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**Article**

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## OPERATIONS, INFORMATION & TECHNOLOGY | REVIEW ARTICLE

# A categorization of quality management and supply chain management frameworks

Assadej Vanichchinchai<sup>1\*</sup>

**Abstract:** This article aims to comprehensively review, discuss, compare, contrast and categorize supply chain management (SCM) and quality management (QM) frameworks. SCM and QM literature were reviewed extensively. Their concepts and frameworks were discussed, compared, contrasted and classified. Several commonly accepted frameworks were raised for illustration. It was found that SCM and QM frameworks can be determined by generality (specific or generic) and scope (narrow or wide) into four categories, namely Qualifier, Improver, Extender and Winner. SCM and QM concepts and frameworks have similar evolutionary trends. Understanding SCM and QM frameworks with their characteristics can help managers improve implementation success and returns. SCM evolution and promotion may be learned from those of QM as its counterpart.

**Subjects:** Operations Management; Quality Management; Supply Chain Management

**Keywords:** supply chain management; quality management; framework; model; categorization

### 1. Introduction

Supply Chain Management (SCM) and Quality Management (QM) have been embedded in operations of most organizations for decades. They have integrated bodies of knowledge in both hard

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### PUBLIC INTEREST STATEMENT

QM and SCM are two most critical disciplines for today's business competitiveness. There are various QM and SCM implementation frameworks. Mismatch in selecting frameworks with a firm's unique requirements will significantly affect their efficiency and effectiveness. Based on two criteria: generalities (generic or specific) and scopes (wide or narrow), this paper classifies QM and SCM frameworks into four groups, namely Qualifier, Improver, Extender and Winner. The generic frameworks are applicable to any organizations regardless of organizational characteristics. The specific frameworks are more suitable for certain industries. The narrow scopes focus on operational issues. The wide scopes are more strategic and cover more partners. Understanding practical QM and SCM implementation frameworks and their characteristics allows managers to efficiently apply appropriate frameworks according to their firm's policy, readiness and resource for application. This can enhance implementation success and returns on investment.

engineering and soft management aspects. Their hard aspects focus on technical tools, techniques or technology. Their soft aspects emphasize social managerial issues (i.e. human resource, relationship, leadership) (Burgess, Singh, & Koroglu, 2006; Rahman & Bullock, 2005). QM has been extended to improve not only quality performance at the operational level, but also business performance at strategic levels (Hsu, Tan, Kannan, & Keong Leong, 2009; Rahman, 2001). Krumwiede and Lavelle (2000) suggested that Total Quality Management (TQM), as a superior QM, can be determined as a philosophy. It sets contexts and contents of corporate culture and norms within the organization. At present, QM definition and conceptual foundation have entered a mature phase (Sousa & Voss, 2002). There are many internationally accepted QM frameworks, such as ISO 9001, ISO/TS 16949, Hazard Analysis and Critical Control Points (HACCP) and Malcolm Baldrige National Quality Award (MBNQA) criteria. More recently, the concept of SCM has been introduced to enhance firm competitiveness. As a result, there are still no universal practical SCM frameworks for implementation (Casadesus & Castro, 2005; Lambert, Garcia-Dastugue, & Croxton, 2005; Vanichchinchai, 2014; 2019).

Various QM and SCM frameworks have been proposed by researchers or professional organizations for selection in implementation. An individual framework has unique components and characteristics. Although some components in each framework are applicable to many industries, they are more effective when being applied to specific business environments and strategies. Mismatch in selected frameworks with a firm's unique requirements will significantly affect efficiency and effectiveness in implementation. Although QM and SCM are the two most critical disciplines for organizational competitiveness, they are rarely examined together (Casadesus & Castro, 2005; Gunasekaran & McGaughey, 2003; Robinson & Malhotra, 2005; Talib, Rahman, & Qureshi, 2011; Vanichchinchai & Igel, 2011). Rashid and Aslam (2012) also suggested that more researchers are interested in the relationship between SCM and QM such as Zhang et al. (2011), Talib et al. (2011), Foster (2008), Kaynak and Hartley (2008), Kannan and Tan (2007) leading to a new challenge in terms of Supply Chain Quality Management (SCQM). The objectives of this paper are to extensively review, discuss, compare, contrast and then categorize QM and SCM frameworks into four groups, namely Qualifier, Improver, Extender and Winner based on two criteria: generalities (generic or specific) and scopes (wide or narrow) to benefit managers for implementation according to their firms' strategy. Categorization and comparison are summarized in Figure 1.

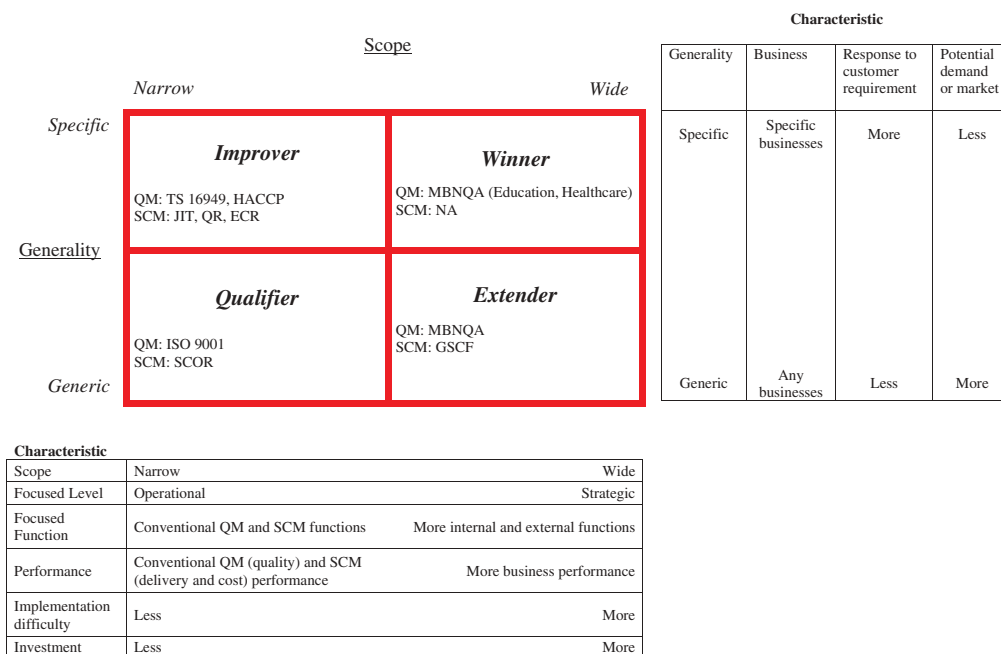
## 2. QM and SCM maturity model

Vanichchinchai and Igel (2009) found that SCM has evolved in a similar path to QM. Both were initiated at operational functions and then expanded to cover all interrelated parties at the strategic level to achieve full integration and gain synergy. Some QM researchers attempted to classify levels of QM development or maturity. For instance, Prabhu, Appleby, Yarrow, and Mitchell (2000) introduced six QM maturity levels, namely Could do better; Room for Improvement; Promising; Vulnerable; Potential Winners and World Class. Chin, Sun, Xu, and Hua (2002) classified five stages of QM, consisting of Unaware, Uncommitted, Initiator, Improver and Achiever (Lau, Zhao, & Xiao, 2004). Accordingly, six levels of QM maturity, comprising Uncommitted, Drifters, Tool Pushers, Improvers, Award Winners and World Class were employed in Claver and Tari (2003) and Li and Yang (2003) in Dale and Lascelles (1997).

Similarly, SCM development in organizations has been categorized. Harland (1996) identified four types of SCM maturity (Harland, Lamming, & Cousins, 1999; Mills, Schmitz, & Frizelle, 2004) including Internal Chain, Dyadic Relationship, External Chain and Network. The Performance Management Group (PMG) and Pittiglio, Rabin, Todd and McGrath (PRTM) developed four levels of SCM maturity (Cohen & Roussel, 2004) composed of Functional Focus, Internal Integration, External Integration and Cross-Enterprise Collaboration. Lockamy & McCormack (2004a) suggested five stages of SCM maturity: Ad Hoc, Defined, Linked, Integrated and Extended. Stevens (1989) also recommended four SCM levels, namely, Baseline, Functional Integration, Internal Integration and External Integration.

This article categorizes QM and SCM frameworks related to their maturity into Qualifier, Improver, Extender and Winner using generalities and scopes of applications as criteria. The generic framework

**Figure 1. QM and SCM Frameworks.**



is applicable to any organizations, without limitation of the business sector, size, product or service. The specific framework is suitable for only specific industries and better respond to their unique industrial requirements. The narrow scope focuses on operational issues and internal functions. The wide scope emphasizes strategic issues and extends to cover more external partners.

### 3. Generic application

The generic framework is applicable to any business sectors. Considering the scope of application, the generic framework can be further divided into narrow scope and wide scope. The narrow scope focuses on operational issues or internal functions, while the wide scope extends to cover strategic issues or more interrelated functions and partners.

Among various QM, ISO 9001 and TQM are two generic principles which are internationally accepted (Sun, 2000). For SCM, Lambert et al. (2005) identified five SCM frameworks in their research. They selected frameworks of the Supply Chain Operations Reference (SCOR) and the Global Supply Chain Forum (GSCF) for analysis. This was because they both SCOR and GSCF were developed by a group of experts and professional organizations from various industrial perspectives. They are more accepted and referenced in SCM literature. Thus, ISO 9001, TQM, SCOR and GSCF framework are used for discussion.

#### 3.1. Generic application & narrow scope (qualifier)

SCM was originated from logistics; while, QM was initiated from quality control (Croom, Romano, & Giannakis, 2000; Gilmour, 1999). According to their origins, the primary goal of conventional logistics is delivery or time-based performance, while, that of traditional quality control is quality or specification-based performance (Vanichchinchai & Igel, 2009). As a result, the narrow scope of generic QM and SCM frameworks still emphasizes operational issues or functions according to their origins and primary goals, yet, are applicable to any businesses.

ISO 9001 was originated by the International Organization for Standardization in 1987 as an international technical standard to facilitate international trade of goods and services in all industries with a common set of quality standards (Martinez-Lorente & Martinez-Costa, 2004). ISO 9001 focuses

on process control rather than product quality in order to prevent producing defectives (Magd & Curry, 2003). It emphasizes compliance to customer requirements with consistent levels of product quality (Karthan, 2004). ISO 9001 is an international quality standard, which can be applied to every business sector worldwide (Goldman, 2005; Talha, 2004). Although ISO 9001: 2015 incorporates some principles of MBNQA criteria, it still covers a small fraction of MBNQA criteria.

SCOR model was introduced by the Supply-Chain Council (SCC), a non-profit organization, from the culmination of 12 months of intensive work during 1996–1997 by 69 world-class manufacturers from various industrial segments (Foggin, Mentzer, & Monroe, 2004; Lambert et al., 2005). SCOR offers common process-oriented practices for communicating operational issues among supply chain partners (Lockamy & McCormack, 2004b). SCOR 11.0 contains six major processes, namely 1) Plan, 2) Source, 3) Make, 4) Delivery, 5) Return and 6) Enable (APICS SCC, 2015a). Therefore, SCOR still focuses merely on operational activities, which are directly relevant to physical movement of the products or logistics activities. It does not include supportive functions such as research and development, sales and marketing, human resource management and quality assurance, accounting or finance (Reichardt & Nichols, 2003). Consequently, the scope of SCOR is still far from the state of the superior Seamless Supply Chain (SSC) in which all partners in the supply chain think and act as one (Towill, Childerhouse, & Disney, 2002). However, SCOR is an attempt to be an international standard for SCM. In 2014, SCC and the American Production and Inventory Control Society (APICS) merged into APICS SCC to become the biggest unbiased, non-profit supply chain professional organization (APIC SCC, 2015b). The promotion of SCOR as a more globally accepted framework should be further encouraged and learned from those of ISO 9001. International operational SCM certificates should be offered to motivate the implementation of operational SCM framework in organizations.

The narrow scope of generic SCM and QM still has less emphasis on strategic issues and supportive functions in the value chain of organizations such as finance and accounting. Even though these frameworks are easier to introduce and manage, they lack the capability to achieve ultimate integration among interrelated internal and external partners, which is a prominent characteristic of SCM and QM (Vanichchinchai, 2012). Due to their generality and narrow scope, these frameworks lack concentration on core and critical competency of individual industry. As a result, they can be considered as “Qualifier” for SCM or QM for doing businesses.

### **3.2. Generic application & wide scope (extender)**

The wide scope of SCM and QM frameworks focuses more on strategic issues and cover more functions as well as business partners so as to gain synergy from integration of multi-disciplinary teams. The wide scope of generic frameworks can be applied to any industries to achieve the ultimate integration from not only internal employee participation but also external business partnerships and gain customer satisfaction, which is the ultimate goal of SCM and QM (Vanichchinchai & Igel, 2009).

Total Quality Management (TQM) can be described as a superior QM, and many experts have attempted to define it (Martinez-Lorente & Martinez-Costa, 2004). MBNQA criteria are often referred to as the most accepted TQM framework (Black & Porter, 1996; Kartha, 2004). MBNQA was created in 1987 by the US Congress to raise quality awareness and to recognize organizations for their achievements in quality performance (Black & Porter, 1996). The National Institute of Standards and Technology (NIST), a non-regulatory agency of the Commerce Department’s Technology Administration, is responsible for managing the program. Many countries such as Thailand have applied MBNQA criteria for their national quality awards (TQA, 2016). MBNQA criteria for performance excellence for general business and non-profit organizations consist of seven categories: leadership, strategic planning, customers, measurement, analysis and knowledge management, workforce, operations and results (NIST, 2016b). Many ISO 9001 certified organizations often include MBNQA as a further step for business excellence (NIST, 2016a; Kartha, 2004).

In 1994, a group of executives from multi-national companies who instituted the GSCF developed a framework of wide scope SCM (Lambert et al., 2005). The GSCF framework is composed of eight key business processes, which require collaboration from all internal functions and from external partners. They are customer relationship management, customer service management, demand management, order fulfillment, manufacturing flow management, supplier relationship management, product development and commercialization, and returns management. These processes are generic and applicable to various industries (Lambert et al., 2005).

The scope of TQM has been broadened to cover best practices. For instance, MBNQA criteria are referred to as criteria for performance excellence not traditional quality excellence ((NIST) National Institute of Standards and Technology, 2016b). Although the broader scopes of generic QM and SCM may be strengthened in enhancing the opportunities to add value through total integration, they are more difficult to implement and manage. Therefore, this type of framework can be determined as “Extender”. There are still neither international nor national SCM award for superior SCM. Thus, awards for SCM excellence should be initiated to promote awareness in SCM development for organizations and countries.

#### **4. Specific application**

Due to unique industry characteristics and requirements, several professional organizations have attempted to introduce dedicated SCM and QM frameworks to specific industries, such as ISO 13485 for medical devices, ISO/TS 16949 for automotive production and relevant service part organizations, ISO/TS 29001 for petroleum, petrochemical and natural gas industries. The specific frameworks focus more on the critical core competencies of their industries. Therefore, their potential markets or demands are more limited. However, they are more suitable for their industries and better respond to unique requirements. Similar to generic frameworks, the specific frameworks of SCM and QM are categorized into narrow and wide scope. Commonly applied frameworks in specific industries such as ISO/TS 16949, HACCP, Just-In-Time (JIT), Quick Response (QR), Efficient Consumer Response (ECR), MBNQA for educational and healthcare business have been raised for discussion.

##### **4.1. Specific application & narrow scope (improver)**

The narrow scope of specific SCM and QM emphasizes operational issues according to their origins (logistics and quality control) and primary goals (delivery and quality performance), (Vanichchinchai & Igel, 2009) in their businesses. Therefore, the functions involved in these frameworks are limited. They are suitable only for dedicated businesses.

The international Automotive Task Force (IATF), an international group of vehicle manufacturers and national trade associations, developed ISO/TS 16949 to be used as an ISO technical specification to serve common quality requirements for the global automotive industry. ISO/TS 16949 was developed from American (QS 9000), German (VDA 6.1), French (EAQF) and Italian (AVSQ) automotive quality standards to become an international standard, and can be substituted for those individual certifications. ISO/TS 16949 aims to manage and improve the quality of all automotive-related products through design, development, production, installation and service processes (ISO, 2016; Kartha, 2004).

The Food and Drug Administration (FDA) of the USA introduced Hazard Analysis and Critical Control Point (HACCP) as an operational specific quality assurance in the food industry. HACCP aims to analyze and control biological, chemical and physical hazards at every step in the food manufacturing process, from procurement, manufacturing to distribution (Taylor & Taylor, 2004). Initially, HACCP was developed as a microbiological safety system for the USA manned space project (Taylor & Taylor, 2004). It has since been applied to specific food industries, such as juices, seafood, and canned food. At present, its application is being extended to other areas of the food industry, such as retail and food service (FDA, 2016). Other commonly applied QM frameworks in the food industry include GMP and HALAL.

Industry-specific SCM concepts are recognized by different names depending on the industries in which they are applied (Gimenez, 2004; Vanichchinchai & Igel, 2009). SCM in the automotive industry utilizes many common principles with JIT (Gimenez, 2004) which was created by Toyota Motor Corporation (Chase, Aquilano, & Jacobs, 2001; Nicholas, 1998). JIT has been widely applied in the automotive industry, and then extended to other industries (Abdulmalek, Rajgopal, & Needy, 2006). In JIT, production can be planned. Raw materials are not inventoried, but scheduled to be received only as needed at short notice (Fiorito, May, & Straughn, 1995; McMichael, Mackay, & Altmann, 2000). Currently, JIT also is recognized by other names, such as lean manufacturing and Toyota production system (TPS) (Bhuiyan & Baghel, 2005; Emiliani, 2006; Yadav, Nepal, Rahaman, & Vinod Lal, 2017). Its concept also has been extended to other managerial frameworks, such as the product development framework (Letens, Farris, & Aken, 2011). In this paper, JIT was conventionally discussed as a hard tool and technique approach not as a soft managerial philosophy for total waste elimination, which can be applied in various types of industries, but still with different degrees of effectiveness (Abdulmalek et al., 2006).

SCM in the textile and apparel supply chain, which emphasizes the timely flow of information and merchandise among business partners, has been referred to as QR (Harris, Swatman, & Kurnia, 1999; Lee & Kincade, 2003; Perry & Sohal, 2001). QR was coined in 1985 from the US apparel supply chain improvement project conducted by Kurt Salmon Associates (Fernie & Azuma, 2004; Lummus, Krumwlede, & Vokurka, 2001; Lummus & Vokurka, 1999). Its concept was further developed from that of JIT (Brockman & Morgan, 1999; Gimenez, 2004; McMichael et al., 2000). Fiorito et al. (1995) reported that QR results in quicker deliveries, faster inventory turns, fewer stock-outs, fewer markdowns and lower inventory investment.

In the grocery industry, SCM is known as ECR. ECR is a further development of QR and JIT. It attempts to streamline the supply chain and to eliminate inefficiencies which cause unnecessary cost along the whole supply chain (Brockman & Morgan, 1999; Fiorito et al., 1995; McMichael et al., 2000). ECR was initiated in 1992 in the US by a group of grocery industry leaders (Gimenez, 2004; Harris et al., 1999; Lummus & Vokurka, 1999) in order to add value by reducing excessive inventory and cost as well as responding to customer requirements quickly (Hoffman & Mehra, 2000; Lummus et al., 2001).

The narrow scope of the specific frameworks is more rigorous than that of generic frameworks because they focus more on critical functions and performance of specific industries. Therefore, these frameworks can be considered as “Improver”. It can be observed that the narrow scope of specific QM frameworks is mostly applied in businesses which seriously need quality in terms of customer safety or security, such as food and automobiles. As a result, many of them become international standards and certificates. Some of them, such as GMP are prerequisites by law for operating a business.

However, there are still no internationally accepted standard frameworks or certificates for the narrow scope of specific SCM. JIT, QR and ECR have concepts or principles, but their implementation frameworks are still unclear. This is because the concept of SCM was much later developed than that of QM. SCM focuses on delivery and cost performance, which are less sensitive to customer safety and security. Some leading companies encourage their business partners to implement a narrow scope of specific SCM in order to improve SCM performance in the whole supply chain. For instance, Toyota Motor initiated joint training programs to transfer TPS principles to their first-tier suppliers. Thus, an international narrow scope of specific SCM standards and certificates is needed to promote the development of dedicated SCM in specific industries. It should start from those industries in which time-based performance or inventory cost is critical, such as automotive, grocery or garments. Encouragement from influential focal companies in the supply chain is needed to facilitate the adoption of such standards or certificates by supply chain members.

#### **4.2. Specific application & wide scope (winner)**

The wide scope of specific SCM and QM frameworks is more strategic and covers more interrelated functions to gain synergy from total integration. They strategically focus and are developed for specific requirements in their businesses. Consequently, they can be determined as superior frameworks for “Winner” in SCM and QM.

As a result of its achievement, generic MBNQA criteria for general businesses and non-profit organizations have been further developed for specific business sectors namely education (Education criteria for performance excellence) and healthcare (Healthcare criteria for performance excellence). Core components of MBNQA specific frameworks are still similar to those of generic ones but detailed criteria are tailored for more efficient responses to specific requirements of individual businesses ((NIST) National Institute of Standards and Technology, 2016b).

Some researchers have attempted to propose a wide scope of the specific framework of SCM; for instance, Vanichchinchai and Igel (2011) in the automotive supply chain, Wong, Arlbjorn, and Johansen (2005) in toy supply chain. However, none is yet internationally accepted. This is because the numbers of organizations in specific industries needing SCM for critical competitiveness are more limited. The implementation of the wide scope specific SCM is more complicated, requiring companies with more SCM maturity. Consequently, potential market or business demand for such frameworks is lower. Most existing wide-scope specific SCM frameworks are proposed by the individual researcher rather than by the professional organizations. The promotional effort and adoption of those frameworks in industries are weak. Development and promotion of wide scope specific SCM should be done in collaboration with leading professional organizations or focal companies in their supply chains.

#### **5. Implications and conclusions**

This paper presents insights into QM and SCM frameworks. Generic QM and SCM frameworks emphasize general soft managerial practices and are applicable to any organizations regardless of organizational characteristics, such as business, size and product. Specific frameworks focus on dedicated hard engineering techniques and are more suitable for specific industries. They better respond to their unique business requirements and the implementations are less complicated. The narrow scope of QM and SCM frameworks focuses more on operational issues and less on strategic ones. Although their implementations are easier, they lack the capability to achieve full integration. The wide scope of both is more strategic and extends to cover more partners. They have strength in enhancing the opportunities to add value through total integration. However, it is rather difficult to implement and needs more investment than a narrow scope framework. Based on generality and scope, practical QM and SCM frameworks can be categorized into four groups, which can represent degrees of development. It starts from Qualifier (generic application & narrow scope) or Improver (specific application & narrow scope). Then, it may be diversified to become Improver, Qualifier or Extender (generic application & wide scope) depending on the strategy or policy in QM and SCM development. Ultimately, it matures to the framework for Winner (specific application & wide scope).

Generally, specific frameworks give more effective results. With industry growth and severe business competition, QM and SCM frameworks should be further researched for more competitive-specific frameworks for better response to increasing dynamic customer requirements. Understanding practical QM and SCM implementation frameworks and their characteristics allows managers to efficiently apply appropriate models according to their firm’s policy, readiness and resource for application. This can enhance implementation success and returns on investment. SCM framework, evolution and promotion may be learned from those of QM as its more developed counterpart. For instance, clearer SCM standards, certificates or awards should be initiated and promoted by leading professional organizations and focal firms in supply chain to become more internationally accepted practical frameworks.



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