



Role of explicit and tacit knowledge in Six Sigma projects: An empirical examination of differential project success

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ABSTRACT

This research develops a conceptual model for predicting success of process improvement projects as a result of knowledge-creation practices employed in the projects. The model is empirically examined in the context of Six Sigma black belt projects. New scales are developed to measure explicit- and tacit-knowledge-creation practices in process improvement. Data is gathered via a cross-sectional sample, and the hypotheses are tested using hierarchical regression. Our results support the notion that knowledge-creation practices influence the success of process improvement projects. Specifically, the inclusion of softer, people-oriented practices for capturing tacit knowledge explains a significant amount of variance in project success, as much as the more analytically focused practices that capture explicit knowledge. This research offers practical insights about the influence of practices that project managers use to create new knowledge by capturing explicit and tacit knowledge, and seeks to advance theoretical understanding of process improvement.

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1. Introduction

Knowledge management continues to generate practitioner and academic interest (Boone et al., 2008; Edmondson, 2008; Nonaka and von Krogh, 2009). One of the more influential knowledge-management theories is Nonaka's (1991) theory of knowledge creation. Since its inception, this theory has inspired a large body of research (e.g., Arikan, 2009; Cook and Brown, 1999; Spender, 1996). However, application of knowledge-creation theory to tasks carried out by ad-hoc project teams, such as discovering process improvements, though pertinent, has remained largely unexplored (Haas and Hansen, 2007). Moreover, in general, there is a dearth of research looking into differential success rates of process improvement projects, although investigations into success factors for new product development projects have been undertaken (e.g., Gerwin and Barrowman, 2002; Swink and Song, 2007; Tatikonda and Montoya-Weiss, 2001). Thus, this research examines the effectiveness of knowledge-creation practices for success of process improvement projects.

The empirical context of process improvement projects involves some characteristics that warrant a unique perspective

to applying knowledge-creation theory to the topic. Process improvement teams are ad-hoc teams put together for the duration of their projects and disbanded after completion of such projects. Typically, work on projects constitutes a fraction of team members' job responsibilities, and accounts for only a portion of their work-times. As a result of these conditions, there are few opportunities for interactions among team members other than project team meetings. Also, team members may not have worked with each other before coming together on a project, and may not formally work together after completion of the project. As such, the social ties among these team members are often not as close as those among team members that work together on portfolios of related projects, as is common in new product development and information technology contexts.

This has implications for the sharing of individual knowledge and its conversion into organizational knowledge (Choo et al., 2007; Siemsen et al., 2009). Thus, the application of knowledge-creation theory in process improvement team projects warrants investigation separate from studies of new product development projects (Boone et al., 2008; Zhang et al., 2004) and information systems projects (Lee and Choi, 2003; Sabherwal et al., 2006), where projects often have longer life-spans and/or more stable team memberships. The study of knowledge creation in process improvement projects also warrants separate inquiry from those conducted at the organizational level of analyses (Anand et al., 2009; Edmondson et al., 2003; Molina et al., 2007), as these studies

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do not deal with practices for creating knowledge but focus instead on the topic of a broader environment conducive to knowledge management.

There is a growing prevalence of process improvement initiatives that have the common characteristics of projects lasting for three to nine months, with each project led by a project methodology expert, and involving a diverse team constructed solely for the purpose of the project. Thus, we focus on the practices used by team leaders to extract and integrate knowledge of team members toward achieving project objectives. The topic of this paper is inherently multi-disciplinary because process improvement is central to Operations Management, while knowledge creation in teams, which also involves team dynamics and leadership, is central to Organizational Behavior. This study responds to calls for incorporating human behavioral issues in Operations Management contexts (Bendoly and Hur, 2007; Boudreau et al., 2003; Mantel et al., 2006).

1.1. Relevance of tacit knowledge

The theory of knowledge creation (Nonaka, 1991) is based primarily on Polanyi's (1966) categorization of knowledge as explicit and tacit. It prescribes the capture of both explicit and tacit types of knowledge, making it available to the organization in order to generate competitive capabilities. Explicit knowledge is codified knowledge articulated in words, figures, and numbers. It is objective, and relatively easy to share in the form of specifications, standard operating procedures, and data. Tacit knowledge is knowledge that has not been codified and is relatively difficult-to-codify. It is subjective and based in individual experiences.

Nonaka and Takeuchi (1995) point out that Western managers were more likely to overlook tacit knowledge than their Japanese counterparts, who were experts at capturing it. Particularly in the context of process improvement, the tendency to focus exclusively on explicit knowledge is exacerbated by the fact that most projects have objectives related to exploiting and controlling existing process capabilities (March, 1991; Schroeder et al., 2008). The tendency for leaders of such projects to concentrate on explicit knowledge that is easier to capture, while getting blindsided by tacit knowledge that may be relevant, makes it important for practice and academia to examine the missed opportunities that may result from ignoring tacit knowledge.

1.2. Empirical context of Six Sigma projects

The Six Sigma process improvement initiative originated in 1986 from Motorola's drive toward reducing defects by minimizing variation in processes, which in turn required explicit measurement of solid metrics (Kumar and Gupta, 1993). Applications of the Six Sigma project execution methodology have since expanded to include more explorative objectives, such as increasing customer satisfaction, or developing closer supplier relationships, and the use of softer practices, such as brainstorming and "five-why" analyses to capture tacit knowledge of project team members (Hoerl, 2001). The question that remains unanswered is whether the use of tacit-knowledge-capturing practices provides a higher degree of project success.

Thus, our research is motivated by two main issues: (1) the application of knowledge creation to explain differences in success levels achieved by process improvement projects; and (2) the potential benefits of practices to capture the more-often ignored, and more difficult to include, tacit knowledge. Although the setting for our empirical investigation is Six Sigma projects, the results of our study are applicable to other process improvement initiatives, such as total quality management (Mukherjee et al., 1998) and lean management (Shah and Ward, 2007). Broadly, the domain of this research is participative team

projects for process improvement under the guidance of leaders who are trained in project execution practices.

We begin by relating knowledge creation to Six Sigma process improvement projects in Section 2. In Section 3, we develop our conceptual arguments, and present hypotheses that relate practices for capturing explicit and tacit knowledge to Six Sigma project success. Section 4 describes the development of our survey instrument and the empirical methodology used to test our hypotheses. We present the results of our analyses in Section 5, followed by a discussion of the implications of these results for theory and practice in Section 6. Section 7 concludes the paper by addressing limitations and directions for future research.

2. Knowledge creation and Six Sigma

The knowledge-based view of business strategy supports the notion that knowledge can be a valuable resource for competitive advantage; see, for example, Argote et al. (2003) and Kogut and Zander (1992). By creating new knowledge about processes, and increasing their productivity, process improvements contribute to the competitive positions of organizations (Shah and Ward, 2003; Zu et al., 2008). The underlying principle for process improvement projects is looking beyond reactive corrections of processes to root causes for problems and to opportunities for enhancements. Thus, knowledge creation provides an appropriate lens through which we can study process improvement projects.

2.1. Explicit and tacit knowledge types

Nonaka's framework (1991, 1994) provides a rationale for the use of knowledge-creation practices to generate group knowledge by engaging individual team members in process improvement projects. The framework depicts the process of knowledge creation as cycles of conversions between two types of knowledge—explicit, and tacit (see Fig. 1). It is worthwhile to note that this classification of knowledge as either explicit or tacit is one of two prominent classifications in the knowledge-management literature (Table 1

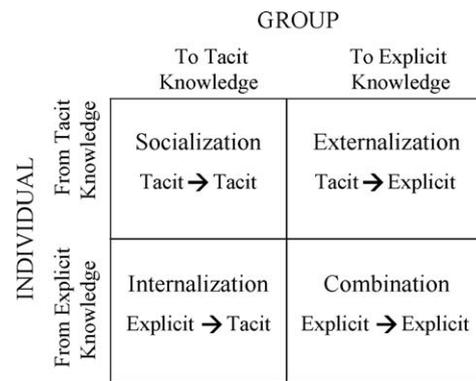


Fig. 1. Nonaka's (1991, 1994) framework of knowledge-creation mechanisms.

Table 1 Selected classifications of knowledge-creation mechanisms.

Author(s)	Year	Knowledge-creation mechanisms
Argyris	1977	Single & double loop learning
Nonaka	1991	Combination, internalization, socialization & externalization
Kogut and Zander	1992	Knowing-what & knowing-how
Kim	1993	Operational & conceptual learning
Spender	1996	Capturing individual and organizational knowledge
Nahapiet and Ghoshal	1998	Acquiring intellectual & social capital

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