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The role of experience in six sigma project success: An empirical analysis of improvement projects

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ABSTRACT

Recent learning-by-doing research highlights the importance of examining multiple measures of experience and their relationship to the performance of work teams. Our paper studies the role of individual experience, organizational experience, team leader experience, and experience working together on a team (team familiarity) in the context of improvement teams. To do so, we analyze successful and failed six sigma improvement team projects at a Fortune 500 consumer products manufacturer with multiple business groups. Such improvement project teams focus on deliberate learning, which differs from the primary focus of work teams.

Our analysis uses archival data generated by these improvement project teams over a six year time span. Of the four experience variables we study, we find that team leader experience exhibits the strongest relationship with project success, followed by organizational experience. Further, in contrast to prior-related research on work teams, we find no relationship between individual experience or team familiarity and project success beyond that explained by team leader and organizational experience. These results suggest that a well-developed and deployed structured problem-solving process—characteristic of effective six sigma deployments—may reduce the importance of team familiarity in the context of improvement teams.

1. Introduction

Substantial empirical evidence relates experience and improvement over time (i.e., learning-by-doing) across a wide variety of business contexts (see, e.g. Adler, 1990; Adler and Clark, 1991; Argote et al., 1990; Darr et al., 1995; Hatch and Mowery, 1998; Ittner et al., 2001; Lapre et al., 2000; Lapre and van Wassenhove, 2001; Thompson, 2010; Upton and Kim, 1998). The majority of such studies quantify experience in a unidimensional fashion, using measures such as cumulative production volume, prior completed projects, etc.

An emerging stream of empirical research within the learning-by-doing literature suggests that a more fine-grained, multi-dimensional view of experience is warranted in the context of teams (Huckman and Pisano, 2006; Huckman et al., 2009; Pisano et al., 2001; Reagans et al., 2005; Shafer et al., 2001). That is, one that explicitly teases out the unique effects of individual, organizational, role, and team experience on performance.

In this regard, Reagans et al. (2005) analyze surgical work teams to uncover the effect of experience with performing joint replacement surgeries on procedure completion time. The authors observe that individual experience, organizational experience, and experience working together on a team (hereafter team familiarity) each provide a distinct contribution to performance. In another services-based work team setting—software development—Huckman et al. (2009) find that both team familiarity and the role experience of individuals within a team (e.g., project manager) improve operational performance over time. Importantly, such studies have begun to shed much-needed light on various forms of learning-by-doing and their contributions to operational improvements in the context of work teams (Argote and Miron-Spektor, 2011; Lapre and Nembhard, 2011).

However, it is unclear the extent to which these results are generalizable to other settings, such as in manufacturing or in the context of quality improvement project teams. The nature of work in improvement teams differs from that in work teams, as the former explicitly involves deliberate or planned learning activities to create, acquire, and implement new knowledge (Adler and Clark, 1991; Lapre and Nembhard, 2011; Lapre and van Wassenhove, 2001; Lapre et al., 2000; Upton and Kim, 1998), while the primary responsibility of the latter is to produce goods and/or deliver services (Cohen and Bailey, 1997).

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With regards to the role of experience in quality improvement teams such as those common to six sigma systems, project team members utilize a structured problem-solving approach to drive learning and improvement. Effective use of this structured problem-solving approach and the supporting set of analysis tools clearly guides team activities, cultural norms, and strategies with respect to methods of hypothesis generation, analysis of data and information, etc. (Choo et al., 2007a; Linderman et al., 2006). As we discuss in the next section, this is likely to reduce the importance of team familiarity on project success relative to other types of experience.

Along these lines, team familiarity may not play as large of a role in predicting organizational learning outcomes in manufacturing settings, on average, as in the context of services (Huckman et al., 2009; Reagans et al., 2005). A common theme in the service operations strategy literature is that service-based businesses tend to include a larger degree of intangible elements relative to product-based businesses (Chase, 1978; Fitzsimmons and Fitzsimmons, 2008; Giffi et al., 1990; Rosenzweig et al., 2011; Sasser et al., 1978). The intangible nature of some services may not lend itself to a structured problem-solving process to the same degree as in product-based businesses, thereby potentially elevating the importance of team familiarity in service-based settings and diminishing it in manufacturing-based settings.

We examine issues such as these in this paper, and in the process, address recent calls by researchers for studies that investigate the effects of various types of experience on organizational learning outcomes in different empirical settings (see, e.g., Argote and Miron-Spektor, 2011; Huckman et al., 2009; Lapre and Nembhard, 2011; Reagans et al., 2005). Specifically, our study investigates the following research questions: What is the relationship between experience and improvement over time in the context of quality improvement projects, a deliberate learning activity? In particular, how do individual experience, organizational experience, team leader experience, and team familiarity contribute to performance in this context? Does one of these types of experience play a larger or smaller role in improving organizational learning outcomes than the others? That is, will team familiarity be a less important predictor of performance relative to the other three types of experience in a setting characterized by the effective use of a structured problem-solving approach?

To investigate these research questions, we analyze archival data from one hundred and fifty-nine improvement projects conducted over a six-year time period in multiple business groups of a Fortune 500 consumer products manufacturer that has successfully implemented six sigma extensively throughout their firm. Organizations characterized by widespread implementation of six sigma represent an ideal setting to examine our research questions.

Six sigma has been widely adopted by many Fortune 500 companies in the U.S. (Aberdeen Group, 2006). It is a management system that focuses on quality improvement, waste elimination, cost reduction, and increased customer satisfaction. Key characteristics of six sigma systems include a focus on processes as a fundamental building block of the organization, and the deployment of project teams using a structured problem-solving approach to drive knowledge gain and process improvement. The six sigma problem-solving framework, along with a supporting set of agreed-upon analysis tools, represents standard routines that are embedded in all activities of the improvement project teams, and are important mechanisms by which knowledge is created, acquired, and implemented (Argote and Miron-Spektor, 2011; Benner and Tushman, 2002, 2003; Choo et al., 2007a; Linderman et al., 2006; Upton and Kim, 1998). As such, deliberate team-based learning is a fundamental part of six sigma systems.

In large organizations, many improvement teams are created during the deployment of six sigma, and these teams, of course, produce varying levels of project success. In fact, in any large-scale six sigma deployment, project team failures are not uncommon. Accordingly, we utilize six sigma project success as the key organizational learning outcome in our analysis.

Using logistic regression analysis, we disentangle the unique effects of individual experience, organizational experience, team leader experience, and team familiarity on the likelihood of improvement project success over time. Our results indicate that team leader experience is the key factor associated with project success, followed by the level of organizational experience. We fail to find a relationship between individual experience or team familiarity and project success. Finally, as expected, our results suggest that team familiarity is the least important for project success in our research context.

2. Conceptual development

We begin this section with additional discussion of the six sigma system and our research site in order to provide background for our hypotheses. Building on this foundation, we develop hypotheses that relate individual experience, organizational experience, team leader experience, and team familiarity to the likelihood of six sigma project success.

2.1. The six sigma system

Technically speaking, the term "six sigma" captures the goal of improving processes by reducing customer-defined defect levels to below 3.4 defects per million opportunities. However, the six sigma system represents much more than that, as it involves the rigorous pursuit of learning, problem-solving, process improvement, and ultimately, better business performance. A recent field study by Schroeder et al., 2008 (540) illustrates this notion of six sigma as a system and proposes the following definition:

Six sigma is an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives. We provide a brief overview of the six sigma system below, using this definition to guide our discussion.

To begin, we note that by a "parallel-meso structure" Schroeder et al. (2008) mean that the six sigma management structures are (a) parallel to and outside of the typical organizational structure (Lawler, 1996); and that they (b) integrate multiple levels of seniority through the use of teams, improvement specialists (e.g., black belts, green belts, etc.), steering committees, champions, and other structures, roles, and methods.

In a six sigma system, improvement project teams are the primary vehicle for improving organizational performance. Thus, the organization's portfolio of improvement projects should align with the overall business strategy (Choo et al., 2007a; McAdam and Lafferty, 2004). These improvement projects are generally led and/or facilitated by black belts, who are extensively trained process improvement specialists. Green belts typically receive more basic six sigma training and generally serve as either project improvement team members or team leaders, often in conjunction with facilitation and support by black belts.

In a traditional six sigma system, the improvement activities of project teams follow the DMAIC (Define-Measure-Analyze-Improve-Control) structured problem-solving framework (Pyzdek and Keller, 2009). The DMAIC framework, together with supporting statistical (e.g., design of experiments) and non-statistical (e.g., flow charts) analysis tools, is key to learning and improvement in six sigma and thus to achieving project goals (Linderman et al., 2003, 2006; Zu et al., 2008).