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Organizing innovation projects under technological turbulence

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ABSTRACT

Research on the organization of innovation projects suggests that increased project flexibility is a common reaction to high levels of technological turbulence. However, existing definitions of project flexibility are inconsistent and sometimes unclear, and empirical evidence is limited. This article makes an important distinction between flexible project planning and flexible project specifications. A negative relationship is found between flexible project planning and innovation project performance, whereas flexible product specifications are found to contribute positively.

This article also examines how technological turbulence contributes to the choice of flexible or inflexible strategies. Technological turbulence can be present in the external environment or can be internal to the firm, when radically new products are developed. The findings suggest that when businesses perceive technological turbulence in the environment they are more likely to adopt flexible approaches to innovation in an attempt to adapt to external pressures. In technologically innovative projects, product specifications are likely to remain fixed while project organization is likely to be adapted to the needs of the project.

Taken together, the findings suggest that innovation projects should maintain stable organization, schedules and budgets, but stay flexible about product specifications. Vigilance with regards to external and internal conditions of technological turbulence, which may lead organizations to be more flexible in terms of project planning, is needed.

1. Introduction

Environmental dynamics need to be taken into account in the management of innovation (Drejer, 2002), particularly turbulence (Fernández et al., 2010; Lee and Wong, 2011). Project flexibility has been proposed as a means to cope with high levels of turbulence (Eisenhardt and Tabrizi, 1995; MacCormack et al., 2001; Garud et al., 2008; Levardy and Browning, 2009; Moorman and Miner, 1998; Lenfle and Loch, 2010). However, definitions and operationalizations of project flexibility are varied and sometimes unclear. Research arguing for flexible approaches mostly falls broadly into two camps with regard to what is meant by flexibility. On one hand, there is *flexible project planning*, which may include overlapping development phases (Iansiti and MacCormack, 1997), improvisation (Moorman and Miner, 1998), short milestones (Eisenhardt and Tabrizi, 1995), cross-functional teams (Buganza et al., 2009), flexible use of resources (Li et al., 2010) and adaptive processes (Levardy and Browning, 2009). On the other hand, there are *flexible project specifications*, which can entail practices such as trial-and-error iteration or prototyping (Eisenhardt and Tabrizi, 1995; Souder et al., 1998; Buganza et al., 2009; Lenfle and Loch, 2010) and postponed concept freeze (Iansiti and MacCormack, 1997; Buganza et al., 2009). There is also research that defines project flexibility in terms both of practices relating to project planning and to product specifications (e.g. MacCormack et al., 2001; Eisenhardt and Tabrizi, 1995; Buganza et al., 2009). Because of these different and sometimes overlapping conceptualizations of project flexibility, it can be difficult to gain a holistic understanding of performance implications.

Although the theme of technological turbulence is widely included in research on flexible project organization, the source of the turbulence that might contribute to—or call for—the adoption of flexible strategies can differ. Existing literature has focused on technological turbulence resulting from the external environment (e.g. Buganza et al., 2009; Moorman and Miner, 1998) or the turbulence resulting from the decision to pursue innovation projects with a high degree of technological novelty (e.g. Tatikonda and Montoya-Weiss, 2001; Eisenhardt and Tabrizi, 1995). Even though existing research suggests that project flexibility is more common under conditions of technological turbulence (Buganza et al., 2009; Moorman and Miner, 1998), it is not clear to what extent this applies for turbulence caused by the external environment or by turbulence caused by the type of innovation project at hand.

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This paper makes an important contribution to research on the organization of innovation projects by distinguishing explicitly between two types of flexibility: *flexible project planning* and *flexible product specifications.* As discussed above, both have been included in existing definitions of flexibility, but we posit that they are conceptually different, will be chosen under different conditions and have different effects on performance. Flexible project planning refers to flexibility in project organization, scheduling and budget, whereas flexible product specifications refer to flexibility in the definition of the product to be developed. The reason for making this distinction is the expectation that planning and specifications address different aspects of project organization, with potentially different performance effects.

Not only technological turbulence existing in the environment but also the newness of technology to be developed has been identified as an important source of uncertainty in product development (Tatikonda and Montoya-Weiss, 2001). Therefore, we also make an important distinction between *external technological turbulence* present in a firm's environment and *internal technological turbulence* due to technological innovation. We examine how both types of technological turbulence contribute to the choice of both types of flexibility. In addition to technology turbulence, uncertainty may also be caused by market turbulence (Calantone et al., 2003). However, our focus is on technological turbulence rather than market turbulence since the implications of technological turbulence for innovation project organization have been found to be more important than market turbulence (Sethi and Iqbal, 2008).

Our findings suggest that when businesses perceive technological turbulence in the environment they are likely to attempt to adapt to these external pressures by adopting more flexible project planning and more flexible project specifications. Conversely, a high degree of technological innovativeness, which is likely to result in internal technological turbulence, is found to contribute negatively to flexible product specifications. Like external technological turbulence, technological innovativeness contributes positively to flexible project planning. This suggests that in technologically radical innovation projects, product specifications are likely to remain fixed while project organization is likely to be adapted to the needs of the project.

Furthermore, our findings suggest that flexible project planning contributes negatively to project performance, whereas flexible product specifications have a positive effect. A possible explanation is that flexible product specifications can facilitate the adaptation of a new product to market conditions whereas flexible project planning may lead to schedule delays and budget overruns, which in turn may lead to higher prices, later-than-competitor market introduction, and thus to lower project performance.

Together these findings suggest important practitioner implications. Practitioners organizing innovation projects should take care to distinguish between the different types of flexibility, and give their teams clear timing and budget targets, but stay flexible about product specifications. They should be especially vigilant about external and internal conditions of technological turbulence that may sway their strategy to be more flexible in terms of project planning, with potentially detrimental effects on project performance.

2. Background and hypothesis development

Methods for organizing innovation projects (also commonly referred to as new product development projects) espoused by the existing literature fall into three categories: sequential methods (Cooper, 2011), parallel or concurrent methods (Wheelwright and Clark, 1992) and flexible methods (Eisenhardt and Tabrizi, 1995; MacCormack et al., 2001).

Sequential approaches divide product development into a set of tasks undertaken one after another, resulting in projects that are easy to track and manage. A well-known and popular sequential approach to innovation is the stage gate model (Cooper, 1994, 2009). However, despite claims about the flexibility of sequential models (Cooper, 2009), in practice they tend to suffer from detrimental rigidity, particularly under conditions of technological turbulence (Sethi and Iqbal, 2008; Iansiti and MacCormack, 1997; Lenfle and Loch, 2010; Bhattacharya et al., 1998).

The parallel model of product development, also referred to as concurrent engineering, is characterized by overlapping phases. The essence of this model is that downstream activities, such as the development of a manufacturing unit or marketing plan, are started during earlier stages, particularly during the design stage (Wheelwright and Clark, 1992; Krishnan et al., 1997). Advantages attributed to the parallel model are improved communication between functional activities (Wheelwright and Clark, 1992), which in the end can save time and costs, while enhancing quality. However, existing research has been inconclusive with regards to the effectiveness of concurrent engineering (Tatikonda and Montoya-Weiss, 2001; Iansiti, 1995).

A third category of innovation organization strategies, and the one on which this paper focuses, is a flexible approach. Eisenhardt and Tabrizi (1995) compare a relatively inflexible parallel approach (compression model) with a flexible approach (experiential model) and argue that the parallel approach is more suitable for stable circumstances and the flexible one for dynamic environments. Subsequent research has suggested that a flexible project approach is particularly effective in turbulent contexts (e.g., MacCormack et al., 2001; Moorman and Miner, 1998).

However, although the work of Eisenhardt and Tabrizi (1995) has been highly cited, it has not resulted in a clear definition of what a flexible approach involves. Eisenhardt and Tabrizi (1995) define flexibility as an approach to cope with uncertainty in shifting markets and technologies and operationalize it in terms of multiple design iterations, extensive testing, frequent milestones to assess project progress, and powerful project leadership. Using what they refer to as the 'high-velocity' computer industry as their empirical setting, Eisenhardt and Tabrizi (1995) find that adoption of these tactics can substantially shorten product development times. MacCormack et al. (2001) propose a definition of flexibility that includes overlapping phases, team adaptability, delay of concept freeze and regular testing. They position their research in the Internet software development industry, which they posit is an industry characterized by high levels of uncertainty and technological turbulence. They find that a more flexible development process is associated with better performing projects in terms of product quality. Buganza et al. (2009) operationalize flexibility in terms of rapid iterations, delay of concept freeze, early experiments involving customers, as well as cross-functional teams and a flat organizational structure. According to Buganza et al. (2009) particularly the last two of these strategies support accelerated project iterations and thus support practices that result in flexible product specifications. Buganza et al. (2009) do not assess performance implications of these strategies, but based on case study data they find that firms tend to adopt delay of concept freeze and rapid project iterations—but not the other strategies identified—when there is a high level of technological turbulence.

Based on a case study of the management of an innovative project in the defense industry (the 'Manhattan Project'), Lenfle and Loch (2010) draw lessons about the need for trial-and-error iterations and prototyping—rather than phased, sequential project organization—to come up with an effective solution that may not have been envisioned at the outset. In contrast with the

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