Even though much attention has been focused on supply chain management (SCM) concepts in recent years, its interlinking with the quality management perspective is often limited and tangential in nature. While the importance of quality management is universally recognized, academic researchers need a more focused approach in evaluating quality management issues within the internal and external supply chain contexts. Consequently, in this study we define the concept of supply chain quality management (SCQM), and evaluate its relevance in academic and industrial practice by comprehensively reviewing prior quality and SCM literature in major journals and inductively identifying the themes that emerge within it. In particular, we take a more critical look at those published studies that specifically lie at the interface of quality and external SCM, and argue that quality practices must advance from traditional firm centric and product-based mindsets to an inter-organizational supply chain orientation involving customers, suppliers, and other partners. We also show that SCQM across inter-organizational supply chains has received scant research attention, even though that perspective is sorely needed in delivering value to customers in often globally scattered supply chains. A case study of a firm that is a first-tier supplier in an offshoot of automotive supply chain is presented to better illustrate the SCQM themes and their treatment in industrial practice. Based on our research, the case study, and experience of working with firms in the domain of quality management and the ISO 9001 certification processes, we propose a Quality-SCM framework that can be used to place prior work in perspective, as well as identify three specific opportunities for future SCQM research.

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1. Introduction

In the struggle for marketplace advantage, organizations, consultants, practitioners and academics have attempted to organize and integrate

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supply chain management (SCM) concepts and practices into their business processes. As a result, many discovered that this subject is neither well defined nor easily implemented, but encompasses an enormous breadth of topics requiring radical new thinking. Moreover, SCM involves challenges such as developing trust and collaboration among supply chain partners, identifying best practices that can facilitate supply chain process alignment and integration, and successfully implementing the latest collaborative information systems and Internet technologies that drive efficiencies, performance, and quality throughout the supply chain.

Much like the recent emergence of SCM initiatives, the topic of quality management and improvement has dominated most manufacturing and service organizations since the early 1970s. During this era, foreign competition challenged the ingrained beliefs of organizations whose quality programs consisted primarily of traditional intra-organizational tools and strategies that resulted in limited success. Deming (1986) cited several “diseases and obstacles” for the inability of organizations to compete globally during this period, including the lack of constancy of purpose, performance measurement and evaluation, emphasis on short-term profits, and lack of management support. Garvin (1983) conducted a study comparing practices in US and Japanese firms and concluded “superior levels of performance come not from national traits or cultural advantages, but from sound management practices deliberately and systematically applied.” Although much has been written about the successful total quality resurrection in the 1980s of companies such as Harley–Davidson motorcycles (Reid, 1989) and Xerox (Howard, 1992), empirical studies that have investigated the process of total quality management (TQM) or quality initiatives on operational performance have produced mixed results (Kaynak, 2003; Samson and Terziovski, 1999). Kaynak (2003) commented that research design may be the culprit for the inconsistency of results, but a fundamental review of the varying definitions of quality and the “broad assortment of analytical tools and quality issues” from well-known quality gurus such as Crosby, Deming, Feigenbaum,

Ishikawa, Juran, Shewhart and Taguchi (Hoyer and Hoyer, 2001) may have also contributed to the varied success of early organizational attempts to establish and launch quality programs. Garvin (1984) further supported this multifaceted concept of quality by identifying five major approaches to defining the ideal meaning of quality (e.g. transcendent, product-based, user-based, manufacturing-based and value-based) that generate perceptual differences and attitudes among managers, functional departments, academics, and even customers. It is simple to recognize from Garvin’s analysis how organizations that strive to compete on the quality playing field may pursue quality initiatives that fail to show real results and sustain competitiveness in the global market, simply because they fail to communicate precisely what they mean by the term “quality.” Moreover, the relevance of the impact of the quality movement in the international marketplace for the last 30 years is well established and documented by the loss of manufacturing jobs to those competitors who successfully understand and translate customer requirements to final products and services. Malhotra et al. (1994) conducted a survey of American manufacturing Vice Presidents and reported that quality management was a key strategic issue facing most manufacturing companies in the 1990s.

In the past decade however, companies have begun to recognize not only the need for continual quality improvement and meeting the needs of their immediate customers, but also the necessity of competing quickly and efficiently in ever-changing global markets. As a result, SCM has come to the forefront as a philosophy by which firms can operate inter-organizationally, and merge both strategic initiatives and upstream and downstream processes in order to achieve business excellence. Traditional quality programs focusing on approaches such as TQM, the Malcolm Baldrige National Quality Award (MBNQA) and ISO 9001 (international quality management system standard), must now transform to a supply chain perspective in order to simultaneously make use of supply chain partner relationships and quality improvement gains essential to marketplace satisfaction.

In the reality of intense global competition, SCM principles and technologies are taking center stage as a means to achieve business excellence. This SCM movement embraces quality management initiatives, further supporting the notion that product quality is only one aspect of quality-oriented continual improvement programs leading to competitive leadership. Highly publicized companies such as Wal-Mart and Dell Computer (Table 1) have integrated their supply chains to make efficient use of information and technologies while orchestrating all activities of the chain (Lee, 2000; Kinsella, 2003). Satisfying final customers can only be achieved when the whole chain commits, integrates, and coordinates to pursue coherent and innovative practices (Simchi-Levi et al., 2000).

In order to further examine the role of quality in a supply chain framework, our focus in this paper is to rigorously analyze prior work that integrates quality management principles within the supply chain arena. Subsequently, we identify dominant themes and gaps within this literature base, and use it to define future research opportunities and agendas in this area. We also show how the pursuit of this research agenda can help practicing managers improve their operations and bottom line performance. This paper illustrates that compartmental and departmentalized quality functions of the past are obsolete and must now integrate with the overall strategic business direction of the entire marketplace.

This paper is organized in the following manner. In Section 2, we present the research that intersects

Table 1
Excellence in supply chain management

| | Dell computer | Wal-Mart |
|------------------------|---|--|
| Inventory management | Dell manufactures more than 50,000 computers every day, but carries only four days of inventory (competition carries 20–30 days) | Wal-Mart uses cross-docking and hub-and-spoke distributions centers to eliminate unnecessary handling and storage of product while targeting a large geographical area. |
| Supplier management | Only about 30 Dell suppliers provide 75% of direct material purchased. If supplier levels exceed 10 days, Dell works with the supplier to lower inventory. | Wal-Mart gives better payment terms to suppliers for their use of electronic ordering and information sharing between Wal-Mart and the supplier. (e.g. Proctor & Gamble). |
| Production management | Dell took a make-to-stock (MTS) industry and shifted it to make-to-order (MTO). Orders are pulled through manufacturing based on actual orders. | Wal-Mart initiated the practice of “everyday low prices” in which there’s no need for weekly sales or special promotions (now almost standard in the retail industry). |
| Information management | More than 50,000 orders come through the Internet. Dell’s legacy order management system records all the orders and releases them to manufacturing. Production lines are scheduled every two hours. | Wal-Mart launched its own satellite creating a communication network to monitor orders and shipments with all stores and suppliers ensuring the quality of data. |
| Technology management | Technology in Dell’s supply chain process provides efficiencies, immediate communication with suppliers and improved operations internally. | Wal-Mart issued a RFID technology mandate to the top 100 suppliers by 2005 (Wal-Mart technology standard). |
| Quality management | To address quality issues Dell launched the Critical Supplier Partnership Program resulting in improvement in quality metrics and continuity of supply. This program reduced early field failures by 37% and manufacturing line failures fell from 15,000 to 3000 defective parts per million (dppm). | Wal-Mart achieves a very high degree of <i>quality</i> with respect to loading pallets and merchandise in correct condition on its trucks that <i>accurately</i> match the bill of lading. High quality procedures minimize loss or damage during material handling within the warehouses and during transportation. |

Sources: Jacobs (2003), Supplier Selection & Management Report (2002), and Moore (1993).

the topic of quality in the supply chain and present a definition of “supply chain quality management (SCQM)”. In Section 3, we introduce a case study of a US Southeastern firm engaged in an industry that is an offshoot of the automotive sector. Section 4 breaks out the thematic linkages related to the SCQM definition, and discusses each stream thus identified with respect to both the extant literature as well as quality practices as evidenced at the case firm. Section 5 introduces our taxonomy. Section 6 discusses a future research framework, after which we conclude in Section 7 with some closing thoughts and comments.

2. Quality management and supply chain research

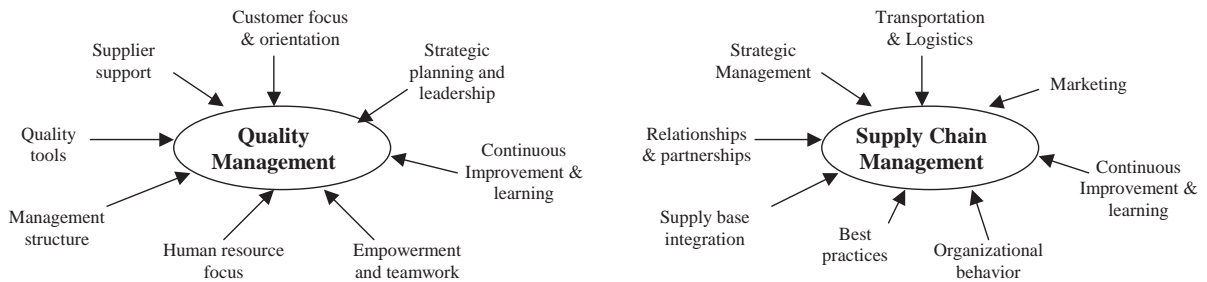
Several research studies considered some aspect of quality management within a supply chain perspective. The research domain for our paper spans across journals primarily consisting of leading journals from the field of Productions and Operations Management (Barman et al., 2001) such as *Journal of Operations Management* (JOM), *International Journal of Operations and Production Management* (IJOPM), *Production and Operations Management* (POM), *International Journal of Production Economics* (IJPE), *Decision Sciences, Omega*, *International Journal of Production Research* (IJPR) and *European Journal of Operational Research* (EJOR). Other journals included in this review include *Interfaces*, *International Journal of Physical Distribution and Logistics Management* (IJPDLM), *Total Quality Management* (TQM), *Journal of Supply Chain Management* (JSCM) and *Integrated Manufacturing Systems* (IMS). The directed purpose of this investigation is to identify those papers that lie on the intersection of quality and supply chain topics, so that we can focus upon and examine quality research positioned strictly in the supply chain context. Each article selected encompasses a theme or body of knowledge relevant and helpful to understanding a topic we identify as “SCQM.”

We find that even though the philosophies of quality management and SCM have been researched extensively in the literature, few studies examine these agendas jointly. Rather, the topic of

quality management in the supply chain is largely fragmented and dispersed across many other disciplines such as supplier–buyer activities, strategic management, manufacturing practices, and process integration. In fact, the term “SCQM” is not a term or phrase that is found to be used in the literature, thus supporting our view that research about quality management in the supply chain is highly disjointed and lacks treatment as a significant dimension of SCM. As discussed above in the introduction section, principles of quality management stem from the writings of quality gurus around a variety of subjects such as product conformance, quality control and analysis, organizational culture, business excellence, customer satisfaction, performance measurement and the processes that unite them. Evans and Dean, (2000) contend that there are as many different approaches to TQM as there are businesses, but that most share the basic elements of (1) customer focus, (2) strategic planning and leadership, (3) continuous improvement and learning, and (4) empowerment and teamwork. In addition, Mehra et al. (2001) compiled an extensive review of TQM research and suggested that there are at least 45 elements that affect TQM implementation categorizing these topics into the five key areas of (1) human resource focus, (2) management structure, (3) quality tools, (4) supplier support and (5) customer orientation.

Similarly, various literature reviews and analysis of SCM literature reveal that this evolving body of knowledge stems from the research disciplines of physical distribution, transportation and networked systems of materials, logistics and transportation, services, supply base integration and information (Croom et al., 2000; Tan, 2001).

Fig. 1 portrays the principle components reflecting the background of quality management and supply chain research. As a result of the integration of these two bodies of knowledge, we believe that the merger of quality management and SCM perspectives requires some type of definition so that it may be looked upon as an emerging and viable area of research. For the purposes of this paper, we provide below our definition of “SCQM” which builds upon the related definition by Ross (1997) and extends it further into the



Source: Evans *et al.* (2000) and Mehra *et al.* (2001) review of TQM research
Croom *et al.* (2000) and Tan (2001) review of supply chain research

Fig. 1. Principle components of quality management and supply chain research.

process centric view of SCQM that we examine throughout this study.

SCQM is the formal coordination and integration of business processes involving all partner organizations in the supply channel to measure, analyze and continually improve products, services, and processes in order to create value and achieve satisfaction of intermediate and final customers in the marketplace.

We use a comprehensive review of extant literature and this definition to provide an agenda for the future study of SCQM principles. We also leverage our understanding of these principles through our experience of working with an actual company in an All Terrain Vehicle (ATV) component supply chain, which we describe next. Lessons learned from this case study are integrated into the thematic analysis of SCQM theories and practices.

3. Case study of ABC Technologies

As a means to illustrating our SCQM themes and resulting taxonomy, and also to explore the dynamics of a supply network, we present a case study of a firm named as ABC Technologies (company name has been changed to protect the confidentiality of the firm). This firm, located in the southeastern United States, is a Tier 1 supplier to Honda America. It manufactures ATV suspension arms, steering shafts, catalytic converters, and

motorcycle disc brakes. Owned 70% by Honda, the parent company is a global firm with nine overseas divisions in China, India, Indonesia, Philippines, Thailand, and the United Kingdom. Although Honda is the primary customer, ABC Technology does business with approximately 100 suppliers on the inbound side, all of which are also Honda-approved sources. ABC Technology's annual sales are approximately 80 million dollars. It employs 250 people, and became registered to ISO 9001:2000 in 2003. Throughout the course of gathering data during a quality audit at the case firm, as well as an interview with the Assistant Vice President, the subjects of quality conformance, customer satisfaction, and delivery reliability were conveyed as the most emphasized, reinforced, and articulated beliefs at the company. This internal conviction stems from Honda's marketplace mission to ensure quality products while delivering value and innovation to the final customer. In that regard, our case firm represents many cutting edge supply chain quality practices prevalent in the industry today.

ABC Technology managers are actively involved in product quality by promoting and highlighting the importance of customer requirements and the critical nature of manufactured components to all employees. ABC managers consider it essential for employees to understand the "functionality and use" of the product and all possible liability issues that are relevant to the product. This message is consistently reinforced in employee orientation, daily departmental kick-off

meetings, and weekly management meetings. Further, ABC Technology involves its employees in problem-solving teams and customer site visits to understand these liability concerns and resolve quality issues. Specifically, ABC actively utilizes the “five principles of problem solving” method to resolve quality concerns. The steps of this process include (1) problem discovery information and problem statement, (2) identification and selection of root cause(s), (3) countermeasure(s) defined and implemented, (4) countermeasure(s) confirmation and evidence of effects, and (5) feedback and feed forward. Cross-functional teams composed of managers and associates conduct this problem solving activity that is focused on improving processes that span departments and supply chain partners.

Information for this case study was gathered during a ISO 9001:2000 pre-assessment audit by the local NIST sponsored manufacturing technology center. In addition, a detailed structured interview (Appendix A) was conducted with the Assistant Vice President of the firm. ABC Technologies was selected as an ideal case firm for this article due to its demonstrated quality-oriented culture and inter-organizational activities that span the customer and supply base. During the audit, the authors observed progress towards quality performance objectives, management system and manufacturing process activities, and continual improvement initiatives. The President and key managers in the facility were interviewed regarding the quality management system activities, customer requirements, and quality program initiatives.

4. Supply chain and quality themes

We specifically reviewed those SCM and quality management articles from the journals mentioned earlier that integrate quality perspectives into a supply chain focus. Criteria emphasizing the key concepts of “supply chain” and “quality” governed our search of articles, which we conceptually cluster and organize by thematic linkages with common and similar patterns among topics. These thematic linkages are shown in Table 2. We find

inductively that this literature can be logically categorized into the themes of (1) communication and partnership activities, (2) process integration and management, (3) management and leadership, (4) strategy, and (5) best practices. As shown in both Table 2, the thematic organization of extant literature that intersects both quality and supply chain domains illustrates that several papers overlap and cut across more than one theme, but all focus on some aspect of quality or quality management from a supply chain perspective. We summarize the main contributions of this research in Table 3, and discuss it next in the context of these themes.

4.1. Communications and partnership activities

Several authors in the above body of work researched the premise of supply chain communication and partnership activities. In essence, the main theses of this work involved organizations working closely together and nurturing relationships with other members of the supply channel in order to share goals, coordinate activities, and improve performance. Tan et al. (1999) discussed the commitment involved to integrate channel suppliers, manufacturers, and customers in order to achieve both long-term growth and financial objectives. Collaborative relationships are also topics reviewed by Choi and Hartley (1996), Forza and Filippini (1998), Waterson et al. (1999), Wong and Fung (1999), Mangiameli and Roethlein (2001), Stanley and Wisner (2001), Fynes and Voss (2002), Mehra et al. (2001), and Wong (2003). This research reinforces the concept that strong, structured and mutual supply chain partner relations result in breaking down the sometimes intangible characterizations of quality, and create definitions that support final customer quality (Mangiameli and Roethlein, 2001).

Additional research investigated the implementation of ISO 9001 as a partnering program. Romano (2002) found among Italian firms that although ISO 9001 registration has no significant effect on product quality or cost performance, the mere fact that a supplier is registered resulted in a higher level of trust in suppliers' internal quality systems. However, Romano and Vinelli (2001)

Table 2
Thematic linkages in quality and supply chain management research

| <i>Communication and partnership activities</i> | <i>Management and leadership</i> | <i>Best practices</i> |
|---|--|--|
| Effective customer relations [1] [29] [31] | Management involvement, commitment and attitudes [1] [24] [31] | Materials management [4] |
| Management of supply base activities [19] [30] | Management understanding of TQM tools/systems [1] [24] | Supplier management [4] [8] |
| Co-management of goals by partners [2] | Effective management of upstream and downstream operations [1] [31] | Customer relationships [4] |
| Building trust [12] | Innovation/knowledge-creating leadership [31] | Logistics [4] |
| Collaborative relationships (e.g. customer involvement) [9] [15] [17] [19] | | Supplier certification/reduction [18] |
| Relationship strengthening [33] | | Strategic partnership [9] |
| Supplier selection criteria [32] | | Design for quality [18] |
| | | Process control and improvement [18] |
| | | Inspection [18] |
| | | JIT capability [5] [9] [28] |
| | | TQM implementation [9] [16] [26] |
| | | ISO 9001 implementation [12] [21] [22] [23] [24] |
| | | Role of Quality Department [8] |
| | | Information sharing [18] |
| | | Training [8] |
| | | Reporting and analysis of quality data [8] |
| | | Team-based groups [9] |
| | | Computer-based technology [9] |
| | | Manufacturing cells [9] |
| <i>Process integration and management</i> | <i>Strategy</i> | |
| Redefined process definitions extended to supply chain [2] [10] [31] | Link and align business practices and activities to performance, partner goals and customer needs [1] [3] [5] [14] | |
| Process improvement in conjunction with partners [2] [10] [31] | Pursue quality initiatives and approaches [4] [18] | |
| Tying internal work practices to customer/supplier interactions [6] [7] [34] [35] | Supply chain integration [5] [13] [20] | |
| Process measurement and control in supply chain [11] [31] | Supplier management orientation [1] [3] [18] [25] | |
| Vertical integration [27] | Multi-directional communication [13] [17] | |

concluded that ISO 9001 registration alone does not become a driver for customer–supplier cooperation and that joint collaborative programs may require other characteristics such as common strategic visions and asset sharing.

Communication and partnership activities at ABC Technologies are strategically integrated with their customer, and are what we describe as inter-organizational (e.g. externally focused). Every quarter, ABC Technologies attends an international “Four Region Summit” to discuss business plan results, performance metrics, product innovation, value analysis and quality with the customer. One of the greatest benefits of attending these meetings is the collaboration and exchange of information with other Honda suppliers in the supply network. The open exchange of information about quality issues and value-added projects has resulted in the initiation of continual improvement opportunities at ABC Technologies. Many times, as a result of topics that were introduced and discussed at these quarterly meetings, managers may organize and deploy project

teams to analyze the feasibility of internal process changes and improvements to improve flexibility, responsiveness or delivery performance. The formal interaction at the quarterly meeting creates a cooperative environment among Honda suppliers to talk not only with the customer, but also with each other about activities that add value, improve competitiveness and ultimately enhance the experience of the final customer.

In contrast, partnership and communication activities with ABC Technology’s own suppliers are integrated, yet can be described as more traditionally structured and formally organized around the objectives of product quality assurance and delivery reliability. In this supply chain, Honda R&D in Japan is involved in all phases of technical development and every supplier must be Honda approved in order to supply parts. Since Tier 1 suppliers manage Tier 2 suppliers, ABC Technologies must in turn define common objectives and communicate quality performance metrics, delivery schedules, and other information to its suppliers.

Table 3
Thematic summary of quality and supply chain management research

| Category | Authors | Main findings |
|--|--------------------------------------|--|
| Communication and partnership activities | [1] Tan et al. (1999) | Effective customer relations positively affects performance |
| | [2] Romano and Vinelli (2001) | Joint definitions and co-management of goals by partner organizations (customers/suppliers) improve supply networks ability to meet the expectations of the final consumer |
| | [9] Waterson et al. (1999) | Survey reveals that supply chain partnering predicted for future use by more than 60% of companies |
| | [12] Romano (2002) | ISO 9000 certified suppliers tend to be more reliant and viewed by customers as more trustworthy |
| | [15] Wong and Fung (1999) | Collaborative and structured relationships with suppliers in meeting quality objectives (case study) |
| | [17] Mangiameli and Roethlein (2001) | Multi-directional communication between channel partners (case study) |
| | [19] Stanley and Wisner (2001) | Implementation of cooperative purchasing/supplier relationships had a significant association with purchasing's ability to deliver service quality to internal customers |
| | [29] Forza and Filippini (1998) | Obtaining customer satisfaction (caused construct) requires greater attention to factors which concern downstream relations with customers such as the involvement in quality improvement programs (causing construct = TQM link with customers) |
| | [30] Wong (2003) | Application of the supply chain excellence model (see Kanji and Wong 1999) applying TQM principles (7 themes) that provides insight into success factors of managing supply partners |
| | [31] Mehra et al. (2001) | Study of future role of TQM in businesses facing global markets. Literature review grouped into 5 categories include "supplier support" and "customer orientation" (customer focus) |
| | [32] Choi and Hartley (1996) | Supplier selection practices suggest that quality conformance is most important factor |
| | [33] Fynes and Voss (2002) | Strong buyer-supplier relationships will improve design quality. |
| | Process integration and management | [2] Romano and Vinelli (2001) |
| [6] Salvador et al. (2001) | | Interacting with customers on both quality and materials flow issues generally affect an organization's time-related performance as partially mediated by changes to/improvements to internal practices |
| [7] Gotzamani and Tsiotras (2001) | | Use of ISO 9001 offers good first step towards TQM (standard includes process management) Work practices tied to close interactions with customers and suppliers ISO 9001's most important contribution is process management |
| [10] Segars et al. (2001) | | Formalization of process boundaries extending to suppliers and customers (Value-added processing) |
| [11] Beamon and Ware (1998) | | System process quality model for identification, measurement and control of supply chain system |
| [27] Singer et al. (2003) | | Cost model analyzing how vertical integration improves quality for the end customer while increasing cost (mutually beneficial transfer contract) |
| [31] Mehra et al. (2001) | | Study of future role of TQM in businesses facing global markets. Literature review grouped into 4 categories of management concentration including customer focus, process focus, innovation focus and environmental focus |
| [34] Park et al. (2001) | | Process management found to be a practice employed by "high |

Table 3 (continued)

| Category | Authors | Main findings |
|---------------------------|---------------------------------------|---|
| | [35] Ahire and Dreyfus (2000) | performers” thus having effect on quality, delivery, cost performance (as evaluated by customer). Processes include statistical techniques, cycle time reduction, continuous improvement Process quality management (involvement of customers/suppliers in process design) has a positive effect on external quality (enables final quality) |
| Management and leadership | [1] Tan et al. (1999) | Management responsiveness to firm’s competitive environment, involvement and effectiveness and management understanding of and use of TQM tools, management of supply base and customer-focus positively affects performance |
| | [24] Yeung et al. (2003) | Quality management (ISO 9001, customer focus, supplier management) effectiveness is dependent on the attitudes and commitment (also confidence of understanding the requirements) of senior management |
| | [31] Mehra et al. (2001) | Study of future role of TQM in businesses facing global markets. Literature review grouped into 4 categories of management concentration including customer focus (customer partnership), process focus, innovation focus (knowledge-creating leadership) and environmental focus |
| Strategy | [1] Tan et al. (1999) | Effective management of supply base activities and customer-focus positively affects performance (use of TQM tools and practices, link business practices to performance, alignment of business practices to strategy) |
| | [3] Narasimhan and Jayaram (1998) | Causal framework that suggests that supplier integration, strategic integration and customer integration across the supply chain determines customer responsiveness |
| | [4] Ulusoy (2003) | Strategies supporting quality is fundamental requirement for sustaining existence in market (survey of Turkish firms) |
| | [5] Tan et al. (2002) | Link business practices to performance. Factors studied SC integration, info sharing, SC characteristics, customer service management, JIT, geographical proximity. Integration requires massive commitment from all supply chain members |
| | [13] Olhager and Selldin (2004) | Survey of supply chain strategies including supply chain (SC) design, SC integration, SC planning and control and SC communication (e.g. supplier selection based on quality most important) |
| | [14] Kanji and Wong (1999) | Development of SCM model. Principles and concepts include leadership, customer focus, cooperative relationship, integrated process and information management, continuous improvement and business excellence |
| | [17] Mangiameli and Roethlein, (2001) | Multi-directional quality awareness and communication between channel partners (case study) can be a competitive advantage |
| | [18] Tan et al. (1998) | Firm’s internal quality approach and supply base management practices can play a significant role in achieving corporate objectives if implemented concurrently |
| | [20] Rosenzweig et al. (2003) | Integration intensity and positive performance effects (quality, delivery, reliability, flexibility, cost leadership) of highly integrated supply chains |
| | [25] Shin et al. (2002) | Supplier management orientation positively associated with business performance (both buyers and suppliers) |
| Best practices | [4] Ulusoy (2003) | Best practices from benchmarking survey and supply chain analysis are logistics, supplier relations, customer relations and production |
| | [5] Tan et al. (2002) | SCM factors JIT capability and supply chain characteristics have |

Table 3 (continued)

| Category | Authors | Main findings |
|----------|-------------------------------------|--|
| | | positive relationship with overall product quality Delivery and communications improve overall customer service levels Six constructs of SCM practices |
| | [8] Forker et al. (1997) | Practices positively related to performance: (1) Supplier QM, (2) Role of the Q. Dept., (3) Training, (4) Q. Data and reporting. Product/service design varied among firms |
| | [9] Waterson et al. (1999) | Most successful practices for quality improvement: TQM, Team-based groups, Manufacturing Cells and Integrated computer-based technologies (survey). Most common practices: SC partnering, TQM, JIT, team-based working and integrated computer-based technology (survey) |
| | [12] Romano (2002) | ISO 9001 certified suppliers are characterized by better level of quality system, greater top-management involvement in formulating, supporting and communicating quality strategy, and larger diffusion and use of quality management procedures (e.g. more advanced internal quality system) |
| | [16] Choi and Rungtusanatham (1999) | Comparison of TQM practices at different levels of the supply chain |
| | [18] Tan et al. (1998) | Operational quality practices (design for quality, inspection, process control, process improvement) Supply-base management practices (decentralized purchasing, supplier certification, info sharing, etc.) |
| | [21] Anderson et al. (1999) | Investigates firms' motivation for ISO 9001 adoption such as improved product quality, internal improvements, communication value to external parties (public signal of credible quality attainment) |
| | [22] Johnson (2002) | QS-9000 adoption in the supply-base to evaluate organizational variables and performance outcome results (quality ppm, delivery performance) to 1st tier customers |
| | [23] Terziovski et al. (2003) | ISO 9001 certification and positive impact on performance. Individual element found to provide largest contribution is customer focus. Principle motivation found to be customer pressure |
| | [24] Yeung et al. (2003) | ISO 9000 as an operational-based program serves as foundation for continuous improvement (extension to supplier management, customer focus and satisfaction, process control) |
| | [26] Choi and Eboch (1998) | TQM practices have positive impact on customer satisfaction and plant performance |
| | [28] Khouja (2003) | Two-stage supply chain inventory model investigating quality output and JIT production |

ABC Technologies works closely with its suppliers making site visits with cross-functional teams for the purpose of reviewing key characteristics, processes, quality data, and progress towards annual goals. We view these upstream alliances as more traditional only because the cooperative relationship ABC Technologies has with its suppliers may not embrace the collaborative possibilities as illustrated by the Honda-sponsored "Four Region Summit" where information, sometimes amongst competitors, flows freely.

The managers at ABC Technologies realize that this type of collaboration occurs only if the suppliers believe that they are true business partners. They plan to begin holding supplier meetings twice a year to discuss quality issues and value analysis in a format similar to the "Four Region Summit." The company perceives formal supplier meetings as a means of creating open and shared channels with suppliers for the purpose of enhancing capabilities and improving quality, but also understands that a high level of commitment

and effort is required to successfully involve suppliers as business partners.

4.2. *Process integration and management*

Process integration and the management of supply chain linkages is another theme that we discovered within the prior literature. The “process” depicted here refers to linked activities both inside and outside of a firm. A smooth and synchronized linkage between dissimilar processes and/or operations is critical to an efficient and operative supply chain. A subject often discussed by researchers is the close interaction of customers and suppliers through the coordination of work practices as they extend across customer and supplier boundaries (Salvador et al., 2001; Romano and Vinelli, 2001; Singer et al., 2003). Specifically, Salvador et al. (2001) studied how time performance can be improved as a result of supply chain inter-organizational interactions leading to change and improvement. Segars et al. (2001) reviewed the importance of extending firm boundaries and transitioning processes to a system-orientation encompassing customers and suppliers. These authors conducted an in-depth case study of a major electronics firm and looked at the implementation of quality initiatives through “process linking” or transfer of the process view to supply chain partners. Beamon and Ware (1998) developed a process-quality model termed “PQM,” to provide a systematic methodology for implementing a new quality program or improving a new one in order to bridge gaps between members of the supply chain. These authors support the objective that quality initiatives can no longer be static and localized, but must interact and synchronize across the entire network of firms in the supply chain. Moreover, Gotzamani and Tsiotras (2001) researched the role of ISO 9001 implementation on firm performance and concluded that “process management” is the standard’s most important contribution.

ABC Technologies manages processes that extend both externally across supply chain boundaries and which internally integrate departments and functions. As an example, production scheduling is always done in harmony with the customers and suppliers. Amendments to the

annual production plan requested by the customer are thoroughly reviewed by ABC Technologies for input. Once approved, the revised plan is updated and distributed by Honda to both ABC Technologies and its other suppliers. ABC Technologies in turn communicates and manages production schedule updates with its own suppliers. In these cases, the schedule changes are typically no more than 3% of the established annual production plan that are driven by an established 3-year plan. Another well-integrated process that extends both to suppliers and customers is the material lot traceability process that is universally required in the automotive industry and by ISO 9001.

ABC Technologies also employs a process approach to its internal operations. For example, materials management is the department that takes responsibility for reporting final shipment quantities for a given day and manages the completeness and reliability of deliveries. The materials manager must communicate and work with production control and other internal functions on issues such as quality, maintenance, engineering, and order fulfillment in order to report final shipping information. The order completion process for shipped orders wholly encompasses many functional areas, as opposed to a compilation of fragmented departmental information. The final measurement of this distinctly integrated process is a report that delineates all variances from the production plan.

Lastly, the “process-approach” to achieving quality and ultimately customer satisfaction is the premise of the ISO 9001 standard as revised in the year 2000. Each department at ABC Technologies establishes criteria for managing and controlling processes (e.g. inputs transformed to outputs) by means of departmental “ki plans.” Variances from ki plans are measured, monitored, and communicated to management on a weekly basis to make certain that ABC Technology’s midterm plan is accomplished and that corrective action is initiated as necessary.

4.3. *Management and leadership*

Management and leadership is the third theme identified in the SCQM literature. In supply

chains, top management must now guide and direct not only individual company efforts, but also encourage participation and cultivate quality measurement and performance among all channel members. Management and leadership in this category imply that management influences relationships and operations with supply chain partners. Tan et al. (1999) conducted a survey of quality directors and vice presidents from a broad range of industries, and concluded that successful management and well-defined linkages between TQM practices and performance is the key to long-term success. Additionally the results of the survey found that organizations must face the reality that they no longer exist in isolation, but are a piece of a sometimes very intricate supply chain. Similarly, Yeung et al. (2003) found that the effectiveness of an ISO 9001 quality management program is highly dependent on the attitudes and commitment of senior management. Lastly, Mehra et al. (2001) carried out a literature review to identify the future role of TQM in businesses facing global markets. They commented that knowledge-creating leadership is essential for globally positioned companies.

ABC Technologies provides an excellent example of the importance of management commitment to supply chain quality. As previously stated, all employees are educated and made aware of each component's functional qualities and how these attributes contribute to the design and use of the final product. ABC Technology receives an immediate feedback from Honda on an Internet portal regarding quality issues (called a "trouble report"). This information is disseminated to all employees at daily kick-off meetings and at weekly manager meetings. ABC Technology utilizes cross-functional teams to conduct problem resolution (e.g. "5P problem solving analysis") and formal corrective action procedures to resolve product and process quality issues. Measures have been put in place by Honda and ABC to monitor both quality and delivery results of its suppliers in the form of defects in parts per million (ppm). In 2004, Honda kicked-off its "Outstanding Quality Initiative" that entails a 50% improvement in quality this year and 90% improvement the following year. Interestingly, ABC Technology regards mis-

takes and errors to be acceptable as long as these mistakes "don't reoccur." Its management encourages discussion and utilizes an open office environment so that the system problems and root causes are analyzed and addressed. ABC Technology management recognizes that they must provide the proper tools (instructions, data, equipment, performance measures, etc.) and necessary support so that employees can properly do their jobs.

4.4. Strategy

Strategies that specify the means and activities to realize supply chain opportunities and achieve competitive advantage are also a premise examined in supply chain quality literature. Although there are some overlapping concepts, the pertinent strategy papers can be segregated by (a) shared goals and strategies among channel partners, including supply base orientation, (b) use and implementation of quality initiatives, and (c) integrative focus and communication.

Several authors have investigated the impact of aligning supply chain and quality management strategies and activities with manufacturing goals and business performance (Tan et al., 1999, 2002; Kanji and Wong, 1999). Other research extends the scope of business performance beyond a firm's own borders and discuss the importance of bonding goals and strategies of upstream and downstream channel members. Tan et al. (1998) studied the effect of operational quality initiatives and supply base management on firm performance, concluding that both approaches should be implemented concurrently to secure significant competitive benefits. Tan et al. (1999) and Shin et al. (2002) also examined supplier management orientation. Shin et al. (2002) concluded that focused supply base orientation is a means to achieving positive business performance by both buyer and supplier partners.

Ulusoy (2003) and Yeung et al. (2003) have studied quality-based supply chain strategies. In a survey of Turkish firms, Ulusoy (2003) commented that firms are aware that a quality strategy is the most fundamental requirement for sustaining their existence in the market. Lastly, the strategy of

supply chain integration and communication as it relates to customer responsiveness or positive performance has been investigated by Narasimhan and Jayaram (1998), Tan et al. (2002), Olhager and Selldin (2004), Rosenzweig et al. (2003), and Mangiameli and Roethlein (2001).

Our interview with the case firm revealed that the common strategy for this entire supply chain is an orientation revolving around final customer value and quality. This strategy is communicated by 3-year plans that govern the formation of “ki plans” documenting strategies, criteria, and goals for every supplier operation in the network. When quality performance is unacceptable, the customer initiates “trouble reports” providing immediate feedback. Suppliers are expected to respond quickly and concisely to the needs of the customer (e.g. site visits, “5P problem-solving analysis”, corrective action). ABC Technology’s commitment to this supply chain strategy becomes apparent when reviewing their behavior regarding unbudgeted expenses. Even in difficult financial periods, ABC Technology does not hesitate to expend funds to improve manufacturing quality.

Additionally, Honda’s R&D integration strategy and dominant role in the production structure is evident at ABC Technologies. The core processes and process equipment are typically proven in Japan before they are distributed to ABC Technologies and other suppliers. This transfer of research and development activities bonds the supply network to Honda and strategically supports focused channel production and design activities and exclusive long-term relations.

4.5. *Best practices*

The last theme recognized in the literature examined involves the use of activities that promote quality in the supply chain framework. We classify these programs or activities as “best practices”. The ones that are highlighted in the extant research (e.g. supplier relations, customer relations, TQM, team building, adoption of ISO 9001) contribute to the discussion and analysis of SCQM. In the widely diverse set of articles categorized in Tables 1 and 2, the authors investigated types of supply chain or quality

practices. The research may involve implementation of the practice and the resultant impact on organizational or supply channel performance, or simply compare and contrast practices that are examined in a literature review (Mehra et al., 2001) or in a research setting (Johnson, 2002; Waterson et al., 1999).

Several articles have reviewed and identified significant activities relevant to improved supply chain performance. Forker et al. (1997) concluded that (1) supplier quality management, (2) role of the quality department, (3) training, (4) quality data and reporting and, (5) product/service design are practices that resulted in positive performance. Similarly, Waterson et al. (1999) conducted a survey of the current use and effectiveness of modern manufacturing practices and found the most common practices to be supply chain partnering, TQM, team-based working, and integrated computer-based technology. Tan et al. (2002) concluded that two SCM factors—JIT capability, and supply chain characteristics such as communication and trust, have a positive relationship with overall product quality. Ulusoy (2003) investigated operational performance in terms of logistics, supplier relations, customer relations, and production in a survey of manufacturing firms in Turkey, and concluded that the closer a company is to best practice, the more likely it is for that company to achieve higher business performance. Lastly, Olhager and Selldin (2004) studied supply chain practices in Swedish manufacturing firms and focused on supply chain issues related to integration, design, communication, and planning and control. These authors concluded that while firms place overall value on resource utilization and cost minimization when considering supply chain design, quality is the single most important criteria when selecting supply chain partners.

Another sub-theme acknowledged in the “best practice” literature is the globally recognized quality management standards. Several articles studied the impact of registered quality management programs such as ISO 9001 and QS-9000 (automotive standard—now known as TS 16949) on some aspect of performance. Johnson (2002) and Terziovski et al. (2003) investigated the adoption

and benefits of ISO 9001 and QS-9000 implementation with varying results. Terziowski et al. (2003) concluded that an organization will realize benefits from implementation, while Johnson (2002) discovered conversely that QS-9000 will still allow the production of poor quality products and unacceptable delivery performance. Romano (2002) and Yeung et al. (2003) reported on ISO 9001 as an operational program that creates a foundation for not only improved internal operations and quality systems, but also as a practical conduit to supplier and customer processes.

Our case study firm, ABC Technologies, employs many of the best practices described in Table 2. For example, they recognize the value and importance of ISO 9001 as a management system to administer continual improvement, and consequently achieved registration in 2003. Also, the organization makes use of the following practices: supplier management, benchmarking, quantitative analysis, cross-functional teams, JIT philosophy with Kanban containers, FMEA (failure mode and effects analysis), PPAP (production part approval process), capability analysis, TQM, “5P problem solving analysis”, automation and manufacturing cells (robotic welding, vision systems, etc.) and workforce training and education. ABC Technologies has not yet formalized a SPC (statistical process control) program on the shop floor, but is planning to do so in 2004.

4.6. Summary of themes

Organizing the journal articles within these five themes illuminates the diverse coverage that has been given to the topic of SCQM within this domain. Although fragmented, the research supports the premise that satisfying the customer can only take place when product quality, service, and value are coupled at every node in the chain. Linking quality at these nodes involves not only a commitment to quality intra-organizationally, but quality initiatives that extend beyond the firm to upstream and downstream channel partners. ABC Technologies, as a leading edge SCQM firm, supports the application of these ideas in practice. In their study, Olhager and Selldin (2004) comment that even though companies show a rela-

tively high awareness of modern supply chain planning and control tools, they tend to utilize them at a relatively low level. While this may not be the case at ABC Technologies, this finding by Olhager and Selldin (2004) reinforces the need for practitioners and researchers to continue to further define and explore the subject of SCQM.

5. Taxonomy

While organizing the literature into the many themes and topics discussed above in Section 3 has been useful in defining and furthering our understanding of SCQM, we need a further distinction to fully evaluate how the past researchers have approached this area. In particular, we propose that the SCQM literature themes have historically been separated by both academics and practitioners between (1) *intra*-organizational coordination (or traditional quality management) within an internal supply chain context and focus and, (2) *inter*-organizational integration interfacing supply chain and quality methodologies from an external supply chain context and focus. This distinction creates a taxonomy that not only provides a better overview of past SCQM research and its attendant themes, but also highlights needs and opportunities for future research in SCQM.

To help in further justifying and establishing this taxonomy, it is advantageous to review and recognize the SCOR model (see Fig. 2) endorsed by the not-for-profit, Supply Chain Council (www.supplychain.org). The membership of this organization includes over 800 multi-industry worldwide companies, consulting firms, software providers, government organizations and educational institutions. This framework, devoted to the topic of SCM, defines a supply chain as integrated processes of “plan,” “source,” “make” and “deliver,” that span the value chain from the supplier’s supplier upstream to the customer’s customer downstream. SCOR’s prescribed analysis of supply chain processes can be employed by managers to characterize, analyze, configure, and describe the depth and breadth of a supply chain, as well as form the foundation for decisions leading to improvement.

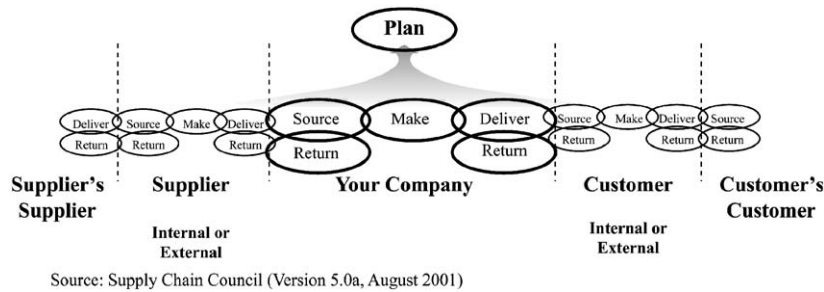


Fig. 2. SCOR model.

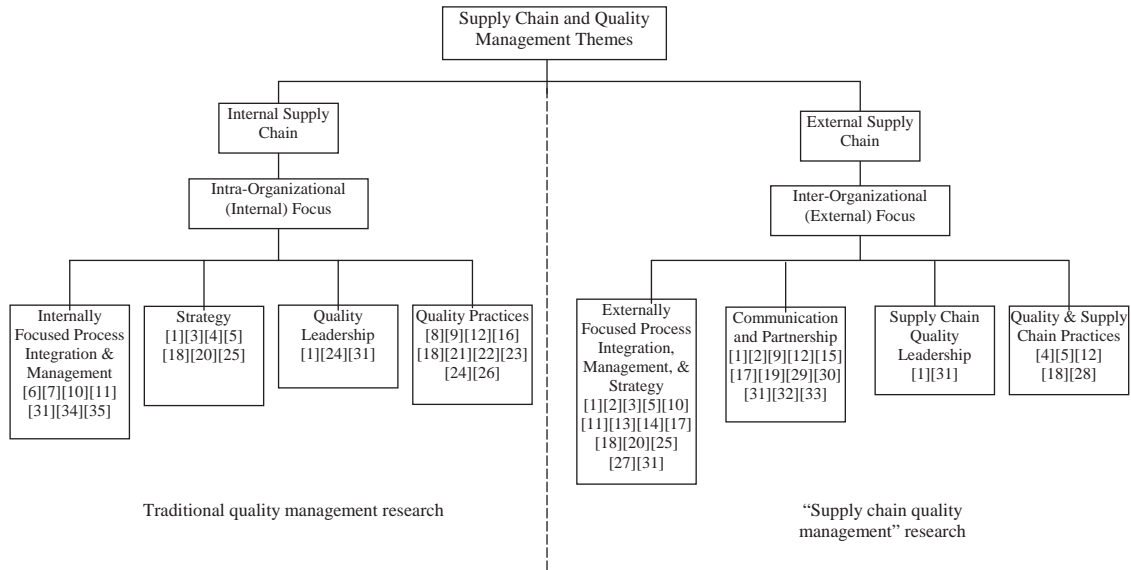
The SCOR model illustrates the linking of value-adding processes that exist in supply chain networks within a firm's departments (intra-organizational), and between firms (inter-organizational). This model reinforces the idea that each linkage and node in the chain must perform without any disruption to eventually satisfy final customers. Further, the model visually demonstrates that only a single weak link in the supply chain is needed to result in detrimental performance such as late deliveries, incomplete order fulfillment, and/or poor product quality.

The SCOR model thus supports the intra-organizational and inter-organizational distinction that drives our own taxonomy. Research and industrial implementation that is focused on traditional quality programs stems from a primarily "internal supply chain" perspective. Such traditional quality management programs are concerned with integrating the enterprise and unifying all organizational functions such as marketing, design, materials, purchasing, manufacturing, and management. The SCOR model reinforces the view that the activities of conventional quality management programs, although customer driven, are constrained for the most part to individual firms within the supply channel. In contrast, quality management functions and activities that merge practices and initiatives beyond enterprise boundaries for the purposes of building upon existing competencies or coevolving new competitive advantages reflect an "external supply chain" perspective.

The taxonomy developed in Fig. 3 divides the targeted research articles into either traditional quality management (intra-organizational supply

chain) or SCQM (inter-organizational supply chain) perspectives. Articles examining predominantly intra-organizational supply chain issues and strategies are categorized in the taxonomy as (1) internally focused process integration and management, (2) strategy, (3) quality leadership, and (4) quality practices. These articles focus on topics, issues and behavior that we perceive as *primarily* intra-organizational, yet also includes research perspectives that may peripherally examine the expansion of quality improvement initiatives beyond organizational borders into the external supply chain space. For example, research investigating ISO 9001 can be considered relevant to supply chain quality because the ISO 9001 standard emphasizes the continual improvement of business processes while interacting with suppliers and customers (see Fig. 4). ISO 9001 research is placed on the intra-organizational side of the framework, and includes research examining internal work practices and processes that are influenced externally by suppliers or customers, but does not concentrate on integrative processes or strategies with these suppliers or customers (Johnson, 2002; Terziovski et al., 2003).

Articles researching external supply chain quality activities move beyond this internally focused perspective with the goal of integrating not only their processes, but also creating formal environments for enhancing collaboration. These activities may involve the redesign of conventional quality or management practices, thus converging quality management processes and external supply chains. The taxonomy on this side of the model is categorized by (1) externally focused process integration and management



Note: In the external supply chain framework, strategy and process integration are highly interconnected and are therefore combined as a single theme.

Fig. 3. Taxonomy of supply chain quality management themes.

strategy, (2) communication and partnership, (3) supply chain quality leadership, and (4) quality and supply chain practices. The journal articles that combine both quality management and SCM theories can be interpreted as a necessary extension of fundamental quality management program activities that are optimized to take advantage of the external supply chain environment. Researchers within this SCQM arena recognize the significance of how supply channel quality must *integrate both service and production processes across the supply network and beyond the boundaries of individual firms.*

The taxonomy proposed by us is useful in that it exhibits the existing stage in the evolution of SCQM. This evolution is schematically shown in Fig. 5, and supports the need for organizations to officially and fundamentally reengineer quality management agendas in order to meet and improve the never-ending demand for superior products and services. The development of this taxonomy has practical value in that it identifies the need to formalize and examine the processes and activities of SCQM. The taxonomy clearly

3.0 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in the ISO 9000 apply.

The following terms, used in this edition of ISO 9001 to describe the **supply chain**, have been changed to reflect the vocabulary currently used:

supplier → **organization** → **customer**

Source: ISO 9001:2000

Fig. 4. ISO 9001:2000 supply chain reference.

shows that this arena is multi-dimensional and involves not only the development of common process methodologies encompassing inter-organizational courses of action, but emphasizes the necessity for creation of channel-wide value that can be effectively measured and continually improved. The establishment of programs and tactics to manage and monitor supply chain quality is a fundamental step towards maximizing the competitiveness and market leadership of supply chains, yet the extant literature or the guidance from practicing managers does not provide a comprehensive examination of this

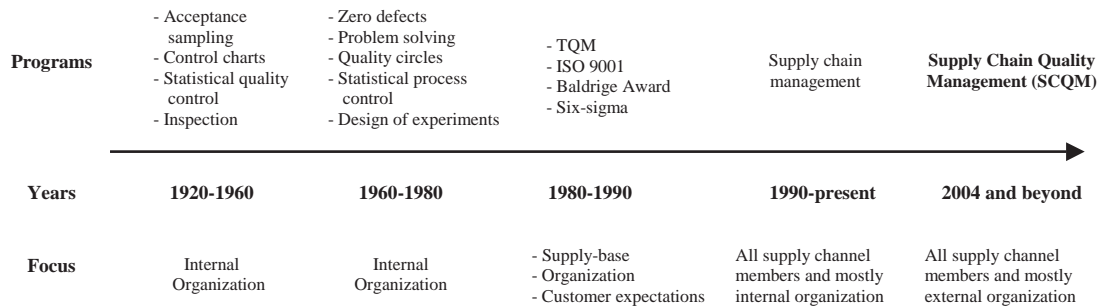


Fig. 5. Evolutionary timeline and focus of supply chain quality management (SCQM).

subject. In order to promote better understanding of SCQM as well as the usefulness of this concept, several gaps in the research that are also relevant to academic and industrial practice are identified and examined in Section 5.

6. Research framework

The review of this literature illustrates that the development of SCQM is in very early stages of understanding and development. In a review of product quality and quality management literature, Sousa and Voss (2002) concluded that as a whole, quality management practices have a significant and strong impact on quality and operational performance, but that the impact of quality management on business performance is weaker and not always significant. This discovery helps us to fully recognize that achieving high quality is no longer a function relying solely upon internal resources. Rather, quality practices must advance from traditional and product-based mindsets to an inter-organizational supply chain orientation involving customers, suppliers, and other partners. *Perhaps the most essential difference in this transition of traditional activities is a shift from a product to a process orientation.* In a supply chain environment, processes represent a continuous series of actions or operations conducting to an end. Management of these processes may lead not only to improved quality, but also to the creation of innovative businesses and new market opportunities. As a result of our research

and work with actual organizations, we have identified three significant opportunities for future SCQM research that we outline below, along with the research methodologies that can be used to pursue such an agenda.

6.1. Fostering of a process orientation

The extension of organizational processes into the supply chain space provides us with a research agenda. What “processes” are organizations integrating with suppliers and/or customers (e.g. product design, transportation and warehousing, product realization, purchasing, etc.) across multiple partners to improve and impact upstream and downstream quality performance? If one firm’s activities can be observed as a sub-process of another firm, what are the integration activities and specific action plans that support these implementation efforts? How must the processes be reengineered and do the results truly benefit the channel while eliminating process sub-optimization? How will the focus change be managed as it evolves from the dimension of finite product quality to service value and process quality? How will this focus on externally aligned processes involve business process reengineering (BPR) and business network reengineering (BNR)? In examining the evolution of BPR and BNR theory, Peppard (1996) comments “redesigning business processes has profound implications in an organization above and beyond the focus on process.”

A case study of Bose (Segars et al., 2001) focuses on how an organization improves performance by

concentrating on processes within and across the supply chain utilizing “process-linking.” This study touches only briefly on this last and final step of integrating business partners. Similarly, Ahire and Dreyfus (2000) developed a framework for identifying the linkages of design and process management to the operational quality outcomes of a manufacturing process (internal quality) and upon field usage of the products (external quality). They find that to attain superior quality outcomes, firms need to balance both design and process management efforts with long-term implementation activities. However, their study is restricted to product quality and process quality management within organizational borders and customer perceptions of final product. While these studies provide a good starting reference for the value of internal process management, they do not invoke or answer research questions that involve process extension and management beyond organizational borders into the supply chain space.

ABC Technologies clearly utilized inter-organizational processes (e.g. supplier relations, performance measurement, R&D), which is a major reason it was selected for this study. However, it is not evident whether or not the existence of these boundary-spanning activities is primarily due to Japanese company inter-firm practices and Japanese manufacturing processes in general. Can non-Japanese firms also practice and become competent in supply chain process orientations? Finally, what is the role played in this context by a dominant and highly involved customer such as Honda?

6.2. *Development of channel quality performance measurements and standards*

Many of the research articles evaluated in this study engage some aspect of performance measurement. For example, what performance measures can a supply chain utilize to consistently monitor supply chain processes and degree of their alignment with end-customer desires? How will this fairly confidential information be shared? If companies merge and align or integrate organizational processes, do they also incorporate specific measures of performance, goals, and analysis tools

that are consistent and common across both or multiple firms? Also, how do these organizations determine what function is responsible for the creation of supply chain measurements and maintaining a possible common database to document and record performance information such as costs, conformance to specifications, process variance, reliability, timeliness or responsiveness and customer expectations? Lastly, how can this information be analyzed to assist companies in improving business processes to ensure positive results? It is important to note that the SCOR model mentioned above proposes the implementation of suitable measures at each of the framework configuration levels.

There seems to be no universal consensus regarding suitable measures of supply chain quality performance. For example, Tan et al. (1999) study whether specific TQM and SCM practices, such as quality practices, customer relations practices, and supply base management practices affect firm performance as measured by corporate indices such as ROA, market share, and overall competitive position. Other researchers (Holmberg, 2000; Brewer and Speh, 2000) look at the application of the balanced scorecard, or a systems perspective on supply chain measurements. These authors agree that commonly implemented supply chain measurements are fragmented and virtually unknown, hence also suggesting that measurement activities will facilitate the supply channel integration process. Additionally, Lapide (2000) comments that financial accounting measures are important to assessing financial health, but are insufficient to measure supply chain performance because they are at a functional level and do not drive improvement across cross-functional processes. He states that the two most important and fundamental measures of overall supply chain performance should relate to (1) availability of products at the point of consumption and (2) total landed costs to get product to the point of consumption.

A recent study by Gunasekaran et al. (2004) develops a supply chain performance measurement framework utilizing a balance between financial and non-financial measures as they relate to the

decision-making levels of strategic, tactical and operational. The authors validate the framework by means of a small sample of companies, yet conclude that the “framework is only a starting point.” We believe there is much research that is needed to study metrics that measure customer-focused quality and process performance collectively and at various levels within the entire supply channel utilizing techniques such as the balanced scorecard, critical success factors (Van Veen-Dirks and Wijn, 2002) and the SCOR configuration framework.

6.3. *Impact of ISO 9001*

Many of the extant research involved companies registered to the international standard, ISO 9001. 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? Conversely, can firms that have not undergone ISO 9001 registration achieve SCQM integration and business success?

Not unlike other quality management directives such as TQM and Malcolm Baldrige, the research concerning ISO 9001 implementation and registration concentrates mostly on the effect of quality management system standards on “internal” company activities and processes. Yeung et al. (2003) studies how gaining ISO 9001 registration affects the development of a quality management system and how it subsequently affects organizational performance. Gotzamani and Tsiotras, 2001 look at the importance of the ISO 9001 standard as an entry key to TQM and performance improvement. However, in both these studies, the impact of ISO 9001 implementation and its effect on downstream and upstream supply chain operations is virtually unknown. Understanding SCQM and the implication of ISO 9001 as a supply chain process-oriented standard (see Fig. 4), is an area ripe for future research.

6.4. *Research methodologies*

We have proposed a variety of research questions and studies in this section that can be utilized

for pursuing this research agenda in SCM that also encompasses quality perspectives. Several different types of methodological approaches can be used to further these objectives. Due to the broad-based nature of SCQM, analytical modeling approaches may be less directly applicable, and we have not seen much use of such methodologies in the extant research. However, empirical modeling approaches have been used before (e.g. Narasimhan and Jayaram, 1998; Shin et al., 2002; Rosenzweig et al., 2003). Overall, we do believe that empirical field studies (including survey-based approaches and case research) would be more appropriate, as is also evidenced by the preponderance of past studies reported in this paper that lie at the intersection of this SCQM research domain (e.g. Choi and Hartley, 1996 Forker et al., 1997; Tan et al., 1998; Salvador et al., 2001; Gotzamani and Tsiotras, 2001). Irrespective of methodologies eventually selected, we hope that researchers would pay particularly close attention to studying several conventional quality topics in the context of external supply chain contexts. This research will help in better understanding and expanding our knowledge of quality perspectives in SCQM.

7. Conclusion

It was the goal of this paper to define SCQM and to create a research agenda for a better and more rigorous understanding of SCQM. The review of literature that intersects quality and supply chain research supports the need for future research to provide further insights on practices, strategy and performance measurement revolving around a continuing shift from product-oriented internally driven supply chain quality management practices to externally focused process-based approaches to SCQM.

As this paper demonstrates, it is easy to see how future research in SCQM that seeks to integrate quality and process improvement strategies across the entire supply chain will benefit the practitioner. A case study conducted by Romano and Vinelli (2001) found conclusively in a textile-apparel network that the entire supply chain improved its ability to meet the expectations of the final

customer by creating joint definitions of quality and co-managing integrated quality practices and processes. Leveraging the traditional TQM toolkit with formal process improvement methodologies and process-oriented performance metrics can bestow organizational practitioners with fundamental building blocks to reexamine their processes and spearhead continual improvements in their products and services that surpass the competition and exceed their customers' expectations.

Appendix A. Interview instrument

1. Overview: Review the SCQM concept
2. General information: Product produced, employees, SIC/NAICS codes, customer/supplier information, ownership, annual sales.

A.1. Quality leadership and management

1. How is quality perceived and managed at ABC Technologies? How are quality goals and objectives formalized throughout the facility? How are they measured? Is improvement managed continually? Or upon crisis? How?
2. What is ABC Technology's "quality culture?" How is it instituted and maintained? How are employees indoctrinated to quality issues/customer requirements?
3. What kinds of business plans/targets/objectives are in place? How are they created/distributed? What is the length of the planning horizon? Are they measurable? Are internal plans created jointly among various functions?
4. Describe management commitments, attitudes and involvement towards quality objectives and improvement.
5. Who is responsible for quality? Is there a reliance on the Quality Assurance Department?
6. What are the strengths and/or weaknesses of quality leadership?

A.2. Internally focused process integration & management (traditional)

1. What is the organizational structure at ABC Technologies? Is it a traditional functional/

departmental structure or a cross-functional structure?

2. How are the departments/functions/activities organized within the facility? What are the advantages/disadvantages of this structure? How is it different from the typical SC or southeastern firm? Is the structure classical Japanese (as in the parent company) or a type of hybrid (since located in US)?
3. What makes this organizational structure distinctive/advantageous in terms of managing and measuring quality? Ensuring customer satisfaction?
4. Can ABC Technology's organizational structure be defined as collaborative/partnering or mutually beneficial among functional departments/activities?
5. How does ABC Technologies develop a new/revised product model? Are the activities integrated? Collaborative? Concurrent? Are teams involved?
6. What *integrative processes are in place internally* and how integrated are these processes? Are the responsibilities shared? Are the performance measures shared? How is information/data shared?
7. How are employee duties/jobs/work practices tied to quality objectives/customer satisfaction?

A.3. Supply chain quality leadership—externally focused process integration, management and strategy

1. What does ABC Technologies understand about the topic and activities of supply chain thinking that has evolved in the past decade? Do managers discuss the supply chain as an emerging business methodology/new concept (or is it just necessary and routine to doing business)?
2. How often does ABC Technologies meet with customers and suppliers? What are the reasons for meeting? Who is involved (e.g. upper management, engineers, production)?
3. Are the members of the supply chain working toward mutual goals (collaborating)? Are alliances win-win situations? Are there any established "rules of engagement?"

4. What information systems are used to relay/communicate information between partners? Is it real time? Is it effectively implemented? How? (The web? Internet, extranet or intranet?)
5. What company “processes” link to either suppliers or customers? Are they seamless? Complicated? Successful? Do they benefit quality (e.g. errors reduced, quality improved, cycle times reduced, safety stocks removed, reduced inspection, minimized paperwork, etc.)?
6. Partnership and communication (how does ABC Technologies involve customers and suppliers in business objectives, customer satisfaction?). What are some benefits that ABC Technologies has realized as a result of partnering (e.g. reduction of redundancy)?
7. Are there any activities that occur between ABC Technologies and suppliers/customers that can be described as essential to “trust building” or “relationship strengthening”? What are they? Do you believe the strength of the relationship(s) affects negotiations? Do you think the strength of the relationship(s) could affect future investment opportunities? How?
8. Are there weaknesses or obstacles in “ABC Technology’s supply chain”? If so, what are they? What would you change or improve?
9. Would you describe any of the partner relationships as adversarial? Risky? Too many barriers?
10. Who do you believe is the most “powerful” partner in your supply chain? Why?

A.4. *Quality practices*

What quality and/or other practices/programs are utilized?

- Benchmarking
- Quantitative methods/graphical tools to analyze data (Pareto, fishbone, etc.)
- Teams, Cross functional? Linked to management? Represent all organizational levels? Formal? Results-oriented?
- JIT/Kanban
- FMEA
- PPAP
- DOE
- TQM
- Six sigma
- ISO 9001
- Process improvement
- Capability analysis
- SPC/Inspection practices (detection vs. prevention), receiving inspection
- Problem-solving
- Performance/reward appraisals systems in place for individuals vs. organization
- Technology/automation/manufacturing cells
- Workforce training and education
- Supplier certification
- Other

References

- Ahire, S.L., Dreyfus, P., 2000. The impact of design management and process management on quality: An empirical investigation. *Journal of Operations Management* 18, 549–575.
- Anderson, S.W., Daniel, D.J., Johnson, M.F., 1999. Why firms seek ISO 9000 certification: Regulatory compliance or competitive advantage. *Production and Operations Management* 8, 28–43.
- Barman, S., Hanna, M.D., LaForge, R.L., 2001. Perceived relevance and quality of POM journals: A decade later. *Journal of Operations Management* 19, 367–385.
- Beamon, B.M., Ware, T.M., 1998. A process quality model for the analysis, improvement and control of supply chain systems. *International Journal of Physical Distribution & Logistics Management* 28, 704–715.
- Brewer, P.C., Speh, T.W., 2000. Using the balanced scorecard to measure supply chain performance. *Journal of Business Logistics* 21, 75–93.
- Choi, T.Y., Eboch, K., 1998. The TQM paradox: Relations among TQM practices, plant performance and customer satisfaction. *Journal of Operations Management* 17, 59–75.
- Choi, T.Y., Hartley, J.L., 1996. An exploration of supplier selection practices across the supply chain. *Journal of Operations Management* 14, 333–343.
- Choi, T.Y., Rungtusanatham, M., 1999. Comparison of quality management practices: Across the supply chain and industries. *Journal of Supply Chain Management* , 20–27.
- Croom, S.R., Romano, P., Giannakis, M., 2000. Supply chain management: An analytical framework for critical literature review. *European Journal of Purchasing and Supply* 6, 67–83.

- Deming, W.E., 1986. *Out of the Crises*. Massachusetts Institute of Technology Center for Advance Engineering Study, Cambridge, MA.
- Evans, J.R., Dean Jr., J.W., 2000. *Total Quality: Management, Organization and Strategy*, second ed. South-Western College Publishing, Cincinnati, OH.
- Forker, L.B., Mendez, D., Hershauer, J.C., 1997. Total quality management in the supply chain: What is its impact on performance. *International Journal of Production Research* 35, 1681–1701.
- Forza, C., Filippini, R., 1998. TQM impact on quality conformance and customer satisfaction: A causal model. *International Journal of Production Economics* 55, 1–20.
- Fynes, B., Voss, C., 2002. The moderating effect of buyer–supplier relationships on quality practices and performance. *International Journal of Operations & Production Management* 22, 589–613.
- Garvin, D.A., 1983. Quality on the Line. *Harvard Business Review* 61, 65–75.
- Garvin, D.A., 1984. What does product quality really mean. *Sloan Management Review* 26, 25–43.
- Gotzamani, K.D., Tsiotras, G.D., 2001. An empirical study of the ISO 9000 standards' contribution towards total quality management. *International Journal of Operations & Production Management* 21, 1326–1342.
- Gunasekaran, A., Patel, C., McGaughey, R.E., 2004. A framework for supply chain performance measurement. *International Journal of Production Economics* 87, 333–347.
- Holmberg, S., 2000. A systems perspective on supply chain measurements. *International Journal of Physical Distribution & Logistics Management* 30, 847–868.
- Howard, H., 1992. The CEO as Organizational Architect: An Interview with Xerox's Paul Allaire. *Harvard Business Review* 70, 106–121.
- Hoyer, R.W., Hoyer, B.B.Y., 2001. What is quality. *Quality Progress* 34, 53–62.
- Johnson, D., 2002. Empirical study of second-tier automotive suppliers achieving QS-9000 reference no. 718. *International Journal of Operations & Production Management* 22, 909–928.
- Jacobs, D.G., 2003. Anatomy of a supply chain. *Transportation & Distribution* 44 (6), 60–63.
- Kanji, G.K., Wong, A., 1999. Business excellence model for supply chain management. *Total Quality Management* 10, 1147–1168.
- Kaynak, H., 2003. The relationship between total quality management practices and their effects on firm performance. *Journal of Operations Management* 21, 405–435.
- Khouja, M., 2003. The impact of quality considerations on material flow in two-stage inventory systems. *International Journal of Production Research* 41, 1533–1547.
- Kinsella, B., 2003. The Wal-Mart factor. *Industrial Engineer* 35, 32–36.
- Lapide, L., 2000. True measures of supply chain performance. *Supply Chain Management Review* (July/August), 25–28.
- Lee, H.L., 2000. Creating value through supply chain integration. *Supply Chain Management Review*, 30–36.
- Malhotra, M.K., Steele, D.C., Grover, V., 1994. Important strategic and tactical manufacturing issues in the 1990s. *Decision Sciences* 25, 189–215.
- Mangiameli, P., Roethlein, C.J., 2001. An examination of quality performance at different levels in a connected supply chain: A preliminary case study. *Integrated Manufacturing Systems* 12, 126–133.
- Mehra, S., Hoffman, J.M., Danilo, S., 2001. TQM as a management strategy for the next millennia. *International Journal of Operations & Production Management* 21, 855–876.
- Moore, J.F., 1993. The evolution of Wal-Mart: Savvy expansion and leadership. *Harvard Business Review*, 71 (3), 82–84.
- Narasimhan, R., Jayaram, J., 1998. Causal linkages in supply chain management: An exploratory study of North American manufacturing firms. *Decision Sciences* 29, 579–605.
- Olhager, J., Selldin, E., 2004. Supply chain management survey of Swedish manufacturing firms. *International Journal of Production Economics* 89, 353–361.
- Park, S., Hartley, J.L., Wilson, D., 2001. Quality management practices and their relationship to buyer's supplier ratings: A study in the Korean automotive industry. *Journal of Operations Management* 19, 695–712.
- Peppard, J., 1996. Broadening visions of business process re-engineering. *Omega* 24, 255–270.
- Reid, P.C., 1989. *Well Made in America: Lessons from Harley–Davidson on Being the Best*. McGraw-Hill, New York, NY.
- Romano, P., Vinelli, A., 2001. Quality management in a supply chain perspective, strategies and operative choices in a textile-apparel network. *International Journal of Operations & Production Management* 21, 446–460.
- Romano, P., 2002. Impact of supply chain sensitivity to quality certification on quality management practices and performances. *Total Quality Management* 13, 981–1000.
- Rosenzweig, E.D., Roth, A.V., Dean Jr., J.W., 2003. The influence of an integration strategy on competitive capabilities and business performance: An exploratory study of consumer products manufacturers. *Journal of Operations Management* 21, 437–456.
- Ross, D.F., 1997. *Competing Through Supply Chain Management-Creating Market-Winning Strategies Through Supply Chain Partnerships*. Chapman and Hall, New York.
- Salvador, F., Forza, C., Rungtusanatham, M., Choi, T.Y., 2001. Supply chain interactions and time-related performances, an operations management perspective. *International Journal of Operations & Production Management* 21, 461–475.
- Samson, D., Terziovski, M., 1999. The relationship between total quality management practices and operational performance. *Journal of Operations Management* 17, 393–409.
- Segars, A.H., Harkness, W.J., Kettinger, W.J., 2001. Process management and supply chain integration at the Bose Corporation. *Interfaces* 31, 102–114.

- Shin, H., Collier, D.A., Wilson, D.D., 2002. Supply management orientation and supplier/buyer performance. *Journal of Operations Management* 18, 317–333.
- Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E., 2000. *Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies*. Irwin McGraw-Hill, Boston, MA.
- Singer, M., Donoso, P., Traverso, P., 2003. Quality strategies in supply chain alliances of disposable items. *Omega* 31, 499–509.
- Sousa, R.V., Voss, C.A., 2002. Quality management re-visited: A reflective review and agenda for future research. *Journal of Operations Management* 20, 91–109.
- Stanley, L.L., Wisner, J.D., 2001. Service quality along the supply chain: Implications for purchasing. *Journal of Operations Management* 19, 287–306.
- Supplier Selection & Management Report, August 2002. How Dell Resolved Its Quality Issue Through Supplier Partnerships, vol. 2(8), pp. 1–3.
- Tan, K.C., 2001. A framework of supply chain management literature. *European Journal of Purchasing and Supply* 7, 39–48.
- Tan, K.C., Handfield, R.B., Krause, D.R., 1998. Enhancing the firm's performance through quality and supply base management: An empirical study. *International Journal of Production Research* 36, 2813–2837.
- Tan, K.-C., Kannan, V.R., Handfield, R.B., Ghosh, S., 1999. Supply chain management: An empirical study of its impact on performance. *International Journal of Operations & Production Management* 19, 1034–1052.
- Tan, K.C., Lyman, S.B., Wisner, J.D., 2002. Supply chain management: A strategic perspective. *International Journal of Operations & Production Management* 22, 614–631.
- Terziovski, M., Power, D., Sohal, A.S., 2003. The longitudinal effects of the ISO 9000 certification process on business performance. *European Journal of Operational Research* 146, 580–595.
- Ulusoy, G., 2003. An assessment of supply chain and innovation management practices in the manufacturing industries in Turkey. *International Journal of Production Economics* 86, 251–270.
- Van Veen-Dirks, P., Wijn, M., 2002. Strategic control: Meshing critical success factors with the balanced scorecard. *Long Range Planning* 35, 407–427.
- Waterson, P.E., Clegg, C.W., Bolder, R., Pepper, K., Warr, P.B., Wall, T.D., 1999. The use and effectiveness of modern manufacturing practices: A survey of UK industry. *International Journal of Production Research* 37, 2271–2292.
- Wong, A., 2003. Achieving supply chain management excellence. *Total Quality Management* 14, 151–159.
- Wong, A., Fung, P., 1999. Total quality management in the construction industry in Hong Kong: A supply chain management perspective. *Total Quality Management* 10, 199–208.
- Yeung, A.C.L., Lee, T.S., Chan, L.Y., 2003. Senior management perspectives and ISO 9000 effectiveness: An empirical research. *International Journal of Production Research* 41, 545–569.