Determinants of Organizational Innovation Capability:

Development, Socialization, and Incentives

by

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ABSTRACT

This paper analyzes how companies develop the innovation capability by analyzing organizational factors and management practices that facilitate knowledge mobilization and creation for innovation. From in-depth comparative case studies, this study proposes that cross-functional communication frequency and overlapping knowledge influence this capability. While cross-functional communication frequency facilitates knowledge mobilization, overlapping knowledge facilitates the creation process. Moreover, it proposes that a set of management practices relate to how employees are managed, specifically selection, orientation, reward, control over the reward, work pattern, and development, not only support this capability directly but also indirectly by generating cross-functional communication frequency and overlapping knowledge. The empirical tests using 182 innovation teams of 38 companies support these propositions. Specifically, cross-functional communication frequency and overlapping knowledge support a wide range of capability outcomes: product innovation, customer satisfaction with the innovation, efficiency, and speed-to-market of the innovation. For management practices, the results reveal that cross-functional development of professional employees is the key practice as it facilitates a wide range of outcomes of this capability: product innovation, customer satisfaction, efficiency, and speed-to-market of the innovation. Moreover, it indirectly supports this capability by facilitating both cross-functional communication frequency and the accumulation of cross-functional overlapping knowledge. The control over individuals’ rewards divided between functional and non-functional managers, orientation, and team-based work patterns support cross-functional communication frequency, which facilitates knowledge mobilization. However, cross-functional development not only provides the benefits of these practices, but also enables the acquisition of overlapping knowledge, which support the new knowledge creation process and thereby the overall innovation capability.

Key words: Knowledge Mobilization, New Knowledge Creation, and Management Practices.
INTRODUCTION

The innovation capability is critical for competitive advantage, however, we still do not know how to develop it. This capability has been discussed as “dynamic capability” (Teece, Pisano, and Shuen, 1997), “core capability” (Leonard-Barton, 1995), “combinative capability” (Kogut and Zander, 1992), “core competence” (Prahalad and Hamel, 1990), and “integrative capability” (Lawrence and Lorsch, 1967), and these authors consider it as key for competition. However, despite the extensive debate about its importance, there is still limited understanding of “how” organizations develop it. As Foss, Knudsen, and Montgomery (1995) indicate: “The question of intentionality becomes particularly salient when considering how a firm sets out to build a given set of capabilities. Because resources that support a competitive advantage are by definition inimitable, and unidentifiability is a sufficient condition for inimitability, it is difficult to say how one should invest to build a competitive advantage. On the other hand, the view that one cannot make such investments purposively is not satisfactory either. Is there a way out of this conundrum?” (p. 13).

Therefore, the overarching research question of this paper is, “What are the factors and personnel management practices that facilitate the development of organizational innovation capability?” In answering this question, I draw on the theoretical approaches of the resource-based theory of the firm (Penrose, 1959; Barney, 1991) and the innovation literature that focuses on the organization level of analysis (Lawrence and Lorsch, 1967; Nohria and Ghoshal, 1997).

I analyze two propositions about the effects of organization-level factors and personnel management practices on innovation capability drawn from in-depth comparative case studies of 24 cross-functional innovation teams of three companies, which is not presented in this paper. These propositions are tested using 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.

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

This paper draws on and integrates two streams of literature that discuss organizational innovation capability: the resource-based theory of the firm and innovation literature that focuses on the organization level of analysis which is strongly influenced by the integration-differentiation framework. The two propositions analyzed in this paper are: (1) The organization-level processes—cross-functional communication frequency, shared mental model of cooperation, and overlapping knowledge—support the innovation capability. (2) Organization-level personnel management practices—selection, reward and control on reward, orientation, training and development, and team-based work patterns—not only support the innovation capability directly but also indirectly by supporting the organization-level processes that facilitate this capability.

Organizational innovation capability

Organizational innovation capability concerns an organization's ability to combine different types of resources, especially firm-specific knowledge embodied in their employees, for creating new resources that enable firms to achieve and sustain their competitive advantage. Organizational capabilities are viewed as a type of strategic resource, because it is rare, valuable,
inimitable, non-tradable, and non-substitutable (Barney, 1991). In this study, I focus on organizational capabilities of mobilizing and creating knowledge for innovation. These capabilities are specified as a firm’s ability to mobilize knowledge, and combine and convert individual knowledge embedded in different disciplines for creation of new knowledge that results in innovation in products and/or processes. Moreover, these capabilities are dynamic in that they involve the interaction and changes between firm’s internal knowledge and the demands of the external market (Helfat and Raubitschek, 2000). In other words, it involves the continuous integration and combination of knowledge from the external market with the internal knowledge and capabilities of the firm such that the demands of the external market are constantly met. Some related concepts of organizational capabilities are: “core capability” (Leonard-Barton, 1995), “organizational routines” (Nelson and Winter, 1982; Winter, 2000), “core competence” (Prahalad and Hamel, 1990), “combinative capability” (Kogut and Zander, 1992), and “dynamic capability” (Teece, Pisano and Shuen, 1997).

I argue that the literature on organizational capabilities tends to either emphasize knowledge mobilization (e.g., Nelson and Winter, 1982; Prahalad and Hamel, 1990; Kogut and Zander, 1992; Teece et al., 1997) or creation (e.g., Nonaka and Takeuchi, 1995) with Leonard-Barton (1995) who tries to argue for both. Researchers that emphasize knowledge mobilization tend to assume creation occurs and that the critical facilitating factors deal with individuals’ motivation to share or mobilize their individual knowledge. For researchers who emphasize the creation process, individuals are boundedly rational, and therefore, even if the motivation problem for knowledge sharing is solved, knowledge that is being mobilized or shared does not lead to new resources creation. Since individuals are boundedly rational, they face the problems of absorbing and converting knowledge that is being shared and convert it into organizational
knowledge because of knowledge specialization in organization. I propose that this limitation is solved by having individuals with the absorptive capacity for different types of knowledge that is being shared. Therefore, in developing the capability to mobilize and create knowledge for innovation, for mobilization, organization design or personnel management practices that motivate knowledge sharing are critical, and the conversion process requires overlapping knowledge (e.g., Nonaka and Takeuchi, 1995; Leonard-Barton, 1995).

**Organization-level processes and innovation capability**

In this paper I analyze three organization-level factors that are often discussed as facilitators of innovation capability: (1) Cross-functional communication frequency among organization members in the daily context of the organization (Lawrence and Lorsch, 1967); (2) The organization-level shared mental model of cooperation of individuals that embodies the organization shared vision (Prahalad and Hamel, 1990), commitment (Lincoln and Kalleberg, 1990), and the understanding by organization members of how the different thought worlds (Dougherty, 1992) or organization subcultures (Schein, 1996) fit together as a system; (3) Organization-level overlapping knowledge is the overlapping disciplinary knowledge of individuals inside the organization (Leonard-Barton, 1995). These three factors support the innovation capability. Cross-functional communication frequency and the shared mental model of cross-functional cooperation facilitate knowledge mobilization, and overlapping knowledge facilitates the process of new knowledge creation.

*Organization-level cross-functional communication frequency.* Cross-functional communication frequency in organizations has a positive effect on the innovation capability, as it influences the amount of knowledge mobilized or exchanged between and among different functions (Lawrence and Lorsch, 1967). Cross-functional communication frequency supports
innovation, since innovation requires the sharing and integration of different types of functional knowledge (Dougherty, 1992). Innovation is most effective when individuals in sales/marketing provide knowledge and information about customer preferences, and design and manufacturing engineers provide their knowledge and expertise on how to design and manufacture the products. Organizations have different communication channels or routines (Nelson and Winter, 1982), and communication is viewed as knowledge and information exchange that facilitates or hinders knowledge mobilization for innovation. Inside the organization, the communication routines may be mainly internal within the same function or external across different functions, depending on the design of the organization or on how employees are managed (Lawrence and Lorsch, 1967).

In organizations, frequent communication between and across different functions enhances innovation (Nohria and Ghoshal, 1997). Other studies have documented the importance of inter-unit communication for the creation and diffusion of innovations within complex multiunit organizations (e.g. Ghoshal et al., 1994). The more frequent the cross-functional communication, the better the innovation, as there is more knowledge being mobilized. These ideas lead to the hypothesis that:

**H1a.** Organization-level cross-functional communication frequency is positively related to innovation, as an outcome of the innovation capability.

**Organization-level shared mental model of cross-functional cooperation.** The organization-level shared mental model of cross-functional cooperation deals with the way in which individuals in different functions view the organization. Depending on the organization, individuals view different functions as coalitions of interests (Cyert and March, 1963) or as a cooperative system (Barnard, 1938). Organization-shared mental model of cross-functional cooperation embodies the organization-shared vision (Prahalad and Hamel, 1990), commitment...
(Lincoln and Kalleberg, 1990), and the understanding of how the different thought worlds or organization subcultures (Schein, 1996) fit together as a system. Therefore, an organization-shared mental model of cross-functional cooperation not only embodies the collective goals and aspirations of organization members (Tsai and Ghoshal, 1998), but also their understanding of how knowledge embedded in different disciplines links together when necessary for creating new resources. The common vision and commitment help organization members to see the potential value of their knowledge and information mobilization. The understanding of how knowledge in different functions is linked together facilitates the process of identifying which knowledge to mobilize, and how best to exchange and integrate it for innovation. Therefore, the organization-shared mental model of cross-functional cooperation serves as a bonding mechanism that helps different parts of the organization to combine knowledge for innovation. Hence, it is hypothesized that:

H1b. The organization-level shared mental model of cross-functional cooperation is positively related to innovation, as an outcome of the innovation capability.

**Organization-level cross-functional overlapping knowledge.** Overlapping knowledge supports individual knowledge conversion into organizational resources. Overlapping knowledge deals with the overlapping disciplinary knowledge in the organization. Organization members that possess overlapping knowledge in other disciplines have absorptive capacity for knowledge in disciplines they overlap. This absorptive capacity facilitates the knowledge creation processes in two ways. First, as each function or a community of practice (Brown and Duguid, 1991) has its own thought world where knowledge is embedded, the overlapping knowledge in other functions enables individuals to take the perspective of other functions during the process of knowledge exchange with members from those functions in the process of innovation (Boland
and Tenkasi, 1996). Second, individuals with the overlapping knowledge of other functions possess absorptive capacity for receiving knowledge from other functions, as their overlapping knowledge enables them to take the perspective of those functions when combining knowledge with their own function in the process of innovation (Boland and Tenkasi, 1996). The underlying logic is that overlapping knowledge sets provide individuals with the cognitive capability and absorptive capacity to combine insights synergistically, effectively, and efficiently from multiple knowledge sets for innovation. This leads to the hypothesis that:

**H1c. Organization-level cross-functional overlapping knowledge is positively related to innovation, as an outcome of the innovation capability.**

**Personnel management practices and innovation capability**

Since organizational innovation capability is about the ability of the firm to mobilize knowledge embodied in employees for combination and creation of new resources, i.e. products or processes, how employees are managed influence the innovation capability. While some researchers suggest that the reward systems motivate knowledge mobilization for innovation (e.g. Manners et al., 1983), others suggest the initial socialization or orientation of new employees that encourage the building of social ties (Nohria and Ghoshal, 1997), training and development of certain groups of employees, particularly the engineers (Basadur, 1992), or the combination of these practices (e.g. Shapero, 1985), support the innovation capability.

**Organization-level selection.** High-performing organizations carefully screen employees for personality traits that are conducive to team work environment for knowledge sharing that is critical for innovation, in addition to using other innovative practices (Ichniowski et al., 1997). Applying this idea to an organization that organizes into project teams to share knowledge to create new knowledge resulting in innovation, selecting employees based on behavioral factors
conducive to knowledge mobilization enhances new resources creation, i.e., innovation. These discussions lead to the hypothesis that:

*H2a. Organization-level selection based, in part, on behavioral factors conducive to knowledge sharing is positively related to innovation, as an outcome of the innovation capability.*

**Organization-level reward systems.** Organizations with extensive knowledge mobilization, reward employees based partly on these behaviors (Aoki, 1988). The author suggests that the willingness to exchange knowledge and information in Japanese firms is not determined by their cultural value systems but by the reward system that encourages these behaviors. Robinson (1996) also shows that in Japanese companies the reward system for non-management employees is not only based on individual-based performance but also on behavioral factors, particularly attitudes related to cooperation and knowledge and information sharing. Moreover, the survey conducted by the Japanese Ministry of Labor (1987) analyzing the factors that companies use in rewarding employees, also shows that morale building, which is related to cooperation and knowledge sharing, is a critical factor in bonus payment and promotion. I hypothesize that:

*H2b. Organization-level reward system based, in part, on cooperative behaviors is positively related to innovation, as an outcome of the innovation capability.*

**Organization-level control over individuals’ rewards.** Previous studies (e.g., Katz and Allen, 1985) suggest that organizations with the innovation capability also grant the project managers some control over individuals’ rewards. Japanese firms that are considered to have superior innovation capability (Nonaka and Takeuchi, 1995) also divide the control over individuals’ rewards between functional and non-functional managers (Robinson, 1996). In Japanese firms, both the functional and personnel managers have influence on the individual
reward system. While functional managers have influence on individual performance evaluation, personnel managers have the final say in the overall performance evaluation and reward of employees. Personnel managers decide on individual job assignment, bonus payment, and promotion. On the other hand, in American firms, which are considered to have lower innovation capability (Clark and Wheelwright, 1992), functional managers exercise sole control over individuals' rewards (Aoki, 1988; Robinson, 1996). Based on these analyses, I hypothesize that:

**H2c. The organization-level reward system that divides the control over individuals' rewards between functional and non-functional managers is positively related to innovation, as an outcome of the innovation capability.**

**Organization-level work patterns.** The use of team-based work patterns enhances teamwork performance (Basadur, 1992; Ichniowski et al., 1997). Since innovation requires the use of project teams (Clark and Wheelwright, 1992), this study applies this concept to project team performance and argues that organizations that have superior innovation capability also use team-based work patterns in performing daily tasks. In Japanese firms, when new employees first arrive in a given department, they are not assigned a task to perform alone, but with others in carrying out tasks (Robinson, 1996; Aoki, 1988). Moreover, participation on cross-functional problem solving teams, such as quality circles in the daily context of organization is also higher in Japanese firms than in their US counterparts (Aoki, 1988). Since daily tasks are organized based, in part, on teams, employees acquire knowledge and skills on how to work on teams. Therefore, when organized into project teams for innovation, they bring knowledge and skills to facilitate knowledge mobilization and creation for innovation (Staw et al., 1981). These analyses lead to the hypothesis that:
H2d. Organization-level cross-functional work pattern is positively related to innovation, as an outcome of the innovation capability.

**Organization-level cross-functional socialization.** Cross-functional orientation is cross-functional socialization of new employees. Companies that provide cross-functional orientation to new employees have higher innovation capability than companies that do not use this practice (Nohria and Ghoshal, 1997). These authors suggest that Japanese firms have superior innovation capability, compared to their European and American competitors, in part, because of the initial socialization of new employees, which exposes them to different parts of the organization. This exposure enables employees to build social ties with other employees in different parts of the organization that encourage knowledge exchange. Other studies (e.g., Basadur, 1992) that compare the innovation capability of North American and Japanese firms also show that newly hired R&D scientists and engineers in Japanese firms are initially exposed to the sales organization, then to manufacturing and other engineering organizations. These discussions lead to the hypothesis that:

H2e. Organization-level cross-functional orientation is positively related to innovation, as an outcome of the innovation capability.

**Organization-level cross-functional development.** Previous research also argues that cross-functional development of employees enhances the innovation capability (e.g., Nonaka and Takeuchi, 1995; Leonard-Barton, 1995), especially the creation process. This practice differs from cross-functional orientation in that its purpose is not only to give employees exposure to these organizations, but also to help them acquire knowledge and skills in these organizations that usually takes a longer period of time to accomplish. Westney and Sakakibara (1986), who compare the development of engineers in US and Japanese computer companies, show that the
career paths of engineers in Japanese companies include spending an extended period of time in manufacturing and R&D organizations. US companies, however, do not use this practice (Leonard-Barton, 1995). Based on these analyses, I hypothesize that:

\[ H2f. \text{ Organization-level cross-functional development is positively related to innovation, as an outcome of the innovation capability.} \]

An indirect effect of personnel management practices on organizational innovation capability. Human resource management practices also affect the innovation capability indirectly by affecting the organization-level processes, particularly cross-functional communication frequency, shared mental model of cross-functional cooperation, and overlapping knowledge, that are proposed to support this capability.

Organization-level orientation, cross-functional communication, and shared mental model of cross-functional cooperation. Cross-functional orientation, or the initial socialization of employees, serves two purposes that enhance the organization’s ability to mobilize knowledge and new knowledge for innovation. On the one hand, by exposing employees to different functions, it encourages cross-functional communication frequency through the building of social networks in these functions (Galbraith, 1977), so that individuals are more willing to share knowledge and information with those with whom they have had prior social interaction (Tsai and Ghoshal, 1998). On the other hand, the initial orientation is critical in shaping how individuals will view the organization (Louis, 1980) for the rest of their careers. Upon entering the organization, individuals are exposed to different organization functions, and cognitive maps of their surroundings (Katz, 1997:26) will include these different “territories” and the way in which they all link together as a cooperative system (Barnard, 1938), replacing individual goals with the goal of the organization (Ouchi, 1979). Therefore, cross-functional orientation builds
organization-level shared mental model of cross-functional cooperation that encompasses shared commitment (Lincoln and Kalleberg, 1990), shared goal (Ouchi, 1979), and the understanding of how knowledge embedded in different disciplines may be linked together for innovation. These discussions lead to the hypotheses that:

**H3a.** Organization-level cross-functional orientation is positively related to organization-level cross-functional communication frequency.

**H3b.** Organization-level cross-functional orientation is positively related to organization-level shared mental model of cross-functional cooperation.

Organization-level control over individuals' rewards and organization-level cross-functional communication frequency. The nature of managerial control over individuals' rewards affects communication patterns in organizations (Morrill, 1995). In the organization where functional managers have all the control on individuals' rewards, communication tends to be vertical, within the same function, between superior and subordinates, with limited cross-functional communication. In the organizations where the influence is divided among managers from within and outside the functions, communication tends to be both within and across different functions. The rational actor model (Milgrom and Roberts, 1992) also suggests that individuals have the incentive to communicate more frequently with managers who have influence on their rewards, and who influence decisions of other in performance evaluation and reward. Therefore, if this influence is divided among managers from within and outside individual functions, employees have the incentive to communicate across functions to influence decisions on their performance evaluation and reward. Over time, these communication patterns become routinized in the organization (Morrill, 1995). These discussions lead to the hypothesis that:
H3c. Control over individuals’ rewards that is divided between functional and non-functional managers is positively related to organization-level cross-functional communication frequency.

Organization-level work patterns and organization-level cross-functional communication frequency. The use of cross-functional work patterns such as task forces facilitates cross-functional communication frequency (Galbraith, 1977). When individuals work on cross-functional task forces, their exposure to individuals from different functions facilitates network formation, which encourages cross-functional communication. Individuals who gained this exposure tended to communicate more frequently cross-functionally in order to acquire knowledge and information as needed for their daily tasks than did those who lack the exposure (Newport, 1969). Moreover, individuals who had this exposure not only tended to communicate more frequently outside their functions, but also tended to use richer means of communication, such as using face-to-face meetings and phone conversations, rather than the written forms of communication used by individuals who lacked the exposure (Newport, 1969). These analyses lead to the hypothesis that:

H3d. Work patterns that include the use of cross-functional teams are positively related to organization-level cross-functional communication frequency.

Organization-level cross-functional development, communication frequency, shared mental model of cross-functional cooperation, and overlapping knowledge. Cross-functional development is a process whereby employees are sent to different functions through on-the-job training and/or career development for an extended period of time, in order to acquire knowledge and skills of those functions. Cross-functional development serves three purposes in facilitating the innovation capability: (1) The benefit that is most frequently discussed in the literature is that cross-functional development enables the acquisition of redundant knowledge (Leonard-Barton,
1995; Nonaka and Takeuchi, 1995); (2) Through cross-functional development, while acquiring knowledge and skills from different functions, employees also form networks in these functions that facilitate cross-functional communication; and (3) Cross-functional development also facilitates the formation of organization-shared mental model of cross-functional cooperation. While acquiring redundant knowledge and forming networks that facilitate cross-functional communication, individuals also gain a better understanding of the different thought worlds of these functions and the way in which knowledge embedded in these functions may be shared and integrated when necessary for innovation. These analyses lead to the following hypotheses:

H3e. Organization-level cross-functional development is positively related to the organization-level overlapping knowledge.

H3f. Organization-level cross-functional development is positively related to organization-level cross-functional communication frequency.

H3g. Organization-level cross-functional development is positively related to organization-level shared mental model of cross-functional cooperation.

**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). Data on the organization-level processes and practices were collected from a personnel manager of each firm, 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 project team-level outcomes of innovation capability were collected from both 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 \( r > 0.40, \ p \geq 0.05 \). However, in order to minimize bias on team performance, instead of using team leaders' answers, project managers' evaluations of these projects are used (Ancona and Caldwell, 1992). The response rate was 88.4%.

**Variables and measures**

The variables and measures are based on the following constructs: Personnel management practices, organization-level processes, and outcomes of the innovation capability at both the organization and project levels. Variables preceded by O- refer to organization-level
variables, variables with the prefix P- indicate project team-level variables, and variables that start with C- are controls.

*The innovation capability.* The innovation capability is measured both at the organization and at the project levels. At the organization level, innovation is measured by organization's level of success in incorporating external customer feedback from its worldwide operations in new product development, product modification, and the number of products developed within the last five years ($\alpha = 0.84$). Effectiveness and efficiency are also used as measures for this capability. For effectiveness, customer satisfaction with the innovation is measured by ratings given by JD Power & Associates for the automobile companies in terms of "dependability", "appearance", and "overall quality", PC World for the computer companies, and an external marketing research company for companies in the photo imaging industry ($\alpha = 0.87$).

At the project level, all the measures are averaged by the organization. Innovation is measured by the extent to which projects using customer feedback led to new product development and/or modification (0.87). Efficiency is measured by staff hours and financial resources used in completing the project measure efficiency ($\alpha = 0.70$). Speed-to-market is measured by the extent to which the innovation was delivered quickly enough to customers to satisfy them.

*Personnel management practices.* In order to capture personnel management practices more realistically, an in-depth comparative analysis of three companies, two located in the USA and one in Japan, was conducted to understand how companies develop the innovation capability. The personnel management practices analyzed in this study are, therefore, based not only on previous research, but also on personal interviews and on first-hand observations of
these companies. The company practices are divided into two groups, those that facilitate knowledge mobilization and the practice that facilitates knowledge creation.

Facilitators of knowledge mobilization are: (1) Selection (O-SELECT), which is selection based on “ability to work on team” and “the willingness to cooperate” coded from the evaluation forms used for recruiting by companies (α = 0.73). (2) The reward structure (O-RWRD) in this system consists of the extent to which “cooperative behaviors” have any impact on individual salary increase, job assignment, bonus payment, and promotion coded from performance evaluation forms used by companies (α = 0.79). (3) Nature of managerial control on individuals’ rewards was determined by how much influence the project managers (O-XCNTRL) have on individual salary increase, promotion and job assignment (α = 0.91). I analyzed project managers’ control, since in the American context, personnel managers have little or no influence on the individual reward system. (4) Cross-functional orientation (O-ORIEN) was measured by whether companies put new professional employees through cross-functional orientation at both the operational and corporate levels (α = 0.81). (5) Work pattern (O-WKPTRN) is measured by whether daily task requires the use of team, and if so, the level of employee participation on cross-functional teams on quality circles (α = 0.73).

The facilitator of knowledge creation is cross-functional development (O-DEVLOP), which is measured by whether companies put their professional workforce, particularly engineers, sales/marketing, and customer service personnel, through on-the-job training, off-the-job training, and job rotation in other functions, particularly R&D, sales/marketing, and manufacturing (α = 0.76).

Organization-level processes. The organization-level process variables are also divided into those practices that facilitate knowledge mobilization and the practice that facilitates
knowledge creation. Facilitators of knowledge mobilization are: (1) cross-functional communication frequency (O-XCOM), which is measured by cross-functional formal communication frequency (dealing with work related issues) and informal (not work-related and on personal time, i.e., coffee breaks, after work) among management and non-management rank employees ($\alpha = 0.73$). (2) For organization-shared mental model of cross-functional cooperation (O-MODEL), the measures are the extent to which employees in different functions share the vision of the organization and their commitment toward achieving it as opposed to focus on individual functional goal ($\alpha = 0.78$). The facilitator of knowledge creation is cross-functional overlapping knowledge (O-OVERLAP), which is measured by the summation of overlapping training domains through on-the-job, off-the-job training, and job rotation of engineers in sales/marketing, R&D, and manufacturing. I select these training practices because they factor together ($0.77$).

The control variables are industry (C-INDUS1, C-INDUS2) and country (C-JAPAN). They are dummy variables.

Methods of analysis

The Tobit method is used to analyze the data since the dependent variables were constrained to an interval. The models use alternative measures of the outcomes of the innovation capability both at the organization level (innovation and customer satisfaction) and project team level (innovation, efficiency, and speed-to-market). Hypotheses (H1a, H1b, H1c), which analyze the relationships between the organization-level processes and the innovation capability, are tested using the following model:

$$\text{Outcomes of the innovation capability} = \alpha + \beta_1 \cdot O\text{-XCOM} + \beta_2 \cdot O\text{-MODEL} + \beta_3 \cdot O\text{-OVERLAP} + \beta_4 \cdot C\text{-INDUS1} + \beta_5 \cdot C\text{-INDUS2} + \beta_6 \cdot C\text{-JAPAN} + \epsilon$$
For testing the direct effect of personnel management practices on the innovation capability (H2a-H2f), the following specifications are used:

Outcomes of the innovation capability = \( \alpha + \beta_1 \cdot O-SELECT + \beta_2 \cdot O-RWRD + \beta_3 \cdot O-XCNTRL + \beta_4 \cdot O-ORIEN + \beta_5 \cdot O-WKPTRN + \beta_6 \cdot O-DEVLOP + \beta_7 \cdot C-INDUS1 + \beta_8 \cdot C-INDUS2 + \beta_9 \cdot C-JAPAN + \varepsilon \)

For testing the indirect effect of personnel management practices on the organization-level processes that support the innovation capability (H3a-H3g), the following models are used:

\( O-XCOM = \alpha + \beta_1 \cdot O-XCNTRL + \beta_2 \cdot O-ORIEN + \beta_3 \cdot O-WKPTRN + \beta_4 \cdot O-DEVLOP + \beta_5 \cdot C-INDUS1 + \beta_6 \cdot C-INDUS2 + \beta_7 \cdot C-JAPAN + \varepsilon \)

\( O-MODEL = \alpha + \beta_1 \cdot O-ORIEN + \beta_2 \cdot O-DEVLOP + \beta_3 \cdot C-INDUS1 + \beta_4 \cdot C-INDUS2 + \beta_5 \cdot C-JAPAN + \varepsilon \)

\( O-OVERLAP = \alpha + \beta_1 \cdot O-DEVLOP + \beta_2 \cdot C-INDUS1 + \beta_3 \cdot C-INDUS2 + \beta_4 \cdot C-JAPAN + \varepsilon \)

**ANALYSIS AND RESULTS**

Table 1 presents the descriptive statistics and correlation analysis. The results show relatively high correlation between the dependent and independent measures. The relatively small correlation coefficients between the independent variables suggest they are distinct from each other, and they thus demand independently treatment in this analysis.

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Insert Table 1 about here
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Table 2 presents the results from testing hypotheses (H1a-H1c). The results support hypotheses H1a, H1b, and H1c, and the proposition that the organization-level processes, particularly cross-functional communication frequency, organization-shared mental model of
cross-functional cooperation, and cross-functional overlapping knowledge, support the innovation capability. Cross-functional communication frequency and overlapping knowledge support innovation and customer satisfaction with the innovation at the organization level. At the project level, both factors support efficiency in the process of creating innovation, speed-to-market, and product innovation. Specifically, Model 1 shows that cross-functional communication frequency and overlapping knowledge have a positive effect on product innovation. Model 2 also shows that these two factors have a positive effect on customer satisfaction. Shared mental model of cross-functional cooperation has a negative effect on customer satisfaction with the innovation. One explanation could be that innovation also requires creative abrasion (Leonard-Barton, 1995), and too much cooperation reduces it. Model 3 shows that cross-functional communication frequency and overlapping knowledge have a positive effect on product innovation. Model 4 shows that cross-functional communication frequency and overlapping knowledge support efficiency. Model 5 shows that cross-functional communication frequency and overlapping knowledge have a positive relationship to speed-to-market of the innovation. Among these two factors, however, cross-functional communication seems to have smaller effect on product innovation than overlapping knowledge but greater effect on other outcomes of this capability.

***************
Insert Table 2 about here
***************

Table 3 presents the results from testing hypotheses (H2a-H2f). The results from these analyses support hypotheses H2a, H2b, H2d, and H2e, and the proposition that personnel management practices have a direct effect on the innovation capability.

Model 1 shows that selection, reward, cross-functional orientation, and cross-functional development have a positive effect on product innovation. Influence of project manager on
individual reward system and team-based work pattern do not have any effect on product innovation, which is contrary to the hypotheses H2c and H2f. Model 2 shows that cross-functional orientation and cross-functional development have a positive effect on customer satisfaction with the innovation. Model 3 shows that selection, control over individuals’ rewards, and cross-functional development have a positive relationship with product innovation at the project level, while reward and cross-functional orientation have a negative effect on product innovation at the project level. At the project level, Model 4 shows that reward, control over individuals’ rewards, and cross-functional orientation, cross-functional development, and team-based work patterns have a positive effect on efficiency at the project level. Model 5 shows that the control over individuals’ rewards and cross-functional development have a positive effect on speed-to-market of the innovation. Overall, cross-functional development seems to support a wider range of outcomes of capability, followed by control over individual’s rewards, cross-functional orientation, reward behaviors, and select behaviors.

***************
Insert Table 3 about here
***************

Table 4 presents the results from testing the indirect effect of personnel management practices on the innovation capability by affecting the organization-level processes that support the process of knowledge mobilization and creation for innovation. The hypotheses tested are (H3a-H3g), and the results demonstrate that all hypotheses are supported.

Model 1 indicates that not only does cross-functional orientation facilitate cross-functional communication frequency, control over individuals’ rewards, cross-functional development, and the use of cross-functional work patterns also have a positive effect on cross-functional communication frequency. Cross-functional work patterns, however, has the strongest effect, as indicated by its coefficient. Model 2 shows that cross-functional orientation
and cross-functional development facilitate shared mental model of cross-functional cooperation. Model 3 shows that cross-functional development is positively related to overlapping knowledge. The overall results show that personnel management practices also support the innovation capability indirectly by supporting the organization level processes that support this capability. Of all the practices, however, cross-functional development supports all three organization-level processes analyzed in this study. Cross-functional development supports cross-functional communication frequency and overlapping knowledge, which support the organizational innovation capability, and shared mental model of cross-functional cooperation, which supports it at the project level.

***************
Insert Table 4 about here
***************

The results show that for innovation as an outcome of the innovation, personnel management practices and processes support this capability. Specifically, for innovation, cross-functional communication frequency and overlapping knowledge support it. Cross-functional communication frequency also supports other outcomes of this capability such as efficiency, and speed-to-market. For overlapping knowledge, it also supports customer satisfaction with innovation at the organization level, and efficiency, speed-to-market, and product innovation at the project level.

Among personnel management practices, selection of employees based on behavioral factors such as their ability to work on team and the willingness to cooperate, reward based on cooperative behaviors, cross-functional orientation, and development directly support innovation as an outcome of this capability. Surprisingly, the control of project manager over individuals’ rewards and cross-functional work pattern do not support this. However, the control of the project manager over individuals’ rewards supports other outcomes of this capability at the
project level, efficiency, speed-to-market, and product innovation. The use of cross-functional work pattern also enhances efficiency in the process of knowledge mobilization and creation for innovation.

Moreover, these management practices also support this capability indirectly by supporting the organization-level processes that also support the capability. The control of project manager over individuals’ rewards, and cross-functional orientation, cross-functional development, and the use of cross-functional work patterns, facilitate cross-functional communication. Among these practices, cross-functional orientation and development facilitate the building of shared mental model of cross-functional cooperation. And, cross-functional development also enables companies to accumulate overlapping knowledge that enhances a wide range of outcomes of this capability. The downside of these practices seem to be that the organization shared mental model of cross-functional cooperation has a negative effect on the overall customer satisfaction with innovation of the company (see Table 2).

DISCUSSION AND CONCLUSIONS

This paper shows the specific organization-level factors and management practices that facilitate knowledge mobilization and creation, and therefore the innovation capability. However, the story of how this capability is developed is not so simple. Since we cannot measure capability directly but its outcomes, depending on the outcomes desired by the firms, different factors and practices seem to support different outcomes of this capability. First, for firms that compete on product innovation, the organization-level process that facilitates knowledge mobilization is cross-functional communication frequency and the factor that facilitates creation is overlapping knowledge, in particular, the redundancy among R&D,
manufacturing, and sales/marketing. The management practices that seem to support knowledge mobilization are: selection of employees based, not only on their individual potential performance, but also their character traits that are conducive to knowledge sharing and cooperation in organization. Moreover, reward is based, not only on their individual explicit output, but also behavioral factors such as cooperation. In addition, cross-functional orientation and development seem to be also important.

Second, for companies that consider customer satisfaction with their innovation to be important, cross-functional communication and overlapping knowledge seem to be important. At the same time, such firms may need to be cautious with the organization shared mental model of cross-functional cooperation, since too much cooperation may reduce the creative abrasion that is also necessary for innovation. Cross-functional orientation and development also appear to be important for this outcome of capability.

Third, for companies that place high value on efficiency, cross-functional communication frequency and overlapping knowledge are important. On the one hand, cross-functional communication frequency facilitates knowledge mobilization while overlapping knowledge supports the new knowledge creation process. Among the management practices that seem to facilitate knowledge mobilization and creation are reward based, in part, on behavioral factors, the division of control on individuals' rewards between functional and project managers, cross-functional orientation, the use of team-based work patterns, and cross-functional development.

Fourth, if speed-to-market is considered important, then similar factors and practices are also considered. Specifically, cross-functional communication frequency and overlapping knowledge may be important. The specific practices that are critical include division of control
over individuals’ rewards between functional and project managers, and development of professional employees cross functionally.

In summary, it seems that organization-level cross-functional communication frequency and overlapping knowledge are the most important organization-level factors in supporting knowledge mobilization and creation, as they facilitate a wide range of outcomes of this capability. As found in the case analysis, organization-level cross-functional communication facilitates knowledge mobilization, while overlapping knowledge facilitates the knowledge creation process. Moreover, although various personnel management practices facilitate cross-functional communication frequency, only cross-functional development seems to facilitate both cross-functional communication frequency and overlapping knowledge. Therefore, it seems that the most critical organization-level factor in developing the innovation capability is cross-functional development of professional employees. This practice entails rotating engineers between R&D and manufacturing, and providing them with some off-the-job training in sales/marketing.
REFERENCES


Ouchi, W. 1979. Markets, bureaucracy and clans. Mimeo, Graduate School of Management, University of California at Los Angeles, Los Angeles, CA.


TABLE 1

Descriptive statistics and correlation matrix

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<td>0.41</td>
<td>0.21</td>
<td>0.23</td>
<td>0.11</td>
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</table>

Note: Correlation coefficients ≥ 0.32 are statistically significant at p ≤ 0.05.
TABLE 2

The direct effect of management practices on organizational innovation capability

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<th>Organization-level</th>
<th>Project-level</th>
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<td><strong>Product innovation</strong></td>
<td><strong>Customer satisfaction</strong></td>
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<td>O-Model of cooperation</td>
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<td>O-Overlapping knowledge</td>
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<td>C-JAPAN</td>
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Note: Standard errors in parentheses. Significance: ***0.001, **0.01, *.05, †0.1.
TABLE 3

The direct effect of management practices on organizational innovation capability

<table>
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<th>Model</th>
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Note: Standard errors in parentheses. Significance: ***0.001, **0.01, *.05, †0.1.
TABLE 4

The indirect effect of organizational management practices on organizational innovation capability

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Note: Standard errors in parentheses. Significance: ***0.001, **0.01, *.05, *0.1.