J. Eng. Technol. Manage. 39 (2016) 13–25

Contents lists available at ScienceDirect

Journal of Engineering and Technology Management

journal homepage: www.elsevier.com/locate/jengtecman

Managing uncertainty and equivocality in joint process development projects

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ARTICLE INFO

Article history:
Received 26 August 2014
Received in revised form 21 December 2015
Accepted 26 December 2015
Available online 6 January 2016

ABSTRACT

Process development is key to competitiveness in process industries. However, budget overruns frequently plague process development projects which span organizational boundaries to involve both buyers and suppliers. We identify uncertainty and equivocality as key antecedents causing such negative effects, and investigate the reduction and performance implications of these two variables. An empirical survey of 52 joint process development projects show that project teams reduce uncertainty through early end-user involvement, whereas equivocality can be reduced by joint problem-solving activities among buyers and suppliers.

1. Introduction

Process development is regarded as a key for competitiveness in process industries and in other manufacturing industries, because it increases production yields, cuts costs, and allows firms to contend with competition (Aylen, 2013; Pisano, 1997; Robertson et al., 2009; van Rooij, 2005). Process development involves developing and implementing new or significantly improved process technology and machinery equipment (OECD, 2005). Process development projects are typically large, in terms of both time and money, entailing significant management challenges (Scott-Young and Samson, 2008). Indeed, a recent study by Ernst and Young (2011) found that process development projects within the metals and minerals industries (the industry on which the present study focuses) are commonly plagued by budget overruns of 70% or more. Consequently, developing and implementing new process technology is a necessary but risky endeavor that may seriously endanger long-term competitive advantages and the financial viability of firms if not managed proficiently (Filippou and King, 2011).

Adding to the management challenge, process firms often lack the internal resources and competences to design new process equipment on their own (Aylen, 2010; Arora and Gambardella, 1997; Reichstein and Salter, 2006), which necessitates collaborating with equipment suppliers and pooling resources in joint projects (Hutcheson et al., 1996; Robertson et al., 2012). Therefore, large-scale process development is often more open and collaborative than product development and brings about challenges in coordinating a multitude of development activities across organizational boundaries (Robertson et al., 2012).

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http://dx.doi.org/10.1016/j.jengtecman.2015.12.001
0923-4748/

Collaboration among buyers from process firms and the suppliers of process equipment is vital in joint process development. Indeed, prior research has shown that joint projects of this type often fail when buyers and suppliers lack a shared basis to understand each other (Rönnberg Sjödin, 2013; van Rooij, 2005). Design and development in the context of joint development projects require a significant amount of information to be gathered, processed, and shared by the buyers and suppliers of the project team to facilitate development work and manage idiosyncratic design requirements. In doing so, buyers and suppliers must address the challenges of both uncertainty and equivocality in the early stages of development (Daft and Lengel, 1986; Galbraith, 1973).

Uncertainty is defined as the difference between the information available and the information needed to complete a task (Galbraith, 1973). Equivocality, on the other hand, is defined as the extent to which multiple and conflicting interpretations of information exist among participants in a project (Daft and Lengel, 1986). Equivocality may be particularly challenging when actors have different backgrounds, roles, and cultures, which is often the case in joint projects. In equivocal situations, individual interpretations of information are unambiguous, but collectively the interpretations differ (Zack, 2001). A lack of information or shared interpretations during the early stages of development can lead to significant problems in joint process development projects. For example, too much uncertainty and equivocality can lead to difficulties in creating explicit, stable, and robust process designs, causing time delays and wasting resources (Sicotte and Langley, 2000; Song et al., 2007).

From a management perspective, the differences between uncertainty and equivocality are critical, because they require different information processing approaches (Chang and Tien, 2006; Daft and Lengel, 1986). Reducing uncertainty is achieved primarily through information gathering and analysis that, if successful, significantly increases the chances of a fruitful project (Ullman, 2010). Consequently, in process development, the joint project team must gather and share information and conduct work analyses to answer questions related to equipment specifications, the design of process flowcharts, and the broader manufacturing environment (Schuman and Brent, 2005). Somewhat paradoxically, in an equivocal situation, new information can actually increase, rather than decrease, equivocality (Weick, 1995), which underscores the importance of distinguishing between uncertainty and equivocality. In contrast, reducing equivocality presupposes the exchange of subjective views among project participants to define problems and resolve conflicting interpretations by explaining different viewpoints and enacting a shared interpretation that can direct future activities (Daft and Lengel, 1986; Weick, 1979).

For several reasons, prior research in innovation-, technology-, and operations management does not provide detailed advice regarding how to reduce uncertainty and equivocality in joint process development projects (Koufteros et al., 2005; Stock and Tatikonda, 2008). First, most prior studies are qualitative with limited generalizability (e.g., Bruch and Bellgran, 2012; Frishammar et al., 2011; Song et al., 2007) or not focused primarily on activities for mitigating uncertainty or equivocality (Chang, 2002; Frishammar et al., 2012; Koufteros et al., 2005).

Second, prior research has been conducted primarily in the context of product development, rather than process development (Gales and Mansour-Cole, 1995; Koufteros et al., 2005; Sicotte and Langley, 2000; Song et al., 2007). Although findings from the product development literature may provide valuable insights for process development (Kurkkio et al., 2011), the effectiveness of different activities may vary according to the characteristics of the development work. In addition, due to industrial firms' heavy investment into process technology and its importance for each firm's competitive advantage (Robertson et al., 2012), the context of process development deserves attention in its own right. We thus lack knowledge on managing uncertainty and equivocality in joint process development projects.

In light of these managerial challenges and theoretical gaps, we seek to contribute to the literature and management practice in two ways. First, we seek to study the performance effects of both uncertainty and equivocality in joint process development projects. Second, we identify two key collaborative information processing activities—early end-user involvement and joint problem solving—which help reduce uncertainty and equivocality. In doing so, we draw on a mixed-methods study of joint process development projects. After a qualitative pre-study, we rely on data from a multiwave, multiple-informant survey, including 251 responses from 52 joint process development projects involving both buyers and suppliers. The next section outlines the conceptual framework that guided the empirical study.

2. Conceptual framework

2.1. Addressing information gaps in joint process development projects

The traditional view of process development with equipment suppliers is primarily a unidirectional process of technology transfer (i.e., technology imports by the buyer side) (Lager and Frishammar, 2010). In contrast, joint process development is an integrative process requiring significant interactions among firms with input from a variety of members with different backgrounds (Abd Rahman et al., 2009; Rönnberg Sjödin et al., 2011; Robertson et al., 2012). The need for interaction and iterations emphasizes the processing of relevant information among the involved parties (Koufteros et al., 2002; Stock and Tatikonda, 2008; Swink et al., 2007).

According to information processing theory, organizational information processing must be matched with the specific task at hand (Galbraith, 1973; Tushman and Nadler, 1978). Central to this perspective is the idea that organizations should reduce potential information gaps in the form of uncertainty and equivocality arising from the context (Daft and Lengel, 1986; Galbraith, 1973). Specifically, research in a variety of settings supports the contention that, to be effective, work units