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Collaboration in Multi-Partner R&D Projects: The Impact of Partnering Scale and Scope

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ABSTRACT

How can firms design collaboration structures for effective performance in R&D projects that involve multiple partners? To address this question, we examine the theoretical underpinnings of collaboration structures in multi-partner R&D projects—i.e., the scale and the scope of partnering efforts. Partnering scale captures the extent of resource interdependencies between a firm and its partners; partnering scope captures both the breadth and depth of the interdependencies between a firm and its partners. Using primary data from 147 multi-partner R&D projects, we develop and test hypotheses that examine the impact of partnering scale and scope decisions on partnering performance. Results indicate that partnering scale has a curvilinear relationship with partnering performance. That is, intermediate levels of partnering scale are associated with higher partnering performance, compared to low or high levels of partnering scale. However, we also find that the nature of this relationship is moderated by the sub-dimensions of partnering scope. Specifically, increase in partnering breadth appears to magnify the negative effect of partnering scale on performance. In contrast, increase in partnering depth appears to overcome this negative effect, allowing firms to operate at higher levels of partnering scale. Taken together, these results highlight the importance of adopting a comprehensive approach to designing collaboration structures for multi-partner R&D projects.

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1. Introduction

In recent years, growing competitive pressures coupled with shorter product life-cycles and advances in communication technologies have motivated firms as diverse as IBM, 3M, Boeing, General Motors and Frito-Lay to involve multiple external partners in R&D projects (Heidl and Phelps, 2010; Amaral et al., 2011; Anderson and Parker, 2013). We define a multi-partner R&D project as *a voluntary association between a firm and multiple partners to conduct a variety of interdependent project activities.* Using multiple partners in R&D projects offer several potential benefits to firms. In addition to supplementing in-house technical capabilities and providing access to advanced technical expertise, partners can help firms lower their development costs and accelerate development efforts (Doz and Hamel, 1998). However, the actual benefits from these efforts have often been lower than anticipated (Sampson, 2007).

Consider, for example, the Boeing 787 Dreamliner project, which relied heavily on collaboration with more than 100 external partners to design and develop major subassemblies such as the vertical stabilizers, nose section and fuselages (Kotha and Srikanth, 2013; Lunsford, 2007). This project required Boeing to coordinate complex design and intellectual property information with multiple external partners during several critical phases of product development (Tang et al., 2009). A recent post-mortem of the 787 Dreamliner project attributes its failures to the numerous coordination challenges that occurred when managing external partners (Rushe, 2013). Similar challenges have been highlighted in media reports on other multi-partner R&D projects—see, for example, a discussion of Airbus (Michaels, 2012), Intel (Collins and Hansen, 2011) and General Motors (Krisher, 2013).

While prior research on R&D management has acknowledged the benefits and challenges associated with partnering (e.g., Clark and Fujimoto, 1991; Eisenhardt and Tabrizi, 1995; McGinnis and Vallopra, 1999), much of this research has examined collaboration in single-partner R&D projects that differ considerably from

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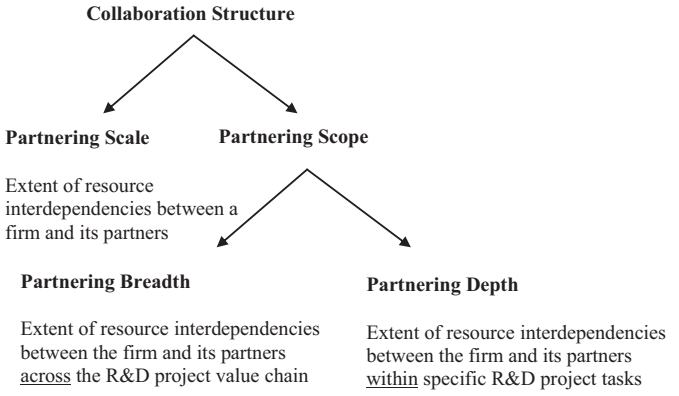

Figure 1. Dimensions of Collaboration Structure for Multi-partner R&D Projects.

multi-partner R&D projects. For instance, unlike single-partner R&D projects, multi-partner R&D projects often involve team members from several different organizations, each with their own project management processes (e.g., decision making and communication processes, project management styles) (Garcia-Canal et al., 2003; Li et al., 2012). Coordinating design and development efforts in such projects requires consistency in the project management processes across all partnering organizations (Dietrich et al., 2010). Furthermore, involving multiple partners in an R&D project often increases the external team size (Hoegl et al., 2004; Kratzer et al., 2008). This, in turn, can increase the number of project tasks that have to be synchronized, thereby escalating the coordination burden and taking the focus away from actual problem-solving (Ahuja, 2000). Finally, multi-partner R&D projects require firms to manage the tensions between increased access to a "*variety of resources and capabilities*" (Zeng and Chen, 2003, p. 1194) from different partners and the increase in "*managerial complexity and coordination costs*." Unfortunately, our current knowledge from studying single-partner R&D projects sheds little light on these issues (Rochemont, 2010; Wu et al., 2010).

Our study addresses this gap by investigating the following research question: *How can firms design collaboration structures for effective performance in R&D projects that involve multiple partners?* We begin by examining the theoretical underpinnings of collaboration structures in multi-partner R&D projects. As shown in Figure 1, we focus on two underlying dimensions—the scale and scope of partnering efforts. *Partnering scale* captures the extent of the resource interdependencies between a firm and its partners and is an important indicator of the overall collaborative effort required in a project (Hoegl and Wagner, 2005). These resource interdependencies are driven both by the number of partners (i.e., the number of external linkages) as well as the resources associated with partnering (i.e., the size of the external partner team and the extent of the budget allocated to partnering). *Partnering scope* comprises of two underlying sub-dimensions: *partnering breadth*—which captures the extent of the interdependencies between a firm and its partners across the R&D project value chain (Oxley and Sampson, 2004; Li et al., 2012), and *partnering depth*—which captures the extent of the interdependencies between a firm and its partners within specific R&D tasks in this value chain (Khanna et al., 1998; Reuer et al., 2002).

Next, we develop hypotheses that explore the performance implications of the interplay between partnering scale and scope. We measure *partnering performance* as the extent to which the use of partners affects the market success of the resulting product through increased revenue generation (Swink and Song, 2007). The hypotheses are tested using primary data from 147 multi-partner R&D projects. Results indicate that partnering scale has a curvilinear relationship with partnering performance; i.e., intermediate levels of partnering scale are associated with higher returns on partnering performance, compared to low or high levels of partnering scale. However, we also show that the nature of this relationship is moderated by the partnering scope sub-dimensions. Specifically, increasing partnering *breadth* appears to magnify the negative effect of partnering scale on performance. In contrast, increasing partnering *depth* appears to overcome this negative effect, allowing firms to operate at higher levels of partnering scale. Taken together, our results highlight the importance of adopting a more comprehensive approach to the design of collaboration structures in multi-partner R&D projects.

2. Prior Literature

The use of partners in R&D projects and the challenges associated with managing partners has been a topic of considerable interest in the R&D management literature (e.g., Clark and Fujimoto, 1991; Eisenhardt and Tabrizi, 1995; Swink, 2006). In this section, we review studies on the scale and scope of collaboration efforts in R&D projects, identify and summarize the gaps in this literature, and discuss how our study attempts to address these gaps.[2]

In terms of partnering scale, majority of research has investigated collaboration structures between a firm and a single partner (i.e., a dyad) at the project-level of analysis (Peng et al., 2013). Such a focus does not address the unique coordination challenges associated with the use of multiple partners, as described earlier. The few studies that focus on multiple partners (e.g., Li et al., 2012) measure partnering scale as a uni-dimensional construct represented by the number of partners. Such a measure fails to capture the heterogeneity in resource interdependencies between a firm and its partners. For example, consider two multi-partner R&D projects, each involving the same number of external partners. The nature of the resource interdependencies in these projects might differ significantly based on the budgets allocated to partnering as well as the size of the external partner teams. The greater the partnering budget, the more significant partners' contributions are likely to be (Hoegl and Wagner, 2005). Similarly, the greater the partnering team size, the greater the number of individual tasks that must be coordinated (Kratzer et al., 2008). Capturing these differences requires a multi-dimensional conceptualization and measurement of partnering scale that is missing from the literature.

In terms of partnering scope, prior literature has widely acknowledged the scope of firm-partner collaboration as an important driver of project outcomes, conceptualizing it in terms of the "timing" of partner involvement in the product development process—i.e., when and to what extent are partners involved in different product development activities (e.g., Clark and Fujimoto, 1991; McGinnis and Vallopra, 1999; Swink, 2006). Findings from these studies suggest that early partner involvement in the product development process enables them to identify and correct unrealistic requirements and conflicting specifications (Gerwin and Barrowman, 2002; Ulrich and Eppinger, 2011), and ensures consistency of effort during the process (Mishra and Shah, 2009). In addition, early partner involvement has been shown to improve product performance through enhanced design for manufacturability (Wasti and Liker, 1997), reduced number of defects and rework (Swink, 2006), and reduced development times (Clark and

[2] We recognize an emerging research in the strategy literature that examines the firm-level challenges associated with involving multiple partners (e.g., Garcia-Canal et al., 2003; Heidl and Phelps, 2010; Li et al., 2012). While empirical analysis at this level is of interest to scholars and practitioners, it is theoretically distant from the project-level where R&D tasks are carried out (Gerwin and Ferris, 2004). As such, we know little about how collaboration structures are developed at the project-level and how these structures interact to influence partnering outcomes.