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# Knowledge Integration in Software Teams: An Assessment of Team, Project, and IT-related Issues

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## ABSTRACT

Organizational knowledge resources typically exist in specialized pockets scattered across the firm. As distributed knowledge systems, firms' capacity to manage their knowledge resources is linked with their ability to integrate these pockets of specialized knowledge. Firms are increasingly depending on teams to strategically consolidate their dispersed knowledge into productive outcomes. Teams integrate knowledge from external sources with internal knowledge such as skills, know-how, and expertise of their members to create project outcomes. The aim of this research in progress will be to examine how knowledge integration in software teams is influenced by various team, project, and IT-related issues.

**Keywords:** Knowledge Integration; Teams; Project Complexity

## INTRODUCTION

Although firms have engaged in knowledge creation, accumulation, and application for many years, only recently has knowledge been identified as a strategic resource (Grant 1996). Defined as a "fluid mix of framed experience, values, contextual information, and expert insight" (Davenport et al. 1998), knowledge underlies a firm's products and services. To remain competitive, firms must find ways to better manage their knowledge resources. However, knowledge typically exists in specialized pockets scattered across the firm and becomes a valuable corporate asset only if it is widely accessible (Nonaka 1991). Thus, a firm's capacity to manage its knowledge resources is linked with its ability to better integrate its dispersed pockets of specialized knowledge (Tsoukas 1996). Teams, supported by information technologies, are better able to facilitate this integration, as compared to individual employees (Faraj et al. 2000).

Organizations are increasingly adopting team-based structures to strategically consolidate their knowledge resources (Lipnack et al. 1997). Team members possess diverse knowledge resources, and teams perform knowledge integration, which is defined as the process of absorbing knowledge from external sources and blending it with internal knowledge resources, to bear upon the project outcomes (Cohen et al. 1997).

Software projects are an appropriate example of team-level knowledge integration. Multiple project stakeholders, within and outside software teams, possess diverse portfolios of know-how, skills, and abilities that teams must integrate to produce project outcomes (Tiwana 2003). Prior research suggests that software teams carry out two types of knowledge integration - *external integration*, i.e., absorbing new knowledge from external sources, and *internal integration*, which includes combining internally available knowledge into collective (project) knowledge (Tiwana et al. 2003). In light of this observation, two issues merit attention: what are some of the antecedents to a software team's knowledge integration? And, what is the nature of their influence?

Past literature identifies three categories of antecedents: (1) team-related, such as the heterogeneity of a software team's internal knowledge resources (Cummins 2004; Tiwana et al. 2005); (2) project characteristics such as complexity (Anand et al. 2003; Zmud 1983); and (3) the team's usage of various information technologies (IT) (Alavi et al. 1999; Guinan et al. 1998).

This brings us to our second issue – how the three categories of antecedents influence knowledge integration in software teams? We focus on this issue in our research by addressing following questions:

1. Are heterogeneous teams better at integrating knowledge?
2. How does project complexity influence knowledge integration in software teams?
3. How does a software team's usage of various IT-based systems moderate the influence of team's knowledge heterogeneity and project complexity on the team's knowledge integration?

## ANTECEDENTS TO KNOWLEDGE INTEGRATION

### Team's Knowledge Heterogeneity

A software team's knowledge heterogeneity is the diversity of its members' technical and functional background and their expertise and skills (Anand et al. 2003). Knowledge heterogeneity fulfills a fundamental pre-condition for team's knowledge integration – the presence of differing knowledge among the members (Moran et al. 1996). Members of such teams are also likely to have differing interpretations of various project related issues. Such teams typically experience higher cognitive dissonance than homogeneous teams (Maruping et al. 2004). To reduce that dissonance, they may bolster their internal knowledge integration to create a common understanding among the team members.

Additionally, members of heterogeneous teams may have interpersonal networks in diverse domains, which can be utilized as sources of external knowledge. Furthermore, heterogeneous teams may have experts in multiple domains, which would improve team's capacity to integrate external knowledge in multiple domains (Cohen et al. 1990). Therefore, heterogeneous teams, as compared to homogeneous teams, may not only have better access to the external knowledge sources in multiple domains but also have higher capacity to integrate knowledge in those domains. Thus, we hypothesize:

Hypothesis 1a: A software team's knowledge heterogeneity will positively influence its internal knowledge integration.

Hypothesis 1b: A software team's knowledge heterogeneity will positively influence its external knowledge integration.

### Project Complexity

Complex software projects are less analyzable and involve more unique yet interconnected sub-tasks (Kim et al. 1992-93; Roberts et al. 2004-5). Low analyzability requires more subjective criteria like judgment and experience to better understand various technical and functional issues (Roberts et al. 2004-5). Using subjective procedures may ultimately benefit team's internal knowledge integration by provoking interactive discussions among the team members. This would require the team members to bring relevant knowledge to such discussions, thereby inflating their requirements of "rich" information (Kim et al. 1992-93), which can be met by substantiating their own knowledge with external inputs. Thus, low analyzability may also improve team's external knowledge integration.

Teams working on complex projects also need to perform more unique yet interconnected sub-tasks, which require specialized knowledge inputs from multiple technical and functional domains. In such a scenario, it is less likely that a single team member will possess all requisite knowledge. Thus, software teams working on complex projects may have to actively integrate specialized knowledge from external sources (Anand et al. 2003).

Additionally, the requirement of unique yet interconnected sub-tasks may demand that the project be completed in separate modules assigned to different experts or groups of experts in the team (Zmud 1980). Teams working on such projects typically need to create specialized knowledge to combine the modules into a coherent software system (Koushik et al. 1995). Creating this systemic knowledge requires teams to combine internal knowledge specific to each module, and substantiate it with inputs from other teams and individuals who may have experience developing and implementing modular software. Thus, we propose:

Hypothesis 2a: Project complexity will positively influence a team's internal knowledge integration.

Hypothesis 2b: Project complexity will positively influence a team's external knowledge integration.

### Moderating Influence of IT Usage

This study examines the usage of two categories of IT-based systems - collaborative systems (e.g., corporate intranets, e-mail, telephone, list serves, and group support systems) (Jarvenpaa et al. 2000) and KM systems (e.g., electronic knowledge repositories, expert directories, and electronic forum software) (Kankanhalli et al. 2005).

### **IT Usage, Team's Knowledge Heterogeneity, and Team's Knowledge Integration**

Heterogeneous teams can gain multiple benefits by using IT-based systems for internal knowledge integration. Earlier we proposed that heterogeneous teams are more likely to bolster their knowledge integration efforts to create a common understanding among the team members. Teams can use IT-based systems to gather knowledge inputs from various internal and external sources, interpret these inputs, and assimilate them (Schultze et al. 2004). IT usage may thus enhance internal collaboration in heterogeneous teams thereby improving their ability to combine their diverse knowledge assets into project-level knowledge.

We also proposed earlier that as compared to homogeneous teams, heterogeneous teams have more diverse expertise, and thus have a higher capacity to integrate external knowledge in multiple domains. Experts in such teams can use IT-based systems not just to collaborate and combine their expertise but also to absorb more appropriate knowledge inputs from external sources and integrate them with their combined expertise to develop a more robust body of project-level knowledge. Thus IT usage may provide heterogeneous teams' access to external knowledge sources in multiple domains, and increase their capacity to integrate knowledge from those sources. It is thus proposed:

Hypothesis 3a: IT-usage will moderate the influence of a software team's knowledge heterogeneity on its internal knowledge integration.

Hypothesis 3b: IT-usage will moderate the influence of a software team's knowledge heterogeneity on its external knowledge integration.

### **IT Usage, Project Complexity and Team's Knowledge Integration**

To examine this moderation, we utilize the theory of task-technology fit, as per which for information technologies to have a positive impact on individual performance, they must be a good fit with the task they support (Constant et al. 1994). The subjective knowledge inputs required in complex projects carry highly contextual information, and require interactive, expressive communication (Zmud et al. 1990). People working on complex tasks thus prefer communicating face-to-face than through IT-based systems (Struas et al. 1994). Thus, it is expected that IT-usage will not aid internal knowledge integration in complex projects. On the contrary, it may have a negative influence in this situation. We propose:

Hypothesis 4a: IT-usage will moderate the influence of project complexity on a software team's internal knowledge integration.

On the contrary, teams working on complex projects can use both collaborative and KM systems to search for and access external knowledge inputs. For example, listserves and electronic forums can be used to contact external experts, or technical white papers and project knowledge documents can be accessed from the KMS. Though, these inputs, once acquired, may be better integrated within the team in face-to-face settings. Thus:

Hypothesis 4b: IT-usage will moderate the influence of project complexity on a software team's internal knowledge integration.

### **PROPOSED RESEARCH METHODOLOGY**

Constructs will be measured using standard scales from prior studies to enhance validity. Data will be collected through an online questionnaire-based survey administered to project leaders of software teams. Project leaders are chosen as respondents as they have better understanding than others (e.g. project managers) regarding most issues examined in this study. Software organizations will be accessed through the network connections of one of the authors. It is expected that data will be collected from 150 project leaders. Data will be analyzed using partial least squares (PLS)<sup>1</sup> technique to test the research hypotheses.

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<sup>1</sup> PLS-Graph version 3.0 build 1126 will be used to run PLS.

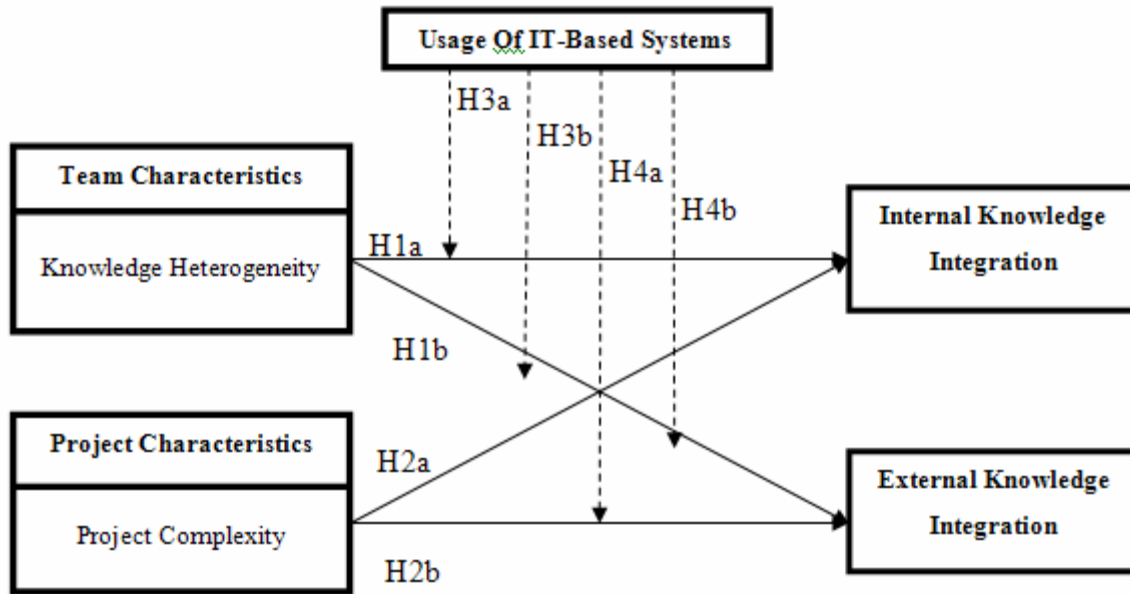


Figure 1. Research Model Indicating Proposed Hypotheses

## EXPECTED CONTRIBUTIONS

### Theory

The primary contribution of this research is to improve our understanding of a software team's knowledge integration by examining the influence of team-, project-, and IT-related issues. The empirical results from this study are expected to help academics and practitioners alike. In academia, the discussion of a team's knowledge integration is a relatively new area of exploration, and this study builds upon the few but nonetheless significant past research inquests within the fields of IS, KM, teams, and boundary spanning. Thus, the results of this study will interlink these fields and provide a foundation for future inter-disciplinary research.

### Practice

For practitioners, it is expected that the results of this study will improve their understanding of knowledge integration *within* their core building blocks of team-based organizations. Second, the results will help managers develop a knowledge integration profile of their teams and projects. For example, they can identify the characteristics of teams that are more of 'external knowledge integrators' versus those that are 'internal knowledge integrators'. Managers can use this information while developing their future KM strategy.

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