Complements or Substitutes?:
The Effects of Organization Communication Routine
and Project Team Management Practices on
Innovation Capability

by

C. Annique Un

October 2000 WP #4140

© C. Annique Un, 2000

*Massachusetts Institute of Technology, Sloan School of Management, 50 Memorial Drive, E52-509, Cambridge, MA 02142. e-mail: cau@mit.edu

The paper is derived from my thesis at the Sloan School of Management, Massachusetts Institute of Technology. The MIT-Japan Program Starr Foundation, the CS Holding Fellowship in International Business, and the Massachusetts Institute of Technology Doctoral Fellowship provided funding for this study. I would like to thank the managers of the companies studied for sharing their experiences with me. The comments of participants at the Academy of Management Annual Meeting in Toronto, and the Massachusetts Institute of Technology Proseminar helped improve the paper. I am also grateful to Eleanor Westney, Michael Beer, John Carroll, Deborah Ancona, and Alvaro Cuervo-Cazurra for their comments and suggestions. All errors remain mine.
COMPLEMENTS OR SUBSTITUTES?:
THE EFFECT OF ORGANIZATION COMMUNICATION ROUTINE AND PROJECT TEAM MANAGEMENT PRACTICES ON INNOVATION CAPABILITY

Abstract
This paper analyzes the effects of the organization communication routine and project team management practices on the capability to mobilize knowledge and create new knowledge for innovation. I argue that for firms that have the organization communication routine that supports innovation, project team management practices that facilitate communication on team and innovation are at most complements. However, for organizations that lack the routine, the practices are substitutes for it. The empirical analysis supports the arguments. [75]

Key words: Capability, Innovation, Routines, Practices.
The capability to mobilize knowledge and create new knowledge for innovation is a source of competitive advantage (Prahalad and Hamel, 1990; Kogut and Zander, 1992; Leonard-Barton, 1995; Nonaka and Takeuchi, 1995; Teece, Pisano, and Shuen, 1997), but empirical analysis explaining the factors and management practices that support this capability remains unclear (Foss, 1997; Wernerfelt, 1997). On the one hand, the literature on innovation based in organization theory, which follows the integration-differentiation framework (Lawrence and Lorsh, 1967; Nohria and Ghoshal, 1997), suggests that organization-level cross-functional communication patterns support this capability. Therefore, organization design that integrates different functions that generates cross-functional communication routine facilitates the development of this capability. On the other hand, the innovation literature based in organizational behavior tends to focus on the project team level of analysis (Clark and Wheelwright, 1992; Dougherty, 1987; Griffin and Hauser, 1992; Ancona and Caldwell, 1992) and suggest that project team-level communication frequency facilitate this capability. This line of research suggests that project team management practices facilitate communication on project teams and therefore, support the development of this capability. Therefore, the question analyzed in this paper is: Are project team management practices complements or substitutes for the organization-level communication routine in developing the capability to mobilize knowledge and create new knowledge for innovation?

I argue that for organizations that have the cross-functional communication routine built into their context, project team management practices that are designed to facilitate communication on project teams, are at most complements, because this routine carries over to project teams (Staw, Sandelands, and Dutton, 1981; Morrill, 1995). As project teams are embedded in organization (Clark and Wheelwright, 1992; Granovetter, 1985), they are subject to
the organization-level communication routine. On the other hand, for organizations that lack this routine, project team management practices are substitutes for organization communication. These ideas integrate two streams of literature on innovation based in organization theory, particularly the integration-differentiation framework, and organizational behavior, specifically the team processes-innovation model, while explaining how the capability to mobilize knowledge and create new knowledge for innovation is developed.

I conduct an empirical analysis to answer the question and test the propositions. The empirical study is based on archival data and surveys of 182 cross-functional innovation teams of 38 large companies in the computer, photo imaging, and automobile industries whose task was to use market knowledge about products and services to generate innovation in response to customer demands. In order to separate out levels of analysis (Rousseau, 1985), in each company, the project manager, team leaders, and personnel manager completed the surveys. Prior to the surveys, extensive qualitative data through field observation and interviews, not presented in this study, was gathered to generate in-depth understanding of the determinants of this capability.

The rest of the paper is organized as follows: Section 2 discusses the theory and hypotheses. Section 3 presents the research design. Section 4 provides the results, and section 5 presents the discussion and conclusions.

THEORY AND HYPOTHESES

The capability to mobilize knowledge and create new knowledge for innovation

An organization’s ability to mobilize knowledge and create new knowledge for innovation is a critical source of competitive advantage (Prahalad and Hamel, 1990; Teece et al.,
1997). It is related to the idea of “combinative capability” (Kogut and Zander, 1992), which is defined as firm’s ability to combine different types of individual knowledge from different functions for innovation. This concept is also related to the idea of “core competence” that is defined as firm’s ability to coordinate and integrate production skills and streams of technologies (Prahalad and Hamel, 1990). Moreover, it is related to the idea of “dynamic capability” (Teece et al., 1997), which is defined as the subset of the competence/capabilities that allow the firm to create new products and processes, and respond to changing market circumstances.

Since the literature on the capability to mobilize knowledge and create new knowledge for innovation discusses product and process innovation as outcomes of this capability, and the capability itself cannot be measured directly (Godfrey and Hill, 1995), this study analyzes innovation as one type of outcome of this capability. By innovation I mean improvement made to existing products and processes of the firm (Van de Ven, 1986; Nohria and Gulati, 1995) in response to external market demands (Teece et al., 1997). Then, I analyze other outcomes of this capability, particularly the effectiveness of knowledge mobilization and creation in terms of speed-to-market of the innovation (Ancona and Caldwell, 1992) and customer satisfaction with the innovation (Clark and Fujimoto, 1991). Moreover, I analyze the efficiency of resources used in achieving the innovation (Clark and Wheelwright, 1992).

Although the resource based view usually discusses the drivers of innovation at the organization-level, it also recognizes the importance of project teams as mechanisms by which knowledge mobilization and creation for innovation occurs (Nonaka and Takeuchi, 1995). In developing the “combinative capability”, knowledge is mobilized among small groups of individuals (Kogut and Zander, 1992), and an organization has this capability when individuals in these small groups effectively communicate their individual knowledge, combine to create
new knowledge for innovation. Prahalad and Hamel (1990) also suggest that organizations that have the core competence provide mechanisms such as project teams for individuals who are “carriers of core competence” to share their individual knowledge for innovation. Similar to Kogut and Zander (1992), an organization is considered to have a “core competence” when individuals who are “carriers of core competence” effectively communicate their individual knowledge in these small groups, combine to create new knowledge for innovation. Teece et al. (1997) also recognize that a firm’s “dynamic capability” is contingent on the cooperation among small groups of individuals in communicating their individual knowledge, combine for creating new knowledge for innovation.

I argue that the capability to mobilize knowledge and create new knowledge for innovation arises from the interaction of organization and team level factors. Specifically, the organization-level cross-functional communication routine, project team level communication frequency, and team management practices directly affect the capability to mobilize knowledge and create new knowledge for innovation. Moreover, both the organization-level cross-functional communication routine and project team management practices affect project team-level communication frequency that influences this capability. Figure 1 highlights the relationships analyzed in this paper.

-------------------------------------

Insert Figure 1 about here

-------------------------------------
Project team-level communication

The stream of literature on innovation that focuses on project team processes and their outcomes suggests the importance of communication frequency on project teams and their performance. Empirical studies (e.g. Griffin and Hauser, 1992; Dougherty, 1987) have shown that communication frequency among project team members influences their performance. The higher the frequency the more knowledge is being exchanged and the better for innovation (Dougherty, 1987; Griffin and Hauser, 1992). More specifically, innovation is more successful if individuals in R&D and engineering understand customer needs, individuals in marketing understand technological capabilities and constraints, and both understand the implications for manufacturing and competitive strategy (Workman, 1995). Dougherty (1987), for instance, suggests that unsuccessful projects have lower communication frequency among members from different functions while successful projects were those that had higher interfunctional communication frequency. Extending Dougherty’s study, Griffin and Hauser (1992) also found that successful new product development teams had higher communication frequency among core team members from marketing, engineering, and manufacturing than project teams that had lower communication frequency. These discussions lead to the hypothesis that:

Hypothesis 1: Project team communication frequency is positively related to innovation as an outcome of the capability to mobilize knowledge and create new knowledge for innovation.

Project team management practices

The literature on innovation that focuses on the project team level of analysis suggests that project team management practices have both direct (Ichniowski, Shaw, and Prennushi, 1997; Wageman, 1995) and indirect effect on their performance (Klimoski and Mohammed,
1994; Menon, Jaworski, and Kohli, 1997; Wageman and Baker, 1997). These project team management practices are project team development (Thamhain and Wilemon, 1997; Hershock, Cowman, and Peters, 1994), reward for project team performance (Roberts and Fusfeld, 1982; Milgrom and Roberts, 1992) and project team membership selection (Ancona and Caldwell, 1992). In this study I analyze the direct and indirect effect of project team development and reward, and control for team membership selection on performance via research design.

The direct effect of project team management practices on performance. Project team development. Project team development is related to team building, a process of taking a collection of individuals with different needs, backgrounds, and expertise, and transforming them into an integrated, effective work unit (Thamhain and Wilemon, 1997). Project team development, which entails teaching team members about the goals of the projects and the processes by which to achieve them, enhances their performance (Hershock et al., 1994). The underlying idea behind project team development is that members represent different “thought worlds” (Dougherty, 1992), with different objectives and expertise, who individually attempt to reduce uncertainty about their roles within the group. They seek to enact (Weick, 1980) their environments on project team by directing their activities toward the establishment of a workable level of certainty and clarity in carrying out this team task. Training on how to manage these processes enables individuals to develop their own situational perspective and therefore work more effectively. A critical factor behind project team development is the interaction among key individuals that are expected to work together to accomplish the project. This development process may require the team leader (Clark and Wheelwright, 1992) to teach members how to organize work processes and how to better communicate with members from outside their
"thought worlds" or subcultures (Schein, 1996) of the organization. The development process may also involve the use of individuals from external sources to the team such as "corporate trainers" specializing in team development or "experts" external to the organization (Un, 2000; Roth and Kleiner, 1996). These analyses lead to the hypothesis that:

Hypothesis 2: Project team development is positively related to innovation as an outcome of the capability to mobilize knowledge and create new knowledge for innovation.

Project team reward. Previous studies suggest that project team reward affects project team performance (e.g. Katz and Allen, 1985; Gladstein, 1984). While some researchers (e.g. Katz and Allen, 1985) suggest that job assignments and promotion impact the process of innovation, other researchers suggest both monetary and non-monetary rewards have impact on innovation (Roberts and Fusfeld, 1982). When individuals believe their contributions on project teams in achieving the goals of the projects are rewarded, they are likely to perform to enhance project team performance (Milgrom and Roberts, 1992; Lawler, 1994; Kerr, 1975). Empirically, reward for team performance has a positive impact on its outcome (Ichniowski et al., 1997; Wageman, 1995). Therefore, project teams that receive reward for their project team performance are likely to perform better than those that do not receive any reward. These discussions lead to the hypothesis that:

Hypothesis 3. Project team reward is positively related to innovation as an outcome of the capability to mobilize knowledge and create new knowledge for innovation.

The indirect effect of project team management practices on performance. Project team development also facilitates project team outcomes indirectly by affecting communication frequency on project teams. Since project team development is a
process by which team members are taught how to organize their work processes such as setting the agenda for meetings, task allocation and suggestions about the resources needed and where they may be acquired, it influences communication frequency in accomplishing the project. In addition, project team development provides team members the understanding of knowledge structure of other members (Nonaka and Takeuchi, 1995), facilitates social integration through trust building (Roth and Kleiner, 1996), and replaces individual goal differences with the collective goal (Klimoski and Mohammed, 1994) of the project. This sense of shared goal and trust encourages communication for accomplishing the project (Madhaven and Grover, 1998). Therefore, I hypothesize that:

**Hypothesis 4**: Project team development is positively related to project team-level communication frequency.

**Project team reward.** The reward for team performance also has an impact on project team communication frequency. In order to motivate knowledge exchange on team, team reward is necessary for project team performance. Wageman and Baker (1997) studying the relationships between team reward and team outcomes found that team reward has a positive effect on observed cooperation. Menon et al. (1997) studying cross-functional product development teams also found that the reward for project team performance increased interdepartmental interaction. Therefore, project teams that receive reward for their performance are likely to communicate more frequently to exchange knowledge in order to enhance project performance. These discussions lead to the hypothesis that:

**Hypothesis 5**: Project team reward is positively related to project team-level communication frequency.
Organization-level communication routines

Every organization has some type of communication patterns (Morrill, 1995), routines (Nelson and Winter, 1982), or codes (Kogut and Zander, 1992). These patterns may be vertical between superior and subordinates within the same function or lateral between employees in different functions (Morrill, 1995; Kogut and Zander, 1992). These communication routines are facilitated by the degree to which different functions are integrated or differentiated (Lawrence and Lorsch, 1967; Nohria and Ghoshal, 1997). Organizations that integrate different functions using various integrative mechanisms such as incentives (Milgrom and Roberts, 1992), team-based job design (Galbraith, 1977; Ghoshal et al., 1994) and/or the initial socialization that exposes employees to different functions (Nohria and Ghoshal, 1997) have cross-functional communication patterns or routines. Organizations that are differentiated have communication patterns that are within the same function rather than across different functions (Galbraith, 1977; Morrill, 1995). Over time these patterns become institutionalized and taken for granted by organizational members (Morrill, 1995). Therefore, one of the differentiating factors among organizations and their performance is their communication routine (Nelson and Winter, 1982).

Direct effect of organization-level communication routines on innovation. Among the different types of organization-level communication routines, cross-functional communication routine by and large is viewed as supporting the organization’s capability to mobilize knowledge and create new knowledge for innovation, because innovation requires the mobilization and integration of different types of functional knowledge (Dougherty, 1992). Therefore, in developing the capability to mobilize knowledge and create new knowledge for innovation, sales/marketing, design and manufacturing are integrated in order to create cross-functional
communication routine among these functions (Lawrence and Lorsch, 1967; Nohria and Ghoshal, 1997). Similarly, Kogut and Zander (1992) propose that in developing the "combinative capability" communication codes that facilitate knowledge mobilization between design and manufacturing are necessary. Prahalad and Hamel (1990) suggest that firms that have the "core competence" provide mechanisms whereby individuals who are "carriers of core competence" are encouraged to communicate across functional and business boundaries to share knowledge to create new knowledge for innovation. Similarly, Dougherty (1992) suggests that an organization's ability to develop new products is contingent on the communication frequency between and among individuals in the sales/marketing, R&D, and manufacturing functions. Empirical studies have also shown that organizations that have higher cross-functional communication frequency have superior capability at mobilizing and creating new knowledge for innovation than organizations that lack this communication routine (e.g. Ghoshal et al., 1994; Nohria and Ghoshal, 1997). Hence, these discussions lead to the hypothesis that:

*Hypothesis 6: Cross-functional communication routine is positively related to innovation as an outcome of the capability to mobilize knowledge and create new knowledge for innovation.*

*Indirect effect of organization-level communication routines on innovation.* Clark and Wheelwright (1992) suggest that regardless of team structures used in the process of innovation, team members remain embedded (Granovetter, 1985) in their daily context of the organization. According to these authors, there are four types of team structures used in the process of innovation: functional, lightweight, heavyweight, and autonomous. The structures that are most frequently used, however, are the first three. For functional project team structure, all team members remain completely embedded in their daily routines, performing their routine tasks, but
given an additional task related to the project to perform. In this project team structure, there is no clear team leader coordinating the different parts of the project. In the lightweight project team structure, all project team members still remain completely embedded in their daily context performing their daily tasks. However, each project team member is given another task from the project to perform and, unlike the functional project team structure, there is a clearly defined team leader who coordinates and acts as a liaison to various project team members. In the heavyweight project team structure, project team members also remain embedded in their daily contexts. The most important differentiating factor between the lightweight and heavyweight structures is the role of the team leader. In the heavyweight project team structure, the team leader is actively coordinating and planning the various tasks and seeing that the project follows the schedule and actively searching for and acquiring resources from external sources to perform the task. Recent studies of product development teams (e.g. Nobeoka, 1993; Aoshima, 1996) also found that project team members rarely devote all their time to working on one particular project team. Simply put, most team members at any given point in time have one "foot" in a project team while another in their daily context of the organization. As project teams remain embedded in their daily context of the organization, they are subject to the on-going organization-level routines, one of which is communication. Since project teams consist of members from different functions, I hypothesize that:

_Hypothesis 7: The organization-level cross-functional communication routine is positively related to project team-level communication frequency._

In summary, I propose that for organizations that have the organization-level cross-functional routine built into their context, project team management practices are complements
while for organizations that lack this routine, these practices are substitutes in developing the capability to mobilize knowledge and create new knowledge for innovation. Specifically, I hypothesize that cross-functional communication routine, project team-level communication frequency and project team management practices have a direct effect on the capability to mobilize knowledge and create new knowledge for innovation. Moreover, I hypothesize that both the organization-level cross-functional communication routine and project team management practices affect project team-level communication frequency.

**RESEARCH DESIGN**

Data were gathered through surveys of 182 cross-functional innovation teams of 38 large US and Japanese multinational firms in the computer, photo imaging, and automobile industries that have operations in the United States. The analysis of companies present in different industries facilitates the generalization of results across industries.

**Selection Criteria**

The industries were selected because they face different innovation cycles—short in the computer industry, medium-sized in the photo imaging industry, and long in the automobile industry—that affect the time pressure on gathering and processing different types of knowledge for innovation (Lawrence and Lorsch, 1967).

The companies were selected based on two factors. First, they were the largest in their respective industries based on revenue as reported in the Hoover’s HandBook of World Business (1999). Second, they had customer service centers in the United States and Japan dealing with similar products. This requirement was necessary because this study is part of a larger study that
compares sources of this capability of US and Japanese multinational enterprises in both the United States and Japan.

For each company, the largest customer service center in terms of employees located in the United States was selected. These centers were identified using the Directory of Corporate Affiliations (1998). The customer service organization was selected because it is the gatekeeper linking firm’s external demands and internal design and manufacturing capabilities (Quinn, 1992). The customer service centers selected had at least three functions represented: sales/marketing, customer service, and engineering linking to the R&D and manufacturing organizations.

In each customer service center, a set of cross-functional project teams was randomly selected. Project teams were selected based on three criteria. First, at least three functions were represented: customer service, engineering (i.e. R&D or manufacturing) and sales/marketing or manufacturing. Second, the main objective of the team was to transform specific external customer feedback obtained from the firm’s worldwide operations about their products into an innovation.

Data Collection

There were three steps to the data collection process. First, in depth field interviews, observations and phone interviews were conducted to ensure a deep understanding of the phenomenon. Second, a pilot study was conducted to test the variables and measures and survey instruments. Finally, the surveys were conducted.

In order to avoid single respondent bias and separate out levels of analysis, I collected data from three different sources using three separate surveys (Rousseau, 1985; Klein, Tosi,
Cannella, and Albert. 1999). Data on the organization-level cross-functional communication routine was collected from a personnel manager, because a personnel function is a boundary function and therefore this manager has the best knowledge about the interaction between and among different functions and can speak about it more objectively.

The data for the team-level variables were collected from the project team leaders and the project managers. For each company the project manager was asked to provide a list of projects and the team leaders that supervised them. Based on this list, randomly selected team leaders were asked to take a survey. Prior to this, surveys were conducted on three companies and their teams to examine the consistency between answers provided by the team leaders and core team members. Results from the correlation analysis suggest some consistency ($r > 0.40$, $p \geq .05$), and therefore, I focus on the team leaders in collecting data on team-level communication frequency, team management practices, and performance. However, in order to minimize team response bias, project managers were also asked to evaluate the outcomes of these projects using the same metrics used in the questionnaire for the team leaders (Ancona and Caldwell. 1992). The correlation coefficients between the two ratings range from $r = 0.41$ to $r = 0.60$ with a mean of $r = 0.50$ and were statistically significant. This analysis suggested agreement between the project managers and team leaders on project team outcomes. The empirical analysis presented in this study is based on the project managers' rating since project managers are probably less biased about team performance than the team leaders, as they were not directly involved in the project. However, team leaders' ratings were also analyzed for comparison. The results of these analysis, not presented in this paper, were consistent with the results based on the project managers' rating.
Variables and measures

There are three sets of variables operating at the organization-level and team-level: (1) the dependent variable, (2) the independent variables, and (3) the control variables.

Dependent variables. The capability construct is represented by its outcome, innovation (Prahalad and Hamel, 1990; Kogut and Zander, 1992; Teece et al., 1997), since capability is an intangible that is not measurable directly but only through its effects (Godfrey and Hill, 1995). Product innovation (PRODNOV) is measured by the extent to which projects using customer feedback led to new product development and/or modification \( (\alpha = 0.87) \). In terms of effectiveness, speed-to-market (Clark and Wheelwright, 1992) and customer satisfaction with the innovation are analyzed (Ancona and Caldwell, 1992). Speed-to-market (SPEED) is measured by the extent to which the innovation was delivered quickly enough to customers to satisfy them. For effectiveness, customer satisfaction with the innovation (CUSTSAT) is measured by ratings given by JD Power & Associates for the automobile companies, PC World for the computer companies, and an external marketing research company for companies in the photo imaging industry \( (\alpha = 0.87) \). Efficiency (EFFIC) was measured by the deviation from the amount of staff hours and financial resources used (excluding staff hours) as expected by management at the beginning of the project in completing the project \( (\alpha = 0.70) \). All the measures are averaged by the firm with the exception of customer satisfaction where an external measure is used.

Independent variables. The organization-level cross-functional communication routine (O-XCOM) is measured by cross-functional communication frequency using face-to-face meetings, phone conversations, and electronic mail formally and informally among different functions in their daily context \( (\alpha = 0.73) \). Project team communication frequency (P-NCOM) is measured by communication frequency among team members using face-to-face meetings.
phone conversations, and electronic mail, formally and informally ($\alpha = 0.83$) (Griffin and Hauser, 1992). Project team-level management practices are project team development (P-DEVLOP) and reward (P-RWRD). Project team development (P-DEVLOP) is measured by whether project team received training specifically for working on this project. Project team reward (P-RWRD) is measured by the impact of project team performance on team members’ salary increase, bonus payment, promotion, and job assignment ($\alpha = 0.78$).

Control variables. At the project team-level, the control variables are tenure diversity (C-P-TENURE) and functional diversity (C-P-#DISCIP). Tenure diversity is measured by the team’s tenure standard deviation divided by its mean (Ancona and Caldwell, 1992). Functional diversity is measured by the number of functions represented on team. This study also controlled for the industry effect (C-INDUS1 and C-INDUS2).

Analysis

This study used path analyses to analyze the hypotheses. Path analysis is used to explore the relationships between the organization-level communication cross-functional communication routine, team level communication frequency, management practices on different outcomes of this capability. For each outcome, separate analysis was performed. To ensure that the assumptions of path analysis were met and that the models used were not misspecified, scatter plots of the residuals were conducted to maintain the assumptions behind OLS.

The analysis involved three steps. The first step involved the correlation analysis between the organization-level cross-functional communication routine, project team level communication frequency, and performance variables to ascertain the total association between each combination. In the second step, two sets of ordinary least square regressions were performed. In the first set, equation (1) was used to test the direct effect of the organization-level
cross-functional communication routine (H1), project team level communication frequency (H2), team development (H3), and reward (H4) on four outcomes of this capability: product innovation, speed-to-market, customer satisfaction with the innovation, and efficiency. The resulting standardized beta values represent the path coefficients of the paths from the organization-level cross-functional communication routine, project team communication frequency, team development, and reward to different outcomes of the capability. In the second set, the project team communication frequency was regressed against the organization-level cross-functional communication routine (H5), project team development (H6) and reward (H7) using equation (2). The standardized beta values represent path coefficients showing the indirect paths to outcomes of capability via project team communication frequency.

(1) \[ \text{Outcome of the capability to mobilize knowledge and create new knowledge} = \alpha + \beta_1 \times O-XCOM + \beta_2 \times P-NCOM + \beta_3 \times P-DEVLOP + \beta_4 \times P-RWRD + \beta_5 \times C-P-TENURE + \beta_6 \times C-P-\#DISCIP + \beta_7 \times C-INDUS1 + \beta_8 \times C-INDUS2 + \epsilon \]

(2) \[ P-NCOM = \alpha + \beta_1 \times O-XCOM + \beta_2 \times P-DEVLOP + \beta_3 \times P-RWRD + \beta_4 \times C-P-TENURE + \beta_5 \times C-P-\#DISCIP + \beta_6 \times C-INDUS1 + \beta_7 \times C-INDUS2 + \epsilon \]

RESULTS

Table 1 presents the descriptive statistics and correlation matrix. Before analyzing the relationships among constructs, the relationships among variables within constructs were analyzed. Several relationships are worth noting. The correlation between PRODNOV and CUSTSAT is \( r = 0.46, p \leq 0.001 \), albeit not strong enough to be redundant measures. Moreover, these variables are conceptually distinct, and therefore will be kept separately in the analysis. The correlation coefficient between project team development (P-DEVLOP) and
reward (P-RWRD) is \( r = 0.42, p < 0.01 \) suggesting that organizations that provide project team development also provide reward for project team performance. These are not redundant measures because they are separate practices, and therefore will also be kept separately in the analysis.

---

Insert Table 1 about here

---

Figure 2 shows the path analyses for product innovation as an outcome of the capability to mobilize knowledge and create new knowledge for innovation. These results support hypotheses (H1, H2, H4, H6, and H7). As predicted, team communication frequency, team development, and organization cross-functional communication routine have a positive effect on this capability. These findings are consistent with both streams of literature on innovation based in organizational behavior that emphasizes team process and outcomes (Griffin and Hauser, 1992; Dougherty, 1987; Roth and Kleiner, 1996) and organization theory that follows the integration-differentiation framework (Nohria and Ghoshal, 1997; Lawrence and Lorsch, 1967; Dougherty, 1992). However, hypothesis 3 that predicts a positive effect of team reward on this capability is not supported. On the one hand, this finding is surprising since previous literature (Ichniowski et al., 1997; Wageman and Baker, 1997; Wageman, 1995) suggest that team reward enhances team performance. On the other hand, this finding is not surprising because the teams in both studies are different from the teams in this study. In the study by Ichniowski et al. (1997) and Wageman (1995) teams belonging to the same function, and in the study by Wageman and Baker (1997) teams are studied in laboratory setting. In this study, they are cross-functional teams. This leads to an interesting idea that for teams consisting of members from different
functions with diverse knowledge sets and thought worlds, reward for team performance may not be adequate for enhancing performance.

Indirectly, both the organization-level cross-functional communication routine and team development support this capability by facilitating team communication frequency. These results support hypotheses (H4 and H7). However, of these two factors, the organization-level cross-functional communication routine appears to have a slightly larger effect on project team communication frequency than project team development (\( \beta = 0.69, p \leq 0.01 \) vs. \( \beta = 0.61, p \leq 0.01 \)). Again, project team reward did not appear to have any impact on team communication frequency. This is contrary to Wageman and Baker (1997) who found that there is more cooperation among team members on teams that were given reward. The difference may be explained by the fact that the teams that Wageman and Baker (1997) studied were in a laboratory setting where as the teams in this study were in their natural setting, and therefore exposed to their contextual factors one of which is communication routine.

---

Insert Figure 2 about here

---

Figure 3 presents the results from testing the effect of the organization-level cross-functional communication routine, team communication frequency, and management practices on speed-to-market. The results support hypotheses (H1, H2, and H6). The results show that team communication frequency, team development, and organization cross-functional communication routine support speed-to-market of the innovation. However, among these three factors, team-level communication frequency and development appear to have a slightly larger effect than the organization-level communication routine (\( \beta = 0.61, p < 0.05 \), \( \beta = 0.57, p < 0.05 \).
and $\beta = 0.53$, $p < 0.05$). One of the reasons for this finding is that although the organization-level communication routine facilitates team communication frequency, in order to deliver the innovation quickly to the market, the team probably had to communicate more frequently than in their daily routine, and this process is facilitated by team development.

---

Insert Figure 3 about here

---

Figure 4 shows the results from testing the model on customer satisfaction with the innovation. The results only support hypothesis (H6). This measure tells us how effective the organization is in incorporating customer preferences, combine them with their design and manufacturing capabilities in generating the innovation that meet these preferences. The results show us that the organization-level cross-functional communication routine or the interaction between these functions on a routine basis supports customer satisfaction with the innovation. Surprisingly, team level factors do not support this measure of capability. Perhaps one of the reasons for this finding is that in achieving high customer satisfaction with the innovation, individuals in different functions have to be kept up to date about any changes in customer preferences even before they organize into project teams for innovation. This requires communication on a routine basis between sales/marketing, design, and manufacturing, regardless of when they are organized into project teams for innovation. This is important because design and manufacturing would be more prepared to listen to sales/marketing about customer preferences and perhaps more willing to make changes in their organizations to accommodate these changes in the external environment.
Figure 5 presents the results from testing team communication frequency, management practices, and organization-level communication routine on efficiency as an outcome of the capability to mobilize knowledge and create new knowledge for innovation. The results support hypotheses (H1, H3, and H6). Team level communication frequency, reward, and organization-level cross-functional communication routine have a positive effect on efficiency. Contrary to previous literature (Roth and Kleiner, 1996), project team development did not have a significant effect on efficiency. According to field interviews, one of the reasons for this finding is that by having to develop the team prior to working on the project, project managers perceived to have used more resources than expected in accomplishing the project, particularly time.

In summary, the results show that both the organization-level and project team level factors have impact on the capability to mobilize knowledge and create new knowledge for innovation. However, the organization-level cross-functional communication routine seems to have impact on a wider range of outcomes of this capability than project team level factors. Although both support product innovation and speed-to-market of the innovation, the organization-level cross-functional communication routine also support the efficiency and customer satisfaction of the innovation. Among the project team management practices, project
team development supports product innovation and speed-to-market of the innovation while project team reward supports efficiency.

These results seem to suggest that organizations that have the organization-level cross-functional communication routine, may find project team management practices less necessary in developing this capability. However, organizations that lack this routine may find the use of project team management practices as substitutes for this limitation. However, these two sets of factors are not perfect substitutes for each other for two reasons. First, the organization-level cross-functional communication routine appears to support a wider range of outcomes of this capability. Second, team communication frequency and development have a larger positive effect on speed-to-market of the innovation than organization-level cross-functional communication routine.

DISCUSSIONS AND CONCLUSIONS

The capability to mobilize knowledge and create new knowledge for innovation is critical for sustaining the competitive advantage, but we do not know how it is developed. The literature on innovation based in organization theory (Lawrence and Lorsch, 1967; Nohria and Ghoshal, 1997) suggests that this capability is supported by the organization-level cross-functional communication pattern or routine, and this routine is developed by integrating different parts of the organization regardless of when employees are organized for innovation. The literature on innovation based in organizational behavior focusing on team internal processes and capability outcomes suggests that team-level management practices facilitate these processes (Ancona and Caldwell, 1992; Clark and Wheelwright, 1992). Therefore, we still do not know whether these practices are complements or substitutes for each other.
This study suggests that for organizations that have the routine that is conducive to knowledge mobilization and creation for innovation, it occurs automatically on project teams, as project teams are embedded in organization. For these organizations project team management practices that facilitate communication on team are at most complements. However, for organizations that lack this supporting routine these practices are substitutes for this limitation.

Therefore, the results suggest that there are potentially two models for developing this capability. On the one hand, it suggests the “organization” model, which follows the integration-differentiation framework and suggests that this capability is developed by creating the organization-level cross-functional communication routine regardless of when it is needed for innovation. On the other hand, it suggests the “project team” model, which proposes that this capability is developed by managing cross-functional communication only as needed when organized into project teams for innovation.

However, this study also shows that these two models are not perfect substitutes for each other. Although project team management practices, particularly project team development looks promising, the team level factors only support product innovation and speed-to-market of the innovation. On the other hand, organization-level cross-functional communication routine, supports a wider range of outcomes of this capability, including the quality of innovation as indicated by customer satisfaction with the innovation and the efficiency in terms of resources used in achieving the innovation.

This study contributes to the literature in several ways. First, it shows empirically how the capability to mobilize knowledge and create new knowledge may be developed. Specifically, it shows that this capability can be developed either by developing the organization-level cross-functional routine regardless of when it is needed for innovation or develop it as
needed at the project team level when organized for innovation, though they are not perfect substitutes.

Second, it integrates two streams of literature on innovation. one that is based in organization theory, particularly the integration-differentiation framework, and the innovation literature based in organizational behavior that emphasizes team processes and their outcomes.

Third, it extends each of these streams of literature. To the innovation literature that follows the integration-differentiation framework, this study shows that instead of integrating different functions to generate communication routine regardless of when it is needed for innovation, communication frequency across these functions can also be created as needed when organized for innovation by using team development. To the innovation literature that emphasizes project team processes and outcomes, this study shows that project teams are embedded in organization and therefore subject to the routines of their context, one of which is communication. The implication is that for organizations that already have the supporting communication routine, when organized into project teams for innovation, the use of team management practices to generate communication is less necessary than organizations that lack this routine.

From a managerial perspective, this study suggests that organizations’ ability to mobilize knowledge and create new knowledge for innovation can be developed using one of two models, depending on the outcomes companies prefer from this capability. For product innovation and speed-to-market of the innovation, organizations can either develop the cross-functional communication routine regardless of when it is needed for innovation or only as needed when organized into project teams for innovation. However, if organizations also want other outcomes of this capability, particularly an innovation that meets customer satisfaction and efficiency in
terms of resources used in the process of achieving the innovation, then developing the organization-level cross-functional communication routine is more effective.
REFERENCES


FIGURE 1

Framework for developing the capability to mobilize knowledge and create knowledge for innovation.
### TABLE 1

Descriptive Statistics and Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Avg</th>
<th>Std Dev</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Product innovation (PRODNOV)</td>
<td>3.72</td>
<td>0.61</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Process innovation (PROCESS)</td>
<td>3.19</td>
<td>0.85</td>
<td>0.13</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Speed-to-market (SPEED)</td>
<td>3.24</td>
<td>0.58</td>
<td>0.22</td>
<td>0.15</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Customer satisfaction (CUSTSAT)</td>
<td>4.05</td>
<td>0.57</td>
<td>0.46*</td>
<td>0.04</td>
<td>0.36*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Efficiency (EFFIC)</td>
<td>1.79</td>
<td>0.37</td>
<td>0.17</td>
<td>0.04</td>
<td>0.04</td>
<td>0.22</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Org. comm. Routine (O-XCOM)</td>
<td>2.63</td>
<td>0.53</td>
<td>0.49**</td>
<td>-0.52***</td>
<td>0.39*</td>
<td>0.36*</td>
<td>0.42</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Team level comm. (P-NCOM)</td>
<td>2.78</td>
<td>0.42</td>
<td>0.58***</td>
<td>0.42**</td>
<td>0.48**</td>
<td>0.32*</td>
<td>0.35*</td>
<td>0.53***</td>
<td>--</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Team development (C-P-DEVLOP)</td>
<td>2.91</td>
<td>0.74</td>
<td>0.42**</td>
<td>0.34*</td>
<td>0.46**</td>
<td>0.25</td>
<td>0.03</td>
<td>0.46**</td>
<td>0.38*</td>
<td>--</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Team reward (C-P-RWRD)</td>
<td>2.12</td>
<td>1.56</td>
<td>0.24</td>
<td>0.15</td>
<td>0.17</td>
<td>-0.04</td>
<td>0.44**</td>
<td>0.33*</td>
<td>0.27</td>
<td>0.42**</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>10. Tenure diversity (C-P-TENURE)</td>
<td>3.40</td>
<td>1.26</td>
<td>0.22</td>
<td>0.14</td>
<td>-0.17</td>
<td>-0.11</td>
<td>-0.13</td>
<td>-0.56***</td>
<td>-0.47***</td>
<td>0.02</td>
<td>-0.21</td>
<td>--</td>
</tr>
<tr>
<td>11. Number of disciplines (C-P-DISCI)</td>
<td>3.63</td>
<td>0.31</td>
<td>0.27</td>
<td>-0.11</td>
<td>0.01</td>
<td>-0.09</td>
<td>0.50***</td>
<td>-0.19</td>
<td>-0.19</td>
<td>0.07</td>
<td>-0.28</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Significance: * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$
FIGURE 2

Path diagram of organization-level communication routine, team communication frequency, management practices, and product innovation as an outcome of the capability to mobilize knowledge and create new knowledge for innovation.

OVERALL MODEL Adjusted $R^2 = 0.22$ ***
Controls: Team Tenure Diversity (C-P-TENURE), Team Functional Diversity (C-P-DISCIP), Industry (C-INDUS1 and C-INDUS2)
Significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Path diagram of organization-level communication routine, team communication frequency, management practices, and speed-to-market as an outcome of the capability to mobilize knowledge and create new knowledge for innovation.

OVERALL MODEL Adjusted $R^2 = 0.24$ ***
Controls: Team Tenure Diversity (C-P-TENURE), Team Functional Diversity (C-P-#DISCIP), Industry (C-INDUS1 and C-INDUS2)
Significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
FIGURE 4

Path diagram of organization-level communication routine, team communication frequency, management practices, and customer satisfaction as an outcome of the capability to mobilize knowledge and create new knowledge for innovation.

OVERALL MODEL Adjusted $R^2 = 0.19$ ***
Controls: Team Tenure Diversity (C-P-TENURE), Team Functional Diversity (C-P-DISCIP), Industry (C-INDUS1 and C-INDUS2)
Significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
FIGURE 5

Path diagram of organization-level communication routine, team communication frequency, management practices, and efficiency as an outcome of the capability to mobilize knowledge and create new knowledge for innovation.

OVERALL MODEL Adjusted $R^2 = 0.23$ ***
Controls: Team Tenure Diversity (C-P-TENURE), Team Functional Diversity (C-P-#DISCIP), Industry (C-INDUS1 and C-INDUS2)
Significance: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$