

“Black-box” and “gray-box” supplier integration in product development: Antecedents, consequences and the moderating role of firm size

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Abstract

We investigate here antecedents and consequences of supplier integration (black-box and gray-box) in product development activities. Antecedents include embeddedness with suppliers, supply base rationalization, and supplier selection based on product development capabilities. Product innovation and quality are modeled as returns of supplier integration in product development. We also assess the moderating role that firm size may play in the relationships we posit. Our research framework relies primarily on the social network perspective (SNP) and using a sample of 157 firms we found support for many of the posited hypotheses. Specifically, we found that embeddedness with suppliers is positively related to supply base rationalization and supplier selection based on product development capabilities. Supply base rationalization has a significant positive impact on gray-box integration (i.e., suppliers working along side the customer’s engineers for product development) but not black-box integration (i.e., suppliers carry out on their own the development of components or parts for the customers). On the other hand, selecting suppliers based on their product development capabilities leads to higher levels of both gray-box and black-box integration. Only gray-box integration manifests statistically significant positive effects towards product innovation. The effects of black-box integration are negligible. Product innovation exhibits strong positive effects on quality. We also found partial support for the moderating impact of firm size. Supply base rationalization practiced by small firms has a statistically significant negative impact on black-box integration but there is no statistically significant effect for large firms. Supply base rationalization is statistically related to gray-box integration only for large firms. Finally, the positive effects of product innovation on quality are more potent for large firms.

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1. Introduction

The competitive capabilities of a firm shape its ability to effectively compete in increasingly demand-

ing environments. Such competitive capabilities may include product innovation and quality, credible means through which a firm can pursue a differentiation strategy (Koufteros et al., 2002a,b). Product innovation, i.e., the ability of a firm to introduce new products and features, is fundamental for the continual prosperity of a firm (Fliess and Becker, 2006; Handfield and Nichols, 2002). The mere number of products and features that

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enter the market however would be inconsequential if their introduction in the market fails to fulfill customer expectations for quality (Koufteros et al., 2002a,b). With competitive capabilities being vitally important, firms constantly seek to engage in practices that would enhance their competitive capacity to innovate.

In order to enhance their product innovation capabilities and subsequently quality, many firms rely on their suppliers for product development contributions (Petersen et al., 2005; Tan, 2001). Due to bounded rationality considerations (Simon, 1957), manufacturers focus on the enhancement of their own core competencies and depend on complimentary competencies that can be garnered from the involvement of their suppliers in product development (Handfield and Nichols, 2002). Two basic forms of supplier involvement in product development are the gray-box and black-box approaches (Petersen et al., 2005). With a gray-box approach the supplier and the customer work along side each other. The supplier provides expertise, suggestions and other input towards the product development effort but typically will not assume sole responsibility for developing parts, let alone modules for the final product. On the other hand, a black-box approach implies that each company would concentrate on certain tasks and components. The supplier can be “trusted” to develop parts, components, or subassemblies. Trusting a supplier is often problematic not only from an ethical or legal perspective, but also from a competency viewpoint (Koufteros et al., 2005).

Integrating suppliers in product development involves significant risk, time, and financial resources from both parties and thus cannot be taken lightly. Firms would have an interest in collaborating with suppliers that do possess product development capabilities in order to capitalize on such supplier competencies and avoid the inherent risks associated with partnering with incapable suppliers. The suppliers in turn would need some assurances that there will be a continuation of the relationship and enough business to make it worthwhile. Such assurances can be presented through a customer’s supply base rationalization practice (Handfield and Nichols, 2002). Supply base rationalization is characterized by a significant reduction in the number of suppliers in the supplier base. This can be an incentive for suppliers to engage in product development activities as they could potentially enjoy higher sales volume amongst other opportunities (Shin et al., 2000). Supply base rationalization also enables more effective management of supplier relationships (Tully, 1995). The continuation, and perhaps an expansion, of the relationship between partners are perhaps predicated on

the cooperative relationship orientation between the customer and the supplier (Tan, 2001).

Fliess and Becker (2006) provide a chronology of the literature on co-development processes. This dates back to Clark (1989) and Clark and Fujimoto (1991), where they compared different product development practices in Japan, Europe, and the U.S. Since then, at least 33 other studies have been published in reputable scholarly journals. While there is a significant body of literature that discusses co-development processes, this manuscript contributes to the literature in unique ways. First, it provides an extensive theoretical treatise supporting the posited relationships between the constructs considered. This is based primarily on the social network perspective (SNP) (e.g., Gulati, 1995, 1998; Gulati and Gargiulo, 1999; Khanna et al., 1994, 1998). The key premise of SNP is that a firm embeds itself in a network to create access to knowledge and other capital that can be mobilized to increase returns for the firm and other network actors (Inkpen and Tsang, 2005). Second, supplier mobilization through integration in product development efforts has been operationalized here through two different constructs, namely gray-box and black-box integration. Prior large-scale empirical research has not made an explicit distinction between these two constructs. A rare exception is Petersen et al. (2005), but they conceptualized gray-box and black-box integration as a dichotomy and as an environmental variable. Subsequently, they modeled the level of supplier integration as a moderator variable. We model gray-box and black-box integration as decision variables (i.e., practices) with defined returns such as product innovation. Third, we develop a nomological network of constructs, i.e., we include antecedents and consequences of supplier integration in product development. Fourth, we examine whether firm size may moderate the relationships between the constructs under study. The examination of firm size as a potential moderator merits investigation. Many of the widely advocated supply chain management practices are based on their successful adoption by relatively large firms. The applicability and feasibility of such practices for small firms are yet to be determined. Finally, we employ a structural equation modeling approach to test the moderating effects. We test for measurement and structural model invariance through multi-group analysis. Multi-group analysis conducted through sequential measurement and structural model invariance tests can identify whether any significant moderated effects can be truly attributed to structural coefficient differences and they are not solely measurement model differences (Koufteros and Marcoulides, 2006).

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