Information technology and knowledge in software development teams: The role of project uncertainty

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ABSTRACT

Knowledge is a strategic resource; information technology (IT) is presumed to facilitate its movement among organizational members. The relevant literature, however, is inconclusive. This study reports the results of the effect of IT on knowledge-sharing processes, i.e., knowledge exchange and knowledge combination, under conditions of project uncertainty. Our results indicate that both exchange and combination are necessary to fully explain the relationships and that the consideration of a project's outcome is also important. While project uncertainty confounds the knowledge-sharing processes regardless of technology, the frequency of technology use routinely increases knowledge exchange and combination in a software team.

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1. Introduction

Although organizations have engaged in the creation, accumulation, and application of knowledge for many years [50], there has been an inconsistent application of knowledge as a strategic resource [31,14]. Defined as a fluid mix of framed experience, values, contextual information, and expert insight [23], knowledge underlies organizations' products and services. To remain competitive, organizations must find better ways to manage their knowledge resources [78]. However, knowledge typically exists in specialized pockets scattered across the organization and becomes a valuable corporate asset only if it is readily available for the task at hand [23,57]. Teams are one mechanism that can be used to bring together individually held knowledge, expertise, and skills to bear on tasks of varied nature [35].

A team is typically embedded in a larger social system such as a business unit or organization. Cohen and Bailey [18] identify four types of teams in organizations: (1) work teams, (2) parallel teams, (3) project teams, and (4) management teams. This research focuses on project teams.

Project teams differ from other teams in the non-repetitive nature of their tasks [18]. Although knowledge and expertise are important in other types of teams, knowledge sharing is key to the development of new outcomes characteristic of project teams. Project teams are generally composed of members from different functional areas that come together to share their knowledge to achieve project outcomes. Typically, project teams also search for and retrieve additional knowledge from outside the team to be integrated with their existing knowledge.

The effectiveness of knowledge sharing in project teams is often determined by the social actions among the relevant human entities inside and outside the teams [53]. These social actions are captured in the concept of *social capital* that consists of three basic dimensions: (1) a structural dimension (linkages among people or units), (2) a relational dimension (trust through interpersonal relationships), and (3) a cognitive dimension (shared understandings and interpretations) [53]. In this study, we focus primarily on the *structural dimension*, although the other two dimensions are also considered. A fundamental feature of the structural dimension of social capital is the promotion of access to other knowledge sources through a connectivity capability provided to network members

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[54]. This feature consequently implies a role for information technology (IT) [69].

There is scant empirical evidence of a positive relationship between IT and knowledge sharing. Additionally, the frequent failures of IT-based knowledge management systems (KMS) have been cited in the business and academic literature [12,17]. Thus, additional research is needed to examine the role of IT in facilitating knowledge sharing, which leads to our first research question:

(1) Does IT use intensity facilitate knowledge sharing in software project teams?

Knowledge sharing results in the development of social knowledge of a team or organization [53]. The development of social knowledge comes from two very different processes: knowledge exchange and knowledge combination. Knowledge exchange requires moving various knowledge elements among human and other entities. Previous work on this concept has shown that knowledge transfer plays a critical role in the effectiveness of organizations 78,8]. Knowledge combination is the process of blending and synthesizing separate knowledge elements or discovering new ways to mix and match elements to create new knowledge [42]. The potential of IT to facilitate and improve knowledge exchange and knowledge combination is often viewed as very high [69]. However, theory and research have yet to address how IT affects these two processes. Thus, a logical question to ask is:

(2) Does IT use intensity affect one process of knowledge sharing more than another in software project teams?

As in many studies, environmental conditions can moderate the relationship between the primary variables of interest. Project uncertainty is a prominent environmental condition that affects nearly all aspects of a software project [55,9]. In software development teams, uncertainty in project requirements or outcomes can confound the team's ability to progress through the project. Often, the presence of uncertainty requires increases in knowledge search and retrieval and project coordination [56]. This leads to the third research question:

(3) Does project uncertainty moderate the relationship between IT use intensity and knowledge sharing?

This study uses a survey methodology to investigate these research questions. This method is an appropriate means of assessing unobservable phenomena [70,27] such as individuals' perceptions of the characteristics of knowledge management. Additionally, a survey methodology is appropriate because the objective of the study is to empirically test the research model, which was developed based on a prior body of research that had adopted observational, qualitative, and experimental methods to examine knowledge management issues in software development teams and other organizational units [64,81].

The remainder of the paper is organized as follows. In the next section, we discuss the theoretical underpinnings of our key constructs and propose testable hypotheses. In Section 3, we discuss the research methodology. In Section 4, we present the data analysis and results. In Section 5, we discuss the theoretical contributions and implications of our findings and the limitations of the study. In Section 6, we summarize our conclusions.

2. Theoretical considerations

2.1. Social capital

Social capital is a term that evolved from community studies centering on the importance of the networks of strong personal relationships, cooperation, and trust in everyday communities.

The term was explicitly defined by Nahapiet and Ghoshal [53], who note that the central proposition of social capital theory is "that the relationships constitute a valuable resource for the conduct of social affairs, providing their members with capital, or 'credential,' that is embedded within networks of mutual acquaintance and recognition" (p. 243). An important distinction of the definition of social capital provided earlier in this paper is the view that social capital is both "a network and the assets that are moved through the network" ([53], p. 243). The inclusion of the network in this view of social capital is key to our study.

Nahapiet and Ghoshal [53] divide social capital into three different dimensions: (1) the structural dimension, (2) the relational dimension, and (3) the cognitive dimension. The structural dimension is composed of the "impersonal configuration of linkages between people or units" ([53], p. 244). A characteristic of this dimension that is important to the current study is the degree of interaction of the people and units in the network. IT provides support for the development, maintenance, sharing of information, and support of these networks. These characteristics are operationalized through the frequency of IT use in this study [38].

The relational dimension is related to the trust from the interpersonal relationships that have been developed over time through a history of interactions among network members [53]. Finally, the cognitive dimension encompasses understandings and interpretations that are shared by network members [53]. According to van den Hooff and Huysman [84], social capital can affect knowledge by creating access to knowledge, mutual trust among participants, and common abilities that facilitate understanding. Aspects of both relational and cognitive dimensions have been shown to relate to knowledge sharing [15].

2.2. Social knowledge

Social knowledge, as opposed to individual knowledge, represents the shared knowledge of the members of a team or an organization [15]. Social knowledge can be either explicit or tacit. Explicit knowledge is knowledge that can be objectively coded. Many organizations have moved aggressively to code, store, share, and leverage this type of knowledge using different resources, including IT [41]. Social tacit knowledge is more abstract, and it is revealed in the forms of the social and institutional practices and collective routines of an organization. This type of knowledge is not obvious to the casual observer. Social tacit knowledge is typically manifested through the sustained interaction of closely knit organizational groups [53]. Spender [77] states, "Collective knowledge is the most secure and strategically significant type of organizational knowledge" (p. 52). It is this social knowledge that is the focus of this study.

Social knowledge, such as all organizational resources, is primarily created through two different processes: exchange and combination [53]. Combination spawns social knowledge either by bringing together previously unconnected elements or by creating new and different ways of mixing elements that have been related before. In addition, there must be a process of exchange to bring together the various elements to create new knowledge.

Given the knowledge-intensive nature of software development, knowledge exchange and combination are critical to project success. Combination is fundamental to software development because teams combine individual perspectives to develop shared project concepts. Additionally, teams synthesize their members' expertise and know-how to jointly solve project-related problems [85]. Prior studies have also reported that IT teams improve their task efficiency by sharing their knowledge internally [82].

It has been acknowledged by prior studies that knowledge exchange is critical to timely project completion [50]. Exchange