The Relationships between Supply Chain Integration and Product Quality

Zahra Lotfi*, Shahnorbanun Sahran, Muriati Mukhtar, Ali Taei Zadeh

School of Information Technology, Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia

Abstract

Information sharing is an essential tool or enabler for supply chain integration. Many researches have been done to investigate the effectiveness of information sharing in supply chain firms. Product quality is one important dimension of operational performance in supply chain management that seeks more attention from the community of researchers. Therefore consideration must be given to the development of collaborative activities between manufacturer, supplier and customer which enables firms to work together and improves in the product quality. So, studies which examine the effect of seamless supply chain on the product quality remain a research opportunity. This research after an overview on supply chain integration and product quality offers an integrated conceptual framework to examine the interaction of internal and external integration on product quality. The purpose of the study was to find out the related internal integration, customer integration and supplier integration effects on conformance quality and design quality on the manufacturing sector. It also aimed to propose an integrated conceptual framework between supply chain integration and product quality with the presentation of six hypotheses. The proposed conceptual model gives an application of the tools suitable for integration between firms and product quality.

© 2013 The Authors. Published by Elsevier Ltd. Open access under CC BY-NC-ND license.
Selection and peer-review under responsibility of the Faculty of Information Science & Technology, Universiti Kebangsaan Malaysia.

Keywords: Supply Chain Integration (SCI); Product Quality; Conceptual Framework; Supply Chain Management; Manufacturing sector;

* Corresponding author. Tel.: +603-8925-6732
E-mail address: zahra@ftsm.ukm.my
1. Introduction

Researchers have demonstrated that firms which collaborate and cooperate with other firms or create an inter-firm relationship with others will have better competitive advantages than those which do not [1-5]. Hence there are an increasing number of empirical studies and investigations devoted to the direct and indirect impacts of seamless supply chain on product quality and firm performance [1, 6-9].

Researchers have stated the need for an intimate, unified relationship among manufacturers and their supply chain members for a very long time [10]. Still, a methodical move to supply chain relationship is recently a very important to integrate among supply chain members. With the increase in global competition, organizations are forced to rethink their approach to information integration.

The existing researches on SCI, however, include meanings and aspects [11]. Some researches concentrate on each aspect of supply chain integration [12-14], especially customer and supplier integration, the other researches apply a variety of meanings to investigate supply chain integration as a unit construct [15, 16]. Furthermore, many conceptualizations of SCI do not include the central link i.e. internal integration, and hence are incomplete [2].

Enhancement of product quality and services of enterprises may offer add value for customers. By evaluating the improvements of the market, managers can rank these improvements. Hence, studies which test the impact of seamless supply chain on product quality that is an important competitive capability, remains a research opportunity.

The aims of the present study are (1) to overview supply chain integration and product quality (2) to propose a conceptual framework (3) to present the hypotheses.

2. Supply Chain Integration in Supply Chain Management

Since 1990ss, the Supply Chain Management (SCM) has gotten more attention [17]. Since then many different ad unique definitions of SCM have been published in books and articles; although all these can be defined using 3 main themes: benefits, activities, components and/or constituents. Each one of these three main themes can be further divided into other sub-themes. Benefits may be the increase in efficiency, value and customers’ satisfaction [18]. While activities can include the flow of information and material and the internal and external flow of network relationships.

Supply Chain management in the eyes of Stadtler [19] was defined as the act of sharing information, material and financial information within the organizational units, so that it will meet the needs of the customer and lead to an enhancing of the entire supply chain involved.

Supply Chain Integration (SCI) can be defined by the amount of collaboration between a manufacturer and its supply chain partners as well as the extent to which a producer conducts internal and external organizational processes [2]. In this study, we consider internal integration, customer integration and supplier integration upon some researches [3, 20-22]. The seamless Supply chain may result in the effective gains and flows of services, money, information, products and decisions, with the goal of offering highest value to firm’s customers [23].

Supply chain integration is divided into internal and external integration. The external integration is also divided into customer and supplier integration.

2.1. Customer Integration (CI)

Customer integration refers to acquiring technological, marketing, production and inventory information from the customers [24, 25]. Manufacturers can use these acquired information and customer requirements to produce products that meet users’ preferences [2, 26, 27].

Customer integration is supply chain integration downstream. It is the outgoing set of products and services and the incoming set of data from customers to suppliers. Customer integration leads to creating a relationship with customers and hence gaining a better and clearer understanding of customers’ preferences [23, 28].

Customer integration involves engaging customers’ opinions in decisions about the production of the goods. It includes methods and ways to enhance coordination among the manufacturer and the customer, as well [23].
2.2. Supplier Integration (SI)

Supplier integration is supply chain integration upstream. It involves a relationship between the firm and the upstream suppliers [29]. With supplier integration, suppliers provide information and participation in making decisions [30]. Such effective relationships and communications possess a major significance in advanced firms since suppliers know the components supplied better than the firms [31, 32].

Supplier integration refers to acquiring operational, technical and financial information with the suppliers [28]. Manufacturers and suppliers may share information including production plans, demand forecasts and levels of inventory [27]. This information sharing results in enhancing the product and production requirements and better utilizing the supplier’s and factory’s capabilities and structure of cost [28].

2.3. Internal Integration (II)

Internal integration is integration within all internal departments from incoming material to distribution. It involves integration across departments and functions under the control of the manufacture in order to fulfill customers’ requirements. This suggests that more consideration should be given to interplay in the middle of functional departments, for instance production, procurement, logistics, inventory, marketing, sales and distribution [33].

Internal integration demonstrates the extent to which a firm can build all its functions and practices into a collaborative and organized manner to meet customers’ needs [1, 27]. Therefore the functions and departments within a manufacturer operate as one integrated and coordinated system working together to meet customers’ requirements and improve performance. There are some very important elements that lead to better performance. For instance, shared information, joint planning, functional coordination teams and collaborating together are needed to make sure products are not delayed and customers’ are happy with the services they receive [2].

3. Product Quality

Juran [34] and Montgomery [35] defined “Quality” as “fitness for use” and DeFeo [36] has settled on a new definition “quality means fitness for purpose” In statistical terms, quality is largely determined by the amount of variability in what is being measured and also product quality refers to a fitness of product to meet customers’ needs and satisfaction [37].

Feigenbaum (cited in [38]) defines product quality as “the composite of product characteristics of engineering and manufacture that determine the degree to which the product in use will meet the expectations of the customer”.

Fujimoto [39] presents that the concept of product quality, in his framework, is related to fitness of information content or accuracy of information processing along a chain of productive resources that link customer needs, product concepts, product plan (basic design), product design, process design, process, product structure and product function. He divides total quality into two categories: design quality and conformance quality that design quality include ,customer needs, product concept and product plan (basic design) and also conformance quality consists product design, process design, process, product structure and product function.

3.1. Design Quality

Design quality can be noted as the inherent value of a product in the marketplace or how to measure the characteristics of a product designed to meet the requirements of a given group of customers. It measures how well the customer expectations are represented in the product concepts and then into detailed product designs.

3.2. Conformance Quality

Clark and Fujimoto [40] state that conformance quality refers to how well products delivered to customers conform to the product design or specifications, including reliability, defects in the field, fit and finish and durability. Schniederjans and Cao [41] state that conformance quality refers to the extent of achieving product design specifications. Based on Fujimoto [39], conformance quality determines how closely the information
embodied in the actual products represents that of the product design.

As the chain of quality indicates, a high design quality and a high conformance quality are required in order to achieve a high level of total product quality [39, 40].

4. Supply Chain Integration and Product Quality

Many researches have been conducted to show the relationship among supply chain integration and some factors of performance. Some of these researches study supply chain integration as a whole, while others find the relationship with some dimensions, and the rest focus on only one or two dimensions of SCI. There are many researches that focus on the interaction among the varied dimensions of supply chain integration for instance, internal integration, supplier integration and customer integration and variety of dimensions of performance for instance: Delivery [1, 12, 16, 20, 28], Cost [1, 5, 12, 16, 20, 28, 42], Customer satisfaction [5, 16, 28, 43], firm performance [22, 44, 45], process flexibility & Process improvement [1, 12, 16, 28], Financial performance [5, 46, 47] and also on product quality [1, 16, 20, 33] but less consideration on design quality and conformance quality being the two important dimensions of product quality [43].

We reviewed the related literature on the relationship among seamless supply chain and dimensions of strategic performance and operational performance in previous study [48]. We can conclude that very little attention has been granted to dimensions of supply chain integration and product quality which contains Design Quality and Conformance Quality. From the literature review, we can conclude that very little consideration has been granted to the dimensions of supply chain integration and product quality which is composed of design quality and conformance quality. Even though Fynes et al [43] investigated on these two dimensions of product quality, but they did not research into their direct effect on supply chain integration. Therefore, the relationship among supply chain integration with the complete dimensions of product quality has not received sufficient attention from the research community.

5. Proposed Conceptual Framework

In a previous study, we reviewed and summarized some prior literature on the relationship between the dimensions of supply chain integration and some dimensions of performance [48]. In this study, we consider internal integration, customer integration and supplier integration upon some researches [3, 20-22] as dimensions of supply chain integration. We propose a conceptual framework based on literature review with 3 independent variables (Internal Integration, Supplier Integration and Customer Integration) and 2 dependent variables (design Quality and Conformance Quality), which altogether make 5 constructs forming the following formula with 10 relationships.

\[
\text{Number of relationships} = \frac{n(n-1)}{2}
\]

In this formula” n” indicates the number of “construct “.

Finally, we consider these relationships in four parts and each part with some hypotheses where the number of relationships shows the number of hypotheses. Then, in the last section, we provide a discussion of this framework.

The review of the literature illustrates that a supply chain is constructed by firms, both upstream (as supply), downstream (as distribution) and the end customer [49]. We argued about product quality based on Clark et al. [50]. Here total product quality is divided into two aspects. The first one is, conformance quality which is interpreted by how well the actual product conforms to the design once it has been produced, and second aspect is the design quality which is interpreted as the degree to which quality is represented by the final creation [43]. Based on this classification for product quality and Flynn et al. [2] research for integrated relationship across firms and their supply chain members, our proposed framework is shown in Fig 1.

The research proposed conceptual framework is divided in two main categories: Supply Chain Integration and Product Quality. Supply chain integration consists of customer integration, internal integration and supplier integration and on the other hand product quality includes conformance quality and design quality.
In Fig 2 shows all 10 relationships of proposed conceptual framework that mentioned in section 3. The arrows in the framework in Fig 2 show the effect of each relationship between variables. We consider three dimensions of supply chain integration: customer integration, internal integration and supplier integration as independent variable and two dimensions of product quality: conformance quality and design quality as the dependent variable.

We now consider these relationships in four parts and each part with some hypotheses. The relationships in part I and II are the research hypotheses and the relationships in part III and IV are proved by the other researches.

I. There are three hypotheses that show the effect of supply chain integration on design quality.
   - **H1**: Customer integration has a positive relationship with design quality.
   - **H2**: Internal integration has a positive relationship with design quality.
   - **H3**: Supplier integration has a positive relationship with design quality.

II. There are three hypotheses that show the effect of supply chain integration on conformance quality.
   - **H4**: Customer integration has a positive relationship with conformance quality.
   - **H5**: Internal integration has a positive relationship with conformance quality.
   - **H6**: Supplier integration has a positive relationship with conformance quality.

III. There are three relationships that show the effect of internal integration on external integration and also between external integration. These are proven by Kotcharin et al. [1].
   - Internal integration has a positive relationship with customer integration.
   - Internal integration has a positive relationship with supplier integration.
   - Customer integration has a positive relationship with supplier integration.
IV. There is one relationship that shows the effect of design quality on conformance quality. It is proved Fynes and De Burca [51].
- Design quality has a positive relationship with conformance quality.

Fig 3 shows our conceptual model with six hypotheses. We will show the effect of each relationship in the future study. In this study we have merely introduced the framework and the hypotheses.

1. Discussion and Conclusion

Our study introduced the conceptual framework that shows the relationship among the dimensions of supply chain integration and dimensions of product quality in manufacturing sector. In the research model that was brought out by the literature review in the field of supply chain management, we indicated that internal integration has effects on supplier integration as well as customer integration. On the other hand design quality has effects on conformance quality and also each dimension of supply chain integration affects each dimension of product quality.

Our study provided theoretical and literature review evidences that internal and external integration have impacts on design quality and conformance quality leading to improvements of competitive capabilities in firms. If the firms pay more attention to supplier integration and customer integration then we predict that their product quality capability may be enhanced.

Our study has several limitations relating to its scope and method. Firstly, we only focused on the effects of a seamless supply chain on product quality but there are several important dimensions of competitive capabilities that improve firm performance. Our model is only constructed for manufacturing sector not the business sector. The other limitation is that we focused only on two dimensions of product quality, while there are other dimensions as well. Further studies should include relationships between more constructs and also involve various types of companies.

References

[1] Kotcharin S., Eldridge S., Freeman J., Investigating the relationships between internal integration and external integration and their impact on combinative competitive capabilities, in: Seventeenth International Working Seminar on Production Economics, Innsbruck, Austria, 2012.
[2] Flynn B.B., Huo B., Zhao X., The impact of supply chain integration on performance: A contingency and configuration approach, Journal of Operations Management, 2010; 28: 58-71.
[3] Koufteros X., Vonderembse M., Jayaram J., Internal and external integration for product development: the contingency effects of uncertainty, equivocality, and platform strategy, Decis. Sci., 2005; 36: 97-133.
[4] Lau A.K.W., Supplier and customer involvement on new product performance: Contextual factors and an empirical test from manufacturer perspective, Industrial Management & Data Systems, 2011; 111: 910-942.
[5] Kim S.W., An investigation on the direct and indirect effect of supply chain integration on firm performance, International Journal of Production Economics, 2009; 119: 328-346.
[6] Zhang G., Ran Y., Ren X., Study on product quality tracing technology in supply chain, Computers & Industrial Engineering, 2011;
[7] Zhu L.L., You J.X., Moral hazard strategy and quality contract design in a two-echelon supply chain, J. Syst. Sci. Syst. Eng., 2011; 20: 70-86.
[8] Musheng Y., Yu Z., Jiarui N., Product quality collaborative control technology in SCM, in, IEEE, 2008, p. 180-185.
[9] Tsung F., Impact of information sharing on statistical quality control, Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on, 2000; 30: 211-216.
[10] Lambert D.M., Robeson J.F., Stock J.R., An appraisal of the integrated physical distribution management concept, International Journal of Physical Distribution & Logistics Management, 1978; 9: 74-88.

[11] Van Der Vaart T., Van Donk D.P., A critical review of survey-based research in supply chain integration, International Journal of Production Economics, 2008; 111: 42-55.

[12] Cousins P.D., Menguc B., The implications of socialization and integration in supply chain management, Journal of Operations Management, 2006; 24: 604-620.

[13] Hornburg C., Stock R.M., The link between salespeople's job satisfaction and customer satisfaction in a business-to-business context: A dyadic analysis, Journal of the Academy of Marketing Science, 2004; 32: 144-158.

[14] Koufteros X.A., Edwin Cheng T., Lai K.H., “Black-box” and “gray-box” supplier integration in product development: Antecedents, consequences and the moderating role of firm size, Journal of Operations Management, 2007; 25: 847-870.

[15] Armistead C., Mapes J., The impact of supply chain integration on operating performance, Logistics Information Management, 1993; 6: 9-14.

[16] Rosenzweig E.D., Roth A.V., Dean J.W., The influence of an integration strategy on competitive capabilities and business performance: an exploratory study of consumer products manufacturers, Journal of Operations Management, 2003; 21: 437-456.

[17] Larson P.D., Rogers D.S., Supply chain management: definition, growth and approaches, Journal of Marketing Theory and Practice, 1998; 6: 1-5.

[18] Stock J., Boyer S., Harmon T., Research opportunities in supply chain management, Journal of the Academy of Marketing Science, 2010; 38: 32-41.

[19] Stank T.P., Keller S.B., Closs D.J., Performance benefits of supply chain logistical integration, Transportation Journal, 2001; 38: 32-46.

[20] Wong C.Y., Boon-itt S., Wong C.W.Y., The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance, Journal of Operations Management, 2011; 29: 604-615.

[21] Stank T.P., Keller S.B., Closs D.J., Performance benefits of supply chain logistical integration, Transportation Journal, 2001; 41: 32-46.

[22] Narasimhan R., Kim S.W., Effect of supply chain integration on the relationship between diversification and performance: evidence from Japanese and Korean firms, Journal of Operations Management, 2002; 20: 303-323.

[23] Frohlich M.T., Westbrook R., Arcs of integration: an international study of supply chain strategies, Journal of Operations Management, 2001; 19: 185-200.

[24] Mentzer J.T., Fundamentals of supply chain management: Twelve drivers of competitive advantage, Sage Publications, Inc, 2004.

[25] Lau A.K.W., Yam R.C.M., Tang E.P.Y., Supply chain integration and product modularity An empirical study of product performance for selected Hong Kong manufacturing industries, International Journal of Operations & Production Management, 2010; 30: 20-56.

[26] Chen I.J., Paulraj A., Understanding supply chain management: critical research and a theoretical framework, International Journal of Production Research, 2004; 42: 131-163.

[27] Zhao X., Huo B., Selen W., Yeung J.H.Y., The impact of internal integration and relationship commitment on external integration, Journal of Operations Management, 2011; 29: 17-32.

[28] Swink M., Narasimhan R., Wang C., Managing beyond the factory walls: effects of four types of strategic integration on manufacturing plant performance, Journal of Operations Management, 2007; 25: 148-164.

[29] Vijayasarithy L.R., Supply integration: An investigation of its multi-dimensionality and relational antecedents, International Journal of Production Economics, 2010; 124: 489-505.

[30] Petersen K.J., Handfield R.B., Ragatz G.L., Supplier integration into new product development: coordinating product, process and supply chain design, Journal of Operations Management, 2005; 23: 371-388.

[31] Jammernegg W., Reiner G., Performance improvement of supply chain processes by coordinated inventory and capacity management, International Journal of Production Economics, 2008; 111: 42-55.

[32] Luo J., Buyer-vendor inventory coordination with credit period incentives, International Journal of Production Economics, 2007; 108: 143-152.

[33] Boon-itt S., Achieving Product Quality Performance: Information Technology, International Journal of Innovation Management and Technology, 2011; 2: 23.

[34] Juran J.M., Juran on leadership for quality, Free Press, 2003.

[35] Montgomery D.C., Introduction to statistical quality control, Wiley-India, 2007.

[36] Defeo J., Juran's quality handbook: The complete guide to performance excellence, in, New York, NY: McGraw-Hill, 2010.

[37] Ryan T.P., Statistical methods for quality improvement, Wiley, 2011.

[38] Reeves C.A., Bednar D.A., Defining quality: alternatives and implications, Academy of Management Review, 1994; 419-445.

[39] Fujimoto T., The evolution of a manufacturing system at Toyota, Productivity Press, 1991.

[40] Clark K.B., Fujimoto T., Product development performance: Strategy, organization, and management in the world auto industry, Harvard Business Press, 1991.

[41] Schniederjans M.J., Cao Q., E-commerce operations management, Imperial Colledge Pr, 2002.

[42] Devaraj S., Krajewski L., Wei J.C., Impact of eBusiness technologies on operational performance: the role of production information integration in the supply chain, Journal of Operations Management, 2007; 25: 1199-1216.

[43] Fynes B., Voss C., De Burca S., The impact of supply chain relationship quality on quality performance, International Journal of Production Economics, 2005; 96: 339-354.

[44] Cao M., Zhang Q., Supply chain collaboration: Impact on collaborative advantage and firm performance, Journal of Operations Management, 2011; 29: 163-180.

[45] Vickery S.K., Jayaram J., Droge C., Calantone R., The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships, Journal of Operations Management, 2003; 21: 523-539.

[46] Droge C., Jayaram J., Vickery S.K., The effects of internal versus external integration practices on time-based performance and overall firm performance, Journal of Operations Management, 2004; 22: 557-573.

[47] Germain R., Iyer K.N.S., The interaction of internal and downstream integration and its association with performance, Journal of Business Logistics, 2006; 27: 29-52.
[48] Lotfi Z., Sahran S., Mukhtar M., A Product Quality - Supply Chain Integration Framework Journal of Applied Sciences, 2013; 13: 36-48.
[49] Christopher M., Logistics and supply chain management Financial Times Prentice Hall, Harlow, England; New York, 2011.
[50] Clark K.B., Chew W.B., Fujimoto T., Manufacturing for design: beyond the production/R&D dichotomy, Integrating Design And Manufacturing For Competitive Advantage, New York, NY: Oxford University Press, S, 1992; 178-204.
[51] Fynes B., De Burca S., The effects of design quality on quality performance, International Journal of Production Economics, 2005; 96: 1-14.