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Managing complex projects in the infrastructure sector — A structural equation model for flexibility-focused project management

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Abstract

Complex construction projects in the infrastructure sector are often beset with delays, which cause benefit shortfalls and increased costs. Prior project management literature and practice have mostly adopted a traditional control-focused approach, but recent research suggests that complex projects need more flexible practices to manage inevitable project change. Thus, the objectives of this study were to develop and empirically test a model for flexibility-focused project management practices to improve time performance in complex projects in the infrastructure sector. Based on empirical data from 138 construction projects procured and managed by the Swedish Transport Administration, the structural equation model shows that complexity and collaboration drive explorative learning, which improves adaptation and thereby improves time performance. Hence, the empirical test verifies that flexibility-focused project management practices based on collaboration, explorative learning, and adaptation enhance time performance in complex projects in the infrastructure sector.

Keywords: Complex projects; Collaboration; Explorative learning; Adaptation; Project performance; Infrastructure sector

1. Introduction

The socio-economic importance of well-managed infrastructure investments in modern societies is well understood and can hardly be overstated (OECD, 2011; WEF, 2012). However, many studies have shown that infrastructure investments in complex construction projects are often plagued by cost and time overruns (Cantarelli et al., 2012; Flyvbjerg et al., 2009; Han et al., 2009). Time is an especially critical performance indicator in this context (de Araújo et al., 2017) because, as noted by Flyvbjerg (2014: p. 11) "*delays are a critical problem for complex projects as they cause both cost overruns and benefit shortfalls*". Delays will increase both fixed costs (due to extended needs for equipment, site huts, and cranes) and variable costs, due to increased and prolonged needs for human resources (i.e., managers and site workers). In addition, project delays will postpone use of the infrastructure, thereby reducing societal benefits from travel and transport. Thus, to promote timely delivery and value for money for taxpayers and society as a whole, it is crucial to ensure that construction projects in the infrastructure sector are managed strategically and efficiently (WEF, 2012).

For these reasons, numerous studies have investigated causes of time overruns in construction projects. Many have found that project change is one of the commonest causes of delays (e.g., Assaf and Al-Hejji, 2006; Han et al., 2009). Many studies have also specifically focused on how project change impairs project performance in relation to pre-determined objectives (e.g., Dvir and Lechler, 2004; Sun and Meng, 2009). Changes have problematic effects, partly because they exacerbate the increases in costs and delays in benefits mentioned above, and partly because of the political importance of setting optimistic pre-determined objectives to increase prospects for public

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investments in infrastructure (Flyvbjerg et al., 2009). Due to their high costs, long durations, and strategic importance, infrastructure investments are often controversial and highly prominent. Thus, it is important to decrease risks for overspending and wasting tax money when commissioning such investments. So, decision-makers are under strong pressure to set rigorous project cost and timeframe objectives, and continuously monitor adherence to them during project execution. Hence, public infrastructure investments are executed within a control-focused project management paradigm, aiming to minimize change and meet pre-determined objectives. Accordingly, many studies have advocated control-focused project management practices, such as strict planning and monitoring of change orders to reduce change and improve performance (Doloi et al., 2011; Giezen, 2012; Menches et al., 2008).

However, changes are inevitable in construction projects, due to unexpected weather and ground conditions, poor design solutions and incomplete drawings, as well as changes in scope and client requirements during long projects (Eriksson et al., 2017; Sun and Meng, 2009). In addition, many project changes are derived from, or exacerbated by, complexity. The more complex a project is, the more chances there are of changes occurring that necessitate adaptive work (Bröchner and Badenfelt, 2011; Nightingale, 2000). Since many construction projects in the infrastructure sector are very large and complex they can be considered as megaprojects (Flyvbjerg, 2014; Han et al., 2009; Whyte et al., 2016) and/or complex product systems (CoPS) (Gil et al., 2012; Hobday, 1998; Nightingale, 2000). Moreover, recent studies on megaprojects indicate that the size of construction projects in the infrastructure sector is continuously increasing, so this type of complex project is becoming increasingly common, despite their performance problems (Flyvbjerg, 2014; Hu et al., 2015). Accordingly, it is essential to improve our understanding of ways to manage these projects more efficiently (Flyvbjerg, 2014).

Prior CoPS literature highlights that in complex projects many tasks and procedures are extremely complicated and non-routine, thus they require a different project management approach based on flexibility, collaboration, adaptation, and exploration of new knowledge and technologies (Geraldi, 2009; Hobday, 1998, 2000). This approach and the traditional project management paradigm can be related to the framework of mechanistic and organic management proposed by Burns and Stalker (1961). These can be respectively classified as focused on *control* vs. *flexibility* (Geraldi, 2009; Lenfle and Loch, 2010; Szentes and Eriksson, 2016) or *hard* vs. *soft* project management (Crawford and Pollack, 2004; Karrbom Gustavsson and Hallin, 2014; Pollack, 2007). However, these two approaches should not be strictly dichotomized, as they may be mixed or combined in practice (Geraldi, 2009; Karrbom Gustavsson and Hallin, 2014; Koppenjan et al., 2011). An important notion is that projects with different characteristics need different types of project management practices (Larsson et al., 2014). Notably, traditional project management practices focusing on control are more suitable for relatively simple and straightforward projects, whereas complex projects need new types of project management practices, promoting flexible management of change by teams rather than *ex ante* planning and control by a project manager (Gransberg et al., 2013; Koppenjan et al., 2011; Williams, 2005).

Our point of departure in this paper is the recognition that public infrastructure investments are generally decided and executed within a control-focused project management paradigm, due to the need for tight pre-determined objectives (Crawford and Pollack, 2004; Karrbom Gustavsson and Hallin, 2014) at the political level. However, change is inevitable in complex construction projects, so there is a need for more flexibility-focused practices at the project management level. Accordingly, we need to improve our understanding of ways to adopt flexibility-focused project management practices to manage change and improve performance of complex projects undertaken within a control-focused paradigm. The objectives of this study were therefore to develop and empirically test a model for flexibility-focused project management practices to improve time performance in complex projects in the infrastructure sector. It is based on empirical data collected through a questionnaire survey regarding 138 construction projects procured and managed by the Swedish Transport Administration (STA).

2. Theoretical model and hypotheses

2.1. Overall presentation and illustration of the developed model

Many scholars have noted that the traditional project management paradigm mainly involves control-focused practices based on extensive planning, monitoring, and exploitation of existing knowledge and experience to minimize uncertainty and complexity (e.g., Karrbom Gustavsson and Hallin, 2014; Pollack, 2007). This control-focused project management approach has been widely studied and many prior analyses of construction projects have shown that it is often successful (e.g., Doloi et al., 2011; Giezen, 2012; Menches et al., 2008). However, as complexity increases, the project manager's ability to control all aspects of the project decreases (Gransberg et al., 2013). Due to the performance problems in many complex projects, recent research on megaprojects and CoPS-projects in the infrastructure sector indicates a need to adopt a more flexible project management approach to embrace and manage changes instead of avoiding them (Geraldi, 2009; Koppenjan et al., 2011; Williams, 2005). However, in contrast to the control-focused approach, the flexibility-focused project management approach has not been sufficiently tested empirically.

In this section, we present and discuss the theoretical model (see Fig. 1) for flexibility-focused project management we have developed and empirically tested. Prior qualitative and conceptual studies suggest that a flexibility-focused management approach is based on three central practices: *collaboration* among key project actors and stakeholders (Koppenjan et al., 2011; Senaratne and Sexton, 2009), *explorative learning* focused on identifying and testing new technical solutions and work processes (Hobday, 1998, 2000; Lenfle and Loch, 2010; Perminova et al., 2008), and *adaptation* of solutions and processes to fit changes in scope and content due to unexpected and/or changed circumstances (Ibbs, 1997; Karrbom Gustavsson and Hallin, 2014; Wu et al., 2005).