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Partnering in engineering projects: Four dimensions of supply chain integration

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ABSTRACT

Although the interest of partnering and supply chain integration (SCI) has increased in various industries, there is still a lack of comprehensive conceptual and practical frameworks that enable both a detailed and systemic understanding of integration in project-based supply chains. In this paper a theoretical framework is developed, based on general SCI literature, but adapted to a project-based context. Integration in project-based supply chains is a multi-dimensional construct, including the four dimensions strength, scope, duration, and depth of integration. Empirical findings from a multiple case study of four engineering projects indicate that these four dimensions are critical when conceptualizing and implementing partnering in engineering projects. The results show that there are strong interdependencies among the four dimensions, suggesting that it is crucial to manage them simultaneously and systemically rather than in isolation. Consequently, it is not enough to decide on the extent to which suitable integrative activities and technologies should be implemented to strengthen integration in project-based supply chains. The integrative activities and technologies must also be implemented together with the right companies (scope), at the right time (duration), and with the right people in the companies (depth).

1. Introduction

Many practitioners and scholars active in the supply chain management (SCM) field highlight the strategic importance of supply chain integration (SCI) (Fawcett and Magnan, 2002). Most research in this field has focused on the link between SCI and performance (Ho et al., 2002; van Donk and van der Vaart, 2004) and many survey studies have also shown that SCI may improve various performance aspects related to customer service, operations, finance, and profits (Frohlich and Westbrook, 2001; Vickery et al., 2003; Bagchi et al., 2005; Flynn et al., 2010; Cao and Zhang, 2011; Huo, 2012). However, recent literature reviews indicate that the results regarding the relationship between SCI and performance are mixed and not very convincing (Fabbe-Costes and Jahre, 2007; van der Vaart and van Donk, 2008).

These mixed findings are partly due to a lack of consistency when it comes to defining and operationalizing the content of SCI (Ho et al., 2002; van der Vaart and van Donk, 2008; Vallet-Bellmunt et al., 2011). When looking at survey studies, a long list of seemingly different constructs and measurements of SCI could be identified. Yet, authors mostly measure only a small number of items, and ignore potential interaction effects between different dimensions of SCI (van der Vaart and van Donk, 2008; Huo, 2012). Although many studies treat SCI as a one-dimensional construct, recent studies highlight its multi-dimensional nature (Fabbe-Costes and Jahre, 2007; Vallet-Bellmunt and Rivera-Torres, 2013). Hence, it is central to improve our understanding of SCI as a multi-dimensional construct and how different dimensions interact sequentially (Huo, 2012; Vallet-Bellmunt and Rivera-Torres, 2013).

Another reason for the mixed results regarding SCI's effect on performance is the lack of contingency perspective in terms of various business conditions (Ho et al., 2002; van der Vaart and van Donk, 2008). van Donk and van der Vaart (2004, p. 52) state that "business conditions influence and determine both the optimum level of SCI as well as the type of integrative activities employed". Prior studies have indicated that the complexity of the purchase (Kaufmann and Carter, 2006), demand uncertainty, product variety, and the decoupling point (i.e. make-to-stock, make-to-order, or engineer-to-order) must be taken into account when investigating SCI (van Donk and van der Vaart, 2004; van der Vaart and van Donk, 2006). Since business conditions may vary significantly across industries it is critical to conceptualize and implement SCI in different ways in different industrial contexts.

While prior SCI studies mostly concern continuous exchanges in manufacturing industries (e.g. Wathne and Heide, 2004; Flynn et al., 2010; Cao and Zhang, 2011), there is considerably less

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research on discontinuous exchanges in project-based supply chains (Briscoe and Dainty, 2005; Crespin-Mazet and Ghauri, 2007; Gil, 2009; Martinsuo and Ahola, 2010). Compared to the continuous manufacturing context, SCI is especially challenging in project-based supply chains due to: the discontinuous demand for projects; the uniqueness of each project in technical and financial terms; uncertain demand requirements and production conditions; and the complexity of each project in terms of a high number of specialized but interdependent suppliers and their activities (Dainty et al., 2001; Skaates et al., 2002; Gil, 2009; Eriksson and Pesämaa, 2013). Accordingly, buyers often rely on competitive tendering, in order to execute every new project to the lowest possible cost, resulting in disjointed supply chains (Briscoe and Dainty, 2005; Kadefors et al., 2007).

During recent years, however, the interest and practice of SCI, often labeled partnering, has increased also in project-based supply chains (Crespin-Mazet and Portier, 2010; Hartmann and Caerteling, 2010). Yet, there are also studies that emphasize the implementation difficulties and the lack of knowledge related to integration in project-based supply chains (Saad et al., 2002; Alderman and Ivory, 2007). The key to improved understanding of how to successfully implement and achieve integration in project-based supply chains is deeper and more detailed knowledge (Humphreys et al., 2003) about how various management practices work and affect each other, since “the devil is in the details” (Gil, 2009, p. 144). Hence, there is a need for conceptual and empirical research that is comprehensive, by addressing several dimensions, yet detailed in the investigation of how specific SCI dimensions interacts and how they can be managed in project-based supply chains.

The empirical context of this study is project-based engineer-to-order industries, which include the construction of plant facilities, oil platforms, ships, buildings, and infrastructures (Hicks and McGovern, 2009). Such undertakings involve engineering projects characterized by high complexity, customization, and uncertainty coupled with long duration (Hicks and McGovern, 2009). These project characteristics typically require inter-organizational integration, in order to enhance coordination, flexibility, adaptability, joint problem solving, and knowledge exchange across the supply chain (Lu and Yan, 2007; Eriksson, 2008). At the same time, SCI is especially challenging due to the low transaction frequency and uniqueness of the projects.

The purpose of this paper is to explore how SCI can be conceptualized and implemented in project-based supply chains. Specifically, the study elaborates on the research question: how are central dimensions of SCI connected to each other and how can they be managed together, when implementing partnering in engineering projects? Furthermore, a contingency perspective is adopted, in order to reflect on how the configuration of SCI dimensions may be adapted to fit various business conditions and project characteristics. In the next section, a theoretical framework is developed, based on general SCI literature, but adapted to a project-based context. Then the multiple case study approach, including four engineering projects, is described. After that, empirical findings from the case study projects are presented and subsequently discussed in relation to prior literature. At the end, conclusions are drawn and theoretical contributions and managerial implications are discussed.

2. Development of a theoretical framework

2.1. Four dimensions of integration in project-based supply chains

Flynn et al. (2010, p. 59) and Huo (2012, p. 596) define SCI as “the degree to which a focal company strategically collaborates with its supply chain partners and collaboratively manages intra- and inter-organizational processes”. As illustrated by the definition, the concept of integration is closely related to collaboration, which involves collective actions to reach mutual goals (Bengtsson and Kock, 2000; Eriksson, 2008). The SCI concept, which originates from a manufacturing industry context, corresponds to the concept of partnering, which is the most commonly used term for integration in project-based supply chains. Lu and Yan (2007, p. 165) defines partnering as “a structured sequence of processes initiated at the outset of the project that is based on mutual objectives and utilizes specific tools and techniques such as facilitated workshops, a dispute resolution system, and continuous improvement techniques”. Both these definitions are based on an explicit process perspective, which is adopted in this paper. The concepts of integration in project-based supply chains and partnering in engineering projects are used in parallel in this paper, which is similar to how they are treated in prior literature (Saad et al., 2002; Briscoe and Dainty, 2005; Hartmann and Caerteling, 2010).

When developing the theoretical framework, meta-analyses and literature reviews on SCI was of particular interest, in order to get a comprehensive view of the broad range of inconsistent conceptualizations of SCI and its dimensions. In a meta-analysis of 86 papers on SCI, Leuschner et al. (2013, p. 34) defined SCI as “the *scope* and *strength* of linkages in supply chain processes across firms”. Similarly, many empirical papers involve investigations of the two dimensions of strength and scope (e.g. Frohlich and Westbrook, 2001; Fawcett and Magnan, 2002; Flynn et al., 2010). Since these two dimensions seem to be the most central in prior SCI literature, they serve as a starting point in this paper.

However, in order to make the developed framework applicable to project-based supply chains, two additional dimensions (duration and depth) were identified in literature on new product development (NPD) and engineering projects. In continuous exchanges in manufacturing industries, SCI is implemented in long-term relationships (Vickery et al., 2003; Wu et al., 2010; Huo, 2012), but this is mostly not the case in project-based supply chains. Due to the low frequency and uniqueness of engineering projects and the separation of projects into different stages that traditionally are executed by different actors with different specialties, the timing and duration of integration is especially critical in project-based supply chains (Crespin-Mazet and Portier, 2010; Martinsuo and Ahola, 2010; Salvador and Villena, 2013), compared to the situation in manufacturing industries. In addition, although some prior studies suggest that interaction among a larger number of individuals at many hierarchical levels and from many corporate functions strengthens integration (Moenaert et al., 1995; Barnes et al., 2007), prior SCI literature lack a discussion in about by whom the integrative activities are performed. Engineering projects involve coordination of activities performed by many people with different specialties and functional roles at different hierarchical levels. Accordingly, prior research has shown that integration is enhanced by both top management commitment (McIvor et al., 2006) and close interaction among personnel at lower hierarchical levels (Zheng et al., 2008). Hence, it is important to include personnel from several hierarchical levels and functions in partnering processes (Bayliss et al., 2004), by considering the depth of integration. Accordingly, by merging SCI literature with literature on NPD and engineering projects, four SCI dimensions and their interdependencies are first conceptualized in the theoretical framework and then illustrated through a multiple case study.

2.2. Strength of integration

Many studies discuss some kind of degree or *strength* of SCI, which involve the question of how to measure more or less integration (Frohlich and Westbrook, 2001; Fabbe-Costes and