ORGANIZATIONAL CAPABILITIES, KNOWLEDGE, AND INNOVATION: STRATEGIES FOR DEVELOPING THE CAPABILITY TO MOBILIZE AND CREATE KNOWLEDGE FOR INNOVATION

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Thesis Abstract

In this thesis I analyze the way in which companies develop the capability to mobilize and create knowledge for innovation. This capability is crucial to achieve and maintain a sustainable competitive advantage. In order to conduct this analysis, I link and integrate three bodies of literature –the literature on resource-based theory of the firm, team-level studies of innovation, and organization-level studies of innovation to provide an integrated view of how companies develop the capability to innovate and how this relates to their performance.

The empirical analysis was conducted in two phases, in order to develop an empirically grounded and generalizable theory. In the first phase, in order to understand "how" companies develop this capability, I conducted a comparative multiple case study of twenty-four cross-functional innovation teams in three companies. The result of this analysis was a general framework for the development of the capability to mobilize and create knowledge for innovation. From this I drew eight propositions regarding what companies do at the organizational level and at the project team level when organizing for innovation. In the second phase, I analyzed these propositions and examined which specific factors and strategies have a greater influence on this capability in a sample of 182 cross-functional innovation teams belonging to 38 companies. The innovation teams were selected from the largest customer service center of each firm. They were formed with the objective of using market knowledge about their products and services to innovate in response to customer preferences. In addition to innovation, I analyzed other outcomes of this capability, such as efficiency in terms of resources used, effectiveness in terms of customer satisfaction and speed-to-market of the innovation, and learning. The results of the tests and their theoretical and practical implications are listed below, grouped by level of analysis:

Capability development at the project team level. In terms of project team-level processes, the results suggest that in developing the capability to mobilize and create knowledge for innovation, the processes facilitating knowledge mobilization through communication and those facilitating knowledge creation, through overlapping knowledge, should be considered separately. Communication frequency facilitates knowledge mobilization among team members and its organizational environment, while overlapping knowledge facilitates the transformation and conversion of individual knowledge into organizational resources.

With regard to the project team-level management practices, project team development, which is training on how to work on team for the particular project, affects team communication.

Membership selection based on tenure diversity is probably more effective in capturing overlapping knowledge than selection based on overlapping knowledge. Among the project team-level management practices, team development supports a wide range of outcomes of this capability –product innovation, speed-to-market of the innovation, customer satisfaction with the innovation, and learning– and indirectly supports this capability by facilitating team-internal and external communication frequency. However, team development also builds a shared mental model of cooperation, which has a negative effect on product innovation. Team membership selection based on overlapping knowledge does not ensure overlapping knowledge on teams, which suggests that individuals in charge of forming teams may not have accurate information about knowledge sets of their team members. Tenure diversity and team size explain more of the variance of overlapping knowledge on teams. Rewards at the team level support speed-to-market of the innovation, but does not have a demonstrated effect on team communication.

Capability development at the organizational level. Regarding the organization-level processes, the results suggest that the capability to mobilize and create knowledge for innovation is supported by processes that not only facilitate knowledge mobilization, particularly communication, but also facilitate knowledge creation, specifically overlapping knowledge. Among the organization-level processes, cross-functional communication frequency and overlapping knowledge are key facilitators for developing this capability as they support a wide range of capability outcomes: product innovation, customer satisfaction, efficiency, speed-to-market with the innovation, and learning. While cross-functional communication frequency facilitates knowledge mobilization in organization, overlapping knowledge supports the process of new knowledge creation.

With regard to the organization-level management practices, the results suggest that for innovation, organization-level management practices that facilitate both knowledge mobilization and knowledge creation are necessary. Organization-level management practices, particularly cross-functional development of professional employees, facilitate a wide range of outcomes of this capability: product innovation, customer satisfaction, efficiency, speed-to-market with the innovation, and learning. Moreover, they indirectly support this capability by facilitating cross-functional communication frequency and the accumulation of cross-functional overlapping knowledge. Other management practices, particularly the division of control on individuals' rewards between functional and project managers, cross-functional orientation, and the use of cross-functional work patterns, support cross-functional communication frequency, which facilitates knowledge mobilization. However, cross-functional development not only offers the benefits of these practices, but also enables the acquisition of redundant knowledge, which facilitates the new knowledge creation process.

Linking project team-level and organization-level capability development. The results suggest that to understand the development of the capabilities to mobilize and create knowledge for innovation, managers and researchers should consider both levels of analysis, because there is a "mirror image" of project teams and their organizations. Organizations that have the supporting organization-level processes –cross-functional communication patterns and a shared mental model of cooperation– built into their organizations, when organized into project teams for innovation, are more likely to find the supporting processes in their project teams. This result suggests that for such organizations, the use of project team management practices that facilitate knowledge mobilization, i.e., team development, is probably less necessary than for organizations that lack these processes. However, project team management practices are not perfect substitutes for the lack of supporting organization-level processes. Overlapping knowledge that is found at the project team level is developed at the organizational level regardless of when it is needed for innovation, since it takes time to acquire.

Finally, this study shows that companies follow one of three strategies for developing the capability to mobilize and create knowledge for innovation: the organization, project team, or mixed strategy. The mixed strategy is associated with highest performance in terms of the capability developed and financial measures, followed by the project team and the organization strategies. The critical mix of management practices at both levels consists, on one hand, of cross-functional development of professional employees, particularly engineers, by their rotation between R&D and manufacturing and off-the-job training in sales/marketing. On the other hand, when project teams are being organized for innovation, it is crucial for project team development to have the team leader, internal "trainer," or external "experts" facilitate project teams as an initial step in organizing their work processes.

Overall, this thesis expands and integrates three bodies of literature to provide an integrated view of how companies develop the capability to mobilize and create knowledge for innovation. In terms of the resource-based theory of the firm, this study shows how companies develop this capability. In terms of the team-level innovation literature, the mirror image between project team-level processes and their organization-level processes suggests that teams should not be analyzed in isolation from their organization-level processes. In terms of the organization-level innovation literature, especially the differentiation-integration framework, facilitators of knowledge mobilization, i.e., communication, can also be developed as needed at the project team level when teams organize for innovation.

Furthermore, this thesis provides recommendations for specific strategies and practices that managers can follow to develop this capability both at the organizational level, regardless of when they organize for innovation, and at the project team level, when firms organize for innovation in order to achieve a sustainable competitive advantage.

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Outline

1. INTRODUCTION AND THESIS OVERVIEW

1.1. MOTIVATION AND RESEARCH QUESTION

The capability to mobilize and create knowledge for innovation has been viewed as critical for competitive advantage (Helfat, and Raubitschek, 2000). It has been referred to as "integrative capability" (Lawrence and Lorsch, 1967), "core competence" (Prahalad and Hamel, 1990), "combinative capability" (Kogut and Zander, 1992), and "dynamic capability" (Teece, Pisano, and Shuen, 1997). However, despite the extensive debate about the value of firms' capability to mobilize and create knowledge for innovation that meets the demands of the external markets (Jamison, 1999; Grant, 1998; Lukus and Ferrel, 2000; Cristiano, Liker, and White, 2000), there is still limited understanding of "how" companies accomplish this, as Foss, Knudsen, and Montgomery (1995) state: "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).

In practice, for example, in August 2000, the inability of Ford Motor, the US carmaker, and Firestone, the Japanese tire maker and supplier to Ford, to mobilize and create knowledge for innovation cost them dearly. Unsolved problems with the tires of the Ford Explorer, the best-selling sport utility vehicle in the US market, not only led to one of the largest product recalls in consumer product history and a drop of 15% and 33% in market price respectively, but also put their brands in jeopardy (The Economist, 2000: 57; Muller, Welch and Green, 2000). Moreover, the stereotype that Japanese companies had superior capability to utilize market knowledge to create new knowledge for innovation had also been demystified (Kunii, 2000). Meanwhile, the ability of 3M's chemicals division to push a new cooling technology into new markets using customer information (Wah, 1999), as well as IBM's ability to incorporate market information about its notebook computers and scanners for innovation, enhanced these companies' performance (Sager, 1998).

Despite the limitation in knowledge of how this capability is developed, there is some agreement about critical features of organizational capabilities. First, these capabilities require knowledge mobilization and combination (Prahalad and Hamel, 1990; Kogut and Zander, 1992; Nelson and Winter, 1982; Winter, 2000; Helfat and Raubitschek, 2000) and new knowledge creation (Nonaka, 1994; and Leonard-Barton, 1995) that result in innovation. On one hand, researchers who analyze knowledge mobilization and assume creation follows from such mobilization (Prahalad and Hamel, 1990; Kogut and Zander, 1992; Nelson and Winter, 1982; Winter, 2000; Helfat and Raubitscheck, 2000) suggest that organization-level processes such as communication and cooperation among individuals in organizations are critical determinants, which are facilitated by incentives (Teece et al., 1997; Prahalad and Hamel, 1990) or social capital (Kogut and Zander, 1992). On the other hand, researchers who focus on the knowledge creation process assume that mobilization occurs, and suggest that the creation process requires slack resources in terms of overlapping knowledge among employees in the organization (Nonaka and Takeuchi, 1995).

Second, although the level of analysis of organizational capability is the organization itself, the unit of analysis is the project team, which acts as the mechanism for knowledge mobilization and creation (Prahalad and Hamel, 1990; Kogut and Zander, 1992; Teece et al., 1997; Nonaka and Takeuchi, 1995; Leonard-Barton, 1995). Explicitly, the source of organizational capabilities is the ability of small groups of individuals, i.e., project teams, to come together to share their individual knowledge, and transform that knowledge into new knowledge that results in new products (Nonaka and Takeuchi, 1995; Leonard-Barton, 1995) or new processes (Teece et al., 1997), which generate value for the firm.

Third, innovation is a key outcome and indicator of this capability (Prahalad and Hamel, 1990; Kogut and Zander, 1992; Teece et al., 1997; Nonaka and Takeuchi, 1995; Leonard-Barton, 1995), since the capability itself cannot be measured directly (Godfrey and Hill, 1995). Although most researchers of organizational capabilities discuss product innovation as the main outcome of this capability (Prahalad and Hamel, 1990; Kogut and Zander, 1992; Nonaka and Takeuchi, 1995; Leonard-Barton, 1995), these innovations also meet the test of the demands of the external market. Therefore, this capability not only allows the generation of product innovation, but the quality of the innovation also matches the needs of the market (Helfat and Raubitschek, 2000).

However, the literature based on the resource-based view does not provide any empirical tests of how companies would go about developing this capability. For example, Kogut and Zander (1992) suggest that organizational principles are important for building social ties in organizations that facilitate knowledge sharing, but we do not know what these organizational principles entail. Prahalad and Hamel (1990) also suggest that there should be mechanisms whereby individuals could come together to share and combine their knowledge in order to generate new resources. However, we do not know what these mechanisms are, although, similarly to other researchers, Prahalad and Hamel (1990) imply that organizations manage their employees so as to encourage knowledge mobilization through communication and cooperation. For researchers who focus on knowledge mobilization, managing employees so that they are motivated to share their individual knowledge, either by using incentives (Teece et al., 1997) or building social ties (Kogut and Zander, 1992), enables firms to gain this capability. Researchers who focus on the creation process suggest that employees should be developed to have some overlapping knowledge. Therefore, in order to have the organizational capability to mobilize and create knowledge for innovation, employees are not only managed to be motivated to share knowledge, but also so that they have the capability to absorb the knowledge being shared and converted into new organizational resources. For knowledge mobilization via communication and cooperation, some researchers suggest the use of organization-level human resource management practices related to selection (Leonard-Barton, 1995) and reward (Teece et al., 1997; Leonard-Barton, 1995; Kogut and Zander, 1992; Prahalad and Hamel, 1990); they also claim that for creation, work experience in more than one function is necessary.

Fortunately, there are two bodies of literature on innovation, one that focuses on the team level of analysis and another that emphasizes the organizational level of analysis. The team-level innovation literature provides suggestions as to what firms could do when organizing employees into project groups for innovation, while the literature on organization-level innovation provides suggestions as to what firms could do at the organizational level regardless of the specific context by which they organize for innovation.

The team-level innovation literature deals with how to manage the process of innovation when firms organize employees into project teams for the purpose of mobilizing and creating new knowledge for innovation. Although it acknowledges the importance of organizational context impinging on team processes in the process of achieving the innovation, it focuses exclusively on generating innovation. As a result, the literature suggests that these processes may be developed as needed when a firm organizes for innovation. This is achieved by using a set of project team management practices, such as team development and reward.

In contrast, the organization-level innovation literature also suggests that a set of organization-level processes, such as cross-functional communication, is critical for generating innovations. As a result, in contrast to the team-level innovation literature, this body of literature suggests that organizational design that integrates or differentiates different parts of the organization affects these organization-level processes.

Therefore, as the literature stands, we still do not know how to develop the capability to mobilize and create knowledge for innovation. On one hand, the resource-based theory of the firm provides us with an understanding of why organizational capabilities are important for competition. On the other hand, the team-level innovation literature and organization-level innovation literature provide us with different explanations of how this capability might be developed.

1.1.1. Research question

The overarching research question is, How do companies develop the capability to mobilize and create knowledge for innovation? The dissertation uses a case study analysis to establish a theory about how companies develop this capability. Unlike previous research on this topic, in this study this theory is also tested using a large sample survey of companies. This enables us to answer the related question, What are the key practices and strategies to develop the capability to mobilize and create knowledge for innovation?

1.2. THESIS OVERVIEW

In chapter 2 I present a critical analysis of three bodies of literature that discuss the capability to mobilize and create knowledge for innovation: the literature on organizational capabilities based in the resource-based theory of the firm, the team-level innovation literature, and the organization-level innovation literature. First, I discuss each body of literature independently, drawing on its insights and assessing its limitations. I then integrate them in order to provide a better understanding of processes and management practices that support the development of the capability to mobilize and create knowledge for innovation. Finally, I develop each body of literature by addressing its limitations, and provide the motivation for comparative case studies.

In chapter 3 I perform a comparative case study analysis of how companies develop the capability to mobilize and create knowledge for innovation. The result of this study is a series of propositions, eight in total. These are later tested and explained in other chapters and are related to each other in a theoretical model presented in Figure 1.1. The propositions are:

Proposition 1: The project team-level processes –internal communication frequency, external communication frequency, shared mental model of cooperation, and overlapping knowledge– support the capability to mobilize and create knowledge for innovation.

Proposition 2: Project team-level human resource management practices –project team development, project team reward, and project team membership selection– support the capability to mobilize and create knowledge for innovation.

Proposition 3: Project team-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by supporting the project team-level processes.

Proposition 4: The organization-level processes –cross-functional communication frequency, shared mental model of cooperation, and overlapping knowledge– support the capability to mobilize and create knowledge for innovation.

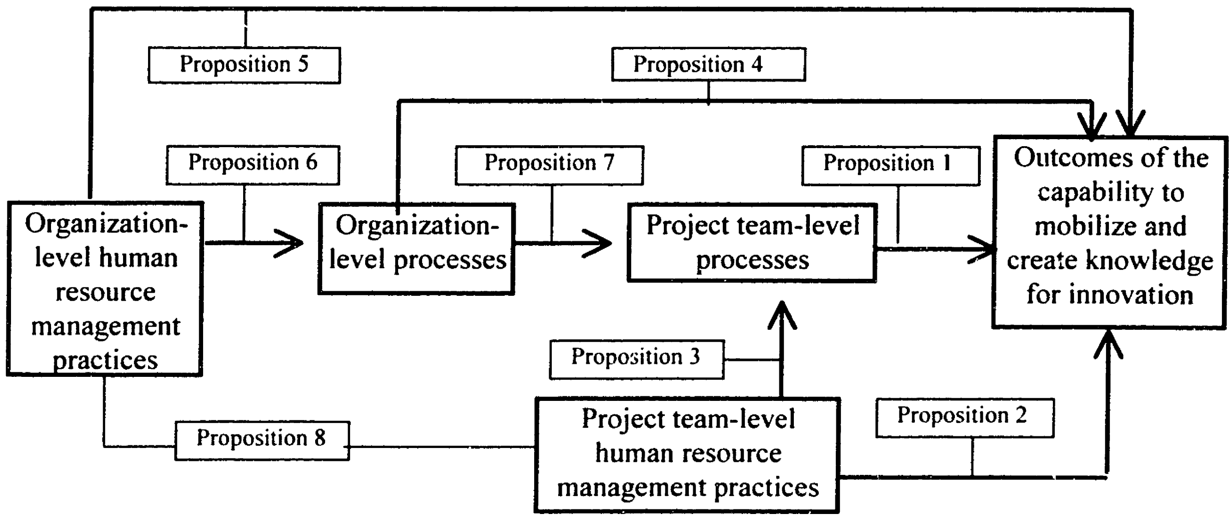
Proposition 5: Organization-level human resource management practices –selection, reward and control on reward, orientation, training and development, and work patterns– support the capability to mobilize and create knowledge for innovation.

Proposition 6: Organization-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by affecting the organization-level processes.

Proposition 7: The organization-level processes support the capability to mobilize and create knowledge for innovation indirectly by supporting the project-team level processes.

Proposition 8: Companies use one of three strategies –"organization," "project team," or "mixed"– to develop the capability to mobilize and create knowledge for innovation. Companies that follow the organization strategy develop their employees such that the organization-level processes that support innovation are generated regardless of when they are used in the process of innovation. Companies that follow the project team strategy develop their personnel only as needed in the process of innovation. Companies that use the mixed strategy develop their employees at both levels.

Figure 1.1. Framework for developing the capability to mobilize and create knowledge for innovation



In Chapter 4 I describe the data collection procedure and empirical setting for the large sample survey used to test the propositions generated in the comparative case studies presented in Chapter 3. In this chapter I describe the selection criteria and methods of data collection. I then describe the empirical setting of customer service centers in detail, indicating their function, internal and external linkages, methods of customer intelligence gathering, and the use of customer intelligence for innovation. I collected data from 182 project teams in the US operations of 38 US and Japanese multinational enterprises, which are in the computer, photo imaging, and automobile industries. The project teams in this analysis are based in the largest customer service center of each firm, and their main purpose is to use market knowledge and information about products and services of the firm to develop innovation in response to customer preferences. Unlike previous studies (e.g. Wageman, 1995; Brown and Duguid, 1991), which examined customer service teams consisting of members only from the customer service function, the project teams I analyze also include members of R&D, manufacturing, and sales/marketing. Moreover, the type of innovation that these teams develop takes into account the preferences of all customers, not just the lead users (Von Hippel, 1986). The chapter concludes with an example of how customer intelligence is used to mobilize and create knowledge for innovation.

In Chapter 5 I analyze the determinants of the capability to mobilize and create knowledge for innovation at the project team level. I examine the project team-level capability first, rather than the organizational level, because project teams are mechanisms by which knowledge is mobilized and new knowledge is created for innovation. In order to accomplish this, I test the effects of project team-level processes and project team management practices on different outcomes of capability as indicated by previous research and suggested by the comparative case studies.

In this chapter I show that the key project team processes are project team-internal and external communication and overlapping knowledge, and the critical project team management practice is project team development or training specifically for the project. It affects a wider range of outcomes of this capability, not only directly, but also indirectly, since it facilitates the project team-level processes that also support this capability. This practice involves developing personnel as needed in the process of innovation, by teaching them how to communicate with people from outside their functions and how to organize their teamwork processes. Moreover, in this chapter I show that overlapping knowledge between manufacturing and R&D engineering members supports many outcomes of this capability, implying that employees must be developed at the organizational level prior to team participation in order to have some overlapping knowledge between these two parts of the organization.

Having analyzed the determinants of capability at the project team level, in Chapter 6 I show what companies do at the organizational level, and how their processes and management practices facilitate knowledge mobilization and creation for innovation, and therefore the organizational capability to mobilize and create knowledge for innovation. However, as the title of the chapter suggests, the way in which this capability is developed is not as simple as it might seem. Since we cannot measure capability directly but rather only its outcomes, depending on the outcomes preferred by the firms, different factors and practices support different outcomes of this capability. First, for firms that are interested in product innovation, the organization-level process that facilitates knowledge mobilization is cross-functional communication frequency, and the factor that facilitates creation is overlapping knowledge, particularly the overlapping among R&D, manufacturing, and sales/marketing. The management practices that seem to support knowledge mobilization include the selection of employees based not only on their individual potential performance but also on character traits that are conducive to knowledge sharing and cooperation in organization. Moreover, reward is based not only on individual explicit output, but also on behavioral factors such as cooperation. Cross-functional orientation and development are also important.

In Chapter 7 I provide an alternative view: that since project teams are embedded in the larger context of the organization, they are subject to ongoing organization-level processes, particularly organization-level cross-functional communication frequency, organization-level shared mental model of cross-functional cooperation, and organization-level overlapping knowledge. These processes support knowledge mobilization and creation for innovation. In this chapter I show that organization-level cross-functional communication frequency supports project team-level internal communication frequency, thereby enhancing knowledge mobilization and creation for innovation at the project team-level. I do not find that it provides support for project team external communication frequency, in part because project team external communication has two components: external communication frequency within different functions and external communication frequency across different functions. Additionally, organizations that share a vision and a sense of commitment to achieving the collective goal (as opposed to the goals of functions represented on a team), are more likely to have project teams that have a sense of shared commitment to achieving the project goal. Moreover, organizations that have higher organization-level overlapping knowledge are more likely to have overlapping knowledge in their project teams.

The main claim of this chapter is that if organizations have the supporting organization-level processes built into the organization, these processes will occur more often on project teams, and therefore, the organizations may find it less necessary to use the additional management practices at the project team level. Organizations that lack these supporting organization-level processes may find it necessary to use the additional project team management practices, particularly project team development, in order to achieve similar performance. Therefore, organizations can either invest up front in developing the necessary processes at the organization level, or develop them only as needed when project teams are set up for innovation. However, since the capability to mobilize and create knowledge for innovation requires both knowledge mobilization and conversion, factors that facilitate both knowledge mobilization and creation are important. Since cross-functional overlapping knowledge takes time to develop, it is developed regardless of when organizations channel their resources into project teams for mobilizing and creating knowledge for innovation. Therefore, although team-level factors and management practices facilitate knowledge mobilization, creation of new knowledge probably requires the development of overlapping knowledge at the organizational level.

In Chapter 8 I develop the resource-based theory of the firm by integrating the three bodies of literature: resource-based theory of the firm, team-level innovation literature, and organization-level innovation literature. At the same time I bridge the gap between the two bodies of literature on innovation, as discussed in Chapter 2, by showing that companies follow one of three distinct strategies in developing the same capability. In addition to the organization and project team strategies suggested by previous research, companies can also follow a mixed strategy. Instead of developing their employees at either level, in such a way that facilitators of knowledge mobilization such as cross-functional communication and cooperation are embedded in their daily context, or developing them as needed when personnel are organized for innovation, companies do a little of both. In particular, the mixed strategy involves developing employees so that facilitators of knowledge mobilization are embedded in the organization and facilitators of knowledge creation or overlapping knowledge are also available at the organizational level. Furthermore, when personnel are organized into project teams for innovation, companies provide some development or training on how teams work together to accomplish the task.

In this chapter I show that the mixed strategy is associated with a wider range of outcomes of this capability and better financial performance than the other two strategies. In particular, it supports overall customer satisfaction with the company's products, product innovation at the project level, and efficiency in terms of resources used in achieving the innovation. The main reason is that the capability to create new resources for firms, i.e., innovation that satisfies the demands of external customers, requires knowledge mobilization of customer preferences, and design and production, as well as the factor that facilitates the conversion and transformation of these knowledge sets. This facilitator is the absorptive capacity for different knowledge being shared. This redundant knowledge is acquired through cross-functional development, the critical organization-level practice. Furthermore, since different innovation projects require different individuals with different knowledge sets, even if there is overlapping knowledge available at the organizational level, additional development, whereby team leaders or corporate trainers facilitate the organization of the work processes of project teams, seems to be most effective. Moreover, in this chapter I show that the different strategies that companies use to develop this capability are not explained by the industries in which they compete, although companies in certain industries tend to emphasize certain practices more than companies in other industries.

Finally, in Chapter 9, I provide the summary and conclusions of this study. I discuss the main finding, which is that the key practice for developing this capability at the project team level seems to be team development, since it assists critical facilitators for knowledge mobilization, i.e., internal and external communication. At the organizational level, cross-functional development of professional employees is critical since it supports both knowledge mobilization and creation.

This chapter also presents some caveats in interpreting the results of this study, which relate to the nature of the data and the sample of companies analyzed. Furthermore, I present the theoretical contributions showing how this study has integrated the three bodies of literature in understanding organizational capability development and has expanded our understanding of each body of literature used in this study. I then discuss the managerial contributions, in terms of key processes and practices in developing this capability, both at the organizational level regardless of when firms organize their employees for innovation and what to do when they organize for innovation. Lastly, I discuss the future directions of this study at both the project team and organizational levels.

2. ORGANIZATIONAL CAPABILITIES, KNOWLEDGE, AND INNOVATION: PERSPECTIVES FROM THE RESOURCE-BASED THEORY OF THE FIRM, TEAM-LEVEL INNOVATION, AND ORGANIZATION-LEVEL INNOVATION

In this chapter I present a critical analysis of three bodies of literature in which the capability to mobilize and create knowledge for innovation is discussed: the literature on organizational capabilities based in the resource-based theory of the firm, that based in the team-level innovation literature, and that based in the organization-level innovation literature. First, I discuss each body of literature independently, in order to draw on its insights and assess its limitations. I then integrate them, thus providing a better understanding of processes and management practices that support the development of the capability to mobilize and create knowledge for innovation. Finally, I develop each body of literature by addressing its limitations.

2.1. LITERATURE ON ORGANIZATIONAL CAPABILITIES IN THE RESOURCE-BASED THEORY OF THE FIRM

The literature on organizational capabilities has its roots in the resource-based theory of the firm, whose main argument is that a firm is a bundle of heterogeneous resources and capabilities, which supports competitive advantage and explains the variance in performance across companies. However, as Foss (1997: 346) pointed out, one of the main problems with this theory is that there is a considerable amount of "terminological soup" for capabilities, with various resource-based theorists using concepts such as "resources", "competencies", "capabilities", "assets," etc., to capture essentially the same concept. Therefore, before I discuss what I mean by organizational capability, it is necessary to provide some key definitions found in the literature.

2.1.1. Definitions

Organizational capability concerns an organization's ability to combine different types of resources, especially firm-specific knowledge embodied in their employees, in order to create new resources that enable firms to achieve and sustain their competitive advantage. Organizational capabilities are viewed as a type of strategic resource (Foss, 1997; Foss et al., 1995), because they are rare, valuable, inimitable, non-tradable, and non-substitutable (Barney, 1991). In this study, I focus on the 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: "productive services" (Penrose, 1959), "organizational routines" (Nelson and Winter, 1982; Winter, 2000), "core competence" (Prahalad and Hamel, 1990), "combinative capability" (Kogut and Zander, 1992), and "dynamic capability" (Teece et al., 1997). More specifically, for Penrose (1959), organizational capability is "the productive services" that result from the interaction between tangible and intangible resources, particularly knowledge and personnel skills. Nelson and Winter's (1982) idea of organizational capability is synonymous with organizational routine; routine refers to organizational memory that embodies individual knowledge, skills, and repertoire in performing their daily tasks. Expanding on Nelson and Winter (1982), Teece et al., (1997) define dynamic capability as coordination routines that facilitate knowledge mobilization and combination for innovation. Prahalad and Hamel's (1990) "core competence" is an organization's ability to coordinate and integrate production skills and streams of technologies for innovation and new businesses. Building on Schumpeter (1934), Kogut and Zander's (1992) "combinative capability" is an organization's ability to combine different types of knowledge for innovation, particularly knowledge that is embedded in different disciplines. Finally, Leonard-Barton's (1995) "core capabilities" also deal with an organization's ability to mobilize and combine knowledge for innovation; they are essentially the management of firm-specific knowledge embodied in employees, their combination, and the factors that facilitate the process of knowledge mobilization for the creation of new resources. The processes of knowledge mobilization and creation or the capability to mobilize knowledge and the capability to create new knowledge, however, are differentiated, since the literature suggests that they are facilitated by different factors with different management practices.

2.1.2. The capability to mobilize knowledge

Researchers who focus on organizational capabilities and are based in the resource-based theory of the firm tend to discuss knowledge mobilization and assume that knowledge creation follows directly from such mobilization. Moreover, when discussing organizational capabilities, these researchers (e.g., Nelson and Winter, 1982; Prahalad and Hamel, 1990; Kogut and Zander, 1992; Hamel, 1994) choose to focus exclusively on firm-specific knowledge and skills of their personnel, especially their tacit knowledge (Nonaka, 1994; Spencer, 1996). The main reason is that firm-specific tacit knowledge embodied in these human resources is rare, valuable, inimitable, non-tradable, and non-substitutable, and therefore enables firms to achieve sustainable competitive advantage (Winter, 1995; Grant, 1996; Liebeskind, 1996) and rents associated with it (Peteraf, 1993). Nelson and Winter (1982), for instance, argue that the differences in firms' performance are explained by the differences in their routines, which embody individual knowledge and skills. Some organizations have routines that are conducive to knowledge mobilization and creation that enable them to expand or maintain their competitive advantage. The authors also argue that this capability is a source of competitive advantage and sustainability, because the way in which routines are developed is difficult to observe and causally ambiguous. Moreover, these routines are built over time as a result of a firm's strategies and structures, which evolve over time and are path-dependent. It is the persistence of these routines that enables firms to enjoy superior performance and at the same time makes it difficult for competitors to catch up (Teece et al., 1997).

Prahalad and Hamel's (1990) core competence is contingent on the firm's ability to mobilize and combine individual knowledge and skills across boundaries to create new resources, i.e., innovation. This ability enables a firm to expand or sustain its competitive position. Therefore, the way in which these human resources are managed is critical in developing or possessing this capability. Similarly, Kogut and Zander (1992) argue that the firm's combinative capability is a more promising source of competitive advantage, because it depends on the social relations within small groups of individuals who share and combine their knowledge to create new resources. Leonard-Barton (1995) and Nonaka and Takeuchi (1995) also discuss knowledge sharing across individuals as critical in having this capability. What is implicit in these discussions is that the capability to mobilize knowledge includes the integrative or combinative capability of knowledge from the external markets with the internal environment of the firm, and these processes themselves safeguard a firm's sources of sustainable competitive advantage.

Although these authors take a more dynamic approach to understanding resources in competition[1], particularly the way in which individual knowledge is mobilized and combined to create new resources, the understanding of how these resources are created is limited if one does not discuss the creation processes[2] (Wernerfelt, 1997).

2.1.3. The capability to create new knowledge

While researchers analyzing organizational capabilities tend to emphasize the knowledge mobilization process and assume creation occurs, a few researchers examine the processes of knowledge creation (Leonard-Barton, 1995; and Nonaka and Takeuchi, 1995). Nonaka and Takeuchi (1995) provide a comprehensive model of the way in which new resources are created in organizations. Their model includes individual knowledge mobilization, combination, and conversion into organizational resources. The model involves two main processes, the mobilization of individual knowledge and the conversion of individual knowledge into organizational knowledge that comes in the form of innovations, which is considered to be a new resource to the firm. The basic argument behind Nonaka and Takeuchi's (1995) knowledge

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[1] In contrast to the static approach that views individual or groups of resources as the sources of rents either through acquisition or protection of critical resources that firms already own (Wernerfelt, 1984; Rumelt, 1982; Barney, 1986; Baumol et al., 1987; Spence, 1981; Stigler, 1968; Bain, 1968), the dynamic approach tries to explain how new resources are generated.

creation model is that knowledge mobilization and creation are difficult, not because of individuals' lack of motivation to share their knowledge, but because the nature of individual tacit knowledge constrains knowledge mobilization and conversion.

According to this model, knowledge mobilization is a necessary but insufficient condition for new resource creation. The initial step in the knowledge creation process is the "socialization" process whereby individual knowledge is mobilized or shared with other individuals. Because of the tacitness of individual knowledge, the sharing process requires the sharing of individual experiences through observation or imitation rather than documentation or articulation. The second step involves a process of "externalization" whereby individual tacit knowledge is made explicit to the receiver through the use of analogies, metaphors, hypotheses, concepts, or models (p. 64). There is then a "combination" process whereby individual explicit knowledge is shared between a group of individuals through the use of different media such as phone conversations, meetings and computer-aided media (p. 67). The final process is "internalization", whereby individuals internalize or absorb new knowledge from the socialization, externalization, and combination processes. This process is basically 'learning by doing', through interaction with other people in the process of creating new resources. All of these processes are interactive and work together in a spiral fashion. The ability of different firms to mobilize individual knowledge and convert it into organizational knowledge varies, and it is arguable that this difference in ability explains the differences in firms' ability to generate innovations, and therefore, their overall performance. Moreover, this capability is protected from

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[2] With the exception of Leonard-Barton (1995) and Nonaka and Takeuchi (1995).

being appropriated away by competitors because the processes underlying the capability are difficult to observe and therefore difficult to imitate.

Leonard-Barton's model of knowledge creation for innovation is viewed as a shared problem-solving activity (1995: p. 61; Leonard and Sensiper, 1998). By putting the creation process under a microscope, the author suggests that the facilitators of knowledge creation are more than just incentives (Teece et al., 1997). For example, some of the barriers to shared problem-solving are the individual-level trap mind-set of organizational success, their signature or highly specialized skills, the lack of differences between individual cognitive styles or mental models, and different preferences in tools and methodologies. However, without empirically and systematically testing and analyzing what companies do and the factors and management practices that facilitate knowledge mobilization and creation, we still do not know how this capability is developed. On one hand, researchers who focus on the knowledge mobilization process suggest that communication patterns or routines and cooperation are critical for organizational capability, and rewards and/or building social ties facilitate their development. On the other hand, researchers who focus on the creation process suggest that the overlapping knowledge is crucial (Leonard-Barton, 1995; Nonaka, 1994), which has strong implications for human resources development in different parts of the organization. For example, Leonard-Barton (1995) suggests that both sets of factors are necessary; however, overlapping knowledge in organizations is limited (p.76).

2.1.4. Limitations of the organizational capabilities literature

The literature on organizational capabilities rooted in the resource-based theory of the firm has several limitations in dealing with (1) the treatment of knowledge mobilization vs. creation, (2) level and unit of analysis, (3) measurement, and (4) empirical tests of how to develop them.

First, by focusing on knowledge mobilization or on creation we cannot fully understand the processes of new knowledge creation in organization. Moreover, making the distinction and analyzing them separately leads to different implications regarding the development of the organizational capability. On one hand, mobilization is supported by incentives (Teece et al., 1997) or social ties (Kogut and Zander, 1992). On the other hand, creation is supported by overlapping knowledge. Since knowledge mobilization seems to be a necessary but insufficient condition for new knowledge creation, the mobilization and creation processes need to be analyzed together in order to determine the factors that facilitate these processes.

Second, the organizational capability literature deals with the organization-level of analysis; however, its unit of analysis is clearly the project team. Project teams are mechanisms for knowledge mobilization and conversion into organizational knowledge. Therefore, organizational capability theorists suggest that the main driver behind this capability is how well small groups of carriers of core competence or project teams can effectively mobilize and convert their individual knowledge into organizational knowledge in the form of product and/or process innovation (Prahalad and Hamel, 1990). Kogut and Zander (1992) also stress the importance of communication or knowledge sharing among small groups of individuals in developing combinative capability. Teece et al. (1997) suggest that one of the main determinants of the dynamic capability is the willingness of groups to share knowledge in order to create the innovation. In the knowledge creation model (Nonaka and Takeuchi, 1995), the level of analysis is clearly the company; however, the unit of analysis is explicitly the project team organized to create new knowledge for innovation. Leonard-Barton (1995) also discusses the core capability at the company level (business unit), but her unit of analysis is clearly a team consisting of members coming together to develop new products.

Third, one of the greatest limitations is the lack of measurement for organizational capability. Godfrey and Hill (1995) suggest that organizational capability is an intangible that is not measurable directly, but only by its outcomes. The use of patent counts (Henderson and Cockburn, 1994) is an objective measure. However, as Foss et al. (1995) pointed out, organizational capability is a process phenomenon dealing with knowledge mobilization (Nelson and Winter, 1982; Kogut and Zander, 1992) and creation (Leonard-Barton, 1995; Nonaka and Takeuchi, 1995). Therefore, patents do not capture these processes and other outcomes of this capability, e.g., speed-to-market of the innovation and the success of that innovation in meeting the demands of the market, which are also important for competitive advantage (Teece et al., 1997; Helfat and Raubitschek, 2000). Moreover, some studies (e.g. Griliches, 1984) found that outside the chemical and agricultural industries, patents are not regarded as essential by innovators.

Fourth, the most critical limitation in understanding this phenomenon is the lack of empirical tests of key factors and management practices that explain how companies can develop it (Foss et al., 1995). Researchers analyzing knowledge mobilization suggest that incentives (Prahalad and Hamel, 1990; Teece et al., 1997) and the building of social ties (Kogut and Zander, 1992) facilitate the process. However, they do not offer explanations of what types of rewards would do this, or how a company would build these social ties. Prahalad and Hamel (1990), for instance, suggest that firms that have core competencies manage their employees such that there is a shared sense of cooperation in achieving organizational goals and communication patterns that transcend functional and business boundaries. They view firms that have core competencies as firms that induce their employees to share or mobilize knowledge and expertise across boundaries to generate innovations. In firms that lack such core competencies, each part of the organization views other parts as rivals. Therefore, knowledge mobilization is limited since the different parts of the organization hide critical knowledge from one another rather than sharing it to create new resources. Kogut and Zander (1992) suggest that "organizing principles" facilitate the development of this capability by facilitating communication and cooperation. However, it is unclear what these organizing principles are.

Moreover, Nelson and Winter (1982) and Teece et al. (1997) suggest that cross-functional communication routines are important factors in possessing this capability. Similar to the previous researchers, they do not clarify the way in which these routines are established. Leonard-Barton (1995) argues that one of the key dimensions in developing this core capability is having the values and norms that encourage knowledge sharing and cooperation. Organizations that have this core capability value cooperation, trust, and the routines of working together to share knowledge in order to create new knowledge for innovation (p. 48). However, we do not know how these supporting routines are developed. In contrast to other researchers, Leonard-

Barton (1995) suggests the use of selection and reward to induce knowledge sharing. She argues that selecting employees based partly on personality traits conducive to collaboration and rewarding them partly based on team performance encourages cooperation and knowledge sharing (p. 14).

Similarly, researchers that focus on the knowledge creation process do not establish tests of the factors that facilitate knowledge creation, although they provide some insights about the factors that might facilitate the process, particularly overlapping knowledge (Nonaka, 1994; Nonaka and Takeuchi, 1995: 77; Leonard-Barton, 1995: 76).

While Nonaka and Takeuchi (1995) take it for granted that overlapping knowledge can be found in the Japanese companies they study, Leonard-Barton (1995) is less optimistic about finding overlapping knowledge in the companies she studies, most of which are US firms. The main reason for their scarcity is that neither the incentive structures nor policies regarding career development in US companies encourage this practice, as she states:

> In most organizations, T-shaped skills [overlapping knowledge] are not created as a deliberate policy but emerge because individuals have been willing to risk pursing a somewhat marginal career. Most formal organizational incentives encourage I-shaped skills [specialized knowledge without overlapping knowledge] –the deep functional expertise represented the T's stem. As a result, the individual is driven even deeper into his or her expertise, which the organization continually draws on and rewards. At the same time, the organization does not provide a career path for those who want to top off the stem with a broad range of applications- i.e., the crossbar (p. 76).

Fortunately, we can turn to the team-level innovation and organization-level innovation literature to better understand the processes and management practices that facilitate innovation. These bodies of literature help to explain how the capability to mobilize and create knowledge for innovation is developed; after all, they are also about new knowledge creation and innovation, although they do not discuss their processes and outcomes in terms of capabilities. Another advantage of linking these bodies of literature to the organizational capability literature is that they provide empirical support for the processes and management practices that facilitate innovation.

2.2. LITERATURE ON TEAM-LEVEL INNOVATION

There exists an extensive body of literature that focuses on the project team-level of analysis, where employees form project teams for the purpose of mobilizing knowledge and creating new knowledge for innovation. This field of research recognizes the importance of organizational context (e.g. Gladstein, 1984; Ancona and Caldwell, 1992b; Hackman, 1986; 1990; Denison, Hart, and Kahn, 1996). However, the focus is still on the project team-level processes, project team management practices, and their outcomes. Similar to the literature on organizational capabilities, this body of literature also stresses the importance of communication and cooperation as facilitators of knowledge mobilization. Studies that focus on the creation process suggest that overlapping knowledge among members enhances the process.

2.2.1. Project-team processes and innovation

Project team-level processes can be divided into two groups: those that facilitate knowledge mobilization and those that facilitate the creation process. While communication and cooperation facilitate knowledge mobilization, overlapping knowledge among team members facilitates the creation process. Communication and cooperation do not support the knowledge creation process, because individuals are boundedly rational, and therefore, do not have the ability to absorb different types of knowledge being communicated or mobilized and transform it into new knowledge.

Project team-level communication. The traditional approach to studying team-level innovation considers communication as the key factor in generating the innovation. At the project-team level, communication is divided into two types: internal communication, which occurs among team members, and external communication, which occurs between team members and their external links. Both types of communication are considered critical for innovation, since communication is assumed to be an exchange of knowledge among individuals involved. Since communication is viewed as an exchange of knowledge or resources, the higher the frequency, the more knowledge is being exchanged, and the better this is for innovation (Dougherty, 1987; Griffin and Hauser, 1992; Allen, 1977).

Empirically, successful innovation has been shown to require communication between R&D, engineering, and marketing to combine technological capabilities and constraints (Souder, 1987; Workman, 1995; Katz, 1982). Dougherty (1987), for instance, suggests that projects with unsuccessful outcomes typically had lower levels of communication frequency, while successful projects were those that had a higher frequency of interfunctional communication.

Project team-level shared mental model of cooperation. A shared sense of cooperation among team members is also proposed to enhance teamwork performance in the process of innovation (Cannon-Bowers and Salas, 1990; Wageman and Baker, 1997). There are numerous definitions for this concept ranging from "group mind", and teamwork schemas to common cause maps (Klimoski and Mohammed, 1994: 403).

In this study, project team shared mental model of cooperation is defined as a team-shared goal and commitment to accomplishing the team task (Gladstein, 1984; Katz, 1997:138). A shared mental model of cooperation enhances innovation, since it motivates knowledge exchange (Madhaven and Grover, 1998).

Project-team overlapping knowledge. While communication and cooperation facilitate knowledge mobilization, researchers who emphasize the creation process suggest that overlapping knowledge among team members supports the creation process of new knowledge for innovation. Project team overlapping knowledge is the common knowledge that team members have, which enables individuals to take the perspective of other team members in the process of exchanging knowledge for innovation (Boland and Tenkasi, 1996; Iansiti, 1998). Additionally, the overlapping can be understood in terms of the absorptive capacity that individuals have for other types of knowledge present within the team. Overlapping knowledge facilitates the conversion and integration of different types of knowledge to create and achieve innovation (Madhaven and Grover, 1998). The underlying logic is that overlapping knowledge provides team members with the cognitive resources to combine insights synergistically from multiple knowledge sets (Madhaven and Grover, 1998).

2.2.2. Project-team management practices and innovation

Project team management practices are divided into two groups. The first facilitates knowledge mobilization, and the second facilitates the creation process. Those who analyze the mobilization process and assume that creation occurs often imply that the motivation to share knowledge is critical. Therefore, rewards for team performance (Ancona and Caldwell, 1999) and team development (Roth and Kleiner, 1996) encourage communication and cooperation. Researchers who focus more on the creation process stress the importance of team membership selection to ensure overlapping knowledge among members (Madhaven and Grover, 1998).

Project team-level reward. Previous studies suggest that rewards at the level of the project team affect 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 that both monetary and non-monetary rewards have impact on innovation (Roberts and Fusfeld, 1982). When individuals believe that their contributions on project teams towards achieving the goals of the projects are rewarded, they are likely to perform in such a way that they 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, Prennushi, and Shaw, 1997; Wageman, 1995).

Therefore, project teams that receive rewards for their project team performance are likely to perform better than those that do not receive such rewards.

Project team-level 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 they can be achieved, 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; individually they attempt to reduce uncertainty about their roles within the group. They seek to enact (Weick, 1995) their environments on their 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 who 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) within the organization.

Project team-level membership selection. For overlapping knowledge, project team membership selection based on some overlapping knowledge among team members is critical

(Madhaven and Grover, 1998). Madhaven and Grover (1998) argue that selection based on these factors is critical because individuals with overlapping knowledge would have the ability to absorb the knowledge being shared, combine it, and convert it into new knowledge. However, this overlapping knowledge is rare in organizations, and thus does not occur automatically on project teams, since the pool of human resources in the organization contains different knowledge sets (Iansiti, 1998), most of which do not have overlapping knowledge (Leonard-Barton, 1995).

2.2.3. Limitations of the team-level innovation literature

The team-level innovation literature presents two limitations. First, it acknowledges the importance of context, but it does not specify which aspects of existing organization-level processes influence team-level processes, and how they do so. Second, it implies that team performance impacts the competitiveness of companies, but does not test this implication.

One of the main limitations of this body of literature is that, despite the fact that the importance of organizational context in impacting team performance in the process of innovation is acknowledged, the specification of which aspects of organization-level processes are important is limited. While some researchers suggest that team performance is affected by organizational culture (Schein, 1996), others completely dismiss the impact of organization-level processes on internal processes of teams (Griffin and Hauser, 1992). Consequently, when employees are organized into project teams for innovation, the implication is that project team management practices such as reward (Ancona and Caldwell, 1999; Katz and Allen, 1985), team development

(Roth and Kleiner, 1996), and careful selection (Madhaven and Grover, 1998) support team internal processes and therefore innovation.

Another limitation is that most of these studies suggest that the performance of these innovation teams influences the organization-level performance (Clark and Fujimoto, 1991; Clark and Wheelwright, 1992; Brown and Eisenhardt, 1995; Brown and Eisenhardt, 1997). However, they do not provide any direct empirical tests.

2.3. LITERATURE ON ORGANIZATION-LEVEL INNOVATION

The innovation literature that focuses on organizational level also refers to new knowledge creation. Similarly to the team-level innovation literature, knowledge mobilization is critical, and the factors that facilitate this process are communication and cooperation among different functions within the organization. Moreover, organizational slack is also considered important for innovation; in this study it is assimilated to the concept of overlapping knowledge across functions.

2.3.1. Organization-level processes and innovation

Similar to the literature on organizational capability and team-level innovation literature, the organization-level innovation literature considers communication and cooperation to be key factors in facilitating knowledge mobilization in organization. However, since the level and unit of analyses are at the organizational level, most of the literature analyzes knowledge mobilization using communication, and assumes that creation occurs.

Organization-level communication. As in the case of the previous two bodies of literature, in this body of literature communication is considered to be key in generating innovation. Every organization has some type of communication patterns (Morrill, 1995; Katz and Kahn, 1966), routines (Nelson and Winter, 1982), or codes (Kogut and Zander, 1992), and cross-functional communication is by and large viewed as supporting knowledge mobilization for innovation. The main reason is that innovation requires the sharing and integration of different types of functional knowledge (Dougherty, 1992). Therefore, 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 communication codes that facilitate knowledge mobilization between design and manufacturing are necessary. Dougherty (1992) also suggests that new product development is contingent on the communication frequency among individuals in the sales/marketing, R&D, and manufacturing functions. As Tushman and Anderson (1997) put it:

> Research and development is often the heart of a firm's capacity for technological innovation. However, management of innovation is a cross-functional challenge. Firms only capture the full value of their technological advances when each of their functional areas brings its strength to bear in support of innovation. Coordinating highly capable functional areas is difficult, but disciplinary strength both within and outside R&D is an essential element of successful innovation (p. vi).

Organization-level cooperation. This body of literature also suggests that knowledge mobilization is facilitated by cross-functional cooperation. Depending on the organization, individuals in different functions view other functions as coalitions of interests (Cyert and

March, 1963) or as a cooperative system (Barnard, 1938). Cross-functional cooperation embodies the organization-shared vision (Prahalad and Hamel, 1990) and commitment (Lincoln and Kalleberg, 1990). Therefore, 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 connects when necessary to create new resources. The common vision and commitment help organization members to see the potential value of their knowledge mobilization.

Organization-level overlapping knowledge. Organizational slack is also important for innovation (Nohria and Gulati, 1995), which in this thesis takes the form of overlapping knowledge. Nohria and Gulati (1995) define slack as the pool of resources in an organization that is in excess of the minimum necessary to produce a given level of organizational output. Some examples of slack resources are redundant employees, unused capacity, and unnecessary capital expenditures. By this definition, overlapping knowledge that supports knowledge creation for innovation is a type of slack resource. According to Nonaka (1994)[3] another name for overlapping knowledge is redundant knowledge, which, by definition, is knowledge that is unnecessarily repetitive or superfluous. To be clear, however, overlapping knowledge in this study deals with the overlapping disciplinary knowledge in the organization. Despite the lack of empirical tests, the argument for overlapping knowledge sets is that they provide individuals with the cognitive capability and absorptive capacity to combine insights synergistically, effectively and efficiently from multiple knowledge sets for innovation. Since each function or community

[3] Nonaka's unit of analysis is the project team, however, his idea of overlapping knowledge among team members has implication about the stock of overlapping knowledge available at the organization regardless of when it is used.

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 of those functions in the process of innovation (Boland and Tenkasi, 1996). Individuals with overlapping knowledge of other functions possess absorptive capacity for receiving knowledge from other functions, since 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).

2.3.2. Organization-level management practices and innovation

Researchers who focus on knowledge mobilization suggest that organizational design is based on the way in which employees are managed generate these organization-level processes. As Tushman and Anderson (1997) put it:

> Management of innovation is an organizational problem. The architecture of an organization –its formal structure, its competencies, its job and career structure, its culture, and its power –determines its capacity to nurture, sustain, and exploit innovation. There is no one best way to organize, but absent an effective organizational weapon, brilliant ideas, good timing, and incisive strategies very seldom lead to successful innovation (p. vi).

The organization design that fosters innovation tends to be flexible. What makes the organization flexible is the way in which they organize and manage their employees, going beyond economic incentives (Teece et al., 1997) or the building of social relations (Kogut and Zander, 1992; Tsai and Ghoshal, 1998). Expanding on Burns and Stalker (1961) and Woodward (1958), Lawrence and Lorsch (1967) suggest that innovation-fostering communication and cooperation are facilitated by the different degrees of integration and differentiation among different functions of the organization. These integrative mechanisms include the use of incentive practices whereby individuals designated as integrators are rewarded in this role. Building on Lawrence and Lorsch (1967), Galbraith (1977) suggests that a job design based on team concepts, e.g., taskforces whereby individuals are assigned to work on projects rather than individually designed tasks, also facilitates communication and cooperation. The explanation is that people tend to communicate and cooperate with people they know more than with those they do not know (Newport, 1969; Weiner, 1970). Miles and Snow (1978) argue that organizations that choose a strategy requiring continuous product innovation also need to have an organizational structure that supports this strategy. The organizational structure that facilitates product innovation is flexible with regard to how its employees are managed. Specifically, job design is less clearly defined for individuals and may be based on team concepts. Individual rewards may be based not only on individual explicit performance, but also on their group performance; they are also given some autonomy in performing their daily tasks. Other researchers discuss other organization-level elements that support technological innovation, e.g., socialization (Katz, 1997), culture as a mechanism for control in organizations (O'Reilly and Tushman, 1997), and power (Pfeffer, 1992). These all relate to how employees are managed.

Initial socialization/orientation. Ghoshal et al. (1994) and Nohria and Ghoshal (1997) studied Japanese and European MNEs, and found that companies use another integrative mechanism, cross-functional socialization or orientation of new employees, to encourage communication and cooperation across boundaries. The explanation is that by exposing employees to different parts of the organization, they form social ties (Tsai and Ghoshal, 1998) that encourage communication and a sense of shared vision and cooperation. These authors suggest that these factors enable the Japanese MNEs to have a superior capability to mobilize and create knowledge for innovation. Other studies (e.g., Basadur, 1992) that compare the innovation processes 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 then to other engineering organizations.

Team-based work pattern. Similar to the argument put forth by Galbraith (1977), the use of team-based work patterns in performing daily tasks 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 are better at mobilizing knowledge and creating new knowledge for innovation also use team-based work patterns (Ghoshal et al., 1994). In Japanese firms, when new employees first arrive in a given department, they are not assigned a task to perform alone, but work with others in carrying out tasks (Robinson, 1996; Aoki, 1988).

Control over individuals' rewards. Katz and Allen (1985) suggest that organizations that are able to encourage knowledge sharing for innovation also grant the project managers some control over individuals' rewards. This is related to the idea of the matrix organization, whereby the control over individual reward is divided between functional and project managers. Japanese firms that are considered to have superior capability to create new knowledge for innovation (Clark and Fujimoto, 1991) also divide the control over individuals' rewards between functional and non-functional managers. In Japanese firms, both the functional and personnel managers have influence over the individual reward system. While functional managers have influence over 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, functional managers exercise sole control over individuals' rewards (Milgrom and Roberts, 1992; Aoki, 1988). It is suggested that these differences between firms facilitate innovation capability differently.

Individual reward structure. The way in which organizations with extensive knowledge mobilization reward employees is based partly on these behaviors (Aoki, 1988; Aoki and Dore, 1994; Dore, 1989). These authors suggest 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 performance but also on behavioral factors, particularly attitudes toward 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.

Selection. Leonard-Barton (1992), observing a company that has the ability to mobilize knowledge for innovation and learning, finds that such an organization not only selects employees based partly on personality traits conducive to collaboration, but also rewards them based partially on team performance. Essentially, the author acknowledges that this organization has employee management practices similar to those of Japanese companies operating in Japan. Recent studies show that organizations that are effective in motivating knowledge sharing also select employees with characteristics that are conducive to cooperation and knowledge sharing (Ichniowski et al., 1997). Therefore, for knowledge mobilization, employees are either given incentives to share their individual knowledge through communication and cooperation, or are managed such that they build social ties with other individuals in different functions to encourage communication.

Development. The development of overlapping knowledge has strong implications for cross-functional training and development of employees. Previous research also suggests that cross-functional development of employees enhances the capability to mobilize and create knowledge for innovation (e.g., Nonaka and Takeuchi, 1995), and particularly enhances 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 assist them in acquiring knowledge and skills in these organizations in a shorter period of time than it would normally take to accomplish this. 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, rarely employ this practice.

Systems of practices. Recent studies have also suggested that the individual practices themselves do not generate processes such as communication and cooperation that enhance productivity in organizations. It is the system of practices and their complementarities that provide these benefits. Aoki (1988) shows that individuals are rewarded for the behavior of knowledge sharing (Aoki, 1988), or they are socialized across different functions (Nohria and Ghoshal, 1997) such that they build social ties across functions that facilitate cross-functional communication frequency. The initial socialization of new employees also facilitates the development of a shared sense of commitment and vision in achieving organizational goals (Ouchi, 1979). Moreover, individual rewards are not only determined by their individual performance, but also by team-based performance and behaviors demonstrating cooperation. High-performing work systems that generate cooperation and commitment tend to have practices similar to the Japanese management system, i.e., selection of employees based not only on their individual potential performance but also on their personality traits conducive to collaboration or cooperation; orientation that exposes them to different parts of the organization; reward based not only on individual performance but also on team-based performance; control of individual reward divided among functional and project managers; job design that is based on a team concept; and career development that includes some cross-functional job rotation or training. Up to this point, empirical studies have only been done on shop floor workers in the production function, and none on the white-collar workforce, particularly their cooperation, commitment, knowledge sharing, and creation, which require cross-disciplinary knowledge for innovation.

2.3.3. Limitations of organization-level innovation literature

The organization-level innovation literature has several limitations: 1) it analyzes knowledge mobilization and assumes creation occurs; and 2) it does not specify who is involved in the innovation process.

The organization-level innovation literature analyzes knowledge mobilization and assumes creation; thus, the factors that facilitate this process tend to be related to the motivation to share knowledge. By focusing on mobilization and assuming creation, this line of research suggests that innovation is generated by organizational design that integrates different functions, that facilitates communication and cooperation through the building of social ties, or that has incentives for these behaviors or outcomes of these collective behaviors.

Since the level and unit of analysis is the organization, most of this literature assumes that the key processes occur at the organization level. But team processes may be developed as needed, as suggested by the team-level innovation literature. Therefore, this stream of literature seems to suggest that in order to have the capability to mobilize and create knowledge for innovation, organizations should be designed such that communication and cooperation are established regardless of when employees are organized for innovation.

2.4. INTEGRATING THE THREE VIEWS: ORGANIZATIONAL CAPABILITIES IN THE RESOURCE-BASED THEORY OF THE FIRM, TEAM-LEVEL INNOVATION, AND ORGANIZATION-LEVEL INNOVATION

After analyzing the team-level innovation literature and organization-level innovation literature, it is still not clear how to develop the capability to mobilize and create knowledge for innovation. On one hand, the team-level innovation literature suggests that the facilitators of knowledge mobilization for innovation may be developed as needed when organized into teams for innovation. On the other hand, the organization-level innovation literature suggests that the development of these facilitators occurs at the organizational level, regardless of when they are needed for innovation. Moreover, we do not know which set of practices, the project team management practices or the organization-level management practices, is more effective in developing this capability.

In order to develop a complete model of how organizational capability is developed, four things are necessary. First, since the capability to mobilize knowledge is a necessary but insufficient condition for creation of new resources, we need to measure both mobilization and creation, and observe which factors facilitate each of these. Second, clarification and integration of levels and units of analyses are required. Third, we need to measure organizational capability. Fourth, we need to understand better the process of development of organizational capability.

2.4.1. Linking the capability to mobilize knowledge and the capability to create knowledge for innovation

I argue that the literature on organizational capabilities tends to emphasize either 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; Nonaka, 1994); Leonard-Barton (1995) attempts to argue for both. Researchers who emphasize knowledge mobilization tend to assume that creation occurs, and that the critical facilitating factors involve 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 problem of motivating knowledge sharing is solved, knowledge that is being mobilized or shared does not lead to creation of new resources. Since individuals are boundedly rational, they face the problem of absorbing knowledge that is being shared and converting it into organizational knowledge, because of knowledge specialization in organization. I propose that this limitation is solved by having individuals with the absorptive capacity (Cohen and Levinthal, 1990) for different types of knowledge that are being shared. Therefore, in developing the capability to mobilize knowledge, organizational design or management practices that motivate knowledge sharing are critical, and the conversion process requires overlapping knowledge (e.g., Nonaka and Takeuchi, 1995; Nonaka, 1994; Leonard-Barton, 1995).

2.4.2. Linking levels and units of analysis

The level of analysis of an organizational capability is the organization, but the project team is the key unit of analysis, since teams are mechanisms for knowledge mobilization and creation for innovation. Therefore, the two levels of analysis can be integrated in order to understand the way in which this capability is developed. By using the organization-level and team-level innovation literatures, this study attempts to integrate these two levels of analysis by suggesting that regardless of team structures used in the process of innovation, team members remain embedded in the daily context of the organization. Therefore, these teams are subject to the ongoing organization-level processes such as communication patterns, a shared sense of cooperation or commitment in achieving organizational goals, and the level of overlapping knowledge (or lack thereof) (Nonaka and Takeuchi, 1995). Staw, Sandelands, and Dutton (1981) and Morrill (1995) suggest that knowledge, skills, communication routines, and the mindset of individuals, which is acquired in the larger context of the organization from performing daily tasks, are carried over when they organize to carry out non-routine tasks, i.e. innovation. Hence, in organizations where the supporting organization-level processes are built into the organizational context, we can also expect to see similar elements of these processes on project teams; this supports the organization-level innovation literature. This suggests that in such organizations, team management practices that generate the supporting team-level processes are probably less necessary. However, for organizations that lack these supporting organization-level processes, team management practices, such as development and reward, are necessary.

2.4.3. Measuring organizational capability

Since we cannot measure organizational capability directly and indirectly using patents, the team-level innovation literature and organization-level innovation literature provide us with some measures beyond innovation. From the team-level innovation literature, we have efficiency in terms of resources used in the process of achieving innovation (Clark and Wheelwright, 1992), effectiveness in terms of speed-to-market of the innovation and customer satisfaction with the innovation (Clark and Fujimoto, 1991). From the organization-level innovation literature, we have product and process innovation as defined by Nohria and Gulati (1995) following the lead of Van de Ven (1986), and learning (Senge, 1990).

2.4.4. Process of developing organizational capability

In terms of "how" companies develop this capability, our understanding is still limited. The three bodies of literature imply two main strategies for developing this capability, which I refer to as the "project team" and the "organization". The "project team" strategy deals with managing employees only when they are organized for innovation such that they are motivated to share knowledge and committed to accomplishing the project by using team management practices, specifically reward for team performance and team development. The "organization" strategy requires that employees be managed such that communication patterns and a shared sense of cooperation and commitment are fused in the organizational context, regardless of when companies organize their employees for innovation. Therefore, as the literature stands, we still do not know how to develop the capability to mobilize knowledge and create new knowledge for generating new resources. Do companies develop this capability by following the organization or the project team strategy? Are there alternative strategies for developing the same capability? Which strategies are more effective and for which outcomes of capability?

In order to answer the "how" question, Yin (1984) suggests comparative case studies, which allow us to understand deeply the processes by which companies develop this capability. Hence, in the next chapter I present a comparative case study of three companies, in order to develop an empirically grounded theory of how companies develop the capability to mobilize and create knowledge for innovation. I then present a research design of a large sample study that enables us to assess the efficacy of various strategies and the specific processes and practices that make up the strategies in developing this capability.

3. HOW DO COMPANIES DEVELOP THE CAPABILITY TO MOBILIZE AND CREATE KNOWLEDGE FOR INNOVATION?: COMPARATIVE CASE STUDIES

In this chapter I report on the comparative case studies of the development of the capability to mobilize and create knowledge for innovation of three companies. This analysis was necessary to generate a better understanding of how companies develop this capability, because, as discussed in Chapter 2, the process by which it is developed has remained unclear. I examine three companies with widely different processes of innovation and divergent human resource management practices at both the organizational and project team levels, as well as different organization-level and project team-level processes. The analysis of individual cases enables us to answer the "how" questions (Yin, 1984) and allows us to develop an empirically grounded theory (Glasser and Strauss, 1967; Eisenhardt, 1989).

The chapter is arranged in four sections. In the first section I discuss the research design, followed by the results and the propositions that emerged from analyzing each set of variables – project team-level processes, project team-level human resource management practices, organization-level processes, and organization-level human resource management practices– and their impact on the capability to mobilize and create knowledge for innovation. I then summarize, conclude, and briefly discuss what will follow.

3.1. RESEARCH DESIGN

The case studies consist of the analysis of the processes and practices used to develop organizational capability in three companies. The companies were selected on the basis of achieving maximum divergence in the practices and processes, which are the independent variables, rather than on organizational capability, the dependent variable.

3.1.1. Case selection

The case studies are based on three organizations, two located in the United States and one in Japan. This selection criterion is important because Japanese and US firms have different human resource management practices (Aoki, 1988; Dore, 1973; Robinson, 1996). Companies in this analysis are in the photo imaging, heavy machinery, and automobile industries. They were selected from different industries because companies operating in different environments face different innovation cycles and manage their human resources differently in order to facilitate knowledge mobilization and creation for innovation (Lawrence and Lorsch, 1967; Miles and Snow, 1978). Moreover, the companies selected for this study are each among the five largest in their respective industries in terms of number of employees and sale revenues. Table 3.1 summarizes these characteristics.

The names given are based on interviews regarding knowledge sharing via communication and the shared sense of cooperation and commitment among different functions of the organization. Tribe stands for tribal, Commune indicates communal or clan (Ouchi, 1979), and Party represents partisan. In Commune, communication is prevalent across all functions and the shared sense of cooperation and commitment occurs across all functions. In contrast, in Party, the same factors are found mainly within the same function, with little communication across functions, and the sense of commitment and cooperation are given to the functional department. Tribe is a hybrid of Commune and Party, where certain functions of the organization share similar levels of commitment and cooperation and tend to share more knowledge and information with each other than the rest of the organization.

TABLE 3.1

Characteristics of cases

Name of company	**Tribe**	**Commune**	**Party**
Country of origin	United States	Japan	United States
Industry	Photo imaging	Heavy machinery	Automobile
Size	Top 5	Top 5	Top 5

Note: The names of the companies have been disguised to maintain confidentiality.

3.1.2. Variables and definitions

This study focuses on variables related to five main constructs: outcome of the capability to mobilize and create knowledge for innovation, project team-level processes, project team-level human resource management practices, organization-level processes, and organization-level human resource management practices. Table 3.2 summarizes the variables and definitions classified according to construct. The selected variables are analyzed either because previous literature has indicated that they are relevant for developing the capability to mobilize and create knowledge for innovation, or because interviews and direct observation indicate that they influence the development of this capability. The measures were developed during and after the study.

Capability to mobilize and create knowledge for innovation. The construct capability to mobilize and create knowledge for innovation is represented by its outcome, in this case, the number of innovations each organization generated through its project teams that were selected for the study.

TABLE 3.2

Summary of variables

Constructs	Variables		Definitions
Outcome of the capability	Innovation		Total number of process and/or product innovations by organization from project teams selected for the study
Project team-level processes	Facilitators of knowledge mobilization	Project-team level internal communication frequency	Communication frequency among team members during the project
		Project-team level external communication frequency	Communication frequency between team members and their external links during the project
		Project-team level shared mental model of cooperation	Level of shared commitment, goal in accomplishing the task, and understanding of who would contribute what toward accomplishing the task
	Facilitators of knowledge creation	Project-team level overlapping knowledge	Number of people on team with job experiences in other functions represented on team
Project team-level human resource management practices	Facilitators of knowledge mobilization	Project-team level development	Training for the particular project received by the team
		Project team-level reward	Reward for performing the particular project in terms of promotion, job assignment, salary increase, bonus payment
	Facilitator of knowledge creation	Project-team level selection	Who and how project team was selected (criteria used in selection)
Organization-level processes	Facilitators of knowledge mobilization	Organization-level cross-functional communication frequency	Communication frequency between non-management and management employees, in formal (work-related) and informal (coffee breaks, lunch, outside of work) settings
		Organization-level shared mental model of cooperation	How each function perceives the other: do they operate as "coalitions of interest" or as "cooperative system," more understanding toward each other, shared commitment
	Facilitator of knowledge creation	Organization-level overlapping knowledge	Tracing career paths of professional employees in terms of job experiences in other functions.
Organization-level human resource management practices	Facilitators of knowledge mobilization	Organization-level selection	Criteria used in recruiting new employees
		Organization-level reward	Criteria used for rewarding individual employee's salary increase, bonus, and promotion
		Organization-level control on individual reward	Who (functional manager, project manager, personnel managers, peers) has the influence on individual reward system (promotion, salary increase, bonus payment, job assignment)
		Organization-level orientation	Step-by-step initial training programs provided to new entrants
		Organization-level work pattern	Whether daily task requires the use of team or each task is clearly defined for each individual; level of participation of employees on cross-functional teams (i.e. Quality Circles)
	Facilitator of knowledge creation	Organization-level development	On-and off-the-job training and career development of professional employees in and outside their own functions

For Tribe, six of the eight teams came up with an innovation; therefore, as an organization, it has six innovations. For Commune, all teams came up with an innovation; therefore, it has eight innovations. Party has only five innovations, since only five out of the eight teams created new knowledge for innovation. Innovations in this study are related both to products and to processes, and are driven by the demands of external customers. Some of the demands lead companies to develop new products, while others force companies to innovate both processes and products in order to improve quality and design. In Tribe, examples of the innovations generated by the project teams are the redesign of manufacturing processes to improve quality of cameras, which is one of its core products, the reduction of down time for assembling cameras, improvement in yield in camera production, and redesign of cameras. For Commune, examples of the innovations created by the project teams are the reconfiguration of components of "heavyweight" construction machines to be launched in the US market, the redesign of plowing machines for the Swedish market, and the redesign of medium-size construction machines with the latest technology licensed from a Swedish company. For Party, some of the innovations include the redesign of alternators for the latest model of the sport utility vehicles (SUVs), and redesign of fuel pumps intended for markets with extreme heat (e.g., Saudi Arabia and Southeast Asia). Different versions of these products have been out on the market but did not meet customers' preferences.

The project team-level processes. At the project team-level, there are two groups of process variables. The facilitators of knowledge mobilization are: (1) internal communication frequency among team members (Smith et al., 1994; Ancona and Caldwell, 1992b; Griffin and Hauser, 1992); (2) external communication frequency between team members and their external links (Ancona, 1990; Griffin and Hauser, 1992); and (3) team-shared mental model of cooperation, which is a team-level commitment, a shared goal in accomplishing the team task, and the understanding of who contributes what knowledge toward the accomplishment of the task (Cannon-Bowers, Salas, and Converse, 1993). The facilitator of knowledge creation is overlapping knowledge on the team, which is measured by the overlapping of knowledge across functions represented on teams (Madhaven and Grover, 1998; Nonaka and Takeuchi, 1995:77).

Project team-level human resource management practices. Project team-level human resource management practices are also divided into two groups: practices that facilitate knowledge mobilization and practices that facilitate knowledge creation. The facilitators of knowledge mobilization are: (1) project team development (Thamhain and Wilemon, 1987), which is the training the company provides to teams for performing a particular project; and (2) project team reward (Wageman and Baker, 1997), which is given either for individual performance on team, for team performance, or for both, and takes the form of salary increases, bonus, job assignment, and promotion. The practice that facilitates knowledge creation is project team membership selection (Madhaven and Grover, 1998). The definitions for this variable are the specific criteria project teams used in forming their teams.

The organization-level processes. The organization-level process variables are divided into two groups. The factors that facilitate knowledge mobilization are: (1) cross-functional communication frequency (Ghoshal, Korine, and Szulanski, 1994; Nohria and Ghoshal, 1997; Galbraith, 1977) by various means, such as face-to-face meetings, telephone conversations, electronic mail, and at different levels of the organization; and (2) organization-shared mental model of cooperation (Floyd and Wooldridge, 1992), which is defined as the way in which each function views the other in terms of their commitment toward the organization (Lincoln and Kalleberg, 1990), their views toward other functions within the organization (Schein, 1996), and their understanding of how knowledge of different functions may be connected to their own function to accomplish strategic tasks (Cannon-Bowers et al., 1993). Here, I examine whether different functions view one another as coalitions of interest or as part of a cooperative system. The factor that facilitates knowledge creation is overlapping knowledge, which is examined by tracing the career paths of employees in different functions (Leonard-Barton, 1995; Nonaka and Takeuchi, 1995; Iansiti, 1998).

Organization-level human resource management practices. The organization-level human resource management practices analyzed in this study are based not only on previous research but also on interviews I conducted and on my first-hand observations of the companies. These practices are divided into two groups: practices that facilitate knowledge mobilization, and practices that facilitate knowledge creation.

The facilitators of knowledge mobilization are: (1) selection (Ichinowski, Prennushi and Shaw, 1997), with definitions coded from evaluation forms used by recruiters of these companies; (2) reward, with descriptions obtained from the company's performance evaluation forms (Japanese Ministry of Labor, 1987) and discussions with personnel managers regarding the critical factors in determining salary increase, promotion, and the award and amount of bonus payment; (3) control over individual reward (Katz and Allen, 1985; Morrill, 1995), coded from interviews concerning the topic of managerial responsibility for control of individual reward (i.e., whether control is in the hands of the functional manager, project manager, human resource manager, or peers); (4) orientation (Nohria and Ghoshal, 1997), coded from interviews with personnel managers about the introductory steps that new employees take upon their arrival in the organization; and (5) work patterns, coded from observation of and interviews with department managers on how daily tasks were performed in the R&D, sales/marketing, and customer service functions. The facilitator of knowledge creation is cross-functional development (Nonaka and Takeuchi, 1995; Leonard-Barton, 1995). I asked personnel managers to explain step-by-step the development processes of professional employees, particularly engineers, sales/marketing and production personnel, from the time of entry to retirement (Westney and Sakakibara, 1986).

3.1.3. Data collection procedures

Data were collected from three manufacturing plants, one located in the Northeastern United States, one in the Midwestern United States, and another in a suburb of Tokyo, Japan. Each plant houses more than 500 employees, with design, manufacturing, production, and sales/customer services in one location. These plants also have project teams working on process and product innovations involving each of these functions. I gained access to these companies through personal business contacts with employees of the firms.

Data were collected following the case study data collection protocol (Yin, 1984). I used five different collection methods: trade journals, company archival records, interviews, direct observation, and a short questionnaire. Before visiting the companies for the purpose of making observations and conducting interviews, I analyzed each company using annual reports, company-supplied archival data, and secondary sources of information such as trade journals. Table 3.3 summarizes the methods of data collection.

TABLE 3.3

Methods of data collection

Company	**Tribe**	**Commune**	**Party**
Location of plants visited	Northeastern USA	Suburb of Tokyo	Midwestern USA
Interviews	4 human resource managers	6 human resource managers	5 human resource managers
	1 corporate trainer	3 corporate trainers	2 corporate trainers
	3 functional managers (Engineering)	4 functional managers (Engineering)	6 functional managers (Engineering)
	21 team members	29 team members	25 team members
Length of interviews	1-2 hours	1-2 hours	1-3 hours
Time of interviews	August 1997-January 1998; January 1999, June-August 1999	May-September 1996, May-September 1997	January-June 1997, June-September 1998
Observation time	Two months	Three months	Two months
Number of surveys	35	44	32

For the organization-level processes, project team-level processes, and project team-level human resource management practices, data were collected from the project team members selected for the study. The eight teams had been formed two years prior to this study and were chosen randomly from a list of between 10 and 15 project teams. Eight projects were selected because this was the maximum number of projects that the first company I approached would allow me to study. Individual team members were asked about their daily experiences related to their communication patterns across functions, their attitudes toward other functions, and their perceptions of how people in different functions view the overall goals of the organization. They were also asked about their orientation within the company and whether or not they received any training and job experience in other functions. The same individuals were then asked about their project team experiences, project team-level human resource management practices, and the team selection process, team rewards, and any training provided for work on the project. Finally, these individuals were asked about the number of innovations the team generated. After the interviews, a short questionnaire on cross-functional communication frequency at the organization level, sense of shared cooperation, and overlapping knowledge were requested from the personnel manager. Core team members were asked about their communication patterns and frequency of communication within and outside the team, and their past work experiences in other functions. These measures are presented in Table 3.9.

3.1.4. Data analysis

I analyzed the data by first building individual case studies. For each project, I used a combination of the "fishbone method" and flow charts documenting the factors by which knowledge is created and transformed into an innovation. I then compared across cases, both within and across companies, constructing a conceptual framework (Eisenhardt, 1989). The analysis proceeded as follows: First, I entered all responses into a database indexed by company, project team for each company, interview questions by their number, and then question number from the questionnaires. Second, I constructed a single version of both the organization- and team-level interviews for each case by collecting all responses to the same question together as a single response. Using the interviews, answers to the questionnaires, and secondary sources, I wrote a case study for each project, then for each organization. I noted similarities and differences with other cases within and across companies, but I did not perform further analysis until I had completed all case write-ups, thereby maintaining independence of the replication logic (Brown and Eisenhardt, 1997). As a check on the emerging case stories, an independent reader was asked to read the original interviews and to form an independent view of each case. I then used this view to crosscheck the emerging story. The case-writing process took about four months.

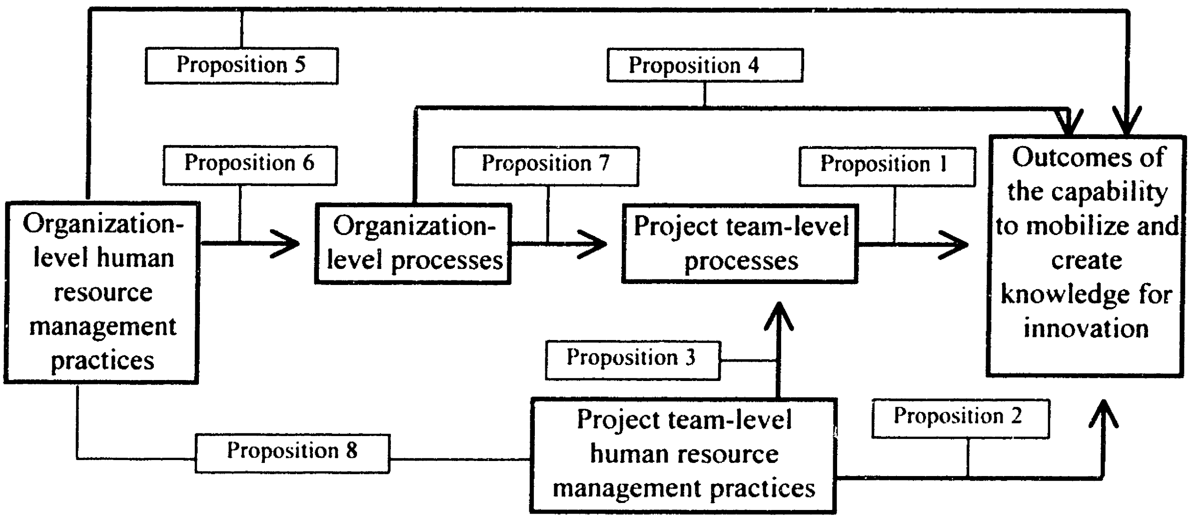
Once the individual case studies were complete, I used a cross-case analysis, relying on methods suggested by Brown and Eisenhardt (1997), Eisenhardt (1989), and Miles and Huberman (1984) to develop conceptual insights. Initially, I compared the cases to identify common processes, enablers, and constraints on each particular case within each company. I created tables to facilitate comparisons, and checked for similarities and differences to develop the emerging constructs and theoretical logic. This research was then set aside for several months so that I could refresh my thinking. As the analysis evolved, referring back to some notes using the fishbone method, I raised the level of abstraction. Each time I completed an attempt to build the insights, I then went back through the cases to confirm and adjust ideas as demanded. In some cases, I also went back to the original interviews and answers to surveys to ensure that the ideas were still consistent with the original data.

3.2. RESULTS

This section presents the results of the comparative case study and derives propositions organized by level of analysis. I discuss the project team-level processes and the project team-level human resource management practices in facilitating the capability to mobilize and create knowledge for innovation. I then discuss the ways in which the organization-level processes and organization-level human resource management practices support this capability directly and indirectly by impacting these project team-level processes. The framework that emerges from the study is depicted in Figure 3.1, which indicates the propositions that are explained in the later sections.

FIGURE 3.1

Framework of the development of the capability to mobilize and create knowledge for innovation



3.2.1. Project team-level processes and the capability to mobilize and create knowledge for innovation

Project team-level processes influence the capability to mobilize and create knowledge for innovation. Table 3.4 presents some quotations which are representative of the relationship between these two constructs. Each project team-level variable and its relationship with the outcome of this capability is discussed in detail in the paragraphs that follow. I first discuss the facilitators of knowledge mobilization, and then the factor that facilitates knowledge creation.

TABLE 3.4

Project team-level processes and the capability to mobilize and create knowledge for

innovation. Representative quotes.

		Tribe	Commune	Party
Facilitators of knowledge mobilization	Internal communication frequency	"We met frequently because our facilitators helped us set the agenda where we have to meet once every two weeks."	"We met as frequently as needed, maybe once every two weeks."	"We met once every two months. Until management got involved and they brought in the consultants."
	External communication frequency	"I personally like to talk to people outside the team and outside my functional area, because they [people outside the function] are less of a threat."	"We talked to people in our own functions as well as outside as needed."	"It seems that people from each function talks to other people in their functions more frequently than others on team. We meet with the rest of the team only when we absolutely need to."
	Shared mental model of cooperation	"Manufacturing gets the most defensive. Whenever we ask for additional information from there, they usually make remarks about how we want to destroy their organization." "Ed [trainer] and his assistant from corporate helped us organize the work processes and dealt with any conflicts that came up between manufacturing and everyone else."	"We pretty much know who would contribute what on the team." "Different people bring different types of information to the team, but we respect [trust] that what they are saying is in the best interest of the project."	"Very charged between the engineers and the finance people. Finance controls the money and the engineers make things. They don't get along." "When the consultants got involved, they taught us how to talk to each other; build trust and remove some of the assumptions we have about each other."
Facilitator of knowledge creation	Overlapping knowledge	"The team leader has some work experience in manufacturing, R&D, and customer services."	"Out of six people on the team, three people have worked in each other's functions."[but not with each other]	"There was none on our team. The consultants tried to establish a new language for us to use."

Internal communication frequency. Overall, Commune seemed to experience the highest frequency of internal communication, followed by Tribe and Party. For Commune, teams that succeeded met as frequently as necessary to accomplish this task. For Tribe, the teams that succeeded met as frequently as they thought necessary. However, they attribute their meeting frequency to the help of the "team facilitators," or trainers, who set the timetable for team meetings. All teams reported some friction between different functions presented on the team, especially between design and manufacturing. Manufacturing team members were less willing to meet than members from other functions. However, the facilitators helped resolve conflicts that arose between team members from the different functions. These facilitators reported to the corporate function, and their main responsibility was to teach cross-functional team members "how to get along" in order to share knowledge in completing the project. As a team member suggested: "We met frequently because our facilitators helped us set the agenda where we have to meet once every two weeks."

For Commune, all teams met as frequently as necessary. Teams viewed meetings to share knowledge and information as natural activities that were necessary to accomplish their task. Teams frequently met after work and on their own personal time, such as during lunch and coffee breaks, to work on their projects. Some teams even met on weekends, outside their daily work environment, to work on their projects. Without any external influence or pressure for teams to meet, a team leader working on a redesign of a heavyweight construction equipment for the US market stated, "We met as frequently as needed, maybe once every two weeks."

At Party, project teams that succeeded in creating knowledge for innovation also met more frequently than those that did not succeed. Teams that did not generate any innovation met less frequently than teams that succeeded, and when they did meet, not all team members attended the meetings. In fact, some team members never showed up at all. A representative quotation for team internal communication in Party came from a team leader working on a redesign of an alternator for an SUV: "We met once every two months. Until management got involved and they brought in the consultants who forced us to meet periodically by setting up the agenda for us to meet. Even then, some team members never showed up at all."

External communication frequency. Overall, external communication frequency of project teams seemed to be highest in Commune, followed by Tribe and Party. For Tribe, external communication occurred both between team members and their colleagues within the same function, and when team members who had contacts in different functions communicated with these contacts to search for the necessary resources and support for the project. Some team members working to improve yield talked not only to other managers who were in charge of production of different products but similar production processes, but also to design engineers, in an effort to better understand production specifications. As a team leader who has worked in design, manufacturing, and who is currently working in customer services, stated: "I personally like to talk to people outside the team and outside my functional area, because they [people outside the function] are less of a threat[4]."

For Commune, each team member was active in searching for the necessary resources external to the team, both inside and outside their functional areas. When team members perceived the need for knowledge and expertise in functions other than those represented on the team, they turned to their networks in different functions to find the necessary resources. In the case of a project team working on the redesign of a mid-size plowing machine, the design engineers not only turned to other experts in their functions, but also to the field technicians,

[4] The explanation here is that, although project managers have some influence on individual rewards, particularly promotion and job assignment, the functional managers hold most of the control. Therefore, if "word gets around" about the performance of the project in the functional department where there is already competition for promotion,

sales/marketing personnel, and sales representatives in that market, allowing them to better understand customer preferences. As one team member indicated: "We talked to people in our own functions as well as outside as needed."

For Party, external communication within the same function was actually higher than internal communication frequency, because team members preferred talking to their colleagues in the same function to talking with people whom they did not know from different functions which are represented on the team. External communication in Party differed from Tribe in that external communication was confined to the same function, with almost no external communication across different functions. The following quotation, which came from an engineer, is representative of this: "It seems that people from each function talk to other people in their functions more frequently than others on the team. We meet with the rest of the team when we absolutely need to."

Shared mental model of cooperation. Overall, Commune seemed to have the highest level of shared mental model of cross-functional cooperation, followed by Tribe and Party. For Tribe, project teams that succeeded also had some sense of shared commitment and a common goal in achieving the innovation. Moreover, they understood who would contribute what in accomplishing their team task. Teams that did not succeed viewed their teams as fragmented. Some members teamed up with other members from the same functional areas. In the case of a team working on process improvement of camera production, team members from manufacturing teamed up to fight off the demands from members in design and sales/marketing over the

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that could affect team members' opportunities within their departments.

changes they had to make to their production processes. Another team that was unable to generate an innovation also faced tremendous friction between team members from R&D and from manufacturing engineering. Despite the representation of other functions, team members representing R&D and manufacturing engineering formed two dominant coalitions, each with its own agenda. Since the infighting could not be resolved between these coalitions, even when the facilitators and top management were involved, the project was delayed and eventually terminated. The following quotation, which came from a team leader working on a process improvement project, is representative of this:

> Manufacturing gets the most defensive. Whenever we ask for additional information from there, they usually make remarks about how we want to destroy their organization. Ed [the trainer] and his assistant from corporate helped us organize the work processes and dealt with any conflicts that came up between manufacturing and everyone else.

For Commune, each team felt some sense of shared commitment and the obligation to other team members to complete the project. Moreover for two reasons, all teams gave their loyalty and commitment to the company and not to the function they currently represented. First, they had worked in different functions and could therefore understand what members of the teams from different functions required of them in order to accomplish the project. Second, since employees were rotated to different functions throughout their careers, R&D engineers would not form coalitions to fight manufacturing engineers, as they would eventually be rotated to work in manufacturing as part of their career path, if this had not already occurred. Likewise, the manufacturing engineers did not want conflict with the R&D engineers, because R&D might also be their next rotation. Therefore, all project teams in Commune had some sense of shared commitment and a common goal in accomplishing the task, a cohesive view that went beyond the objective of their individual functional department. The following quotation, which came from a team leader working on introducing a new technology licensed from a Swiss company into their midsize construction machine, is representative of this: "We pretty much know who would contribute what on the team. Different people bring different types of information to the team, but we respect that what they are saying is in the best interest of the project."

For Party, the opposite group dynamic occurred. All project teams experienced some infighting. However, on three project teams, infighting and a lack of commitment led to the termination of the projects. Members from each function expected the worst from one another, and brought with them their own agenda and cultural elements that were distinct from each other and, in some cases, incompatible. There was a history of resentment between manufacturing engineers and finance. Manufacturing engineers resented the fact that their projects had to be approved by the finance department, who, in their opinion, did not possess the technical knowledge that would enable them to assess accurately the cost and value of the projects. Members of the finance department resented members of manufacturing engineering, who had historically underestimated the project costs and overestimated their benefits in order to get project approval, and then requested more money after the approved amount had been spent. The lack of a shared goal and commitment in accomplishing the project led to project delay and eventual termination. The teams that succeeded attributed their success in part to the intervention by the "trainers," or facilitators, who helped them to communicate better and organize their work processes. One team member described the relationship between members of different functions on his team in the following way:

> Very charged between the engineers and the finance people. Finance controls the money and the engineers make things. They don't get along. If you bring the production people into the picture, it is an even bigger mess. They trust neither of these guys. When the consultants got involved, they taught us how to talk to each other; build trust and remove some of the assumptions we have about each other.

Cross-functional overlapping knowledge. Overall, Commune had the highest cross-functional overlapping knowledge, followed by Tribe and Party. For Tribe, team leaders who possessed the overlapping knowledge in design and manufacturing were able to convince managers in these functions to support their projects by explaining in the words of these organizations how the innovation would help rather than hurt their organizations. Cross-functional overlapping knowledge seemed to be a function of length of company tenure. The team leaders of projects that succeeded had been with the companies for 20 to 25 years. For example, the team leader that worked on designing miniature cameras for the children's market has some work experience in manufacturing, R&D, and customer services. As one customer service manager stated: "If you look hard enough, you'll find people who have worked in different disciplines, especially the old-timers." In the two teams that did not succeed in creating new knowledge for innovation, the team leaders had no work experience in functions outside the ones they represented, and their tenure with the company was only from one to five years.

In Commune, all project teams had members who possessed some overlapping knowledge. All project team leaders tended to have the longest tenure with the company and had also gained overlapping knowledge. As a team leader suggests: "Out of six people on our team, three people have worked in each other's functions." This knowledge of different functions enabled them to comprehend and use the different types of knowledge being shared by different members. Moreover, when misunderstandings occurred between members who lacked overlapping knowledge, the team leaders intervened to bridge their differences.

For Party, none of the project teams possessed overlapping knowledge. As a team member indicated: "There was none (of overlapping work experience) on our team. The consultants tried to establish a new language for us to use." All teams suggested that the difficulty in understanding the knowledge being shared on the team occurred because members from each function brought with them their own "jargon" and some elements of their own inside jokes, as well as sarcasm. Since there was no one on the team who could bridge the differences in the types of knowledge being shared, in two cases, team members decided to spend some time in one another's workstations to try to understand better what each member was attempting to share.

In summary, at the team level, Commune appeared to have the highest level of knowledge mobilization capability as indicated by its level of internal communication frequency, external communication frequency, and shared mental model of cooperation, which were also the highest. In addition, it seemed to have the highest capacity for converting individual knowledge into organizational knowledge, as indicated by its level of overlapping knowledge, which was the highest. Tribe seemed to come in second place on these facilitating factors, followed by Party. Moreover, all project teams in Commune were able to generate innovation; Tribe was the second most successful, followed by Party. These analyses and previous discussions lead to the proposition that:

Proposition 1. The project team-level factors –internal communication, external communication, shared mental model of cooperation, and overlapping knowledge– support the capability to mobilize and create knowledge for innovation.

3.2.2. Project team-level human resource management practices and the capability to mobilize and create knowledge for innovation

Project team-level human resource management practices influence the capability to mobilize and create knowledge for innovation. Table 3.5 summarizes the project team-level human resource management practices used by each firm. Each project team-level human resource management practice and its relationship with the resulting capability to mobilize and create knowledge for innovation is discussed in detail in the paragraphs that follow.

TABLE 3.5

Project team-level human resource management practices and the capability to mobilize and create knowledge for innovation. Practices used by each firm

		Tribe	Commune	Party
Facilitators of knowledge mobilization	Project team development	-Extensive training -Use external facilitators in project teams through out life of project	-	-Extensive training -Use external facilitators in project teams throughout life of project
	Project team reward	Reward through promotion and favorable job assignment	-	Reward through bonus, promotion, favorable job assignment
Facilitators of knowledge creation	Project team membership selection	-Select on social networks, cross-functional knowledge, expertise	-Select on social networks, expertise	Select on expertise, cross-functional knowledge and experience, expertise

Project team development. Project teams in Tribe and Party attributed their performance to project team-level human resource management practices, particularly project team development, whereby team members were taught how to organize their work processes, such as setting the agenda to perform certain project tasks and deciding upon how frequently to meet. Moreover, trainers taught them how to communicate better with team members from different functions. The presence of the trainers as "facilitators" throughout the life of the project also helped minimize conflicts and enhanced members' ability to share knowledge and information. For project teams working on innovation projects, Party often hired external "consultants" to train and facilitate knowledge sharing, whereas Tribe instituted the project team development program into the corporate function. For Commune, the team leader organized the work processes and set the agenda from meetings as agreed by the team. No additional "trainers/facilitators" participated on the team.

Project team reward. Tribe and Party also rewarded members for project team participation. Tribe rewarded project team performance by providing team members with favorable job assignment and promotion after the project had been successfully completed. Party provided monetary rewards, favorable job assignments and greater opportunity for promotion. These practices turned out to be motivating factors in project team performance and therefore innovation. However, the practices were not institutionalized as part of the larger human resource management system, as they were ad hoc in most project teams. In Tribe, team members may have received different types of rewards. Some core team members may have received a favorable job assignment, while others received a promotion. In Party some members may have received a bonus payment, while others received a favorable job assignment or promotion. In Commune, members of project teams did not receive any reward for their participation on project teams.

Project team membership selection. In Tribe and Party, the top management team of the organization, consisting of the plant and functional managers, usually selected the project teams. Team membership selection in Tribe was strongly based on cross-functional knowledge, particularly on job experience in different functions and possession of expertise needed for the task. For Party, managers selected members they perceived to have the most suitable expertise. For Commune, team members self-selected, often based on social networks and the fit between task and expertise.

In summary, project team-level human resource management practices associated with knowledge mobilization and creation seemed to support the outcomes of project teams in Party and Tribe. This leads to the proposition that:

Proposition 2. Project team-level human resource management practices –project team development, project team reward, and project team membership selection– support the capability to mobilize and create knowledge for innovation.

3.2.3. Project team-level human resource management practices and project team-level processes

Project team-level human resource management practices also have an indirect effect on the capability to mobilize and create knowledge for innovation, since they affect the project team-level processes that support the process of innovation.

Project team-level development, team internal communication, and shared mental model of cooperation. Team training on how to communicate better with people from different functions, how to set the agenda for meetings, or how to resolve conflicts, affected communication frequency on project teams as indicated by some team members in Tribe and Party (see Table 3.4). Additionally, project team development involving trust building helped build a shared "mental model of cross-functional cooperation," particularly shared commitment and goals in accomplishing the project, as well as the understanding of who would contribute what in accomplishing the task.

Project team-level reward, team-internal, and team-external communication. Reward for project team performance also facilitates knowledge sharing. In Tribe and Party, some team members suggested that before teams were recognized for their participation on these projects through monetary compensation, promotion, or favorable job assignment, meetings were even less frequent despite the facilitators' insistence on meeting. A representative quotation came from a team member in Party: "It used to be much worse when we weren't being recognized for this [work] that we're forced to do. There were people whose names were on the list as part of the team but never showed up to any of the meetings." A team leader in Tribe also suggested: "I would be lying if I say that I didn't know that I might get a promotion out of doing a good job on the last project."

Project team-level membership selection and team overlapping knowledge. In the case of Tribe, where only certain employees were assigned cross-functional job rotation, and in the case of Party, where cross-functional job rotation was not assigned, careful selection ensured some overlapping knowledge. In both of these companies, project membership selection was based in part on this factor. Commune relied on the relationship between tenure and overlapping knowledge. Therefore, if the team leaders and core team members had sufficient tenure, they expected there would be some overlapping knowledge on the team.

These analyses lead to the proposition that:

Proposition 3. Project team-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by supporting the project team-level factors.

3.2.4. Organization-level processes and the capability to mobilize and create knowledge for innovation

The capability to mobilize and create knowledge for innovation is directly influenced by organization-level processes. Table 3.6 presents some representative statements regarding the relationship between these two constructs; it is followed by discussion of each organization-level variable and its relationship to the outcome of the capability.

Cross-functional communication frequency. Of the three organizations, Commune most frequently demonstrated that cross-functional communication was integral to the daily context of the organization, followed by Tribe and Party. Tribe seemed to have some cross-functional communication embedded in their daily routines. However, this communication seemed to be formal and occurred mainly among managers who met to discuss work-related issues pertaining to the organization. Cross-functional communication among non-management employees was even less frequent, unless they were working on a cross-functional team. Cross-functional informal communication, communication that was not required by their jobs, was very infrequent. Employees segregated themselves by functions, not only in performing their daily tasks, but also informally in their social interactions. As one personnel manager stated: "We don't talk much to people outside of our functional area. If you come to the cafeteria, you'll see the engineering clique, production, HR, etc. I don't know what it is, but I think it is our professional pride that prevents us from talking to each other."

Commune seemed to have higher cross-functional communication frequency than Tribe. Cross-functional communication occurred among employees in both the management and non-management ranks. While employees in the management ranks communicated cross-functionally about work-related issues, among employees in the non-management ranks, cross-functional communication was informal, and did not pertain to work-related issues. The non-management employees communicated with their social counterparts in different functions while on the job, requested knowledge and information to perform daily tasks, and met during personal time such as coffee breaks, as well as after work for social activities. These social ties were formed during the initial orientation, when all new employees, regardless of function, were exposed to each other. The ties were reinforced during cross-functional on-the-job training and job rotation, and were maintained through cross-functional social communication.

TABLE 3.6

Organization-level processes and the capability to mobilize and create knowledge for innovation.

Representative quotes

		Tribe	Commune	Party
Facilitators of knowledge mobilization	Cross-functional communication frequency	"We talk to each other only when we have to. Maybe once every two months. Professional pride keeps us from talking to people outside our function."	"Talking to people in other functions is part of life here. We know each other in other functions, going way back. We get together may be once a week."	"I don't think anyone else besides the managers talk to each other outside their functions. Maybe once every three months?"
	Shared mental model of cooperation	We operate like a fiefdom. The engineers have more respect than anyone else. If you're an engineer, you have an edge here."	"After having worked on the production floor and other places, we have become very humble and respect what other people have to do in their organization."	"We are definitely a silo organization. Each function has its own agenda and thinks that each is better than others. Some functions thinks others are out to get them."
Facilitator of knowledge creation	Overlapping knowledge	"If you look hard enough, you can find them—especially the old timers."	"If you ask any of the engineers who have been with the company more than eight years, they have some overlapping knowledge."	"I don't know anyone who has worked in different functions. Maybe the plant manager?"

Party seemed to have the least cross-functional communication, which occurred mainly among employees in the management ranks, and was limited to work-related issues. Cross-functional communication frequency among non-management employees was lower than that of either Tribe or Commune. Similar to the case of Tribe, Party's lack of communication can be attributed to two factors. First, non-management employees did not see the need for communication outside their functional areas, as their daily tasks did not require it. Second, most employees only formed social ties within the same function. In other words, job performance did not demand communication across functions.

Shared mental model of cooperation. Overall, Commune demonstrated the highest level of shared mental model of cross-functional cooperation, followed by Tribe and Party. Within

Tribe there was some friction between individuals from different functions, particularly designs and manufacturing. Moreover, individuals accorded different levels of prestige to different functions. There appeared to be some sense of commitment and shared goals, although different functions also had their own agendas, and their ultimate loyalty remained with the goal of the functional department. In summary, Tribe seems to have the fiefdom mentality, whereby different parts perceive each other as coalitions of interest rather than collectively as a cooperative system, as one engineering manager in production indicated:

> We operate like a fiefdom. The engineers have more respect than anyone else. If you're an engineer, you have an edge here. And their mindset is still that of 'if we build it they will come'[5]. Therefore, they don't listen to the sales/marketing people to get ideas about what customers want. Moreover, I have been here nearly 30 years and I never knew what is cooking in R&D. Now they say they are putting posters up outside their office doors to share with people about what they are doing, let's go and look.

Individuals in Commune felt a stronger sense of shared commitment in achieving the organizational goal, rather than the goal of their department. In fact, commitment to the functional department was lower, as they viewed each function in which they worked as a temporary stop on their career development path. They viewed different parts of the organization as part of the larger system that needed to work as a whole in order to achieve the organization's goal. Moreover, since they had been exposed to various functions, they had a better understanding of how the different parts of the organization fit together and had to work together as a system. They saw the value of shared commitment and how knowledge embedded in different parts of the organization could be shared to accomplish certain tasks. Essentially, individuals from different parts of the organization appear to have a cooperative system mentality about their organization. The following quotation, which came from an engineering manager whose current position was to train/socialize engineers into the company, is representative of this:

> Like other large prestigious Japanese companies, we only hire the best engineers, and of course, initially, they all think that they are hot shots because they are from Tokyo University etc. In order to break the mentality that only they matter, we force them to see what other people do in other parts of the company and how valuable these other people are in relation to what they have to do. After making them sweep floors, work on assembly lines, side-by-side with the real production workers and customer service representatives answering calls from customers, and yes, all the hours that these workers put in, they become more humble, respectful, and cooperative with people from other parts of the organization.

Party lacked the organization-shared mental model of cross-functional cooperation. The sense of shared commitment in achieving organizational goals seemed to be lower than that of Commune or Tribe. Different functions viewed each other as separate coalitions of interest rather than as parts of a larger system with a coherent goal benefiting all functions. Their sense of commitment was toward their functional departments and, since they expected to stay within the same function throughout their careers, their loyalty and commitment remained with their functional department rather than the organization as a whole. In summary, Party is a silo organization that has a "coalitions of interest" mentality, and therefore demonstrates a lack of cooperation with other people outside their functional areas, as one engineer indicates:

> We are definitely a silo organization not only in how we do things, but also in our mindset. Each function has its own agenda and thinks that each is better than the others. People in some functions are more paranoid than other people in different functional areas about being sabotaged by outsiders. Others discourage their

[5] This is in reference to the movie "Field of Dreams".

people from making friends with people from outside their areas to preserve their credibility and conflict of interest.

Overlapping knowledge. Tribe exhibited some overlapping knowledge embedded in the larger context of the organization. It provided job rotation of engineers between R&D and manufacturing, and thus established some overlapping knowledge between these functions. However, Tribe's level of overlapping knowledge was lower than that of Commune, which provided cross-functional-job rotation and on-the-job training to a wider range of their professional employees than just engineers. As an HR manager stated: "Engineers do receive training in other functional areas, but usually voluntarily. Now we are trying to systematize it, but it is not easy. The departments receiving them resist the idea of having to develop people who will be there only temporarily. Most managers do not see the value of this program yet." Party had the lowest level of overlapping knowledge, as it did not provide any cross-functional job rotation or on-the-job training to any employees.

In summary, at the organization-level, Commune appeared to demonstrate the highest level of knowledge mobilization, as indicated by its level of cross-functional communication frequency and a shared mental model of cooperation. Commune also appeared to demonstrate the highest capacity for converting individual knowledge into organizational knowledge, as indicated by the level of overlapping knowledge embedded in its organization. Tribe appeared to rank second, in this regard, and Party third. Moreover, Commune demonstrated the highest capability to mobilize knowledge and create new knowledge, followed by Tribe and Party. These analyses lead to the proposition that:

Proposition 4. Organization-level processes –cross-functional communication, shared mental model of cooperation, and overlapping knowledge– support the capability to mobilize and create knowledge for innovation.

3.2.5. Organization-level human resource management practices and the capability to mobilize and create knowledge for innovation

Organization-level human resource management practices influence the capability to mobilize and create knowledge for innovation. Table 3.7 summarizes the organization-level human resource management practices used by each firm. The relationship between the organization-level human resource management practices and the capability to mobilize and create knowledge for innovation are discussed in the following paragraphs, which first explore the facilitators of knowledge mobilization, and then examine the factor that facilitates knowledge creation.

Selection. Tribe not only recruited employees based on their potential individual performance, as measured by their academic performance and school reputation, but also based on behavioral factors, particularly their "ability to work" in a team and the "willingness to cooperate." Commune only recruited candidates from targeted schools and used personality tests to determine employee personality traits that are conducive to a teamwork environment. Party, on the other hand, recruited employees based solely on their potential individual performance, as measured by school reputation and academic performance.

Reward and control on individual reward. Tribe and Commune rewarded individual performance and behavioral factors, particularly cooperation, and the sharing of knowledge and information. For Commune, these behavioral factors affected salary increases, the award of bonus payments and their size, and promotion, while for Tribe they affected job assignment and promotion. Party, on the other hand, rewarded only individual performance, particularly the quality and quantity of work performed. Tribe and Commune also divided the control of the system determining individual rewards among different managers. For Tribe, both the functional and project managers had control over the system determining individual rewards. Although most of the power to award salary increases was given to the functional manager, project managers had some influence over promotion and job assignment. For Commune, the influence determining the assignment of individual rewards was divided between the functional and the personnel managers. Although the functional managers had more influence, personnel managers made the final decisions on the overall performance evaluation of an individual. Personnel managers also made the final decision about individual salary increases, job assignment, bonus payment and promotion. In Party, functional managers had all the power to assign individual rewards.

TABLE 3.7

Organization-level human resource management practices and the capability to mobilize and create knowledge for innovation. Practices used by each firm

		Tribe	Commune	Party
Facilitators of knowledge mobilization	Selection	-Academic performance -School reputation -Ability to work on team -Cooperative behaviors -Flexibility -Fit with firm culture -Leadership potential	-School reputation -Fit with firm culture -Flexibility -Ability to work on team -Cooperative behaviors -Personality tests -Competency tests -Leadership potential	-Academic performance -School reputation -Fit with company culture -Flexibility -Leadership potential
	Reward	-Individual performance -Business unit performance -Reputation for cooperation -Reputation for reliability -Quantity of work -Quality of work performed	-Individual performance -Quantity and quality of work performed -Business unit performance -Attitude -Contribution toward "morale building" through high motivation, reputation for being cooperative, reputation for being reliable	-Individual performance -Quality and quantity of work performed
	Control on reward	-Functional manager (all components) -Project manager (job assignment and promotion)	-Functional manager -Project manager -HR manager -Peers	-Functional manager
	Orientation	-New employees oriented by function both at corporate and operation levels	-Cross-functional, new employees (engineers, sales/marketing, customer services) together -Manufacturing -Customer services/sales -Regroup one year later	-New employees oriented by function both at corporate and operation levels
	Work patterns	-Individual-based daily task -Encourages participation on cross-functional teams (i.e., Quality Circles)	-Daily task team-based -High participation on cross-functional teams (i.e. QC)	-Clear job definition for each individual -Starting to encourage participation on cross-functional teams (QC)
Facilitators of knowledge creation	Training and Development	-Engineers receive on-the job-training and rotation in R&D, manufacturing, customer services, off-the-job training in cost analysis and management of human resources	Engineers receive on-the-job training and rotation in design manufacturing, customer services, sales/marketing, off-the-job training in cost analysis, strategic management, problem solving	-Ground-up but function-specific, new employees start at the plant level, move progressively up but within function

Work patterns. Work patterns in Tribe were similar to Party in that the daily task was clearly defined for each individual. However, Tribe had been trying to encourage process and product innovation by encouraging cross-functional team participation such as quality circles. In

Commune, when new employees first arrived in a given department, they were not assigned a task to perform alone. Instead, an older employee with around five years of experience was assigned to work with the new employee. The older employee was expected to train the new employee and work together to accomplish the task. Since the older employee had to train the younger employee and accomplish the task at the same time, other employees were also assigned to help the mentor, so that this employee would not be slowed down. This work pattern was common in the engineering, sales/marketing and finance departments. These practices also supported innovation, since they encouraged knowledge and information sharing. Moreover, from the beginning, employees belonged to some type of quality circle that was based on cross-functional teams.

Orientation, training, and development. For orientation, Tribe and Party did not provide cross-functional orientation to their new employees. Commune, on the other hand, employed this practice with all new employees, regardless of the functions in which they would be placed. For cross-functional on-the-job training and development, both Tribe and Commune employed these practices. Tribe limited its cross-functional on-the-job training and development only to the engineers. Typically, engineers spent some time in manufacturing and R&D and then some time in customer services dealing with the customer-product interaction. At the same time, they were given off-the-job training on cost analysis and other issues dealing with business that were outside of engineering. In Commune, after two months of training in the manufacturing organization, new employees were divided into different groups for more specialized training, such as advanced topics in engineering for engineers and other highly specialized fields for other groups of employees. They were then trained in sales management and customer services for another two months. During this training, regardless of whether they were to be placed in engineering or finance, new employees worked with other sales people dealing directly with the customers. This was emphasized most strongly for engineers who were to be placed in product design and manufacturing. After the first year of on-the-job training, new employees were once again assembled at the headquarters for two days to discuss what they had learned and the kind of problems they had faced. Moreover, throughout their careers, they were rotated to different functions for career development. Party provided extensive function-specific orientation and training but did not provide any cross-functional training and development.

In summary, the differences in organization-level human resource management practices influenced the capability to mobilize and create knowledge for innovation. Commune seemed to have the most practices that were associated with knowledge mobilization and creation, followed by Tribe, and then Party. This leads to the proposition that:

Proposition 5. Organization-level human resource management practices –selection, reward and who has the control over reward, orientation, work patterns, and development– support the capability to mobilize and create knowledge for innovation.

3.2.6. Organization-level human resource management practices and organization-level processes

Organization-level human resource management practices influence not only the capability to mobilize and create knowledge for innovation, but also the organization-level processes. This second relationship is discussed in detail in the coming paragraphs.

Cross-functional communication frequency. In Tribe, employees who had job experience in different functions had been able to form social networks that encouraged communication, especially as needed to perform daily tasks or when working on project teams. However, since Tribe provided cross-functional training and development only to its engineers, its cross-functional frequency seemed to be lower than that of Commune. Commune exposed employees from the beginning to different functions of the organization. This exposure also enabled them to form social ties that facilitated communication across functions. Moreover, since Commune also provided cross-functional training and development not only to its engineers but also to all its professional employees, there appeared to be more social ties across functions, encouraging communication not only for work purposes but also for social activities. Party, which did not provide any cross-functional orientation or development, had employees with few to no social ties across functions. Since daily tasks were individually defined, there was no need to communicate cross-functionally for professional or social reasons.

Organization-shared mental model of cooperation. Commune, which provided cross-functional orientation, training and development, had a higher level of shared mental model of cross-functional cooperation. The exposure they received enabled them to see how different parts of the organization were connected in maintaining daily operation. Moreover, the sense of commitment and loyalty was given to the overall organizational goal, rather than the departmental goal, since they viewed themselves as working for the company rather than for any one functional department. Tribe and Party, on the other hand, did not have these practices, and viewed the organization as more fragmented. This was particularly true for Party.

Cross-functional overlapping knowledge. By providing some cross-functional development for its engineers, Tribe had some overlapping knowledge, although less than Commune, which provided cross-functional development to all professional employees. Party, which did not employ this practice, had little or almost no overlapping knowledge.

In summary, Commune, which had the most human resource management practices that were associated with knowledge mobilization and creation, also seemed to have the highest level of organization-level factors that facilitated knowledge mobilization and creation. Again, Tribe seemed to come second, followed by Party, on these dimensions. This leads to the proposition that:

Proposition 6. Organization-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by affecting the organization-level processes.

3.2.7. Organization-level processes and project team-level processes

The analysis of the previous sections and the data presented in Table 3.4 and Table 3.6 suggest a "mirror image" of organization-level factors and project-team level factors in a given organization. In organizations that have higher cross-functional communication frequency, a shared mental model of cooperation and overlapping knowledge, these patterns are also found on their project teams. In Commune, where cross-functional communication in the daily context of organization was more frequent, team-internal and external communication also appeared to be more frequent, as needed by the project team. Additionally, the shared mental model of cooperation and overlapping knowledge found at the organizational level were also found at the project team level. Party, which lacked these factors in the larger context of the organization, also lacked them on project teams. Similar patterns were found in Tribe. This leads to the proposition that:

Proposition 7. The organization-level processes also support the capability to mobilize and create knowledge for innovation indirectly by supporting the project-team level processes.

3.2.8. Comparing organization-level human resource management practices, project team-level human resource management practices, organization-level processes, project team-level factors, and the capability to mobilize and create knowledge for innovation.

This subsection compares the organization-level human resource management practices and project team-level human resource management practices as systems, and examines whether companies using these different management systems have significantly different organization-level processes, project team-level processes, and capability to mobilize and create knowledge for innovation.

TABLE 3.8

Comparison of human resource management practices and their use by firms

Constructs	Variables		Descriptions	Tribe	Commune	Party
Organization-level human resource management practices	*Facilitators of knowledge mobilization*	O-Selection	Recruit team-based behaviors	Yes	Yes	-
		O-Reward	Reward cooperative behaviors	Yes	Yes	-
		O-Control on reward	Control of project manager	Yes	Yes	-
		O-Orientation	Cross-functional orientation	-	Yes	-
		O-Work pattern	Cross-functional work patterns	Yes	Yes	-
	Facilitator of knowledge creation	O-Development	Cross-functional development	Yes	Yes	-
Project team-level human resource management practices	*Facilitators of knowledge mobilization*	P-Development	Training for the particular project	Yes	-	Yes
		P-Reward	Reward for performing the particular project	Yes	-	Yes
	Facilitator of knowledge creation	P-Selection	Team membership selection on cross-functional knowledge	Yes	-	Yes

Human resource management practices. The case study analysis suggests that companies use human resource management practices together as a system. Table 3.8 summarizes the human resource management practices used by firms in this study. Tribe used both organization-level and team-level human resources management practices, Commune used only the organization-level human resources management practices, while Party used only the project team-level human resources management practices.

TABLE 3.9

Comparative analysis of organization-level processes, project team-level processes and outcome of the capability to mobilize and create knowledge for innovation

			Firm			T-tests			Tamhane's T2 Test
			Tribe (N = 35)	Commune (N = 44)	Party (N = 32)	Tribe vs. Commune	Tribe vs. Party	Commune vs. Party	Tribe vs. Commune vs. Party
Organization-level processes		***Measures***							
Facilitators of knowledge mobilization	Organization-level cross-functional communication Frequency	Cross-functional face-to-face communication frequency	2.12 (0.27)	3.35 (1.08)	1.77 (0.24)	*	*	**	*
	Shared mental model of cooperation	Shared commitment across functions toward achieving organizational goal	2.08 (0 16)	2.88 (0.49)	0 91 (0.39)	†	**	***	*
Facilitator of knowledge creation	Overlapping knowledge	Total cross-functional on-the-job training, job rotation of engineers, for each equals 1	1.66 (0.43)	2.66 (1.03)	1 27 (0 18)	***		***	
Project team level processes									
Facilitators of knowledge mobilization	Internal communication	Communication frequency among core team members using face-to-face meetings	2 62 (0 74)	3 25 (0.70)	2.37 (0.74)			*	
	External communication	Communication frequency between team members and their external links using face-to-face meetings	2.12 (0.83)	2 25 (0.70)	2 00 (0.53)				
	Shared mental model of cooperation	Shared commitment among team members	2 62 (0.51)	3.25 (0.70)	2.62 (1 06)	†			
Facilitator of knowledge creation	Overlapping knowledge	Overlapping knowledge among engineering team members, each overlapping equals 1; otherwise 0	2 12 (0.83)	3.00 (0.53)	1.87 (0.99)	*		*	
Capability									
	Avg. number of Innovation/ Team	Project team resulted in new product development, product modification, or process innovation (average to company level); yes = 1	0.75 (0 46)	1.00 (0.00)	0.62 (0.51)			†	

Standard deviation appears in parentheses. Significance: ***0.001, **0.01, *0.05, † 0.1.

The differences among companies are evident not only in the human resource management practices used, but also in the organization-level and project team-level factors followed, and in the outcomes of the capability to mobilize knowledge and create new knowledge for innovation. Table 3.9 presents the results of a comparison of means among firms and measures used. Data came from the questionnaires described in Section 1.3.

Organization-level processes. The results show that Commune had the highest level of knowledge mobilization, as indicated by frequency of cross-functional communication, followed by Tribe, and then Party. The mean of cross-functional communication frequency for Commune (3.35) is statistically higher than for Tribe (2.12) or Party (1.77). The means for the shared mental model of cooperation are significantly different between Commune (2.88) and Party (0.91) and between Party and Tribe (2.08). In addition, the mean overlapping knowledge is also significantly higher for Commune (2.66) than Tribe (1.66) and Party (1.27), which means that Commune had the highest capacity for converting individual knowledge into organizational knowledge in terms of innovation.

Project team-level processes. At the project team level, Commune also seemed to have the highest level of knowledge mobilization, as indicated by its team-level internal communication frequency (3.25), followed by Tribe (2.65) and Party (2.37), with the differences between Commune and Party being statistically significant. For team-external communication frequency and team-level shared mental model of cooperation, there are no significant differences among these three companies. There are no differences between Party and Tribe. Moreover, Commune also seemed to have a higher capacity for converting individual knowledge into organizational knowledge, as indicated by the fact that it had the highest level of team-level overlapping knowledge. Commune had a significantly higher level of overlapping knowledge (3.00) than Party (1.87) and Tribe (2.12).

The capability to mobilize and create knowledge for innovation. On average, Commune generated more innovations than Party per team (1.00 vs. 0.62). This difference, however, is not statistically significant. There are also no significant differences in the number of innovations generated by Commune and Tribe, or between Party and Tribe.

The results of the comparison across companies suggest that companies can use three different strategies in developing the capability to mobilize and create knowledge for innovation. Commune, which only used organization-level human resource management practices, developed its human resources such that the supporting organization-level factors for knowledge mobilization, particularly cross-functional communication frequency, a sense of shared mental model of cooperation, and for knowledge creation, overlapping knowledge, were built into the larger context of the organization. I refer to an organization that uses this human resource management system as following the 'organization strategy' in developing the capability to mobilize and create knowledge for innovation.

Party did not develop its human resources at the organizational level such that the supporting organization-level factors for knowledge mobilization and creation were built into the organization, but rather developed its human resources as needed when organized into project teams for innovation. An organization that uses this human resource management system is referred to as following the 'project team strategy'.

Finally, Tribe developed its human resources using both organization-level human resource management practices and project team-level human resource management practices to achieve the capability to mobilize and create knowledge for innovation. An organization that develops its human resources both at the organizational and project levels is referred to as following the 'mixed strategy'.

This leads to the proposition that:

Proposition 8: Companies use one of three strategies –organization, project team or mixed– to develop the capability to mobilize and create knowledge for innovation. Companies that follow the organization strategy develop their human resources such that the organization-level processes that support innovation are generated regardless of when they are used in the process of innovation. Companies that follow the project team strategy develop their human resources only as they are needed in the process of innovation. Companies that use the mixed strategy develop their human resources at both levels.

3.3. DISCUSSION AND CONCLUSIONS

The comparative case study analysis served to answer the question, How do companies develop the capability to mobilize knowledge and create new resources, particularly innovation? In attempting to answer this question, I put forward eight propositions regarding the process by which companies develop this capability. The analysis showed differences in the organization-level and project team-level processes, the human resource management practices, and the efficacy of the organization, project team and mixed strategies in terms of the capability to mobilize and create knowledge for innovation. However, these differences are still not completely clear. Furthermore, the case analysis showed that companies use different strategies to develop the same capability.

These findings are different from what we have seen in the literature presented in Chapter 2. First, we found that in addition to the project team or the organizational strategy, which are discussed in the team-level innovation literature and organization-level innovation literature, companies may also use the mixed strategy to develop the same capability. However, unlike previous studies, which argue for a system of practices, this study also shows that the mixed strategy consists of only certain organizational strategy practices, and certain project team strategy practices. Second, contrary to the skepticism that overlapping knowledge exists in US companies located in the US (Leonard-Barton, 1995), this study also shows that US companies also have some overlapping knowledge, although it is not developed as systematically as is the case in Japanese companies located in Japan (e.g. Westney and Sakakibara, 1986; Leonard-Barton, 1995). Third, this study shows the mirror image of project team-level processes and their organization-level processes, which previous studies have neglected.

There are two main limitations to this study: 1) measurement of the dependent variable and 2) the sample, which consisted of a Japanese company located in Japan and US companies located in the United States. First, the capability to mobilize and create knowledge for innovation is unobservable and can only be measured through its outcomes; although measuring the outcomes in terms of innovation is consistent with the discussions on organizational capability in the resource-based theory of the firm (Nelson and Winter, 1982; Prahalad and Hamel, 1990; Kogut and Zander, 1992), such analyses are incomplete. Other outcomes of this capability are also important in understanding the capability. Particularly important are explanations offered by the team-level innovation literature and organization-level innovation literature, such as efficiency in terms of resources used in achieving the innovation (Ancona and Caldwell, 1992b; Clark and Wheelwright, 1992), effectiveness in terms of speed-to-market of the innovation (Clark and Fujimoto, 1991), and customer satisfaction with the innovation (Quinn, 1992). Another significant outcome of this capability is learning, which is the firm's ability to apply the knowledge created in one part of the organization to other relevant parts (Prahalad and Hamel, 1990; Senge, 1990; Nonaka and Takeuchi, 1995). Since these outcomes of the capability to mobilize knowledge and create new knowledge are important for firms in order to achieve and sustain their competitive advantage, they are discussed in the following chapters. While this study does not show whether this capability is associated with higher financial performance, it touches upon this question in later analyses.

Second, comparing a Japanese company located in Japan and US companies located in the United States poses some limitations. The institutional environments of the two countries may explain why we see the different practices in these two settings; if this is the case, the transfer of practices across these institutional environments should proceed with caution. As we see in the case of Commune, which is a Japanese company, tremendous investment is made up front in selecting the right people, socializing, evaluating, compensating, training, and developing them regardless of when they organize for innovation. Some researchers (e.g. Milgrom and Roberts, 1992) would argue that Japanese companies can do this because the external labor market is not as developed as in the United States, and therefore, employers can recover these investments. As one personnel manager states:

> We have no fear about our employees leaving the company, despite the very slow promotion pace. For the larger and prestigious companies, our employment system is like going to buy a ticket for a very popular concert. The lines are always long, and if you leave the queue for another that is equally long, why bother? You can't butt in. Of course, they can always go to the less popular concert where the queues for tickets are much shorter."

In contrast, because of the well-developed external labor market in the United States, companies are reluctant to make the same type of investments, since there is a risk that they may not be able to recover them. Therefore, it is argued that there is little economic incentive for companies to undertake these investments, except perhaps for when they are needed to perform a particular task, e.g., developing an innovation. Moreover, the allocation of human resources in Japanese and US companies located in the United States also differ, perhaps also due to influence from their external labor markets. In the case of Commune, the allocation process of their employees is centralized and controlled by the human resource department, and thus, the movement of employees for development purposes is much more fluid. In contrast, in the United States, the functional departments control the allocation of their human resources, and therefore, the movement of employees is much more difficult. However, in the case of Tribe, we see that cross-functional development of employees is done, but in an ad hoc manner whereby employers, the functional departments receiving employees, and the employees involved have to be willing to undertake this development.

I deal with this limitation by controlling for the institutional context in the large sample study, collecting data only on Japanese and US companies located in the United States. The research design for the large sample study is discussed in the next chapter; the subsequent chapters present the empirical tests of the processes and management practices that are proposed to support the capability to mobilize knowledge and create new knowledge for generating new resources. These procedures enable us to expand the case study to determine whether the different strategies that firms use to develop this capability can be generalized, and to ascertain which strategies are associated with higher performance in terms of the capability developed and financial outcome, or profitability.

4. RESEARCH DESIGN FOR THE LARGE SAMPLE STUDY: DATA COLLECTION PROCEDURES AND EMPIRICAL SETTING

In this chapter I describe the data collection procedure and empirical setting for the large sample survey that I use to test the propositions presented in the previous chapter. In order to answer the "which" and "what" questions, the relationships between variables underlying each construct (Judd, Smith, and Kidder, 1991; Yin, 1984) must be tested using a large sample.

I collected data from 182 cross-functional project teams in the US operations of 38 US and Japanese multinational enterprises (MNEs). These companies belong to the computer, photo imaging, and automobile industries. The project teams in this analysis are based in the largest customer service center of each firm, and their main purpose is to use market knowledge and information about the firm's products and services to develop innovation in response to customer preferences. Unlike previous studies (e.g. Wageman, 1995; Brown and Duguid, 1991), which examined customer service teams consisting only of members of the customer service function, the project teams I analyze also include members of R&D, manufacturing, and sales/marketing. Moreover, the type of innovation that these teams develop takes into account the preferences of all customers, not just the lead users (Von Hippel, 1986).

In the first section, I present the sample selection criteria, followed by a description and explanation of the data collection procedures. I then describe the empirical setting –the customer service center– indicating its function, internal and external linkages, methods of customer intelligence gathering, and the use of customer intelligence for innovation. I conclude the chapter with an example of the use of customer intelligence to mobilize and create knowledge for innovation.

4.1. SAMPLE SELECTION CRITERIA

I collected data from 182 cross-functional project teams in the US operations of 38 US and Japanese multinational enterprises, which belong to the computer, photo imaging, and automobile industries. The analysis of companies in different industries enables us to generalize the results across industries (Chandler, 1990). In the following paragraphs I explain in more detail the rationale behind this sample selection.

Customer Service Centers. The main reason for analyzing innovation based on the customer feedback and originating in the customer service center is that most successful innovation is market-pulled rather than technology-pushed (Tushman and Anderson, 1997). I selected the customer service center based on the following factors: (1) it is the largest customer service center in terms of employees; (2) it handles all the products and services provided by the business unit; (3) it is directly linked to all the main functions of the company, i.e., manufacturing, engineering, and sales/marketing; and (4) all of the smaller customer service centers report to it. These operations were initially identified using the Directory of Corporate Affiliations (1998) and later verified through phone calls to all the customer service centers.

Industries. I selected companies in multiple industries (computer, photo imaging, and automobile) so that a theoretical framework could be developed that would apply across industries. I selected these particular industries because they face different innovation cycles that affect the time constraints on gathering and processing different types of knowledge and information for innovation (Lawrence and Lorsch, 1967). The computer industry's innovation cycle is less than three years (Kai, 1992), the photo-imaging industry's innovation cycle ranges from three to six years (Jacobson and Hillkirk, 1986), and the automobile industry's innovation cycle ranges from six to 12 years (Clark and Fujimoto, 1991).

Countries. I selected the largest US customer service centers of companies that are of US and Japanese origin and that operate in both the United States and Japan. This parameter is demanded by the study, because it is part of a larger study that compares sources of the capability to mobilize knowledge and create new knowledge of US and Japanese multinational enterprises in both the United States and Japan. I selected US and Japanese companies because they differ in management of human resources (Aoki, 1988; Bartlett and Ghoshal, 1990; Dore, 1973; Ouchi, 1981; Robinson, 1996; Westney and Sakakibara, 1986). While the human resource management practices of US firms are viewed as inhibitors of knowledge sharing and therefore, barriers to innovation, the practices of Japanese firms are viewed as facilitators of knowledge sharing, which support innovation (Aoki, 1988; Dore, 1973; Ouchi, 1981). The comparative case study analysis in Chapter 3 also shows that Commune, a Japanese firm, exhibits a greater number of human resource management practices supporting the organization-level factors that facilitate knowledge sharing for innovation than Tribe and Party, which are US firms. A systematic comparison across firms from different countries within one institutional context illuminates this discussion.

Companies. I selected companies on the basis of their size and multiple functional departments; they are the largest in their industries based on revenue, as reported in the Hoover's HandBook of World Business (1999) and they have a customer service center, and manufacturing, engineering, and sales/marketing functions in the United States. According to these prerequisites, the initial sample was composed of 46 firms. During the research process, three of the companies merged into one and therefore had to be dropped from the sample, as these companies were in the midst of changing their human resource management policies. Of the 43 remaining firms, I obtained data from 38 companies, which is equivalent to a company-level response rate of 88.4%.

Project teams. The project teams were selected based on several criteria. First, at least three functions were represented: customer service, engineering (manufacturing, design, and/or R&D), and production or sales/marketing. The main reason for this requirement is the fact that innovation critical to company performance is linked to design and/or quality that meets customer demands (Quinn, 1992; Dougherty, 1992). Customer service organizations provide knowledge and information about customer demands, while engineering provides knowledge and expertise on design and manufacturing that affect quality and design. Second, they finished or nearly finished the project within the last two years. Completed or nearly completed projects rather than ongoing projects were selected so that their outcomes could be examined. The two-year requirement (rather than one-year) is selected in order to get a large enough base from which to choose sample projects. Third, the main objective of the projects was to raise sales performance and customer satisfaction by innovating products in design, quality, or both. Finally, in order to control for task complexity (Nobeoka, 1993) projects did not deal with routine issues. The response rate for the project team level was 95.8%.

4.2. DATA COLLECTION PROCEDURES

I used different methods to collect data –interviews, surveys, and secondary data– to achieve triangulation and better understanding of the process of knowledge mobilization and creation for innovation. A summary of the methods applied appears in Table 4.1.

TABLE 4.1

Methods of data collection

Interviews	
Number of interviews	26 vice presidents of customer services, 26 human resource managers, 66 team leaders, 22 others
Length of interviews	1-3 hours
Date of interviews	June 1996-December 1998
Locations	Japan and USA
Surveys	
Number of surveys	182 project teams in 38 companies
Date of surveys	August 1999-April 2000
Locations	USA
Secondary data	
Company archival data	Performance evaluation forms, recruiting forms, benchmarking reports for customer services, annual reports
External evaluations	JD Power & Associates, PC World, benchmarking report for photo-imaging companies, trade journals

4.2.1. Units and levels of analysis

In this study, I use two units and levels of analysis. I analyze the capability to mobilize and create knowledge for innovation both at the organizational and at the project levels. Multi-level theories are complex (Rousseau, 1985), but they provide important practical insights (Klein, Tosi, and Cannella, 1999). Multi-level theories illuminate the context surrounding individual processes (Klein et al., 1999). In this study, the interaction between individuals on project teams and in their daily context within the organization constitute individual processes at the organizational and project-team level.

At the organizational level, the unit of analysis is the largest customer service center of each company selected for the study. This center handles all the products for the business unit or division. Since the customer service center is a boundary organization that links the company's external environments with all the critical functions within the firm, the outcomes of the capability to mobilize and create knowledge for innovation are extrapolated to the firm level.

At the project team level, the unit of analysis is the cross-functional project team initiated by the customer service center. Project teams are selected as the second unit of analysis because previous studies (Ancona and Caldwell, 1992b; Nonaka and Takeuchi, 1995) and the discussion of the theoretical framework in Chapter 2 suggest that teams are mechanisms for knowledge mobilization and creation. Moreover, in Chapter 3 it is proposed that project team-level processes and management practices also support the capability to mobilize and create knowledge for innovation.

In this study I link these two levels within the organizations. The results of the case study in Chapter 3 also show that because project teams are embedded in the organization, they are subjected to the ongoing organization-level processes of the organization.

4.2.2. Surveys

In order to minimize response bias, I separated the two levels of analysis by collecting data from different sources for each group of variables (Rousseau, 1985; Klein et al., 1999). For the project team-level variables, I collected data from the team leaders. For the organization-level variables, specifically the ongoing organization-level processes and personnel practices, I collected data from the head of the personnel function of that organization. For the project-team level and organization-level outcomes of capability, I collected data from the project managers.

The project team-level data. For each organization, the project manager answered a questionnaire about the outcomes of the selected projects and the overall capability of his/her company to use customer intelligence for innovation. For each company, the vice president of the customer service center was asked to introduce the project manager, and the project manager was asked to provide a list of projects and the team leaders who supervised them.

The project team leaders answered questionnaires about their processes, project team management practices, and the outcomes of their projects. Based on the list provided by the project manager, I randomly selected five team leaders to respond to the survey about their team processes, team management practices, and their outcomes. These team leaders were sent a survey directly. The team leaders were selected for the survey because they have the best knowledge of what happened on the teams they supervised.

In order to minimize team bias on their project team outcomes, I surveyed the project manager of each organization on the outcomes of the selected projects. These managers were asked to rate the outcomes of the project teams using the same variables and measures that were used in the surveys on project outcome sent to the team leaders.

The organization-level data. The head of the human resource management department of the largest customer service center of each company answered the questionnaire on personnel policies for the white-collar professional workforce, particularly engineers, sales/marketing, and customer services. They also answered questions about the ongoing processes that occur between these functions. The personnel managers were asked about the human resource management policies and communication patterns between different functions, such as customer service, design engineering, manufacturing engineering, production, and R&D engineering. They were also asked about the type of attitudes and the level of commitment shown by different functions toward one another, and their views of each other, which define the organization-shared mental model. The personnel manager was selected for two reasons. First, s/he has the best knowledge of personnel policies. Second, because the personnel function is a boundary function, s/he is the most qualified to comment on and elucidate the type of interaction that occurs between different functions.

In order to minimize organizational bias on their performance ratings, I also used external ratings of companies in the study. I used ratings by JD Power & Associates to evaluate organization-level capability to mobilize and create knowledge for innovation for the automobile companies. In particular, ratings on their "appearance", "dependability", and "quality" were used. For the computer companies, I used ratings from PC World Magazine. For companies in the photo-imaging industry, the data were provided by a marketing research company that performs benchmarking for companies in this industry.

All the major products of each company were evaluated in terms of quality, customer satisfaction, and time for new product introduction. If a given product is rated first on any one of these three dimensions, it is given a value of 1; otherwise it is given a value of 0. The points are then tallied for each company. The limitation of this measure is that since companies have different quantities of products on the market, those that have more products have greater probability of meeting the standards set by these rating agencies.

4.2.3. The pilot test

Before conducting the survey, I conducted a pilot test to ensure that the survey instruments would capture the underlying phenomena. This pilot study was conducted on a photo-imaging company, which was selected because of its geographical proximity and its willingness to participate. The initial company contact was the vice president of human resources. This executive then provided the names of the human resource manager and the vice president of customer services, who were located in their largest customer service center. The personnel manager at the customer service center filled out the questionnaire on human resource management policies and organization-level processes. Before sending him the questionnaire, I asked him to schedule a personal interview regarding the questionnaire. The vice president of the customer service center gave me the name of a project manager. The project manager provided a list of projects and the names of team leaders who supervised them. From this list, I randomly selected three team leaders to answer the questionnaires designed for the team leaders on their team processes, project management practices, and their outcomes. Before sending each team leader the questionnaire, I also made appointments with them for personal interviews, so that I could clarify and improve the questionnaire. The project manager was also sent a questionnaire about the outcomes of the same projects selected for the study. Again, before sending the questionnaire, an appointment was made to interview him about the questionnaire he was going to answer. After this pilot test, I rewrote the questionnaires, in order to achieve greater clarity. The company used in the pilot test is not included in the 38 companies surveyed.

4.3. THE EMPIRICAL SETTING: THE CUSTOMER SERVICE CENTER

In this section I describe the empirical setting of the study –the customer service center. I first present the strategic roles of the customer service center, and its external and internal linkages. I then discuss the methods by which the customer service center gathers customer intelligence from the external environment. Next, I explain the general processes by which companies use customer intelligence to create new knowledge for innovation. Finally, I provide an example to illustrate these processes (Goffin, 1998; Tebbe, 1998; Jamison, 1999).

4.3.1. Functions of the customer service center

A firm's largest customer service center monitors sales performance of the products and services the firm provides. Its main objectives include promoting sales to capture new market share and maintaining the customer base by continuously promoting customer satisfaction with its products and services (Grant, 1998; Kroll, 2000). It achieves these objectives by continuously collecting knowledge and information about customer preferences, and feeding them back to the rest of the firm for product and services innovations that meet these preferences (Lukus and Ferrel, 2000; Cristiano, Liker, and White, 2000).

The customer service center performs the following functions (Figure 4.1):

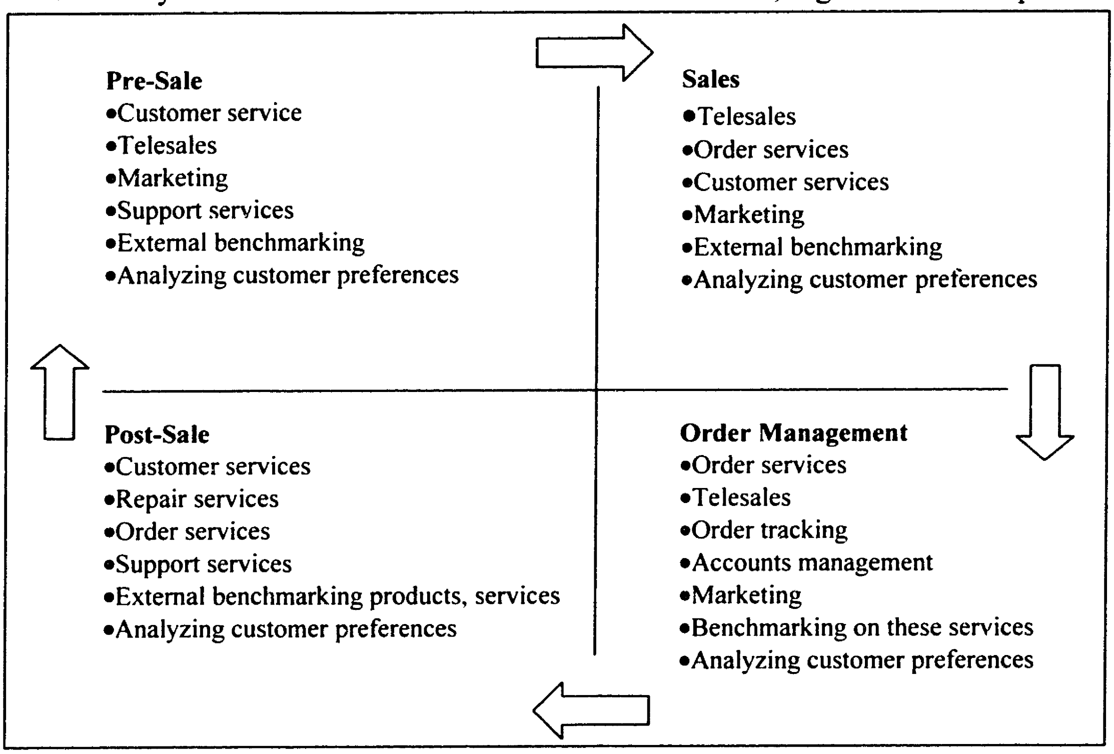
1) It gathers product and marketing information and facilitates marketing programs.
2) It provides customer problem solving and acts as a liaison with sales, logistics, and planning.
3) It documents internal and external information related to products and services for accountability and for external purposes.
4) It communicates with dealers on product/pricing changes, provides feedback to sales and marketing, and manages data for dealers and end users.
5) It assists marketing groups with end-user product survey campaigns, creates and manages service satisfaction index, and deals with high-risk customer retention.
6) It reports the marketing program of new product introductions and manufacturing data for engineering and manufacturing.
7) It benchmarks internally and externally in terms of quality of products and services provided.
8) It facilitates sales and provides services to external customers, specifically dealing with pre-sale, sales, order management, and post-sale.
9) In the pre-sale phase, it helps in customer services by soliciting sales, helps marketing develop campaigns, and provides support services by answering questions that customers raise.
10) In the selling stage, it deals with order services, customer services, and telesales.

11) Following that, it manages accounts by keeping customers satisfied in order to maintain this customer base.

12) In the post-sale phase, it provides customer services, resolves any problems raised by the customers, and provides support services.

FIGURE 4.1

Summary of the functions of the customer service center, organized in four phases



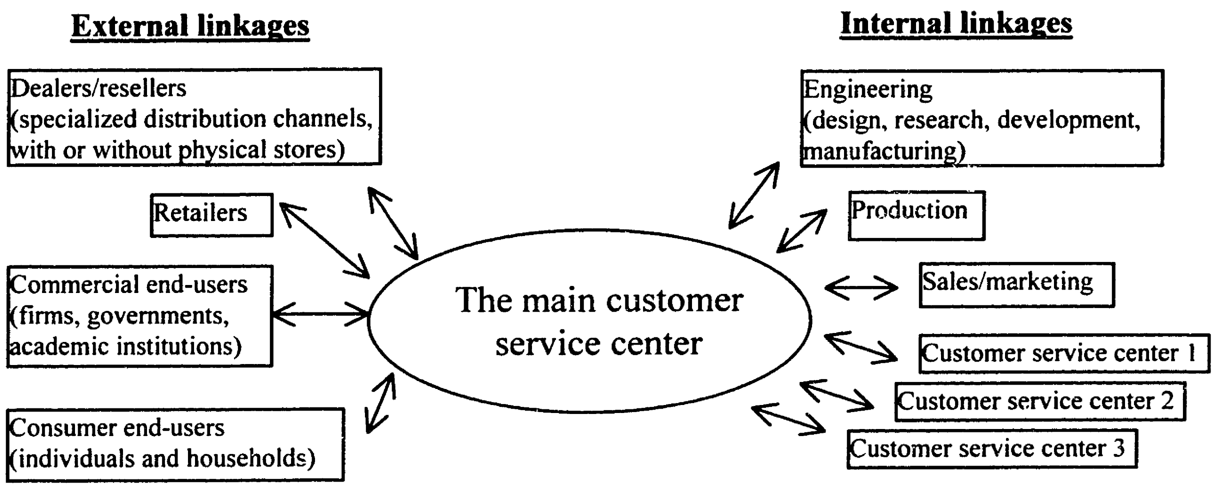
Note: Based on reports compiled by the customer service center of each company.

4.3.2. Linkages of the customer service center

The customer service function has both external and internal linkages. Its external linkages are to dealers/resellers, retailers, commercial end-users, and consumer end-users. Its internal linkages are to engineering, production, sales/marketing, and other customer service centers within the firm. Figure 4.2 summarizes these linkages.

FIGURE 4.2

Summary of external and internal linkages of the main customer service center



Note: Based on reports compiled by the customer service center of each company.

The external linkages of the customer service center. The external linkages of the customer service organization include dealers/resellers, retailers, commercial end-users, and consumer end-users. Dealers/resellers buy a large volume of products directly from the manufacturers at a discount and sell these products through catalogue sales, online, and through telemarketing, without setting up shops. Retailers, who normally hold the national accounts, also buy products at a discount from manufacturers and sell them nationwide through their retail chains. Commercial end-users are firms, governments, and academic institutions. The consumer end-users are individuals and household users.

The customer service function of a manufacturing firm deals with the commercial and individual end-users directly. Additionally, the dealers and retailers have their own customer service organizations that interact with the customer service organization of the original manufacturers, and concern themselves with customer satisfaction and sales. In particular, they track return sales and the reasons for them on behalf of manufacturers. In both cases, these linkages are critical sources of information about product quality, reliability, and aesthetics that affect customer buying decisions, satisfaction, and sales performance (Lukus and Ferrel, 2000; Cristiano et al., 2000; Goffin, 1998; Tebbe, 1998). While the end-users inform the companies directly about their preferences regarding the products, dealers and retailers can also provide similar information through return sales and the reasons for returns (Kroll, 2000), and information on repeat business.

The internal linkages of the customer service center. The internal linkages of the customer service function are engineering, manufacturing, sales/marketing, and other customer service centers in other major markets.

Links to the engineering function. The customer service organization is linked to all types of engineering organizations within the firm. For the manufacturing engineering organization, it provides information about customer satisfaction with products in terms of how they are manufactured. It provides information about product reliability and quality. The customer service function also serves the design engineering organization by providing information gathered from customers about product design, satisfaction with product, preferences, and suggestions about how the design may be improved for better performance and/or better appearance. The customer service organization also solicits ideas from potential customers, as well as current customers, through survey campaigns and/or hiring external marketing research companies to conduct studies on consumer preferences. In this way they can benchmark themselves against competitors. It provides this information to the design engineers for the purpose of improving existing products or developing new ones as demanded by the market. The customer service organization provides the research and development engineers (R&D) with customer intelligence concerning anticipated needs and preferences, as well as activities of competitors based on customer services' marketing research, external benchmarking, and interaction with their external customers.

Links to the production function. The customer service organization provides information to the manufacturing organization about product quality and quantity, as demanded by the customers. It also provides forecasts of expected demands and sales of these products. Furthermore, the customer service organization keeps track of shipping and handling of the products for the manufacturing organization. The information that the customer service function collects from customers impacts inventory management and production volume, which consequently affects production schedule, management of human resources, and associated financial costs in the manufacturing organization.

Links to the sales/marketing function. The sales organization is a source of information about customer preferences for the customer service organization, since they interact directly with customers in selling the products and services. However, the customer service organization also bears the brunt of any mistakes made by the sales organization. While the objective of the customer service organization is to maintain the customer base by managing customer satisfaction with products and services of the firm, the goal of the sales organization is to maximize sales, at times even at the expense of the customer base over the long term. In order to maximize sales, sometime the sales organization or particular salespersons will make inaccurate promises about the products, inflating claims concerning product capabilities even beyond the capabilities intended by the design and manufacturing organizations. Since the customer service organization deals with customer satisfaction and maintaining the customer base, it usually goes to the marketing organization, which deals with pricing, and urges marketing to make special offers to customers in order to satisfy them and maintain them as future customers. Since consumers purchase products from specific companies with certain expectations of their capabilities and performance, price cuts sometimes do not lead to higher satisfaction.

For the marketing organization, the customer service organization provides information about sales performance and customer satisfaction with the products. At times, the marketing organization must revise the original pricing strategies in order to boost sales of certain products or to cut losses, and must move to the next model or leave the market altogether, as frequently happens with new product roll-outs.

Links to the other customer service centers. The customer service organizations are also linked to other customer service centers in major markets, in order to encourage knowledge and information sharing on customer preferences and satisfaction, and sales performance in different markets. Companies accomplish this in one of two ways. The first strategy is used by companies that value knowledge and information sharing among customer service centers worldwide. They invest in information technologies whereby knowledge and information that can be coded is inputted into an information system that is accessible to all customer service organizations from anywhere within the firm. Since this method only allows the sharing of information and explicit knowledge, companies that value sharing of both explicit and tacit knowledge accomplish this by rotating their customer service personnel across markets.

4.3.3. Methods of customer intelligence gathering

Based on the data compiled by the customer service centers in this study, I identified nine methods that companies use to gather information from clients and customers. These methods can be grouped into three types of media: (1) For data collection by telephone, companies use 800 numbers, outbound calls, switchboard, broadcast fax, fax, and voice recognition units (VRU). (2) For data collection by direct mailing, companies use correspondence and direct mail outbound. (3) For data collection through the internet, companies use e-mail to receive and solicit information from customers.

Table 4.2 presents the summary of different methods used by the customer service organizations to gather information from their customers, from a sample of 38 companies in the personal computer, photo imaging, and automobile industries. The data show that the most commonly used medium is the telephone, which provides a richer medium of communication using 800 numbers, followed by outbound calls by the customer service organization, and switchboards. Companies in the PC industry had an average of almost two million customer contacts annually. Photo-imaging companies had an average of over a million and a half contacts. Automobile companies had an average of less than a million contacts.

TABLE 4.2

Annual contact frequency with external customers (industry averages of 38 firms in 1998)

Methods		Computer	Photo imaging	Automobile
Phone	800 number	850,000	654,000	390,000
	Outbound calls	410,000	344,000	209,000
	Switchboard	320,000	207,000	100,000
	Broadcast Fax	110,000	78,000	56,000
	Fax	52,000	55,000	21,000
	Voice recognition units (press 1 for…press 2 for…)	12,000	50,000	32,000
Mail	Correspondence	150,000	113,000	66,000
	Direct Mail Outbound	79,000	76,000	42,000
Internet	Internet electronic mail	15,000	12,000	8,000
Total		1,998,000	1,589,000	924,000

Note: Based on reports compiled by the customer service center of companies in this study.

4.3.4. Using customer intelligence for innovation

Customer intelligence is used for innovation following three stages (Figure 4.3): 1) evaluation of sales performance and customer satisfaction by top management; 2) communication between internal and external linkages; 3) knowledge mobilization and creation for innovation using project teams. The process presented here is based on field observation and interviews. It is a generic representation of the knowledge mobilization and creation processes for innovation, using external customer feedback rather than a specific process used by a particular firm.

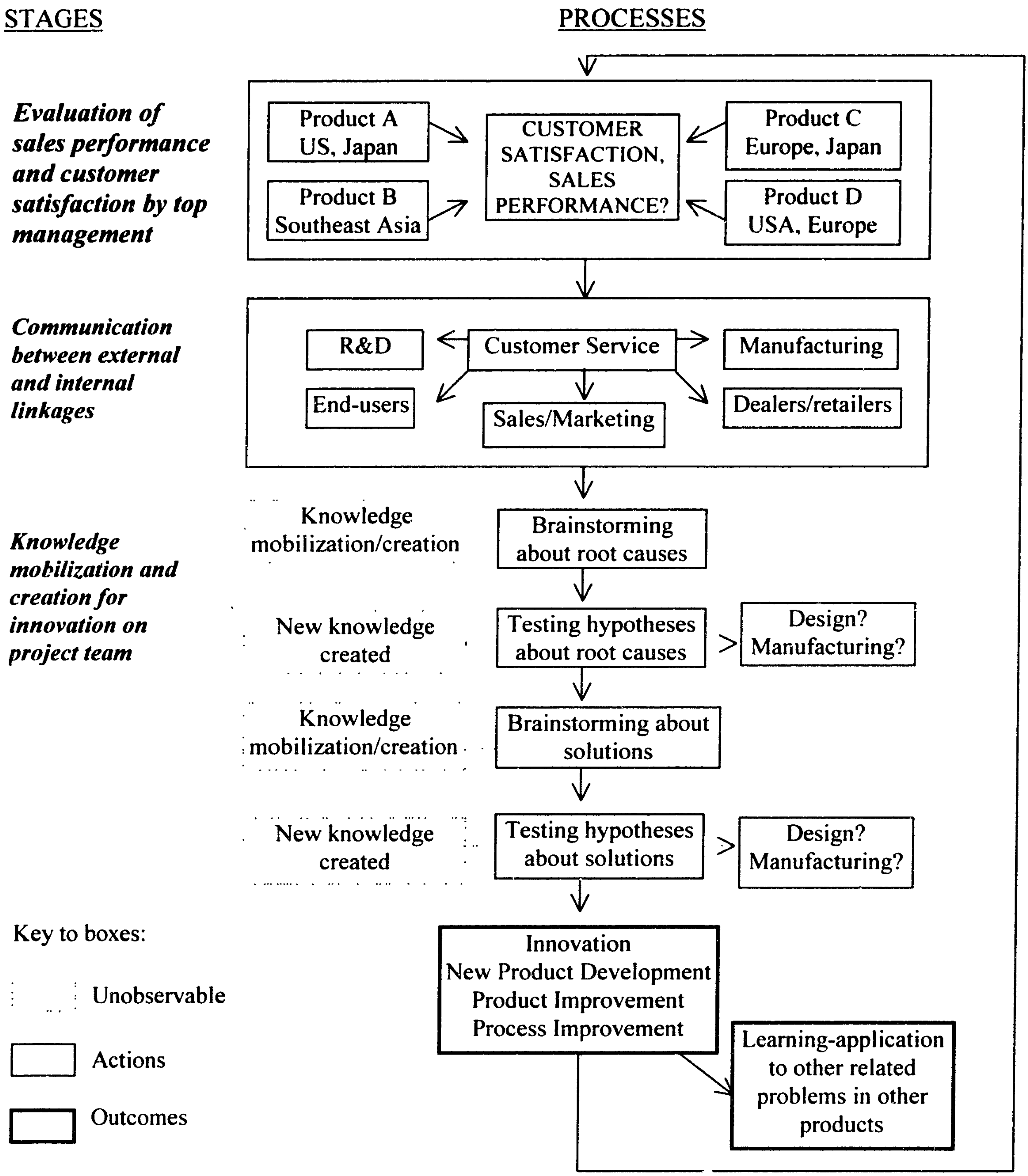
1) Evaluation of sales performance and customer satisfaction by top management. In each company, the top management team of the customer service function evaluates sales performance and customer satisfaction. As indicated in interviews, managers are conscientious about this, because their performance evaluation is tied to various components of customer satisfaction with firm's products and services. The top management team selects for analysis products that achieve below-expected performance, so that they are able to understand the root causes (Carroll, 1998) of poor performance. Initially, they analyze product performance as a whole; they then segment it by major market. The top management team then delegates the list of products that need further analyses down to the "project manager" of each organization. The project manager consolidates results from customer surveys, customer visits, complaints, comment cards, field service reports, product returns, sales contact reports, trade show intelligence, new product suggestions, and results from benchmarking. The project manager then contacts a relevant person to take over the task.

2) Communication between internal and external linkages. The project manager of the customer service organization delegates the responsibility to mid-management of the customer service organization, whose responsibility it is to consolidate knowledge and information about products under analysis in order to determine the root causes of their poor performance. The mid-manager, usually an engineer working in the customer service organization, communicates this information to the external and internal linkages of his/her organization. Interacting with the external linkages, customer service representatives gather information about the products being analyzed from dealers and retailers; all return sales are analyzed. The customer service organization analyzes all its interactions with customers and clients, examining all interactions that have occurred since the last evaluation. The principal objective is to determine patterns in their comments and suggested improvements for the products. Depending on how critical the products are to the overall financial performance of the firm, product survey campaigns are undertaken with major clients and commercial end-users. At the same time, the customer service organization hires a marketing research company to analyze what competitors are doing. Internally, this manager alerts the sales/marketing organization about possible changes in competitors' pricing strategies. This manager also informs design, manufacturing engineering, and production about product performance.

3) Knowledge mobilization and creation for innovation using project teams. In order to boost customer satisfaction and maintain the customer base, companies face pressure to innovate continuously. Because the root causes for low sales performance and customer satisfaction are usually unknown, the project manager who links top management and mid-management of the customer service organization selects a group of individuals and organizes them into project teams, to share knowledge and create new knowledge for innovation. These project managers hold different positions in different companies. In many computer companies, the project managers are the account managers. Among the photo-imaging companies, project managers range from a manager who is a statistician, and whose main responsibility is to forecast and monitor sales of all products and services of the firm, to customer service managers who monitor sales and customer satisfaction index. For automobile companies, project managers also range from product reliability managers to product design managers. Regardless of their titles, based on interviews and field visits, the top management of the firm's largest customer service center (VP of sales and customer services) and team leaders are aware of the individuals "called" project managers, or individuals in charge of a set of projects.

FIGURE 4.3

Process of knowledge mobilization and creation for innovation



In some companies, project managers are responsible for forming these project teams, while in others a project manager selects the team leader, and it is the responsibility of the team leader to form the team. A project team usually consists of individuals from the customer service organization who provide information collected from customers, surveys, and an independent marketing-research company. Since product reliability, quality, design, or their combination determines the level of customer satisfaction and sales performance, engineers from design and manufacturing, and sometimes sales/marketing personnel as well, are also included on the project team.

The first step in the knowledge mobilization and creation for innovation stage is to share knowledge and then create new knowledge through brainstorming about root causes. The innovation that has to be implemented is either in the manufacture or in the design of the product. Once hypotheses are generated about root causes (Carroll, 1998), they are tested either in manufacturing or in design, as called for by the hypotheses. After the root causes are identified, the project team must generate hypotheses about solutions or innovations to the existing product, or create new products if the old one is not worth fixing.

Once the hypothesized solutions are created, they are tested in relevant parts of the organization, usually in design or manufacturing. Therefore, the result is innovation either in the design, which occurs through a change in the current design, or in manufacturing, when the processes involved in manufacturing these products are modified. These results are sometimes applied to other relevant products or new product development. In the process of creating new knowledge for innovation, new product concepts also emerge.

4.4. EXAMPLE OF KNOWLEDGE MOBILIZATION AND CREATION FOR INNOVATION: THE DEAD BATTERY

A photo-imaging company faced a problem with a dead battery, whose solution led to innovation in both product and processes. The information about "dead battery" came through the institutionalized means of receiving customer information. In the review of sales performance and customer satisfaction with cameras, the head of the customer service center decided that the issue should be analyzed because nearly 50,000 commercial customers were affected, which had translated to a sales loss of $8 million per year for the previous eight years. The head of the customer service center delegated the issue to the technical support engineer. The technical engineer, whose previous experience was in the manufacturing of cameras, contacted the manufacturing manager of cameras for support. He had to decide whether the issue was related to the manufacturing of cameras, of batteries, or to a design problem.

Since the information mostly came from the US market, the technical support engineer did not communicate with other centers outside the United States. Additionally, all the information related to this product was given to a statistician to analyze. After the analyses, the technical engineer decided that the problem could be related to the manufacturing of batteries, or to the design or manufacturing of cameras. The technical support engineer decided to form a cross-functional team involving personnel from customer services, manufacturing of batteries and cameras, and chemical engineers for batteries, and design engineers of cameras. He designated himself team leader.

The technical support engineer could choose anyone he wanted to be on the team to come up with new ideas to improve the existing cameras or to make new cameras. Although he wanted representatives from camera manufacturing, battery manufacturing, customer service, production of batteries and R&D, he faced difficulty in forming the team. He turned to the corporate support manager in forming this cross-functional team and asked this manager to facilitate not only the team formation process, but also the processes of coming up with new ideas either to redesign the cameras or batteries, or to make new ones. It took time for the corporate cross-functional team manager to identify personnel from the necessary functions who were willing to participate.

In the brainstorming sessions about root causes, different functions were defensive in protecting their turf. Sensing the defensiveness, the corporate cross-functional team facilitator called time out and provided training to the team on how to better share their knowledge and information in this process. The training involved the simulation of a hypothetical situation whereby employees from different parts of the organization came together to work on an issue. Despite the training, however, knowledge and information sharing was complicated by lack of cooperation from the manufacturing organization. Before they would cooperate, each manufacturing function insisted that more evidence and testing was needed if it was to be shown that their departments were the source of the problem. Even after thorough testing, as the facilitator stated, "they wanted the team leader to be more than 93% confident that the cause of the problem had something to do with their department." The team leader then asked some of his personal networks in battery manufacturing to examine the processes by which the batteries were produced by specific machines, and the processes through which the used batteries were managed. At the same time, he asked his personal contacts in cameras to randomly select cameras for testing to see whether certain cameras, because of their design, "drain" the batteries in cameras when they are not in use. Only when the team leader had strong evidence for probable causes did the manufacturing department of cameras and batteries allow the project team to explore potential solutions in their organizations.

The initial hypothesis was that innovation in the design of the camera was needed, as the camera probably drained the battery when it was not in use. Camera design engineers argued against this hypothesis and suggested that the batteries might be incorrectly manufactured. The batteries were probably bad from the beginning, so when customers used the camera, they were quickly drained. Therefore, innovation in camera design was not necessary. They argued that the battery manufacturing processes demanded innovation to achieve higher quality. After months of arguing hypothetical points, each hypothesis was tested in the relevant parts of the organization. Some manipulation in the design of cameras was made to examine any possible alleviation of the dead battery problem. At the same time, all battery manufacturing processes were reviewed. The results showed that certain changes in the designs reduced the dead battery syndrome. In the manufacturing organization, studies revealed that batteries that had been used for testing were sometimes put back in the stream of brand new batteries by production workers. Therefore, some of the batteries sold on the market had used up half of their life by the time they reached the end-users. The struggle between camera design and battery manufacturing was so intense that both functions refused to innovate unless the other started making changes first.

After solving the difficulty in mobilizing knowledge, new knowledge for innovation was created. For the cameras, new designs were created and implemented. For the battery manufacturing organization, new methods of managing used and new batteries were established. Production workers were given training on these new processes. In this case, not only product, but also process innovations resulted from the capability to mobilize and create knowledge for innovation.

In the next chapter I analyze the key project team-level factors and management practices and their effects on the capability to mobilize and create knowledge for innovation at the project level.

5. DETERMINANTS OF THE CAPABILITY TO MOBILIZE AND CREATE KNOWLEDGE FOR INNOVATION AT THE PROJECT-TEAM LEVEL

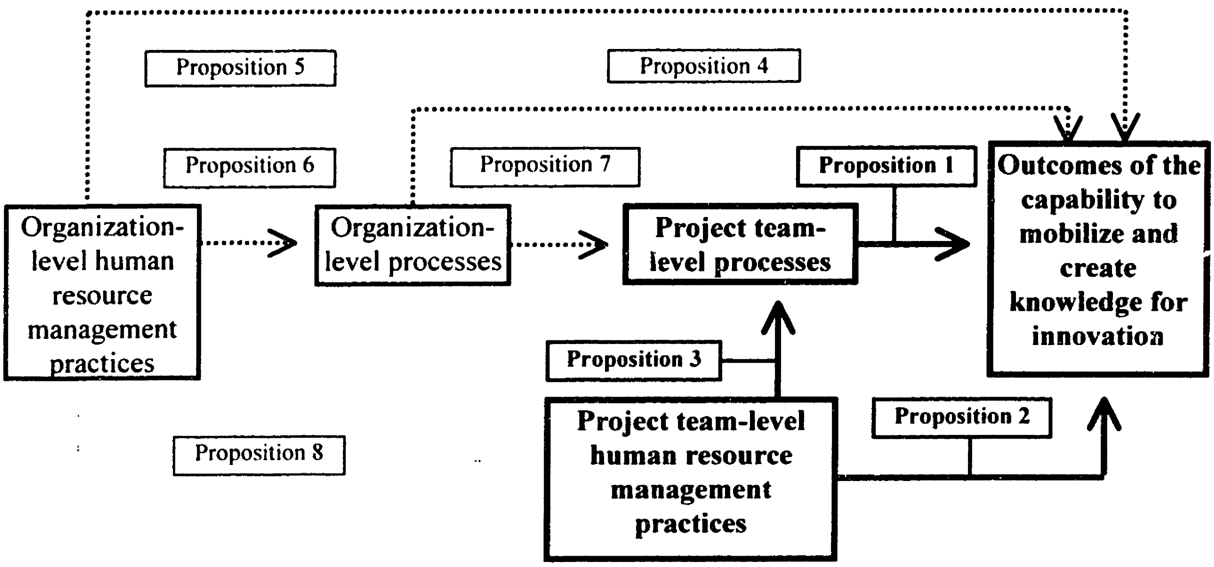
In this chapter I test three propositions that emerged from the case studies of Chapter 3 and that relate to the ways in which the project team-level processes and project team-level management practices affect the capability to mobilize and create knowledge for innovation at the project-team level. In Proposition 1, I put forward the idea that the project team-level processes –project team-internal communication frequency, project team-external communication frequency, project team shared mental model of cooperation, and project team overlapping knowledge– support the capability to mobilize and create knowledge for innovation at the project-team level. In Proposition 2, I argue that the project team-level human resource management practices –project team development, project team reward, and project team membership selection– support the capability to mobilize and create knowledge for innovation. In Proposition 3, I suggest that the project team-level human resource management practices also have an indirect effect on the capability to mobilize and create knowledge for innovation, since they support the project team-level processes. Figure 5.1 presents, within the general framework of the thesis, the theoretical model tested in this chapter. The constructs and relationships studied in this chapter appear in bold.

I organize this chapter as follows. In the first section, I present the hypotheses for testing each proposition; these hypotheses build on the team-level innovation literature and the theoretical discussion presented in Chapter 2. In the second section, I briefly describe the research design used specifically for this chapter, which is based on the data described in Chapter 4, and which differs from the research designs used in the other chapters. In the third section, I present the results and analyses, followed by the discussion and conclusions in the last section.

FIGURE 5.1

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

Propositions and relationships analyzed in the chapter are highlighted



5.1. THEORY AND HYPOTHESES: DETERMINANTS OF THE CAPABILITY TO MOBILIZE AND CREATE KNOWLEDGE FOR INNOVATION AT THE PROJECT TEAM-LEVEL

5.1.1. Analyzing Proposition 1: Project team-level processes support the capability to mobilize and create knowledge for innovation

Four main project team-level processes are presented as supporting the capability to mobilize and create knowledge for innovation and project team performance. The factors that facilitate knowledge mobilization are: (1) internal communication frequency (Allen, 1970; 1977);

(2) external communication frequency (Ancona and Caldwell, 1992a); and (3) team shared mental model of cooperation (Cannon-Bowers and Salas, 1990). The factor that facilitates knowledge creation is project team overlapping knowledge (Madhaven and Grover, 1998). All four factors facilitate knowledge mobilization and creation and, therefore, innovation. In the following discussion I present each variable in more detail.

Project team-internal communication frequency. Communication frequency between project team members has a direct effect on innovation (Griffin and Hauser, 1992; Dougherty, 1987; Souder, 1987). The team level-innovation literature views communication as knowledge exchange. The higher the frequency, the more knowledge is being exchanged, and the better this is for innovation (Dougherty, 1987; Griffin and Hauser, 1992; Allen, 1977). More specifically, innovation is more successful if R&D and engineering understand customer needs, marketing understands technological capabilities and constraints, and both R&D and marketing understand the implications for manufacturing and competitive strategy (Souder, 1987; Workman, 1995). Dougherty (1987), for instance, suggests that projects with unsuccessful outcomes typically had lower levels of communication frequency, while successful projects were those that had a higher frequency of inter-functional communication. Extending Dougherty's study, Griffin and Hauser (1992) also found that project teams are more successful at new-product development if there is more communication among marketing, engineering, and manufacturing team members. The study found that project teams with more communication among core team members achieved higher performance than those teams with less communication frequency. This leads to the hypothesis that:

H1a. Project team-internal communication frequency is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

Project team-external communication frequency. Previous studies on communication and innovation in project teams tend to blur the boundaries that divide communication amongst team members and communication between team members and their external links (e.g., Nonaka and Takeuchi, 1995; Clark and Fujimoto, 1991). Ancona (1984) and Ancona and Caldwell (1992a) suggest that teams are embedded in the larger context of the organization, and make the distinction between internal and external communication. The authors found that communication frequency between team members and their external links is positively related to innovation and the efficiency and effectiveness of managing that process. The boundary-spanning literature (Tushman, 1977, 1979; Allen, 1984) also shows that the frequency of external communication affects team performance in the process of innovation positively. These analyses lead to the hypothesis that:

H1b. Project team-external communication frequency is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

Project team shared mental model of cooperation. Project team shared mental model of cooperation is also proposed to enhance teamwork performance (Cannon-Bowers and Salas, 1990; Nonaka and Takeuchi, 1995). There are numerous definitions of this concept ranging from "group mind", teamwork schemas to common cause maps (Klimoski and Mohammed, 1994: 403). In this study, project team shared mental model of cooperation is defined as a team-shared goal and commitment to accomplishing the team task (Gladstein, 1984; Katz, 1997:138), and the understanding of knowledge structure held by team members that enables the formation of accurate expectations of the task and team (Cannon-Bowers et al., 1993; Nonaka and Takeuchi, 1995), or who will contribute what from the different functions represented on the team to accomplish the project (Cannon-Bowers and Salas, 1990). On one hand, project team shared mental model of cooperation motivates knowledge exchange that is critical to innovation, as team members share similar vision and aspirations (Nonaka and Takeuchi, 1995). On the other hand, it enables team members to better understand who, on the team, will contribute what toward accomplishing the task, thereby enhancing team ability to identify which knowledge from various parts of the organization will contribute to accomplishing the task. However, project teams that have an excessively strong shared mental model of cooperation, where all team members share the same goal and commitment and understand who will contribute what, may minimize the necessity of "creative abrasion" (Leonard-Barton, 1995) or may become wrapped up in "groupthink" (Janis, 1972) that hinders innovation (Madhaven and Grover, 1998). This leads us to hypothesize that:

H1c. Project team shared mental model of cooperation and innovation, as an outcome of the capability to mobilize knowledge and create new knowledge, has an inverted U-shaped relationship.

Project team overlapping knowledge. Project team overlapping knowledge supports the capability to mobilize and create knowledge for innovation by supporting the creation or conversion process of individual knowledge into organizational knowledge (Nonaka and

Takeuchi, 1995; Madhaven and Grover, 1998). Project team overlapping knowledge is the overlapping knowledge among team members. Overlapping knowledge among team members enables individuals to take the perspective of other team members in the process of exchanging knowledge in order to produce innovation (Iansiti, 1998). Additionally, the redundancy can be understood in terms of the absorptive capacity that individuals have for other types of knowledge present on the team. Overlapping knowledge facilitates the conversion and integration of different types of knowledge to create and achieve innovation (Nonaka and Takeuchi, 1995; Madhaven and Grover, 1998). The underlying logic is that overlapping knowledge provides team members with the cognitive resources to combine insights synergistically from multiple knowledge sets. In the context of cross-functional project teams, the overlapping knowledge of team leaders plays an especially important role in maintaining a disciplinary vision that integrates multiple perspectives and manages conflicting technical trade-off (Nonaka and Takeuchi, 1995). The cognitive skills to handle such integration and trade-off, gained through the process of integrating two disparate areas, will help the team leader craft a unifying vision that does justice to all the disciplines represented (Madhaven and Grover, 1998). However, while the redundancy enhances the sharing and integration process, up to a point, the lack of diversity hinders innovation as it decreases the creative abrasion that is also critical for innovation (Nonaka and Takeuchi, 1995; Madhaven and Grover, 1998). This leads to the hypothesis that:

H1d. Project team overlapping knowledge and innovation, as an outcome of the capability to mobilize knowledge and create new knowledge, have an inverted U-shaped relationship.

5.1.2. Analyzing Proposition 2: Project team-level human resource management practices support the capability to mobilize and create knowledge for innovation

There are direct relationships between project team-level human resource management practices and the capability to mobilize and create knowledge for innovation. Among the project team-level human resource management practices supporting this capability that are found in the literature are: (1) project team development, (2) reward for project team performance, and (3) project team membership selection. The first two practices facilitate knowledge mobilization, while the third facilitates the creation process by supporting individual knowledge conversion into organizational knowledge.

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, 1987). Project team development supports project team performance (Hershock et al., 1994). Project team development entails teaching team members about the goals of the projects and the processes by which they can be achieved (Hershock, 1997:168). The underlying idea behind project team development is that members represent different "thought worlds", with different objectives and expertise, and individually attempt to reduce uncertainty about their roles within the group. They seek to enact (Weick, 1995) their environments on the 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 who are expected to work together to accomplish the project. This development process may require the team leader to teach members how to organize work processes and how to better communicate with members from outside their thought worlds or organization subcultures (Schein, 1996). Moreover, it may involve individuals from sources external to the team, such as corporate trainers, as in the case of project teams in Tribe, or external experts, as in the case of Party. These analyses lead to the hypothesis that:

H2a. Project team development is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

Project team reward. Previous studies suggest that project team reward affects knowledge mobilization for innovation (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 that both monetary and non-monetary rewards have an impact on innovation (Roberts and Fusfeld, 1982). When individuals believe their contributions on project teams to achieving project goals are rewarded, they are likely to perform in a way that enhances 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 and Baker, 1997; Wageman, 1995). Therefore, project teams that receive rewards for their project team performance are likely to perform better than those that do not receive any reward. This leads to the hypothesis that:

H2b. Project team reward is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

Project team membership selection. Project team membership selection also has a direct effect on project team performance (Thamhain and Wilemon, 1987). Performance is enhanced by careful screening and selection of team members who match the demands of the tasks (Katz, 1997:137). On one hand, since project teams consist of individuals from different thought worlds with different knowledge sets, project team membership selection based, in part, on overlapping knowledge facilitates knowledge mobilization and new knowledge creation for innovation. On the other hand, project team membership selection based, in part, on deep knowledge and expertise that fit the task also facilitates project team performance, since innovation requires the combination of these knowledge sets (Thamhain and Wilemon, 1997:133). This leads to the hypothesis that:

H2c. Project team membership selection based on cross-functional overlapping knowledge is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

5.1.3. Analyzing Proposition 3: Project team-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by supporting the project team-level processes

Project team-level human resource management practices also indirectly affect the capability to mobilize knowledge and create new knowledge at the project level by affecting the factors that facilitate knowledge mobilization and creation. The factors that facilitate knowledge mobilization are: (1) project team-internal communication frequency, (2) project team-external communication frequency, and (3) project team shared mental model of cooperation. (4) Project team overlapping knowledge facilitates knowledge creation.

Project team rewards and project team communication frequency. The reward for team performance also has an impact on knowledge mobilization, since it affects project team communication frequency. In order to motivate knowledge exchange on team and between team members and their external links, team rewards are necessary for project team performance (Ancona and Caldwell, 1999). Employees working on teams in Japanese firms are more willing to share knowledge than employees in US organizations, in part, because they are rewarded for these behaviors (Aoki, 1988). Wageman and Baker (1997), in a study of the relationships between team reward and team outcomes, found that team reward has a positive effect on observed cooperation. Menon, Jarworski, and Kohli (1997), in a study of cross-functional product development teams, found that rewarding project team performance increases interdepartmental interaction. Therefore, project teams that receive a reward for their performance are likely to communicate more frequently to exchange knowledge in order to enhance task performance. Moreover, project teams that receive a reward for their performance are more likely to communicate outside the team to search for resources that enhance task performance. This leads to the hypotheses that:

H3a. Project team reward for a particular project team task is positively related to project team-internal communication frequency.

H3b. Project team reward for a particular project team task is positively related to project team-external communication frequency.

Project team development and project team shared mental model of cooperation. Project team development builds a project team shared mental model of cooperation (Klimoski and Mohammed, 1994; Roth and Kleiner, 1996), which facilitates knowledge mobilization on a team. A project team shared mental model of cooperation is built using formal and informal training of how to work on teams (Klimoski and Mohammed, 1994). Project team development is a process whereby team members are taught how to manage their work processes by the team leader and/or corporate trainer, whose daily responsibility is to train and facilitate various project teams in accomplishing the projects. Project team development may also occur by hiring external consultants to teach project teams how to manage their work processes, dividing and coordinating tasks, and how team members from different thought worlds or subcultures of the organization work together to exchange knowledge to accomplish the project. The purpose of project team development is to achieve "alignment", building a shared experience that, in turn, facilitates project team performance. These development processes not only provide an understanding of the knowledge structure of team members (Nonaka and Takeuchi, 1995), but also facilitate social integration, build trust, and replace individual goal differences with a collective goal (Roth and Kleiner, 1996). Moreover, the analyses of Tribe and Party also showed that project team development facilitates internal and external communication. On one hand, corporate trainers, as in the case of Tribe, or external experts, as in the case of Party, helped the team set the agenda for meetings to work on the project. This intervention influenced the frequency of internal communication. On the other hand, these trainers also encouraged external communication to search for the necessary resources for accomplishing the project. This leads to the hypotheses that:

H3c. Project team development is positively related to project team shared mental model of cooperation.

H3d. Project team development is positively related to project internal communication frequency.

H3e. Project team development is positively related to project external communication frequency.

Project team membership selection and project team overlapping knowledge. Project team membership selection influences the project team knowledge creation process (Madhaven and Grover, 1998). The underlying logic is that this overlapping knowledge does not occur automatically on project teams, since the pool of human resources in the organization contains different knowledge sets (Iansiti, 1998; Leonard-Barton, 1995). Even in Japanese firms, overlapping knowledge on a team is not automatic; not all human resources have the same knowledge sets, since such sets are not developed the same way at any given point in time. Therefore, in order to ensure some overlapping knowledge on project teams, members are selected based, in part, on this factor (Nonaka and Takeuchi, 1995: 77). This leads to the hypothesis that:

H3f. Project team membership selection based on cross-functional overlapping knowledge is positively related to project team-level overlapping knowledge.

In summary, the study proposes that the capability to mobilize and create knowledge for innovation on project teams is facilitated by project team-level processes –project team-internal communication frequency, project team-external communication frequency, project team shared-mental model, and project team overlapping knowledge– that influence the capability to mobilize and create knowledge for innovation. Moreover, project team-level human resource management practices –project team development, project team reward, and project team membership selection– not only affect this capability directly, but also indirectly, through their effect on the project team-level processes.

5.2. RESEARCH DESIGN

Data analyzed in this chapter are based on the surveys of 38 companies and their 182 cross-functional project teams working on product and process innovations using external market information. The companies are the largest in the computer, photo imaging, and automobile industries. Data sources, selection criteria, and data collection procedures are described in the research design in Chapter 4.

5.2.1. Variables and measures

The variables and measures are based on the following constructs: project team human management practices, project team-level processes, and the capability to mobilize knowledge and create new knowledge at the project team level. Table 5.1 summarizes the variables and measures used in this chapter. I performed a reliability test (Crombach α) for those variables that are composites of several indicators. The rule of thumb is that the indicators are reliable when Crombach α is above 0.60 (Willett, 1998). All the composites used have Crombach α above 0.60. Variables preceded by a P- refer to project team-level variables. Variables with the prefix C- indicate a control variable.

The capability to mobilize and create knowledge for innovation. The capability to mobilize knowledge and create new knowledge construct is represented by its outcome, innovation, since this intangible capability is not measurable directly but only through its effects (Godfrey and Hill, 1995). At the project team-level, innovation (P-PRODNOV) is measured by the extent to which projects using customer feedback led to new product development and improvement (0.87). In order to measure the efficiency, effectiveness, and learning gained from this process of knowledge mobilization and creation, other outcomes of this capability are also analyzed. For efficiency (P-EFFIC), the measures are labor and financial resources used in completing the project (α = 0.70). For effectiveness, speed-to-market (P-SPEED) is measured by whether the innovation was delivered quickly enough to meet market demands, and customer satisfaction with the innovation (P-CUSTSAT) is measured by assessing how satisfied the customers are with the innovation the project team generated. For learning, the measure is the application of innovation created in one part of the organization in other relevant parts of the organization (P-LEARN).

TABLE 5.1

Summary of variables and measures

Constructs	Variables		Descriptions	Measures	α
Outcomes of the capability to mobilize and create knowledge for innovation	P-PRODNOV		Project team-level product innovation	-Project team led to new product development -Product modification	0.87
	P-PROCESS		Process innovation	-Project team led to process innovation	
	P-EFFIC		Project team-level efficiency	-Financial resources used -Staff hours used (more than, less than, or same as expected by management)	0.70
	P-CUSTSAT		Customer satisfaction of innovation	-Level of satisfaction of innovation created by the team	--
	P-LEARN		Project team-level spillover	-Application of innovation created by the team to other relevant parts of organization	--
Project team-level processes	*Facilitators of knowledge mobilization*	P-NCOM	Project team-internal communication frequency	-Communication frequency among core team members using face-to-face meetings, phone, electronic mail	0.83
		P-XCOM	Project team-external communication frequency	-Communication frequency between team members and their external links, using face-to-face meetings, phone, electronic mail	0.77
		P-MODEL	Project team shared model	-Shared commitment among team members -Shared understanding of who contributes what on team	0.87
	Facilitator of knowledge creation	P-OVERLAP	Project team overlapping knowledge	-Overlapping knowledge among engineering team members based on their prior work experiences in manufacturing and R&D, each overlapping equals 1; otherwise 0	--
Project team-level human resource management Practices	*Facilitators of knowledge mobilization*	P-DEVLOP	Training for the particular project	-Project team received training specifically for performing this project	--
		P-RWRD	Reward for performing the particular project	-Project team performance impacted team members' salary, bonus, job assignment, promotion	0.78
	Facilitator of knowledge creation	P-SELECT	Team membership selection	Membership selection based on: cross-functional job experience, knowledge, and expertise for project	0.76
Control Variables	C-P-SIZE		Team size	Number of core team members on team	--
	C-P-TENURE		Tenure diversity in team	Team tenure standard deviation divided by its average	--
	C-P-SRDEXP		Prior shared team experience	This team is designated to deal with this type of issue, yes equals 1; otherwise 0	--
	C-P-NUMDIS		Number of functions in team	Total number of functions represented on team by core members	--
	C-P-SUPORT		Management support	Team received necessary resources from management for this project	--
	C-COMP		Indicator of company	Dummy: 1 for each company; otherwise 0	--

Project team-level human resource management practices. Project team-level human resource management practices are divided into two groups, those that facilitate knowledge mobilization and those that facilitate knowledge creation. There are three facilitators of knowledge mobilization. The first is project team development (P-DEVLOP), the training that the project teams receive for working on this project. The second is project team reward (P-RWRD), which is measured by the impact of project team performance on team members' salary increase, bonus payment, promotion, and job assignment (α = 0.78). The third is project team membership selection (P-SELECT), which facilitates knowledge creation and is measured by the selection of team members based on their expertise related to the project, cross-functional knowledge, and cross-functional job experiences (α = 0.76).

Project team-level processes. Project team-level processes that have an impact on the capability to mobilize and create knowledge for innovation are also divided into two groups, those that facilitate knowledge mobilization and those that facilitate knowledge creation. Facilitators of knowledge mobilization are internal communication frequency, external communication frequency, and shared mental model of cooperation. Internal communication frequency (P-NCOM) (Griffin and Hauser, 1992) is measured by the frequency of communication among team members using face-to-face meetings, phone conversations, and electronic mail, formally and informally (α = 0.83). External communication frequency (P-XCOM) (Ancona and Caldwell, 1992a) is measured by the frequency with which team members communicated with people outside the team using face-to-face meetings, phone conversations, and electronic mail (α = 0.77). Shared mental model of cooperation (P-MODEL) (Cannon-Bowers et al., 1993) is measured by perceived shared commitment in accomplishing the project and shared understanding of who will contribute which knowledge from their functions to accomplish the task (α = 0.87). Overlapping knowledge (P-OVERLAP), which facilitates knowledge creation, is measured by the total amount of overlapping knowledge among core engineering team members, based on their past and current work experience.

Control variables. There are controls at two levels, company and project team. At the company level, C-COMP is a company dummy variable for each company. At the project team-level, the control variables are team size (C-P-SIZE) (Smith et al., 1994; Ancona and Caldwell, 1992a; Bantel and Jackson, 1989), tenure diversity (C-P-TENURE), functional diversity (C-P-NUMDIS), shared prior experience working on team (C-P-SRDEXP), and management support (C-P-SUPORT). Tenure diversity is measured by team tenure standard deviation divided by its average (Bantel and Jackson, 1989). Functional diversity (Ancona and Caldwell, 1992b) is measured by the number of functions represented on the team (Bantel and Jackson, 1989). Prior shared experience working on team is measured by whether this project team is designated to work on this type of issue. Management support is measured by the extent to which the team receives adequate resources from management to accomplish the project.

5.2.2. 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 capability to mobilize and create knowledge for innovation (innovation, efficiency, speed-to-market, customer satisfaction, and learning). I also conduct path analyses to graphically show the relationships among variables analyzed in this chapter. Hypotheses H1a to H1d are tested using the following model:

Outcomes of the capability to mobilize and create knowledge for innovation $= \alpha + \beta_1 \cdot P\text{-}NCOM + \beta_2 \cdot P\text{-}XCOM + \beta_3 \cdot P\text{-}MODEL + \beta_4 \cdot P\text{-}MODEL^2 + \beta_5 \cdot P\text{-}OVERLAP + \beta_6 \cdot P\text{-}OVERLAP^2 + \beta_7 \cdot C\text{-}P\text{-}SIZE + \beta_8 \cdot C\text{-}P\text{-}TENURE + \beta_9 \cdot C\text{-}P\text{-}SRDEXP + \beta_{10} \cdot C\text{-}P\text{-}NUMDIS + \beta_{11} \cdot C\text{-}P\text{-}SUPORT + \beta_K \cdot C\text{-}COMP + \varepsilon$

For testing the direct effect of project team management practices on the capability to mobilize and create knowledge for innovation (H2a-H2c), the following specifications are used:

Outcomes of the capability to mobilize and create knowledge for innovation $= \alpha + \beta_1 \cdot P\text{-}DEVLOP + \beta_2 \cdot P\text{-}RWRD + \beta_3 \cdot P\text{-}SELECT + \beta_4 \cdot C\text{-}P\text{-}SIZE + \beta_5 \cdot C\text{-}P\text{-}TENURE + \beta_6 \cdot C\text{-}P\text{-}SRDEXP + \beta_7 \cdot C\text{-}P\text{-}NUMDIS + \beta_8 \cdot C\text{-}P\text{-}SUPORT + \beta_K \cdot C\text{-}COMP + \varepsilon$

For testing the effect of project team management practices on project team-level processes (H3a-H3d), the following models are used:

For H3a: $P\text{-}NCOM = \alpha + \beta_1 \cdot P\text{-}DEVLOP + \beta_2 \cdot P\text{-}RWRD + \beta_3 \cdot P\text{-}SELECT + \beta_4 \cdot C\text{-}P\text{-}SIZE + \beta_5 \cdot C\text{-}P\text{-}TENURE + \beta_6 \cdot C\text{-}P\text{-}SRDEXP + \beta_7 \cdot C\text{-}P\text{-}NUMDIS + \beta_8 \cdot C\text{-}P\text{-}SUPORT + \beta_K \cdot C\text{-}COMP + \varepsilon$

For H3b: $P\text{-}XCOM = \alpha + \beta_1 * P\text{-}DEVLOP + \beta_2 * P\text{-}RWRD + \beta_3 * P\text{-}SELECT + \beta_4 * C\text{-}P\text{-}SIZE + \beta_5 * C\text{-}P\text{-}TENURE + \beta_6 * C\text{-}P\text{-}SRDEXP + \beta_7 * C\text{-}P\text{-}NUMDIS + \beta_8 * C\text{-}P\text{-}SUPORT + \beta_K * C\text{-}COMP + \varepsilon$

For H3c: $P\text{-}MODEL = \alpha + \beta_1 * P\text{-}D\ EVLOP + \beta_2 * P\text{-}RWRD + \beta_3 * P\text{-}SELECT + \beta_4 * C\text{-}P\text{-}SIZE + \beta_5 * C\text{-}P\text{-}TENURE + \beta_6 * C\text{-}P\text{-}SRDEXP + \beta_7 * C\text{-}P\text{-}NUMDIS + \beta_8 * C\text{-}P\text{-}SUPORT + \beta_K * C\text{-}COMP + \varepsilon$

For H3d: $P\text{-}OVERLAP = \alpha + \beta_1 * P\text{-}SELECT + \beta_2 * C\text{-}P\text{-}SIZE + \beta_3 * C\text{-}P\text{-}TENURE + \beta_4 * C\text{-}P\text{-}SRDEXP + \beta_5 * C\text{-}P\text{-}NUMDIS + \beta_6 * C\text{-}P\text{-}SUPORT + \beta_K * C\text{-}COMP + \varepsilon$

5.3. ANALYSIS AND RESULTS

Table 5.2 presents the descriptive statistics and correlation analysis. The relatively small correlation coefficients between the independent variables suggest they are distinct from one another; thus, they will be treated independently in this analysis.

TABLE 5.2

Descriptive statistics and correlation analysis

	Mean	Stdev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. P-PRODNOV	*2.74*	*1 50*	1.00																
2. P-PROCESS	*3.22*	*1.10*	0.13	1.00															
3. P-EFFIC	*1.75*	*0.64*	0.22	0.05	1.00														
4. P-SPEED	*3.32*	*1.02*	0.01	0.06	0.14	1.00													
5. P-CUSTSAT	*3.73*	*0.93*	0.04	0.04	0.13	0.55	1.00												
6. P-LEARN	*3.83*	*1.14*	-0.02	0.12	0.00	0.45	0.53	1.00											
7. P-NCOM	*3.29*	*1.01*	0.44	0.45	0.43	0.05	0.14	0.38	1.00										
8. P-XCOM	*2 26*	*1 36*	0.51	0.08	-0.03	0.10	0.35	0.67	0.43	1.00									
9. P-MODEL	*4.19*	*0.78*	-0.43	0.32	-0.37	0.37	0.39	0.43	0.13	0.14	1.00								
10. P-OVERLAP	*3 46*	*3.36*	0.47	0.43	0.44	0.45	-0.24	0 26	0.31	0.26	0 20	1.00							
11. P-DEVLOP	*2 87*	*1.31*	0.38	0.34	0.03	0.46	0.26	0.50	0.40	0.42	0.31	-0.08	1.00						
12.P-RWRD	*4.32*	*4.07*	0.17	0.12	0.45	-0.05	0.64	0.02	-0.15	0.20	0.15	0.64	0.33	1.00					
13. P-SELECT	*2.78*	*1.03*	-0.08	-0.56	0 08	-0.41	-0.31	-0.41	0.10	0.11	0.12	0.12	0.30	0.27	1 00				
14. C-P-SIZE	*9 32*	*3.06*	-0.15	0.02	-0.04	-0.41	0.13	0.25	-0.09	-0.06	-0.04	0.44	-0.10	0.10	-0.06	1 00			
15.C-P-TENURE	*3 06*	*1.80*	0.22	0.14	-0.12	-0.17	-0.11	-0.17	-0.04	-0.16	-0.07	0.43	0 07	0.25	0.15	-0.15	1.00		
16 C-P-SRDEXP	*0 14*	*0.38*	-0.38	0.41	-0 13	-0.30	0.00	0.08	-0.08	-0.03	0.26	0.01	0.07	0.08	-0.02	-0.06	-0.09	1.00	
17 C-P-NUMDIS	*3.58*	*0 69*	0.27	-0 12	0.51	0.00	-0.09	0.25	0 06	-0.02	-0.04	0.12	0 07	0.14	0.06	-0 02	0.15	-0.01	1.00
18.C-P-SUPORT	*4 57*	*0 68*	0 03	0.22	-0 05	0.13	0.04	0.24	0.04	-0.01	0.17	-0.10	0.03	-0.10	0.07	0.02	0 05	0.00	0.02

Note: Correlation coefficients above 0.20 are statistically significant at $p \leq 0.05$.

5.3.1. TESTING PROPOSITION 1: PROJECT TEAM-LEVEL PROCESSES SUPPORT THE CAPABILITY TO MOBILIZE AND CREATE KNOWLEDGE FOR INNOVATION

Table 5.3 presents the results of testing the project team-level processes, hypotheses (H1a-H1d). The results show that only H1a, H1b, and H1d are supported. Project team-level internal and external communication frequency, shared-mental model, and overlapping knowledge support different outcomes of the capability to mobilize and create knowledge for innovation. Internal and external communication frequency and overlapping knowledge support innovation. Shared mental model of cooperation hurts innovation.

Model 1 shows that team internal communication frequency (P-NCOM), team external communication frequency (P-XCOM), and team overlapping knowledge (P-OVERLAP) have a positive effect on product innovation (P-PRODNOV). Team shared mental model of cooperation (P-MODEL) has a negative effect on product innovation (P-PRODNOV). Model 2 shows that only team internal communication frequency (P-NCOM), team shared mental model of cooperation (P-MODEL), and team overlapping knowledge (P-OVERLAP) have a positive effect on product innovation (P-PROCESS), and no significant relationship exists between team external communication frequency (P-XCOM) and process innovation (P-PROCESS). Model 3 indicates that team internal communication frequency (P-NCOM), team shared mental model of cooperation (P-MODEL), and team overlapping knowledge (P-OVERLAP) have a positive effect on efficiency (P-EFFIC). Model 4 shows that team shared mental model of cooperation (P-MODEL) and team overlapping knowledge (P-OVERLAP) support speed-to-market of the innovation (P-SPEED). However, there is a decreasing return of team overlapping knowledge (P-OVERLAP) on speed-to-market of the innovation (P-SPEED). Model 5 shows that team external communication frequency (P-XCOM) and team overlapping knowledge (P-OVERLAP) have a positive effect on customer satisfaction with the innovation (P-CUSTSAT). Team shared mental model of cooperation (P-MODEL) has a decreasing return on customer satisfaction with the innovation (P-CUSTSAT). Model 6 shows that team internal communication frequency (P-NCOM), team external communication frequency (P-XCOM), team overlapping knowledge (P-OVERLAP), and team shared mental model of cooperation (P-MODEL) support learning (P-LEARN). However, there is a decreasing return of team shared mental model of cooperation (P-MODEL) on learning (P-LEARN).

TABLE 5.3

Results from testing Proposition 1: The effect of project team processes on the capability to mobilize and create knowledge for innovation

		P-PRODNOV	P-PROCESS	P-EFFIC	P-SPEED	P-CUSTSAT	P-LEARN
	Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
VARIABLES	Internal communication frequency (P-NCOM)	0.26 ** (0.09)	0.24 * (0.34)	0.48 * (0.21)	-0.02 (0.09)	0.17 (0.15)	0.34 *** (0.10)
VARIABLES	External communication frequency (P-XCOM)	0.32 *** (0.09)	0.16 (0.13)	-0.41 † (0.23)	0.13 (0.10)	0.31 * (0.14)	0.66 *** (0.11)
VARIABLES	P-Shared mental model of cooperation (P-MODEL)	-0.30 *** (0.09)	0.60 * (0.23)	0.75 ** (0.22)	0.31 ** (0.09)	0.33 * (0.15)	0.34 ** (0.10)
VARIABLES	P-Shared mental model of cooperation-squared $(P\text{-}MODEL)^2$	-0.08 (0.05)	-0.41 * (0.17)	0.15 (0.14)	0.01 (0.06)	-0.25 * (0.09)	-0.20 ** (0.06)
VARIABLES	P-Overlapping knowledge (P-OVERLAP)	0.82 *** (0.11)	0.95 ** (0.31)	0.59 * (0.27)	0.75 ** (0.11)	0.47 * (0.16)	0.24 † (0.13)
VARIABLES	P-Overlapping knowledge squared $(P\text{-}OVERLAP)^2$	-0.84 *** (0.07)	0.28 (0.31)	-0.03 (0.18)	-0.44 * (0.07)	0.23 † (0.12)	0.05 (0.08)
CONTROLS	Size (C-P-SIZE)	-0.16 (0.65)	0.09 (0 14)	0.02 (0.18)	-0.39 *** (0.08)	0.19 (0.12)	0.18 * (0.08)
CONTROLS	Tenure diversity (C-P-TENURE)	0.16 * (0.04)	-0.31 (0.27)	-0.38 † (0.23)	-0.05 (0.09)	0.17 (0.15)	-0.00 (0.10)
CONTROLS	Prior shared team experience (C-P-SRDEXP)	-0.22 ** (0.07)	0.42 * (0.19)	-0.22 (0.18)	-0.19 * (0.07)	-0.14 (0.12)	0.09 (0 08)
CONTROLS	Number of disciplines (C-P-#DISCIP)	0.12 † (0.07)	0.02 (0.19)	0.50 ** (0.19)	-0.00 (0.07)	-0.06 (0.12)	0.21 * (0 08)
CONTROLS	Management support (C-P-SUPORT)	0.02 (0.07)	0.17 (0.24)	0.13 (0.19)	0.02 (0.08)	-0.07 (0.12)	0.20 * (0.08)
CONTROLS	Company (C-COMP)	Yes	Yes	Yes	Yes	Yes	Yes
	N	182	182	182	182	182	182
	Log Likelihood	-236.10	-40 06	-311.27	-251.29	-322.88	-226.48
	Chi Square	55 81 ***	29 73 **	25.93 *	52.5 ***	42.35 ***	95.05 ***
	Pseudo R2	0.47	0.27	0.44	0.49	0.41	0.47

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

5.3.2. Testing Proposition 2: Project team-level human resource management practices support the capability to mobilize and create knowledge for innovation

Table 5.4 presents the results from testing the project team-level human resource management practices, hypotheses (H2a-H2c). The results show that only H2a is supported. Project team development and reward support the capability to mobilize knowledge and create knowledge for innovation. However, project team development has a positive effect on a wider range of outcomes of this capability.

TABLE 5.4

Results from testing Proposition 2: The direct effect of project team-level human resource management practices on the capability to mobilize and create knowledge for innovation

		P-PRODNOV	P-PROCESS	P-EFFIC	P-SPEED	P-CUSTSAT	P-LEARN
	Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
V	Project team development (P-DEVLOP)	0.13 *** (0.02)	0.38 * (0.17)	-0.09 (0.21)	0.25 ** (0.09)	0.45 * (0.14)	0.43 *** (0.11)
B L	Project team reward (P-RWRD)	0.14 † (0.08)	-0.49 * (0.22)	0.19 (0.19)	-0.05 (0.08)	0.61 *** (0.13)	0.11 (0.11)
E S	Project team selection (P-SELECT)	-0.12 (0.08)	-0.63 ** (0.17)	-0.11 (0.20)	-0.27 ** (0.09)	-0.32 * (0.14)	-0.30 * (0.11)
	Size (C-P-SIZE)	-0.11 (0.07)	0.19 (0.13)	-0.03 (0.18)	0.37 *** (0.08)	0.16 (0.12)	0.23 * (0.10)
C O	Tenure diversity (C-P-TENURE)	0.19 * (0.09)	-0.18 (0.23)	-0.40 † (0.22)	-0.02 (0.09)	0.05 (0.15)	0.05 (0.12)
N T	Prior shared team experience (C-P-SRDEXP)	-0.24 ** (0.07)	0.30 (0.19)	-0.28 (0.18)	-0.14 † (0.07)	-0.16 (0.12)	0.08 (0.10)
R O	Number of disciplines (C-P-#DISCIP)	0.15 † (0.08)	-0.34 † (0.19)	0.58 * (0.20)	-0.07 (0.08)	-0.13 (0.12)	0.27 * (0.10)
L S	Management support (C-P-SUPORT)	0.02 (0.07)	-0.09 (0.15)	0.10 (0.19)	0.08 (0.08)	-0.00 (0.12)	-0.05 (0.10)
	Company (C-COMP)	Yes	Yes	Yes	Yes	Yes	Yes
	N	182	182	182	182	182	182
	Log Likelihood	-246.02	-239.07	-315.16	-254.95	-326.61	-257.01
	Chi Square	35.97 ***	31.73 ***	18.16 *	45.19 ***	34.90 ***	33.99 ***
	Pseudo R2	0.46	0.48	0.47	0.48	0.45	0.46

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

Model 1 shows that team development (P-DEVLOP) has a positive effect on product innovation (P-PRODNOV). Model 2 shows that team development (P-DEVLOP) has a positive effect on process innovation (P-PROCESS), while team reward (P-RWRD) and team membership selection (P-SELECT) have a negative effect on process innovation (P-PROCESS). Model 3 shows no significant relationships between the predictors and efficiency (P-EFFIC).

Model 4 shows that team development (P-DEVLOP) has a positive effect on speed-to-market of innovation (P-SPEED), while team membership selection (P-SELECT) has a negative effect. Model 5 shows that team development (P-DEVLOP) and team reward (P-RWRD) have a positive effect on customer satisfaction with the innovation (P-CUSTSAT), and team membership selection (P-SELECT) has a negative effect. Model 6 shows a positive relationship between team development (P-DEVLOP) and learning (P-LEARN). It also indicates that team membership selection (P-SELECT) has a negative effect on learning (P-LEARN).

5.3.3. Testing Proposition 3: Project team-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by supporting the project team-level processes

Table 5.5 presents the results of testing hypotheses (H3a-H3f). The results show that only H3c, H3d, and H3e are supported. These results show that team development (P-DEVLOP) not only affects the capability to mobilize knowledge and create new knowledge directly as shown in the previous tests, but also indirectly, through its support of the project team-level shared mental model of cooperation (H3c), and internal and external communication frequency. These results suggest that project teams that receive project team development are more likely to have shared commitment and understanding of who will contribute which knowledge in accomplishing the project. Moreover, project teams that receive project team development are more likely to engage in communication that is internal and external to the team than project teams that do not receive the development. Interestingly, project team reward (P-RWRD) does not lead to higher internal or external communication frequency. What is even more interesting is that team membership selection based on cross-functional knowledge and job experiences does not ensure overlapping knowledge on the team. One of the explanations could be that project team leaders or managers who select team members do not have accurate information about the knowledge sets of individuals they select.

Model 1 shows that team development (P-DEVLOP) has a positive effect on team internal communication frequency (P-NCOM) (H3c). Model 2 shows that team development (P-DEVLOP) also supports team external communication frequency (P-XCOM) (H3d).

Model 3 shows that team development (P-DEVLOP) has a positive relationship with team shared mental model of cooperation (P-MODEL) (H3e). Model 4 shows that team membership selection (P-SELECT) has no effect on team overlapping knowledge (P-OVERLAP). However, the controls, team size (C-P-SIZE) and team tenure diversity (C-P-TENURE), have a positive effect on team overlapping knowledge (P-OVERLAP).

TABLE 5.5

Results from testing Proposition 3: The indirect effect of project team-level human resource management practices on the capability to mobilize and create knowledge for innovation

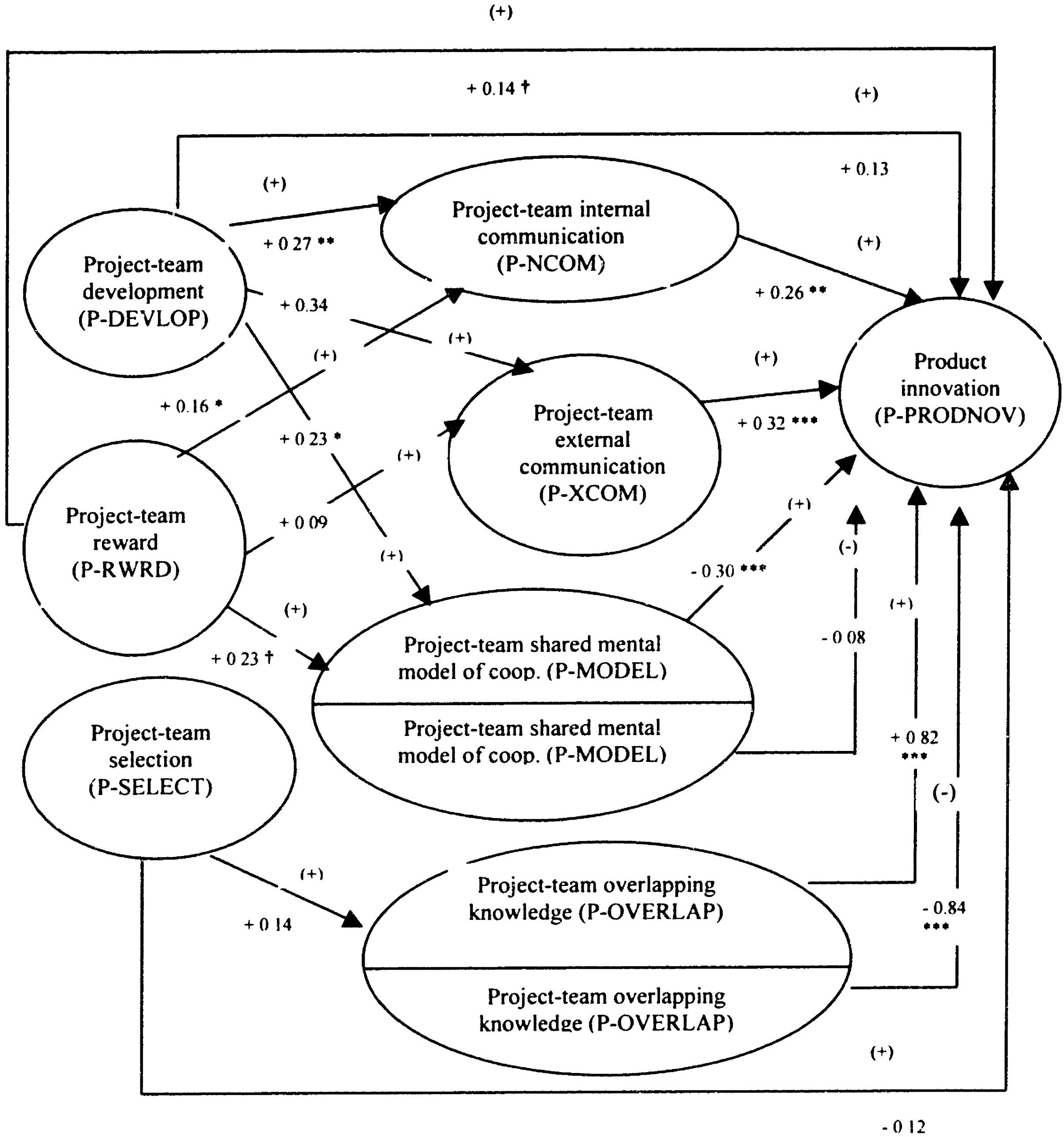
		Project team-internal communication frequency (P-NCOM)	**Project team-external communication frequency (P-XCOM)**	**Project team shared mental model of cooperation (P-MODEL)**	**Project team overlapping knowledge (P-OVERLAP)**
	Model	Model 1	Model 2	Model 3	Model 4
V B L E S	Project team development (P-DEVLOP)	0.27 ** (0.09)	0.34 * (0.09)	0.23 * (0.08)	-
	Project team reward (P-RWRD)	0.16 † (0.08)	0.09 (0.08)	0.23 † (0.12)	-
	Project team selection (P-SELECT)	0.06 (0.08)	0.08 (0.09)	0.09 (0.13)	0.14 (0.09)
C O N T R O L S	Size (C-P-SIZE)	-0.06 (0.07)	0.04 (0.08)	-0.10 (0.11)	0.31 *** (0.09)
	Tenure diversity (C-P-TENURE)	-0.07 (0.09)	-0.09 (0.10)	-0.00 (0.14)	0.34 ** (0.11)
	Prior shared team experience (C-P-SRDEXP)	-0.13 † (0.07)	0.03 (0.07)	0.28 * (0.12)	0.10 (0.09)
	Number of disciplines (C-P-#DISCIP)	0.04 (0.08)	0.08 (0.08)	0.01 (0.12)	0.14 (0.09)
	Management support (C-P-SUPORT)	-0.00 (0.07)	0.09 (0.08)	0.22 † (0.12)	-0.14 (0.09)
	Company (C-COMP)	Yes	Yes	Yes	Yes
	N	182	182	182	182
	Log Likelihood	-260.24	-263 74	-254.27	-247.51
	Chi Square	18.71 *	20.08 *	31 53 ***	46.11 ***
	Pseudo R2	0.43	0.33	0.45	0.58

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

The following figures illustrate in graph form the direct and indirect relationships between project team management practices and processes, and different outcomes of this capability. These are presented in Table 5.3, Table 5.4, and Table 5.5, summarized by outcome of the capability.

FIGURE 5.2

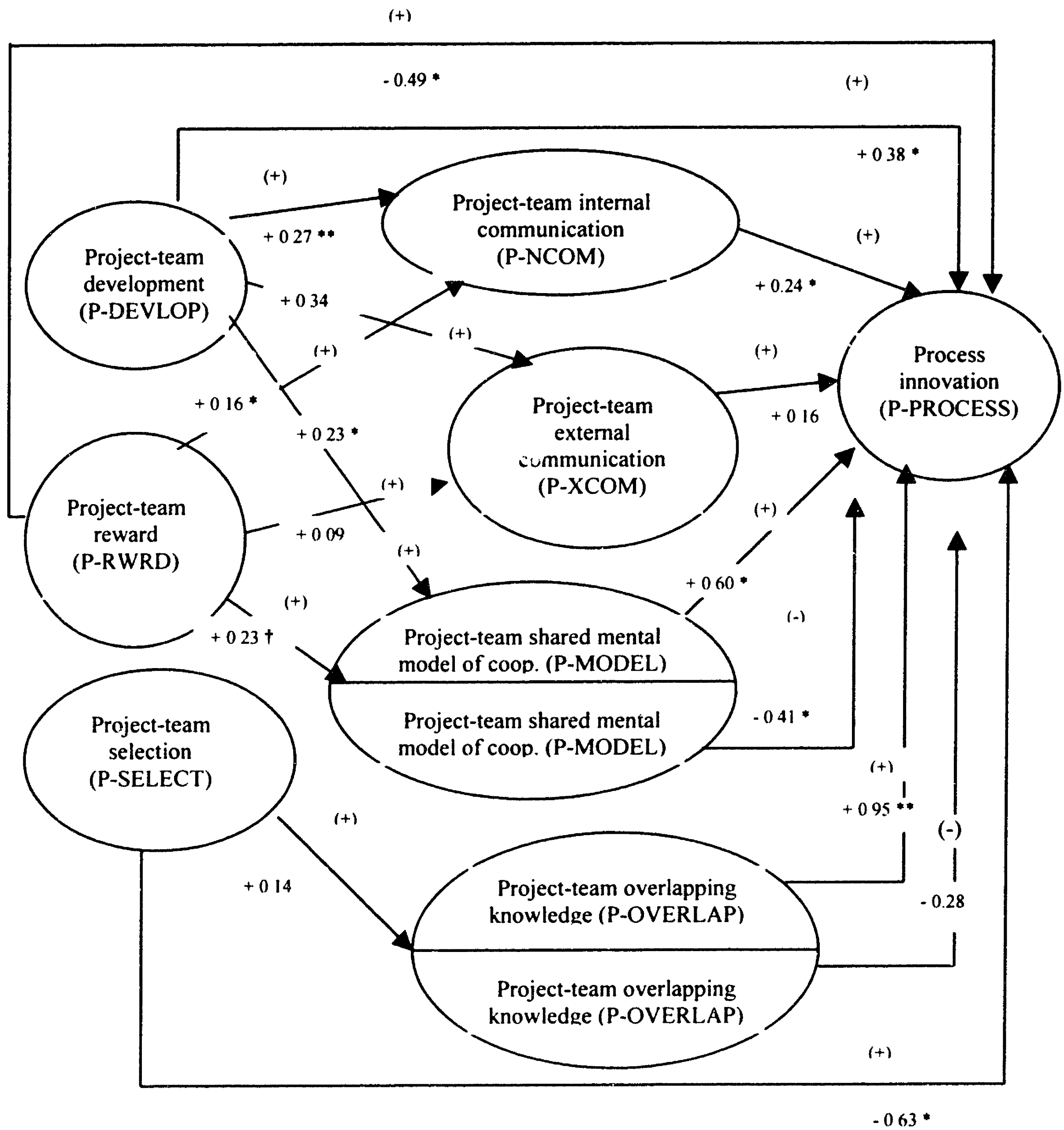
Path analyses for developing the capability to mobilize and create knowledge at the project level: **Product innovation (P-PRODNOV)**



Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. In circles with variable listed twice, the first half relates to the first order effect and the second half relates to the second order effect. This model controlled for C-P-SIZE, C-P-TENURE, C-P-SRDEXP, C-P-#DISCIP, C-P-SUPORT, C-COMP.

FIGURE 5.3

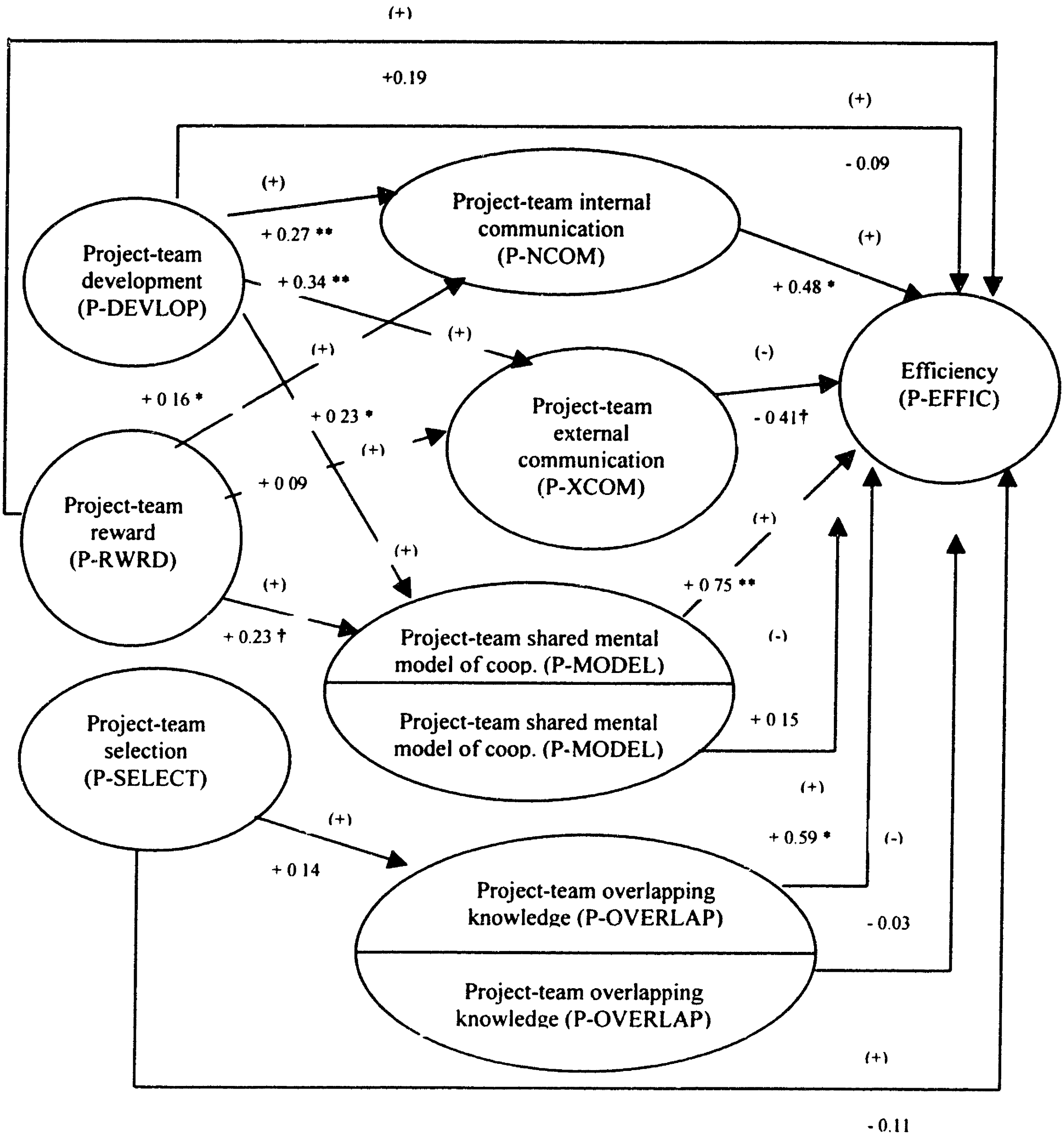
Path analyses for developing the capability to mobilize and create knowledge at the project level: **Process innovation (P-PROCESS)**



Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. In circles with variable listed twice, the upper half relates to the first order effect and the bottom half relates to the second order effect. This model controlled for C-P-SIZE, C-P-TENURE, C-P-SRDEXP, C-P-#DISCIP, C-P-SUPORT, C-COMP.

FIGURE 5.4

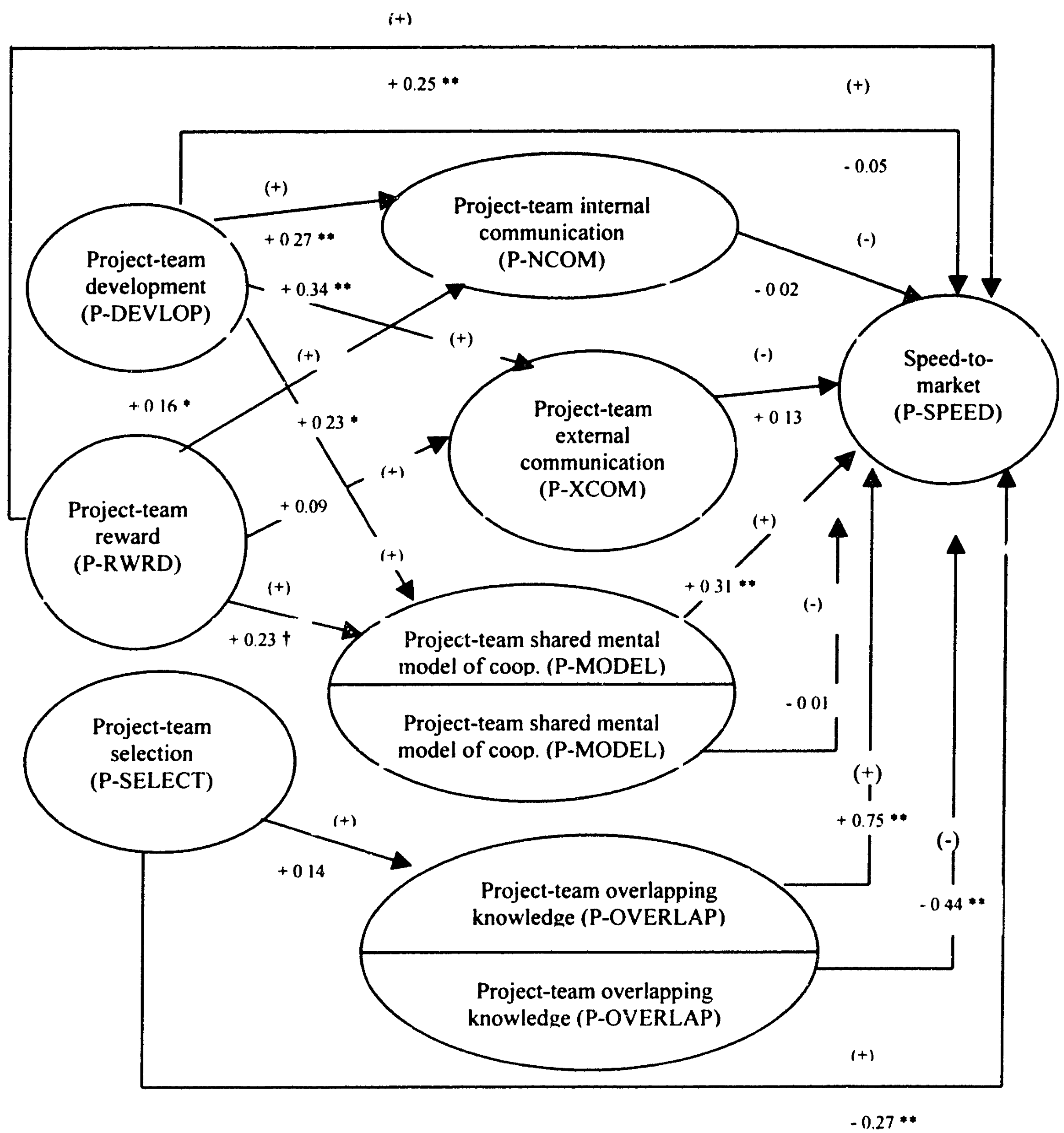
Path analyses for developing the capability to mobilize and create knowledge at the project level: Efficiency (P-EFFIC)



Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. In circles with variable listed twice, the upper half relates to the first order effect and the bottom half relates to the second order effect. This model controlled for C-P-SIZE, C-P-TENURE, C-P-SRDEXP, C-P-#DISCIP, C-P-SUPORT, C-COMP.

FIGURE 5.5

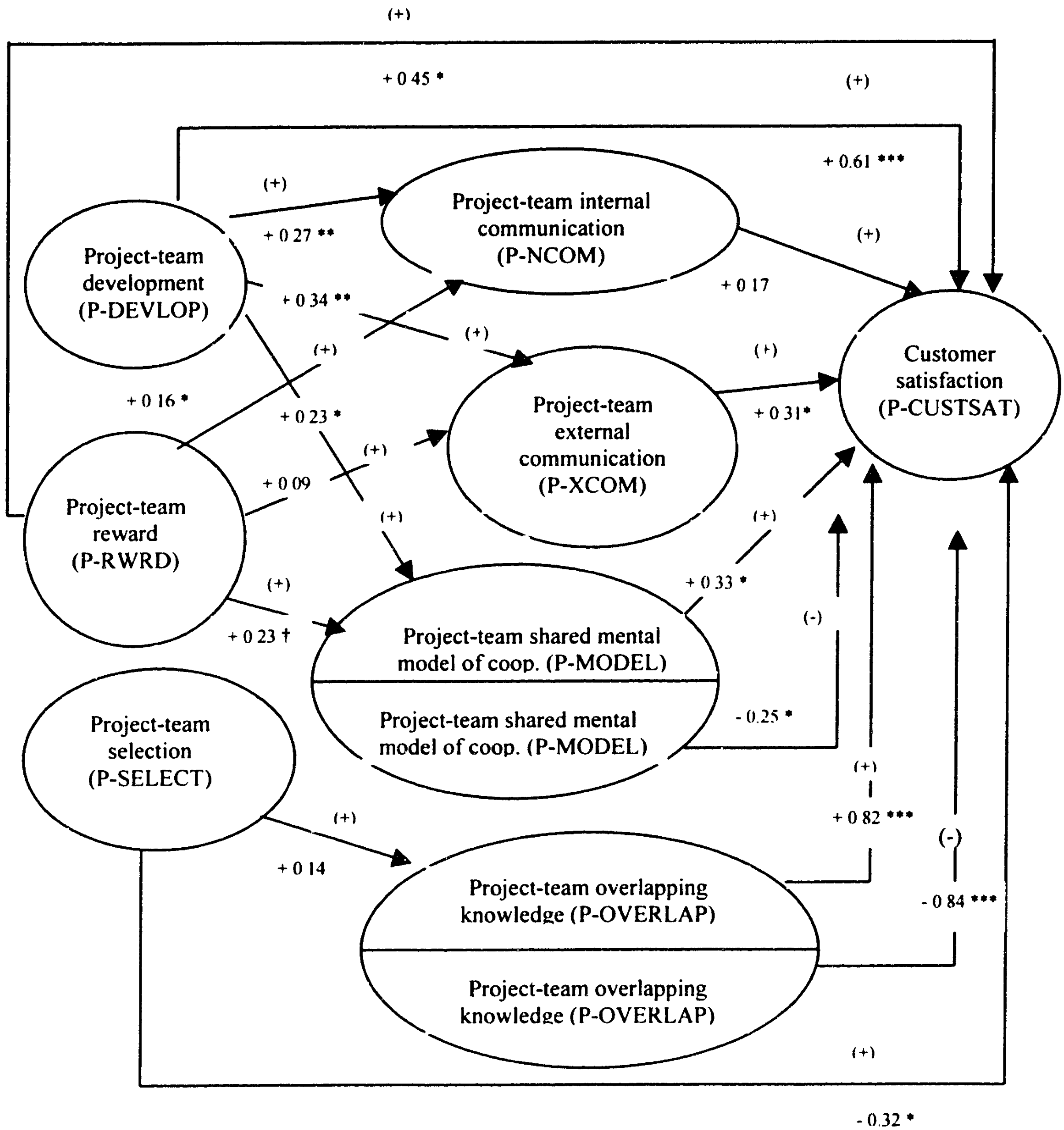
Path analyses for developing the capability to mobilize and create knowledge at the project level: **Speed-to-market (P-SPEED)**



Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. In circles with variable listed twice, the upper half relates to the first order effect and the bottom half relates to the second order effect. This model controlled for C-P-SIZE, C-P-TENURE, C-P-SRDEXP, C-P-#DISCIP, C-P-SUPORT, C-COMP.

FIGURE 5.6

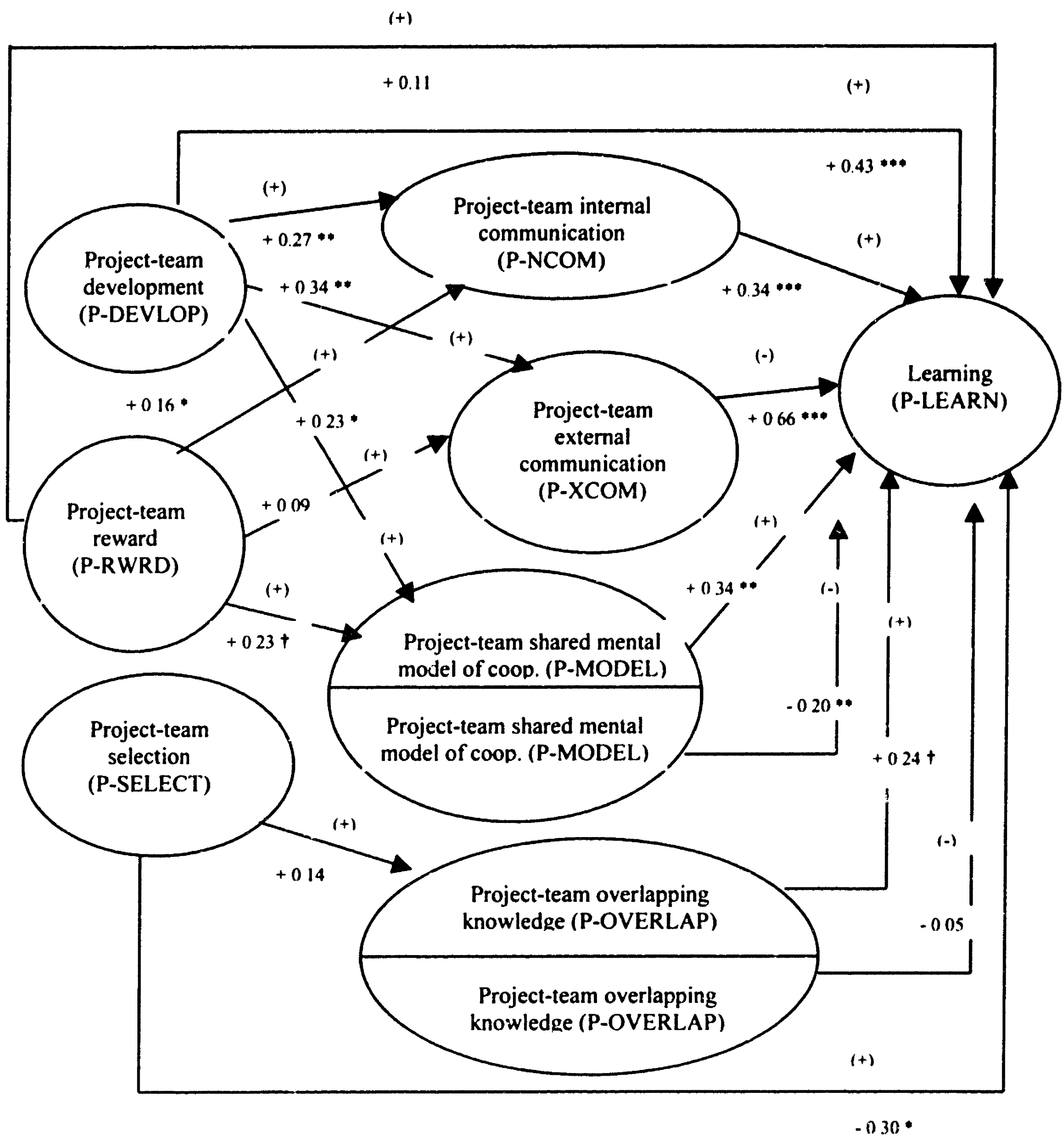
Path analyses for developing the capability to mobilize and create knowledge at the project level: **Customer satisfaction with the innovation (P-CUSTSAT)**



Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. In circles with variable listed twice, the upper half relates to the first order effect and the bottom half relates to the second order effect. This model controlled for C-P-SIZE, C-P-TENURE, C-P-SRDEXP, C-P-#DISCIP, C-P-SUPORT, C-COMP.

FIGURE 5.7

Path analyses for developing the capability to mobilize and create knowledge at the project level: **Learning (P-LEARN)**



Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. In circles with variable listed twice, the upper half relates to the first order effect and the bottom half relates to the second order effect. This model controlled for C-P-SIZE, C-P-TENURE, C-P-SRDEXP, C-P-#DISCIP, C-P-SUPORT, C-COMP.

Table 5.7 summarizes the results of the analyses of propositions and hypotheses. The analyses in this chapter support the propositions that team-level human resource management practices not only support the capability to mobilize knowledge and create new knowledge directly, but also indirectly, since they encourage the team level processes that support team performance (Proposition 1, Proposition 2, and Proposition 3).

TABLE 5.7

Summary of the propositions and hypotheses supported and not supported

Propositions	Hypotheses	Expected relationships	Results
P1. Project team-level processes support the capability to mobilize and create knowledge for innovation	H1a. Project team-internal communication frequency and innovation	+	**Supported**
	H1b. Project team-external communication frequency and innovation	+	**Supported**
	H1c. Project team shared mental model of cooperation and innovation	Inverted U-shaped	Not Supported
	H1d. Project team overlapping knowledge and innovation	Inverted U-shaped	**Supported**
P2. Project team-level human resource management practices support the capability to mobilize and create knowledge for innovation	H2a. Project team development and innovation	+	**Supported**
	H2b. Project team reward and innovation	+	Not supported
	H2c. Project team membership selection based on cross-functional overlapping knowledge and innovation	+	Not supported
P3. Project team-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by supporting the project team-level processes	H3a. Project team reward and project team-internal communication frequency	+	Not Supported
	H3b. Project team reward and project team-external communication frequency	+	Not supported
	H3c. Project team development and project team shared mental model of cooperation	+	**Supported**
	H3d. Project team development and project team-internal communication frequency	+	**Supported**
	H3e. Project team development and project team-external communication frequency	+	**Supported**
	H3f. Project team membership selection based on cross-functional overlapping knowledge and project team overlapping knowledge	+	Not supported

The results show that different factors support different outcomes of the capability to mobilize and create knowledge for innovation. Among the project team-level process variables, project team-internal communication frequency facilitates product and process innovation, efficiency in terms of resources used in achieving the innovation, and learning from the innovations. External communication frequency supports product innovation, customer satisfaction with the innovation, and learning. Project team shared mental model of cooperation has a negative effect on product innovation but supports efficiency and speed-to-market, and has a decreasing return on process innovation, customer satisfaction with the innovation, and learning. This finding suggests that creative abrasion (Leonard-Barton, 1995) is important for product innovation. Overlapping knowledge between manufacturing and R&D engineering team members has a decreasing return on product innovation and speed-to-market, but has a positive effect on efficiency. This finding also suggests that although overlapping knowledge facilitates knowledge conversion, up to a point, it minimizes the creative abrasion that is also necessary for product innovation.

Among the project team-level human resource management practices, project team development directly supports product and process innovation, speed-to-market, customer satisfaction with the innovation, and learning, and indirectly supports it by facilitating internal and external communication. However, this practice also facilitates the development of project team shared mental model of cooperation, which reduces creative abrasion and thus hurts product innovation, and has a decreasing return on process innovation. Project team reward has no effect on either process or product innovation and efficiency, but has a positive effect on speed-to-market, customer satisfaction with the innovation, and learning. This finding is contrary to the discussion in the literature (Wageman, 1995; Wageman and Baker, 1997). This difference may be explained by the fact that previous studies tend to analyze the effect of incentive in isolation from other human resource management practices at the project level. Project team membership selection based on cross-functional knowledge and the fit between expertise and the nature of the project has no effect on innovation, and a negative effect on all other outcomes of this capability. One possible explanation for this finding is that the managers or team leaders that formed the teams did not have accurate information about team members' prior job experiences, as team tenure diversity and size explain more of the variance in overlapping knowledge than selection based on this factor (see Table 5.5).

5.4. DISCUSSION AND CONCLUSIONS

This chapter tested the arguments that the project team-level processes –project team-internal communication frequency, project team-external communication frequency, project team shared mental model of cooperation, and project team overlapping knowledge– support the capability to mobilize and create knowledge for innovation. Moreover, these project team-level processes are supported by project team management practices, specifically, project team development, reward, and membership selection.

In recent years, the resource-based view of the firm has recognized that the sources of rents may reside deeper in the organization, at the substructure level, for example, in project teams used for mobilizing and creating new resources (Wernerfelt, 1997; Prahalad and Hamel, 1990; Kogut and Zander, 1992). However, despite the discussions, empirical work is limited (Foss, 1997). Therefore, this chapter develops the resource-based theory of the firm by showing specifically how companies develop the capability to mobilize and create knowledge for innovation at the project team-level. It also expands the team level-innovation literature, which views the processes of innovation as an input-output process. It shows that in addition to careful selection of team members (Ancona and Caldwell, 1992a), there are other mechanisms that organizations use to develop the supporting team-level processes. It argues that these mechanisms are important in achieving this capability. Specifically, organizations generate supporting processes as necessary in the process of achieving the innovation by developing their teams.

Depending on the outcomes of the capability desired by the firms as dictated by their strategies (Miles and Snow, 1978) or the environment in which they compete (Lawrence and Lorsch, 1967), different factors seem to lead to different outcomes. First, firms that compete on product innovation may need to focus on the factors that facilitate both knowledge mobilization and creation. The results from this study suggest that these factors are internal communication frequency (Griffin and Hauser, 1992; Dougherty, 1987), external communication frequency (Ancona and Caldwell, 1992b), and overlapping knowledge (Nonaka and Takeuchi, 1995; Leonard-Barton, 1995; Iansiti, 1998). At the same time, they may need to guard against two drawbacks. On one hand, team shared mental model of cooperation seems to hurt innovation, because product innovation also requires some creative conflict or abrasion (Leonard-Barton, 1995). On the other hand, too much overlapping knowledge reduces knowledge diversity, which may also hurt product innovation.

Second, for companies that consider process innovation (Teece et al., 1997), the factors that facilitate knowledge mobilization and creation seem to be team internal communication frequency (Griffin and Hauser, 1992; Dougherty, 1987), team shared sense of cooperation, overlapping knowledge, and team development. In this instance, the frequently-discussed team reward does not appear to facilitate this process. In fact, it seems to have a detrimental effect on this outcome of capability. Finally, the way in which teams are formed within the firm also seems to affect this outcome.

Third, for firms that consider efficiency, in terms of cost of the amount of resources used in mobilizing and creating new knowledge for innovation, to be critical, the important factors seem to be team internal communication frequency, team shared sense of cooperation, and overlapping knowledge.

Fourth, firms that consider speed-to-market of their innovation to be important (Clark and Fujimoto, 1991; Clark and Wheelwright, 1992) may need to focus on team-shared sense of cooperation, overlapping knowledge, and development. The way in which teams are formed may also affect this outcome (Hackman, 1987).

Fifth, for firms that consider customer satisfaction with their innovation to be crucial, team external communication frequency (Ancona and Caldwell, 1992a), shared mental model of cooperation, overlapping knowledge (Nonaka and Takeuchi, 1995), development (Thamhain and Wilemon, 1997) and reward (Wageman, 1995; Wageman and Baker, 1997) appear to be important.

Sixth, companies that find learning, or the ability to apply knowledge or innovation created in one part of the organization to other relevant parts, to be important, might need to focus on team internal communication, external communication, shared sense of cooperation (Senge, 1990), and team development (Roth and Kleiner, 1996).

Finally, we consider firms that find most or all of these outcomes to be critical for competition, and wish if possible to choose a specific practice to develop this capability. This chapter shows that project team development appears to be most promising. It not only affects a wider range of outcomes of this capability directly, but also does so indirectly, by facilitating the project team-level processes that support this capability. This practice entails developing human resources as needed in the process of mobilizing and creating new knowledge for innovation, by teaching personnel how to communicate with people from outside their functions regarding the way in which team work processes should be organized. This development process may be accomplished by the team leader, by individuals who are not members of the team such as corporate trainers, or by external experts, as the companies analyzed in the case study, Commune, Tribe, and Party, illustrated respectively.

Moreover, this study shows that overlapping knowledge between manufacturing and R&D engineering supports many outcomes of this capability, implying that human resources must be developed at the organization-level (Beer, Eisenstat and Spector, 1990; Pfeffer, 1994; 1998) prior to team participation, in order to have some overlapping knowledge between these two parts of the organization. Organizations may also need to track employees' job experience, and in the process of team formation, the team leader or managers in charge of selection should use this information.

In the next chapter, I analyze the key organization-level factors and organization-level human resource management practices that affect the capability to mobilize and create knowledge for innovation at the organization level. Since, as shown in Chapter 2 and Chapter 3, there is potentially a "mirror image" of project team-level processes and their organization-level processes, the constructs, variables, and measures have similar labels. In fact, in some cases, they are the same. However, to differentiate the team-level from the organization-level variables, all organization-level variables start with the prefix "O-", while the project team-level variables are preceded by "P-", and the controls start with "C-", as indicated before.

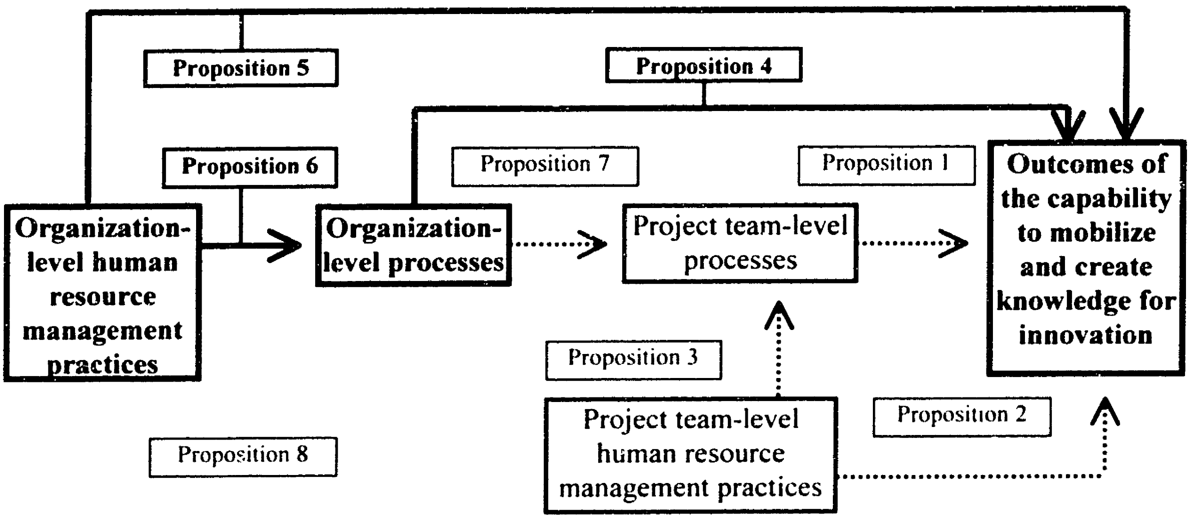
6. DETERMINANTS OF THE CAPABILITY TO MOBILIZE AND CREATE KNOWLEDGE FOR INNOVATION AT THE ORGANIZATIONAL LEVEL

In this chapter I test another three propositions, also derived from the case studies presented in Chapter 3, linking the organization-level processes and the capability to mobilize and create knowledge for innovation. I first test Proposition 4, which argues that the organization-level processes –organization-level cross-functional communication frequency, organization-level shared mental model of cross-functional cooperation and organization-level overlapping knowledge– support the capability to mobilize and create knowledge for innovation. I then test Proposition 5, which states that the organization-level human resource management practices –organization-level selection, organization-level reward and influence on reward, organization-level orientation, training and development, and organization-level work patterns– support the capability to mobilize and create knowledge for innovation. The third proposition I test is Proposition 6, which claims that organization-level human resource management practices also have an indirect effect on the capability to mobilize and create knowledge for innovation, since they affect the organization-level processes. Figure 6.1 presents the theoretical model tested in this chapter within the framework of the thesis. I highlight the constructs and relationships analyzed.

In the first section of this chapter, I present the hypotheses used to test the three propositions, hypotheses that are based on organization-level innovation literature as presented in Chapter 2. I then present the research design for this chapter based on the data described in Chapter 4, which differs from the previous chapter in terms of the variables and methods used to test the hypotheses. In the third and fourth sections, I present the results of the analyses, followed by discussion of these results and conclusions.

FIGURE 6.1

Framework for developing the capability to mobilize and create knowledge for innovation



6.1. THEORY AND HYPOTHESES: DETERMINANTS OF THE CAPABILITY TO MOBILIZE AND CREATE KNOWLEDGE FOR INNOVATION AT THE ORGANIZATIONAL LEVEL

6.1.1. Analyzing Proposition 4: Organization-level processes support the capability to mobilize and create knowledge for innovation

In this chapter I analyze three organization-level factors that are often discussed as facilitators of the capability to mobilize and create knowledge for innovation: (1) cross-functional communication frequency among organization members in the daily context of the organization (Galbraith, 1977; Ghoshal et al., 1994); (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 (Senge, 1990); and (3) organization-level overlapping knowledge, which is the overlapping disciplinary knowledge of individuals inside the organization (Leonard-Barton, 1995; Iansiti, 1998). These three factors complement one another and support the capability to mobilize and create knowledge for innovation. Cross-functional communication frequency and the shared mental model of cross-functional cooperation facilitate knowledge mobilization, and overlapping knowledge facilitates the process of knowledge creation.

Organization-level cross-functional communication frequency. Cross-functional communication frequency in organizations has a positive effect on the capability to mobilize and create knowledge for innovation, as it influences the amount of knowledge mobilized or exchanged between and among different functions (Ghoshal et al., 1994). Cross-functional communication frequency supports innovation, since innovation requires the sharing and integration of different types of functional knowledge (Brown and Eisenhardt, 1997). 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 (Dougherty, 1992). Organizations have different communication channels or routines (Andrews, 1971; Nelson and Winter, 1982), and communication is viewed as knowledge and information exchange that facilitates or hinders knowledge mobilization for innovation (Brown and Eisenhardt, 1997; Tsai and Ghoshal, 1998). Inside the organization, the communication routines may be mainly internal, i.e., within the same function, or external, i.e., across different functions, depending on the design of the organization or on how human resources are managed (Galbraith, 1977). In subsidiaries of European multinational enterprises (MNEs), frequent communication between and across different functions enhances innovation (Bartlett and Ghoshal, 1990). 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, since there is more knowledge being mobilized. These ideas lead to the hypothesis that:

H4a. Organization-level cross-functional communication frequency is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge

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). An 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 (Senge, 1990). 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 to create 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 to achieve innovation. Therefore, the organization-shared mental model of cross-functional cooperation serves as a bonding mechanism that helps different parts of the organization combine knowledge for innovation. It is thus hypothesized that:

H4b. The organization-level shared mental model of cross-functional cooperation is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

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 (Cohen and Levinthal, 1990) for knowledge in disciplines with which their knowledge overlaps. This absorptive capacity facilitates the knowledge creation processes in two ways. First, as each function or 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 adopt 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 overlapping knowledge of other functions possess the absorptive capacity to receive knowledge from other functions, due to their ability to adopt the perspective of those functions (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:

H4c. Organization-level cross-functional overlapping knowledge is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

6.1.2. Analyzing Proposition 5: Organization-level human resource management practices support the capability to mobilize and create knowledge for innovation

Organization-level human resource management practices support the capability to mobilize and create knowledge for innovation. While some researchers suggest that reward systems motivate innovation (Manners et al., 1997, 1983; Kiely, 1997; Badawy, 1978), others suggest the initial socialization or orientation of new employees (Nohria and Ghoshal, 1997; Katz, 1997), training and development of certain groups of employees, particularly the engineers (Basadur, 1992), or the combination of these practices (Shapero, 1985; Maister, 1985), support the capability to mobilize and create knowledge for innovation. In the case studies, Commune, which had the superior capability as indicated by the fact that it had the highest number of innovations, followed by Tribe and Party, employed human resource management practices that the literature discussed above suggests support knowledge mobilization and creation for innovation.

Organization-level selection. High-performing organizations carefully screen employees for personality traits that are conducive to a team work environment for knowledge sharing, which is critical for innovation (Shapero, 1997:44; Maister, 1985), in addition to using other innovative practices (Ichniowski et al., 1997). The case studies described in Chapter 3 also show that Commune, which had superior capability in creating new knowledge for innovation, selects new employees not only on the basis of potential individual-based performance as measured by their academic performance and school reputation, but also on behavioral factors that are conducive to knowledge sharing. Applying this idea to an organization that organizes into project teams to share knowledge for innovation, selecting employees based on behavioral factors conducive to knowledge mobilization enhances new resources creation, i.e., innovation. This leads to the hypothesis that:

H5a. Organization-level selection based, in part, on behavioral factors conducive to knowledge sharing is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

Organization-level reward systems. Organizations with extensive knowledge mobilization reward employees based partly on these behaviors (Aoki, 1988; Aoki and Dore, 1994; Dore, 1989). These authors suggest 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 performance but also on behavioral factors, particularly attitudes related to cooperation, and knowledge and information sharing. Furthermore, the survey conducted by the Japanese Ministry of Labor (1987), analyzing the factors that companies use in rewarding employees, shows that morale building, which is related to cooperation and knowledge sharing, is a critical factor in bonus payment and promotion. The case studies discussed in Chapter 3 show that Tribe and Commune, which reward employees based not only on their individual performance, but also on cooperative behaviors, also performed better at generating new knowledge for innovation than Party, which only rewards for individual explicit outputs.

For Commune, there are two evaluation forms that are used simultaneously to evaluate and reward non-management professional employees. One form is a performance evaluation form directed at individual explicit outputs, particularly quality and quantity of work performed, while the other is the attitude evaluation form, which examines behavioral factors, particularly cooperation and morale building. Similarly, Tribe, an American photo-imaging company, uses only one evaluation form, but it contains both individual explicit output measures such as quality and quantity of work performed, and behavioral factors, particularly "cooperation", all of which affect job assignment and promotion. Party, which is an American automobile company, has only one performance evaluation form, which also includes both individual explicit output measures and behavioral factors. However, according to several functional and personnel managers interviewed, in practice, unlike Tribe, Party only rewards individual explicit outputs as measured by quality and quantity of work performed, when determining salary increase, job assignment, and promotion. Overall, Commune has the superior capability, followed by Tribe and Party. Based on these discussions, I hypothesize that:

H5b. Organization-level reward system based, in part, on cooperative behaviors is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

Organization-level control over individuals' rewards. Previous studies (e.g., Katz and Allen, 1985) suggest that organizations with the capability to mobilize and create knowledge for innovation also grant the project managers some control over individuals' rewards. Japanese firms that are considered to have superior capability to create new knowledge for innovation (Nonaka and Takeuchi, 1995; Clark and Fujimoto, 1991) 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 over the individual reward system. While functional managers have influence over 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 capability to mobilize knowledge and create new knowledge for innovation (Clark and Fujimoto, 1991; Clark and Wheelwright, 1992), functional managers exercise sole control over individuals' rewards (Milgrom and Roberts, 1992; Aoki, 1988; Robinson, 1996). In the case analysis, Tribe and Commune also divide the control over rewards for individuals between different managers. For Tribe, both the functional and project managers exercised control over individuals' rewards. While functional managers had more influence over salary increase, project managers had some influence over promotion and job assignment. For Commune, both the functional and personnel managers had influence over individual reward. While functional managers had some influence over individual performance evaluation, personnel managers had the final say in the overall performance evaluation and reward of employees. Personnel managers decided on individual job assignment, bonus payment, and promotion. In Party, functional managers exercised sole control over individual reward. Overall, Commune performed the best in mobilizing and creating knowledge for innovation, followed by Tribe and Party. Based on these analyses, I hypothesize that:

H5c. An 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 capability to mobilize knowledge and create new knowledge.

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 greater capability to mobilize and create knowledge for innovation also use team-based work patterns (Ghoshal et al., 1994) 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 rather work 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 the organization, is also higher in Japanese firms than in their US counterparts (Aoki, 1988). In the case studies, Commune, which exhibits greater capability to mobilize and create knowledge for innovation, also used team-based work patterns. In Commune, when new employees first arrive in a given department, they are not expected to perform tasks alone. Instead, an older employee with around five years of experience is assigned a task on which to work with the new employee. The older employee is expected to teach the new employee, and they work together to accomplish the task. Moreover, Commune participation on cross-functional teams in quality circles was also higher than in Tribe and Party. Since daily tasks are organized based, in part, on teams, employees acquire knowledge about and skills in teamwork. 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:

H5d. Organization-level cross-functional work pattern is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

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 capability to mobilize and create knowledge for innovation than companies that do not use this practice (Nohria and Ghoshal, 1997). These authors suggest that Japanese MNEs have superior capability to mobilize and create knowledge for innovation, 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. Other studies (e.g., Basadur, 1992) that compare the capability of North American and Japanese firms to create new knowledge for innovation 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. In the case analysis, Commune also provides cross-functional orientation to new employees. New entrants are first exposed to the manufacturing organization for two months, working side-by-side with production workers. This assignment is followed by training in sales and customer services organizations, for engineers, and specialized training in advanced topics in engineering. This is most strongly emphasized with the engineers who will be placed in design and manufacturing of the products. After the first year of on-the-job training, new employees are once again assembled at the headquarters for two days to discuss what they have learned and the kind of issues they have encountered. Given the information discussed above, I advance the hypothesis that:

H5e. Organization-level cross-functional orientation is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

Organization-level cross-functional development. Previous research also suggests that cross-functional development of employees enhances the capability to mobilize and create knowledge for innovation (e.g., Nonaka and Takeuchi, 1995; Leonard-Barton, 1995), particularly to create knowledge. 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 take a longer period of time to acquire. 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 employ this practice.

In the case studies, Commune also provides its engineers on-the-job training and job rotation across different functions. At the same time, engineers are given off-the-job training on cost analysis and other business issues that are outside the scope of engineering. Tribe also gives this training and development to its engineers, although less so than Commune. Party, while providing extensive training within the same function, does not provide any cross-functional training and development. Overall, Commune has the highest capability to mobilize and create knowledge for innovation, followed by Tribe and Party. Based on these analyses, I hypothesize that:

H5f. Organization-level cross-functional development is positively related to innovation, as an outcome of the capability to mobilize knowledge and create new knowledge.

6.1.3. Analyzing Proposition 6: Organization-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by affecting the organization-level processes

Organization-level human resource management practices also affect the capability to mobilize and create knowledge for innovation indirectly by affecting the organization-level processes, particularly organization-level cross-functional communication frequency, organization-level shared mental model of cross-functional cooperation, and organization-level overlapping knowledge, which are proposed to support innovation.

Organization-level orientation, cross-functional communication, and shared mental model of cross-functional cooperation. Cross-functional orientation, or the initital socialization of employees, serves two purposes that enhance the organization's ability to mobilize knowledge and new knowledge for innovation. On 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; Newport, 1969; Weiner, 1970), since 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. Their 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 an 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. In the case studies, Commune with its higher level of cross-functional communication frequency and shared mental model of cross-functional cooperation, not only exposes all new employees to each other, regardless of the functions in which they will be placed after the orientation, but also exposes them to the production and the customer service organizations. Tribe and Party, which do not employ this practice, have lower cross-functional communication frequency and shared mental model of cross-functional cooperation. This leads to the hypotheses that:

H6a. Organization-level cross-functional orientation is positively related to organization-level cross-functional communication frequency.

H6b. 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 over 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 over whether they are rewarded, and who influence others' decisions about performance evaluation and reward. Therefore, if this influence is divided between 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). Moreover, the case studies indicate that in Party, where all the influence over individual reward belongs to the functional managers, communication was most frequent within the same function, with limited cross-functional communication. In Tribe and Commune, where the influence was shared between functional and non-functional managers, cross-functional communication frequency was higher than in Party. This leads to the hypothesis that:

H6c. 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; Ghoshal et al., 1994). 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 lacked the exposure (Newport, 1969). Moreover, individuals who had this exposure not only tended to communicate more frequently outside their function, 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). In the case studies, Tribe and Commune, which have higher employee participation on cross-functional teams in quality circles, have higher cross-functional communication frequency than Party, which does not use this practice. This leads to the hypothesis that:

H6d. 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 in those functions. Cross-functional development serves three purposes in facilitating the capability to mobilize and create knowledge for innovation. First, 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). Second, through cross-functional development, while acquiring knowledge and skills from different functions, employees also form networks in these functions that facilitate cross-functional communication. Third, cross-functional development 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. In the case studies, Commune, which has the highest level of overlapping knowledge, cross-functional communication frequency, and shared mental model of cross-functional cooperation, provides cross-functional development to their professional workers through extensive job rotation. In Tribe, where cross-functional development is provided to the engineers, there is evidence of these processes, compared to Party, where such processes are absent. This leads to the following hypotheses:

H6e. Organization-level cross-functional development is positively related to organization-level overlapping knowledge.

H6f. Organization-level cross-functional development is positively related to organization-level cross-functional communication frequency.

H6g. Organization-level cross-functional development is positively related to organization-level shared mental model of cross-functional cooperation.

6.2. RESEARCH DESIGN

As in the last chapter, data analyzed in this chapter are based on surveys of 38 companies and their 182 cross-functional project teams, working on product and process innovations using external market information. These companies are the largest in the computer, photo imaging, and automobile industries. Data sources, selection criteria, and data collection procedures are described in the research design in Chapter 4.

6.2.1. Variables and measures

The variables and measures are based on the following constructs: Human resource management practices, organization-level processes, and outcomes of the capability to mobilize knowledge and create new knowledge innovation at both the organizational and project levels.

Table 6.1 presents the summary of variables and measures used in this analysis. I performed a reliability test (Crombach α) for those variables that are composites of several indicators. The rule of thumb is that the indicators are reliable when Crombach α is above 0.60 (Willett, 1998). 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 capability to mobilize and create knowledge for innovation. The capability to mobilize and create knowledge for innovation is measured both at the organization and at the project levels. At the organization level, innovation (O-PRODNOV) 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 (α = 0.84). Effectiveness, efficiency and learning are also used as measures for this capability. For effectiveness, customer satisfaction with the innovation (O-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 (α = 0.87).

TABLE 6.1

Summary of variables and measures

Constructs	Variables		Descriptions	Measures	Cronbach α
Outcome of the capability to mobilize and create knowledge for innovation	O-PRODNOV		Innovation	-Success in incorporating customer feedback in new product development -Success in incorporating customer feedback in product improvement -Number of new products customer service organization helped develop in the last five years	0.84
	O-CUSTSAT		Customer satisfaction	External rating on product appeal, dependability quality provided by JD Power & Associates, PC World, external marketing research company	0.87
	P-PRODNOV		Project team-level innovation	-Project team resulted in new product development -Product modification (average to company level)	0.82
	P-PROCESS		Process innovation	- Project team resulted in process innovation (average to company level)	--
	P-EFFIC		Project team-level efficiency	-Financial resources used -Staff hours used (more than, less than or same as expected by management)	0.68
	P-CUSTSAT		Customer satisfaction of solutions created by the team	-Solutions created by the team satisfied customers (average to company level)	--
	P-LEARN		Project team-level spillover	-Application of solutions in other relevant parts of organization (average to company level)	--
Organization-level human resource management practices	*Facilitators of knowledge mobilization*	O-SELECT	Select team-based behaviors	-Select on "ability to work on team" -Select on willingness to co-operate	0.73
		O-RWRD	Reward on team-based behaviors	-"Cooperative" behaviors impacted salary increase, bonus payment, promotion, and job assignment	0.79
		O-XCNTRL	Control of project manager	Influence of project manager on individual reward (salary increase, job assignment, promotion)	0.91
		O-ORIEN	Cross-functional orientation	Policy on cross-functional orientation at corporate and operational levels, yes equals 1, otherwise 0	0.81
		O-WKPTRN	Cross-functional work patterns	Team-based job design, level of participation on cross-functional teams (i.e., quality circles)	0.73
	Facilitator of knowledge creation	O-DEVLOP	Cross-functional development	- Total cross-functional training of white-collar workforce (engineers, sales/marketing, customer services) in R&D, manufacturing, sales/marketing, customer services, adding one for each function	0.76
Organization-level processes	*Facilitators of knowledge mobilization*	O-XCOM	Cross-functional communication frequency	-Cross-functional communication frequency formally (work related) and informally (not work related and on personal time, e.g., coffee breaks after work)	0.83
		O-MODEL	Organization shared mental model of cooperation	-Shared vision across functions toward achieving organizational goal -Shared commitment across functions toward achieving organizational goal	0.78
	Facilitator of knowledge creation	O-OVERLAP	Cross-functional overlapping knowledge	Cross-functional on-the-job training, job rotation of engineers in R&D and manufacturing, and off-the-job training in sales/marketing, for each equals 1	0.77
Control variables	C-INDUS1		Computer industry	Dummy variable, computer industry equals 1, otherwise 0	--
	C-INDUS2		Photo-imaging industry	Dummy variable, photo-imaging industry equals 1, otherwise 0	--
	C-JAPAN		Japanese subsidiary	Dummy variable, subsidiary of a Japanese firm equals 1, otherwise 0	--

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 (P-PRODNOV) (0.87), and to process innovation (P-PROCESS). Satisfaction with the innovation generated by the project team is measured by the extent to which customers were satisfied with the innovation the project team generated (P-CUSTSAT). Staff hours and financial resources used in completing the project measure efficiency (P-EFFIC) (α = 0.70). Learning from this knowledge mobilization and creation process is measured by the application of new knowledge created in one part of the organization to its application in other relevant parts of the organization (P-LEARN).

Organization-level human resource management practices. In order to capture the human resource management practices more realistically, an in-depth comparative analysis of three companies, two located in the USA and one in Japan, was conducted; this allowed us to better understand how companies develop the capability to mobilize and create knowledge for innovation. The results of this analysis were presented in Chapter 3. The human resource 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.

There are five facilitators of knowledge mobilization. The first is selection (O-SELECT), which is selection based on "ability to work on team" and "the willingness to cooperate" (α = 0.73). Second, 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 (α = 0.79). The third factor, 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, human resource managers have little or no influence on the individual reward system. The fourth, cross-functional orientation (O-ORIEN), was measured by assessing whether companies put new professional employees through cross-functional orientation at both the operational and corporate levels (α = 0.81). Finally, work pattern (O-WKPTRN) is measured by whether daily tasks require 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 communication frequency (not work-related and on personal time, e.g., coffee breaks, after work) between management and non-management rank employees (α = 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 focusing on individual functional goals (α = 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 training, 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 (α = 0.77).

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

6.2.2. 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 capability to mobilize knowledge and create new knowledge both at the organizational level (innovation, customer satisfaction) and project team level (innovation, efficiency, speed-to-market, customer satisfaction, and learning). I also conduct a path analysis to illustrate the relationships between variables analyzed in this chapter. Hypotheses H4a, H4b, and H4c, which analyze the relationships between the organization-level processes and the capability to mobilize and create knowledge for innovation, are tested using the following model:

$$\textit{Outcomes of the capability to mobilize and create knowledge for innovation} = \alpha + \beta_1 * \textit{O-XCOM} + \beta_2 * \textit{O-MODEL} + \beta_3 * \textit{O-OVERLAP} + \beta_4 * \textit{C-INDUS1} + \beta_5 * \textit{C-INDUS2} + \beta_6 * \textit{C-JAPAN} + \varepsilon$$

To test the direct effect of human resource management practices on the capability to mobilize and create knowledge for innovation (H5a-H5f), the following specifications are used:

$$\textit{Outcomes of the capability to mobilize and create knowledge for innovation} = \alpha + \beta_1 * \textit{O-SELECT} + \beta_2 * \textit{O-RWRD} + \beta_3 * \textit{O-XCNTRL} + \beta_4 * \textit{O-ORIEN} + \beta_5 * \textit{O-WKPTRN} + \beta_6 * \textit{O-DEVLOP} + \beta_7 * \textit{C-INDUS1} + \beta_8 * \textit{C-INDUS2} + \beta_9 * \textit{C-JAPAN} + \varepsilon$$

For testing the indirect effect of human resource management practices on the organization-level processes that support the capability to mobilize and create knowledge for innovation (H6a-H6g), the following models are used:

$$\textit{O-XCOM} = \alpha + \beta_1 * \textit{O-XCNTRL} + \beta_2 * \textit{O-ORIEN} + \beta_3 * \textit{O-WKPTRN} + \beta_4 * \textit{O-DEVLOP} + \beta_5 * \textit{C-INDUS1} + \beta_6 * \textit{C-INDUS2} + \beta_7 * \textit{C-JAPAN} + \varepsilon$$

$$\textit{O-MODEL} = \alpha + \beta_1 * \textit{O-ORIEN} + \beta_2 * \textit{O-DEVLOP} + \beta_3 * \textit{C-INDUS1} + \beta_4 * \textit{C-INDUS2} + \beta_5 * \textit{C-JAPAN} + \varepsilon$$

$$\textit{O-OVERLAP} = \alpha + \beta_1 * \textit{O-DEVLOP} + \beta_2 * \textit{C-INDUS1} + \beta_3 * \textit{C-INDUS2} + \beta_4 * \textit{C-JAPAN} + \varepsilon$$

The main limitation of this chapter is the small sample size used, which precludes analyses of other potential alternative explanations, particularly the project team-level human resource management practices, such as project team development, project team reward, and membership selection discussed in the previous chapter. Furthermore, because of the small sample size, the study cannot include other types of overlapping knowledge, or differentiate the depth and breadth of overlapping knowledge that may have different effects on different outcomes of this capability.

6.3. ANALYSIS AND RESULTS

Table 6.2 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 one another; thus they demand independent treatment in this analysis.

TABLE 6.2

Descriptive statistics and correlation matrix

	Mean	Stdev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. O-PRODNOV	3.84	0.91	1.00															
2 O-CUSTSAT	2.98	1 09	0 34	1.00														
3. O-XCOM	2 74	1.81	0.46	0.42	1 00													
4. O-MODEL	3.82	0.83	0.02	-0.44	0.49	1.00												
5. O-OVERLAP	2.11	2.19	0.54	0.47	0.37	0.50	1 00											
6. O-SELECT	3 87	0.91	0 41	0.11	0 03	0.12	0.02	1.00										
7. O-RWRD	3.37	1.44	0.31	0.09	-0.03	0.17	0.15	0.07	1.00									
8. O-XCNTRL	2.74	1 37	0 14	0 07	0.45	0.31	0.15	0.25	0 23	1.00								
9. O-ORIEN	0.50	0 51	0.46	0.46	0.53	0.51	0.13	0 22	-0.07	0.54	1 00							
11 O-WKPTRN	3 50	1.11	0.12	-0.19	0 73	0.34	0 12	0.14	0.12	0.56	0.48	1 00						
10 O-DEVLOP	5.05	5 02	0.49	0 36	0 30	0 47	0.50	0.20	0.11	0.14	0.41	0 37	1 00					
12. P-PRODNOV	2 84	0 85	-0.15	-0.15	0.49	-0 10	0.35	0.39	-0.18	0 31	-0.23	0 44	-0.25	1.00				
13. P-PROCESS	3.22	1 10	0.21	0.12	-0.53	-0.21	0.15	0.12	0 14	-0.13	0.13	0.17	0.16	0.13	1.00			
14. P-EFFIC	1.79	0.37	-0.21	-0.13	0.42	0 22	0 29	-0.12	-0.35	0.33	0.43	0.42	-0.27	0.50	0.05	1.00		
15. P-SPEED	3.24	0.58	0.14	0.01	0.40	0.13	0.35	-0.07	0.06	0.39	0.17	0.41	0.21	0.23	0.14	0.11	1.00	
16. P-CUSTSAT	3.72	0.61	-0.02	-0.08	-0.06	0.42	-0.10	-0 15	0.08	0.08	0.00	-0.19	0.13	0.18	0.04	0.25	0.27	1.00
17. P-LEARN	3.77	0.76	0.11	0.02	0.36	-0.06	-0.06	-0.22	0.05	-0.03	-0.02	-0.07	-0.03	0.07	0.12	-0.03	0.59	0.35

Note: Correlation coefficients ≥ 0.32 are statistically significant at $p \leq 0.05$.

6.3.1. Testing Proposition 4: Organization-level processes support the capability to mobilize and create knowledge for innovation

Table 6.3 presents the results of the tests of hypotheses H4a-H4c. The results support hypotheses H4a, H4b, and H4c, 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 capability to mobilize and create knowledge for innovation. Their effects, however, differ for different outcomes of this capability. Cross-functional communication frequency and overlapping knowledge support innovation and customer satisfaction with the innovation at the organizational level. At the project level, both factors support efficiency in the process of creating innovation, speed-to-market, and product innovation. Cross-functional communication frequency enhances learning but hurts process innovation. The organization-shared mental model of cross-functional cooperation, which does not support any outcomes of the capability at the organizational level, supports the outcomes of this capability at the project level, particularly customer satisfaction with the innovation. However, at the overall organizational level, it hurts customer satisfaction with the innovation.

Model 1 shows that cross-functional communication frequency (O-XCOM) and overlapping knowledge (O-OVERLAP) have a positive effect on product innovation (O-PRODNOV). Model 2 shows that these two factors have a positive effect on customer satisfaction (O-CUSTSAT). Shared mental model of cross-functional cooperation (O-MODEL) has a negative effect on customer satisfaction with the innovation (O-CUSTSAT). Model 3 shows that cross-functional communication frequency (O-XCOM) and overlapping knowledge

(O-OVERLAP) have a positive effect on product innovation (P-PRODNOV). For the capability at the project level, Model 4 shows that cross-functional communication frequency (O-XCOM) has a negative effect on process innovation (P-PROCESS). Model 5 shows that cross-functional communication frequency (O-XCOM) and overlapping knowledge (O-OVERLAP) support efficiency (P-EFFIC). Model 6 shows that cross-functional communication frequency (O-XCOM) and overlapping knowledge (O-OVERLAP) have a positive relationship to speed-to-market of the innovation (P-SPEED). Model 7 shows that the organization-shared mental model of cross-functional cooperation (O-MODEL) influences customer satisfaction with the innovation (P-CUSTSAT). Model 8 shows that cross-functional communication frequency (O-XCOM) has a positive effect on learning (P-LEARN).

TABLE 6.3

Results from testing Proposition 4: Organization-level factors as facilitators of the capability to mobilize and create knowledge for innovation

		Organization-level		**Project-level**					
		O-PRODNOV	**O-CUSTSAT**	**P-PRODNOV**	**P-PROCESS**	**P-EFFIC**	**P-SPEED**	**P-CUSTSAT**	**P-LEARN**
	Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
VARIABLES	Intercept	-1.46 * (0.60)	-1 49 *** (0.23)	0.51 (0.49)	0 28 (0.60)	-0 69 (0.95)	-0.07 (0.53)	'.14 (0 84)	1.29 * (0.64)
	Cross-functional communication frequency (O-XCOM)	0.62 * (0.24)	0.40 ** (0.08)	0.82 *** (0.18)	-0.58 * (0.24)	0.94 * (0 36)	0.45 * (0.19)	0.38 (0 22)	0 51 * (0.22)
	Shared Mental Model (O-MODEL)	-0.35 (0.25)	-0.24 * (0.10)	-0 07 (0.21)	-0.27 (0 27)	-0.26 (0.42)	0.08 (0 21)	0.59 ** (0.15)	-0 13 (0.27)
	Overlapping knowledge (O-OVERLAP)	0.69 * (0.22)	0.67 *** (0 07)	0.56 * (0.16)	-0.11 (0.22)	0 78 * (0 32)	0.31 ** (0.10)	0.01 (0 29)	0.02 (0.20)
CONTRL	C-INDUS1	1.95 *** (0.66)	2.12 *** (0.22)	-0.68 (0 48)	0.39 (0.60)	-0.009 (0.92)	0 16 (0 55)	-0.72 (0 86)	-0.70 (0 62)
	C-INDUS2	1 44 † (0 76)	1.35 *** (0.27)	0 16 (0 59)	0 20 (0 73)	0 56 (1.12)	-0 40 (0.67)	-1 94 † (1 04)	-1 26 (0.75)
	C-JAPAN	1 20 ** (0 57)	0 09 (0.20)	0.51 (0 42)	-0.02 (0 54)	1.78 * (0.83)	0.24 (0 47)	-0 50 (0.73)	-0.16 (0.52)
	N	38	38	38	38	38	38	38	38
	Log Likelihood	-49.04	-25.27	-48.56 *	-50.85	-63.43	-54.97 *	-67.02 *	-49.43 *
	Chi Square	16.17 *	61.68 ***	10.78 *	28 17 *	19.69 *	22.29 *	16.28 †	25.40 *
	Pseudo R2	0.44	0.54	0 21	0.27	0.27	0.22	0.44	0.51

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

6.3.2. Testing Proposition 5: Organization-level human resource management practices support the capability to mobilize and create knowledge for innovation

Table 6.4 presents the results from testing hypotheses (H5a-H5f). The results from these analyses support hypotheses H5a, H5b, H5d, and H5e, and the proposition that human resource management practices have a direct effect on the capability to mobilize and create knowledge for innovation.

Model 1 shows that selection (O-SELECT), reward (O-RWRD), cross-functional orientation (O-ORIEN), and cross-functional development (O-DEVLOP) have a positive effect on product innovation (O-PRODNOV). Influence of project manager over individual reward system (O-XCNTRL) and team-based work pattern (O-WKPTRN) do not have any effect on product innovation (O-PRODNOV), which is contrary to hypotheses H5c and H5f. Model 2 shows that cross-functional orientation (O-ORIEN) and cross-functional development (O-DEVLOP) have a positive effect on customer satisfaction with the innovation (O-CUSTSAT). Model 3 shows that selection (O-SELECT), control over individuals' rewards (O-XCNTRL), and cross-functional development (O-DEVLOP) have a positive relationship with product innovation at the project level (P-PRODNOV), while reward (O-RWRD) and cross-functional orientation (O-ORIEN) have a negative effect on product innovation at the project level (P-PRODNOV). Model 4 is not statistically significant. At the project level, Model 5 shows that reward (O-RWRD), control over individuals' rewards (O-XCNTRL), and cross-functional orientation (O-ORIEN), cross-functional development (O-DEVLOP), and work patterns (O-WKPTN) have a positive effect on efficiency at the project level (P-EFFIC). Model 6 shows that the control over individuals' rewards (O-XCNTRL) and cross-functional development (O-DEVLOP) have a positive effect on speed-to-market of the innovation (P-SPEED). Model 7 and Model 8 show no statistically significant relationships.

TABLE 6.4

Results from testing Proposition 5: The direct effect of human resource management practices on the capability to mobilize and create knowledge for innovation

		Organization-level		Project-team level					
		O-PRODNOV	O-CUSTSAT	P-PRODNOV	P-PROCESS	P-EFFIC	P-SPEED	P-CUSTSAT	P-LEARN
	Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
	Intercept	-0.69 (0 40)	1.10 *** (0.14)	-0.44 ** (0.08)	0.49 (0.44)	-1.15 (0.68)	-0.07 0.40	0.90 (0.66)	0.29 (0.46)
VARIABLES	Select behaviors (O-SELECT)	0.49 * (0.12)	-0.046 (0.04)	0.58 * (0.22)	0.04 (0.14)	-0.08 (0.21)	0.18 (0.40)	-0.08 (0.19)	-0.23 (0 46)
	Reward behaviors (O-RWRD)	0.53 * (0.21)	-0.09 (0.07)	-0.44 * (0.18)	-0.24 (0.24)	0.82 * (0.36)	-0.07 (0.12)	0.47 (0.33)	0.27 (0.58)
	Control of project manager (O-XCNTRL)	0.61 (0.35)	0.02 (0.05)	0.55 ** (0.21)	0.15 (0.14)	0 86 ** (0.24)	0.40 * (0.17)	-0.38 (0.19)	-0 41 (0.27)
	Cross-functional orientation (O-ORIEN)	0.29 * (0.12)	0.62 * (0.28)	-0.38 * (0.19)	0.06 (0.02)	0.68 ** (0.21)	0.04 (0 13)	0 004 (0.21)	0.12 (0.31)
	Cross-functional work pattern (O-WKPTN)	-0.56 (0.28)	0.14 (0.19)	-0.46 (0.24)	0.89 (0.54)	1.07 *** (0.46)	0.31 (0.26)	0.16 (0.41)	-0.18 (0.15)
	Cross-functional development (O-DEVLOP)	0.63 * (0.21)	0.61 ** (0.04)	0.63 * (0.23)	-0.10 (0.11)	0.42 * (0.20)	0.05 * (0.01)	-0.15 (0.18)	-0.02 (0.13)
CONTROL	C-INDUS1	0.83 (0.51)	2.00 *** (0.18)	-0.16 (0.41)	0.45 (0.37)	-1.04 (0.85)	0.08 (0.50)	-0.64 (0.82)	0.27 (0.58)
	C-INDUS2	1.50 † (0.86)	1.48 *** (0.28)	1.02 (0.67)	1.05 (0.86)	-0.35 (1.31)	-0.40 (0.78)	-1.68 (1.26)	-0.11 (0.92)
	C-JAPAN	0.57 (0.43)	-0.07 (0.15)	0.60 † (0.33)	0.21 (0.47)	1.08 (0.69)	0.18 (0.40)	-0.34 (0.64)	0.23 (0.46)
	N	38	38	38	38	38	38	38	38
	Log Likelihood	-45.02	-19.58	-44.33	-53.05	-61.45	-53.97	-66.40	-49.97
	Chi Square	24.23 **	63.84 ***	19.25 *	3.77	23.65 *	24.29 *	27.52 *	24.32 *
	Pseudo R2	0.36	0.61	0.28	0.14	0.31	0.38	0.25	0.34

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

6.3.3. Testing Proposition 6: Organization-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by affecting the organization-level processes

Table 6.5 presents the results of testing the indirect effect of human resource management practices on the capability to mobilize and create knowledge for innovation, which it achieves through its effect on the organization-level processes that support the process of knowledge mobilization and creation for innovation. The hypotheses tested are (H6a-H6g), and the results demonstrate that all hypotheses are supported.

Model 1 indicates that not only does cross-functional orientation (O-ORIEN) facilitate cross-functional communication frequency, control over individuals' rewards (O-XCNTRL), but cross-functional development (O-DEVLOP), and the use of cross-functional work patterns (O-WKPTRN) also have a positive effect on cross-functional communication frequency (O-XCOM). Cross-functional work patterns (O-WKPTRN), however, have the strongest effect, as indicated by the coefficient. Model 2 shows that cross-functional orientation (O-ORIEN) and cross-functional development (O-DEVLOP) facilitate shared mental model of cross-functional cooperation (O-MODEL).

TABLE 6.5

Results from testing Proposition 6: The indirect effect of human resource management practices on the capability to mobilize and create knowledge for innovation

		Cross-functional communication frequency (O-XCOM)	Organization shared mental model of cross-functional cooperation (O-MODEL)	Cross-functional overlapping knowledge (O-OVERLAP)
	Model	Model 1	Model 2	Model 3
VARIABLES	Intercept	-0.36 (0.39)	-0.11 (0.38)	-3.18 ** (1.45)
	Control of project manager (O-XCNTRL)	0.27 * (0.12)	-	-
	Cross-functional orientation (O-ORIEN)	0.38 * (0.15)	0.45 * (0.15)	-
	Cross-functional work pattern (O-WKPTRN)	1.23 *** (0.28)	-	-
	Cross-functional development (O-DEVLOP)	0.60 *** (0.11)	0.37 * (0.15)	0.59 * (0.17)
CONTRL	C-INDUS1	0.23 (0.46)	0.11 (0.47)	2.95 ** (1.08)
	C-INDUS2	0.72 (0.73)	-0.09 (0.76)	3.88 * (1.75)
	C-JAPAN	0.39 (0.43)	0.95 * (0.46)	-1.47 (1.07)
	N	38	38	38
	Log Likelihood	-38.75	-46.11	-36.00
	Chi Square	38.58 ***	24.3 **	34.96 ***
	Pseudo R2	0.33	0.20	0.32

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

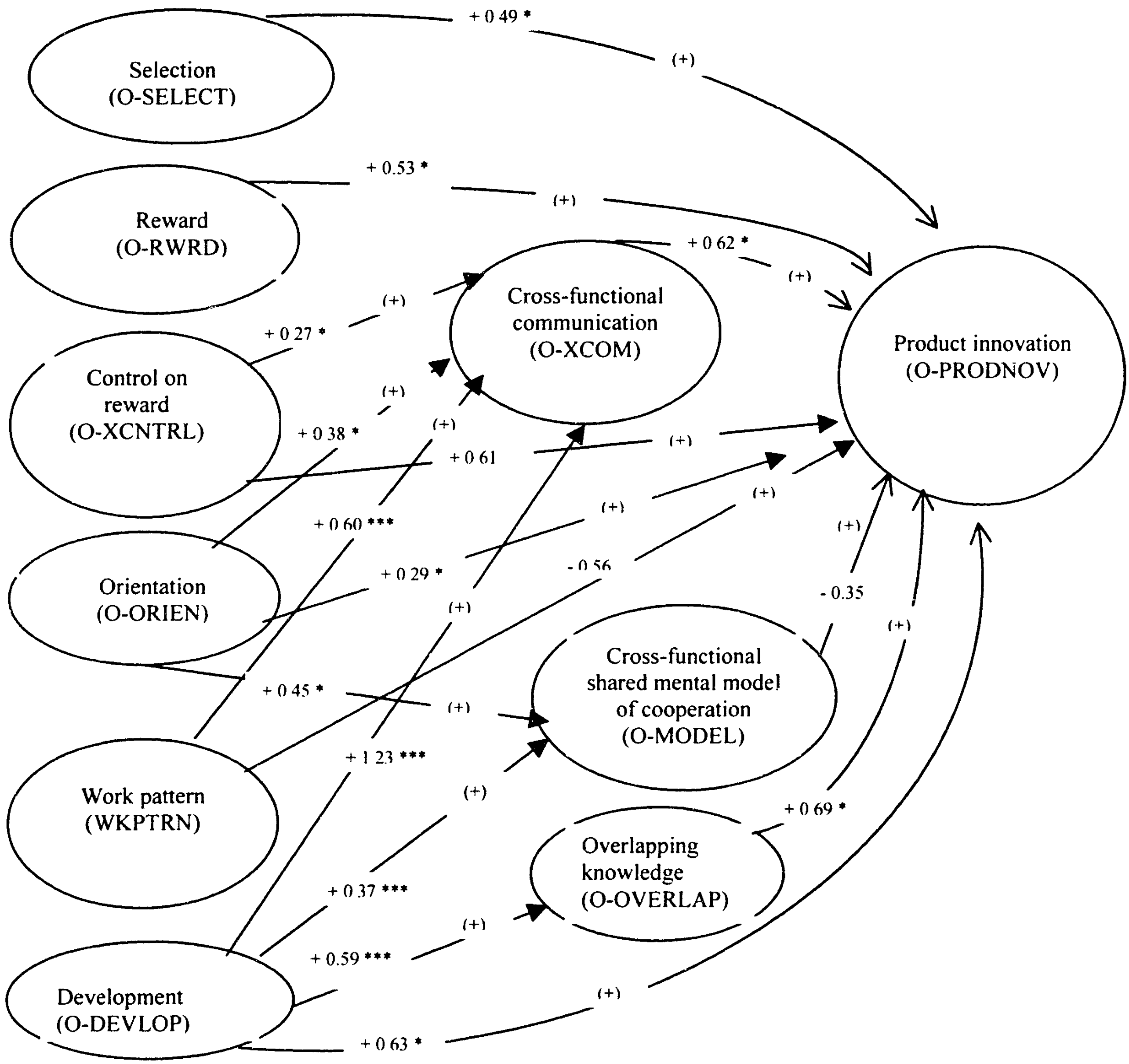
Model 3 shows that cross-functional development (O-DEVLOP) is positively related to overlapping knowledge (O-OVERLAP). The overall results show that human resource management practices support the capability to mobilize and create knowledge for innovation indirectly, by supporting the organizational level processes that encourage this capability. Of all the practices, however, cross-functional development (O-DEVLOP) supports all three organization-level processes analyzed in this study. Cross-functional development (O-DEVLOP) supports cross-functional communication frequency (O-XCOM) and overlapping knowledge (O-OVERLAP), which support the capability at the organization level; they also support shared mental model of cross-functional cooperation (O-MODEL), which supports the capability at the project level.

The following figures illustrate the full path relationships between organization-level variables and the different outcomes of the capability to mobilize and create knowledge for innovation. Figures 6.2 and 6.3 illustrate in graph form the direct and indirect relationships between organization-level human resource management practices, processes, and different outcomes of the capability to mobilize and create knowledge for innovation. Figures 6.4 to 6.9 present the path analyses of the outcomes of the capability at the project level, which is how well each company does on each of the following outcomes of the capability to mobilize and create knowledge for innovation: product innovation, process innovation, efficiency in terms of resources used in the process of mobilizing and creating knowledge for innovation, speed-to-market of the innovation, customer satisfaction with the innovation, and learning that resulted from creating this innovation.

FIGURE 6.2

Path analyses for developing the capability to mobilize and create knowledge for innovation:

Organization-level Product Innovation (O-PRODNOV)

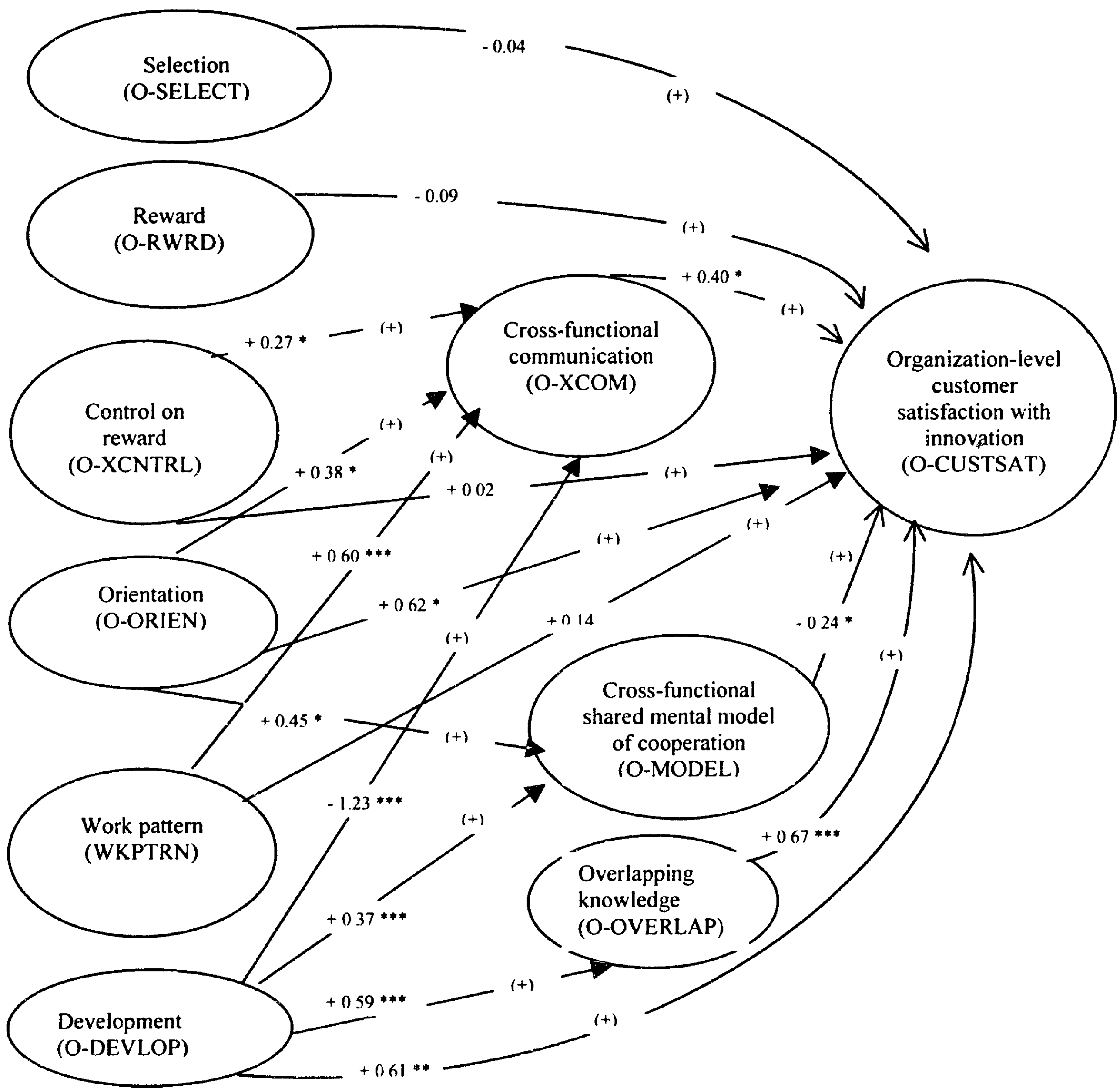


Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. Controlled for the following variables: industry (C-INDUS1, C-INDUS2) and country of origin of companies (C-JAPAN).

FIGURE 6.3

Path analyses for developing the capability to mobilize and knowledge for innovation:

Organization-level Customer Satisfaction with the Innovation (O-CUSTSAT)

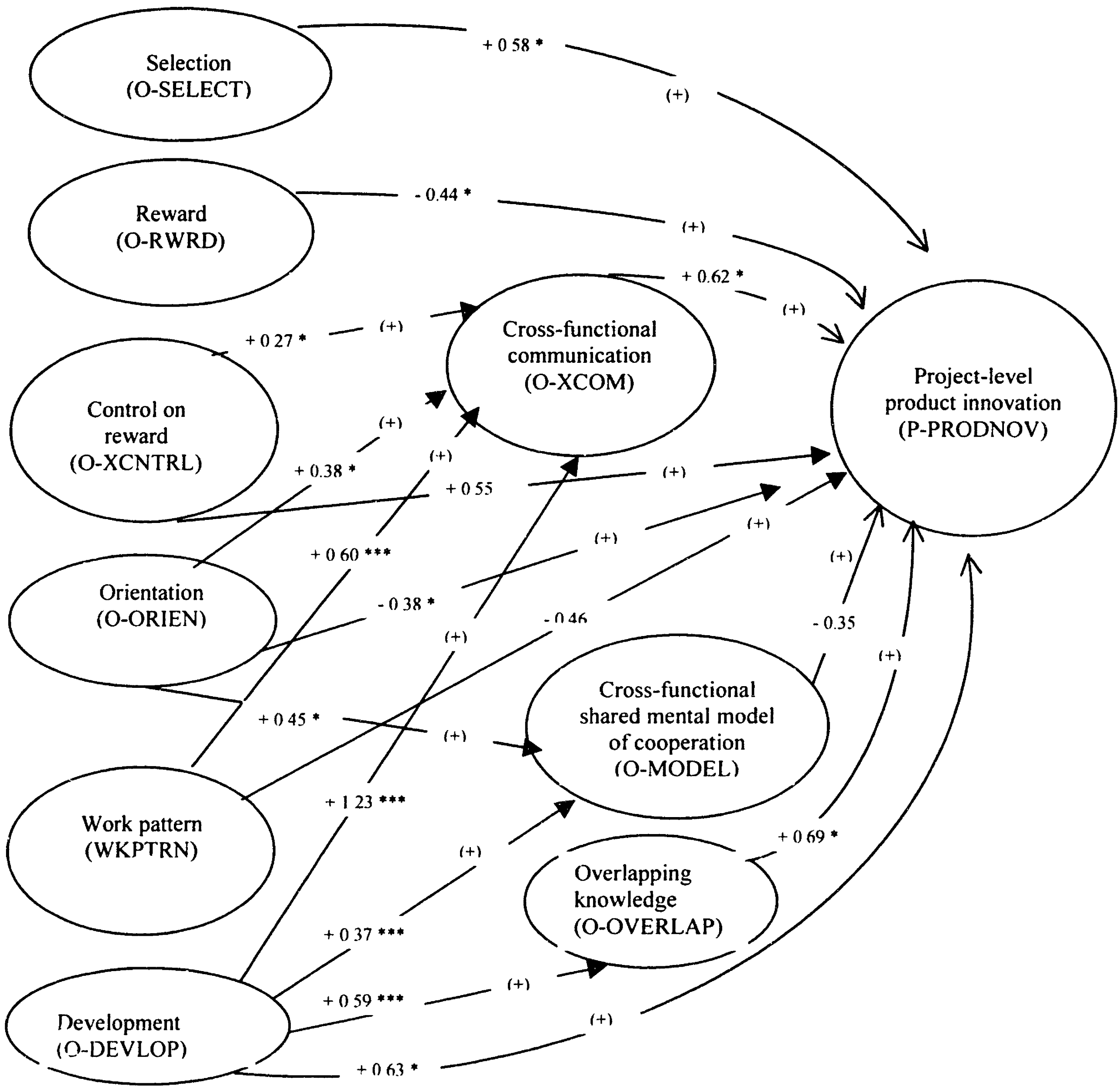


Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. Controlled for the following variables: industry (C-INDUS1, C-INDUS2) and country of origin of companies (C-JAPAN).

FIGURE 6.4

Path analyses for developing the capability to mobilize and create knowledge for innovation:

Project-level Product Innovation (P-PRODNOV)

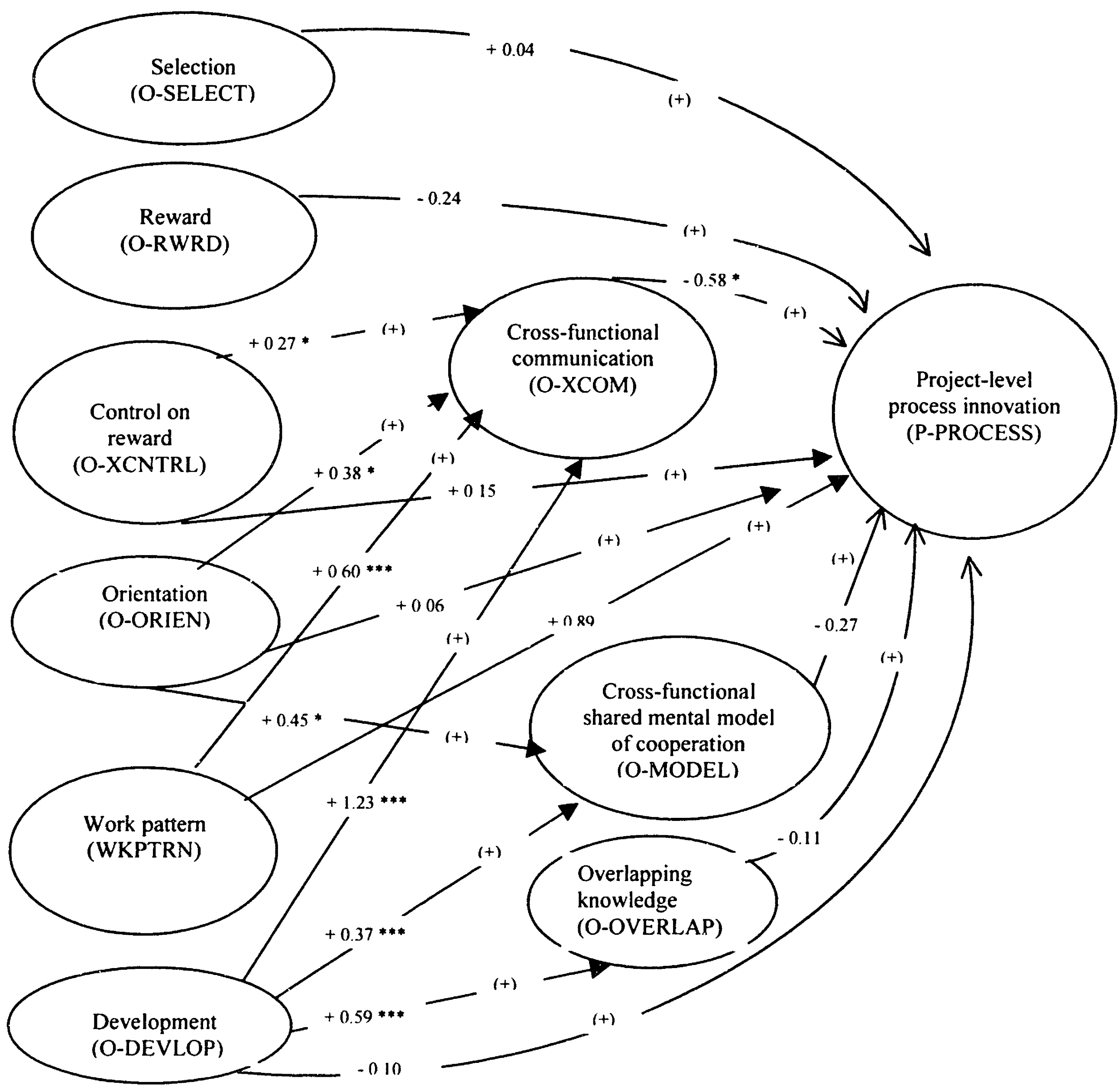


Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. Controlled for the following variables: industry (C-INDUS1, C-INDUS2) and country of origin of companies (C-JAPAN).

FIGURE 6.5

Path analyses for developing the capability to mobilize and create knowledge for innovation:

Project-level Process Innovation (P-PROCESS)

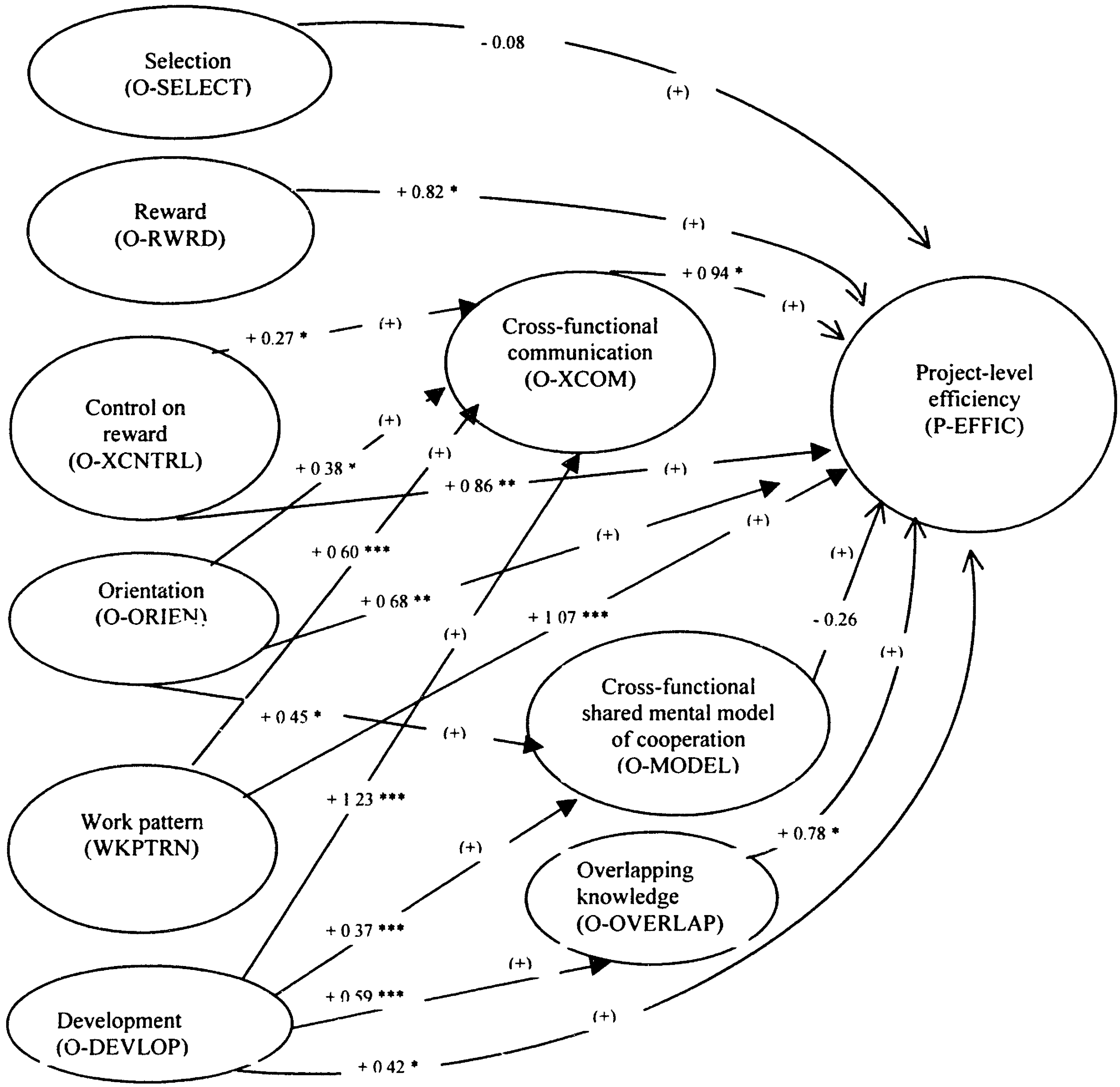


Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. Controlled for the following variables: industry (C-INDUS1, C-INDUS2) and country of origin of companies (C-JAPAN).

FIGURE 6.6

Path analyses for developing the capability to mobilize and create knowledge for innovation:

Project-level Efficiency (P-Efficiency)

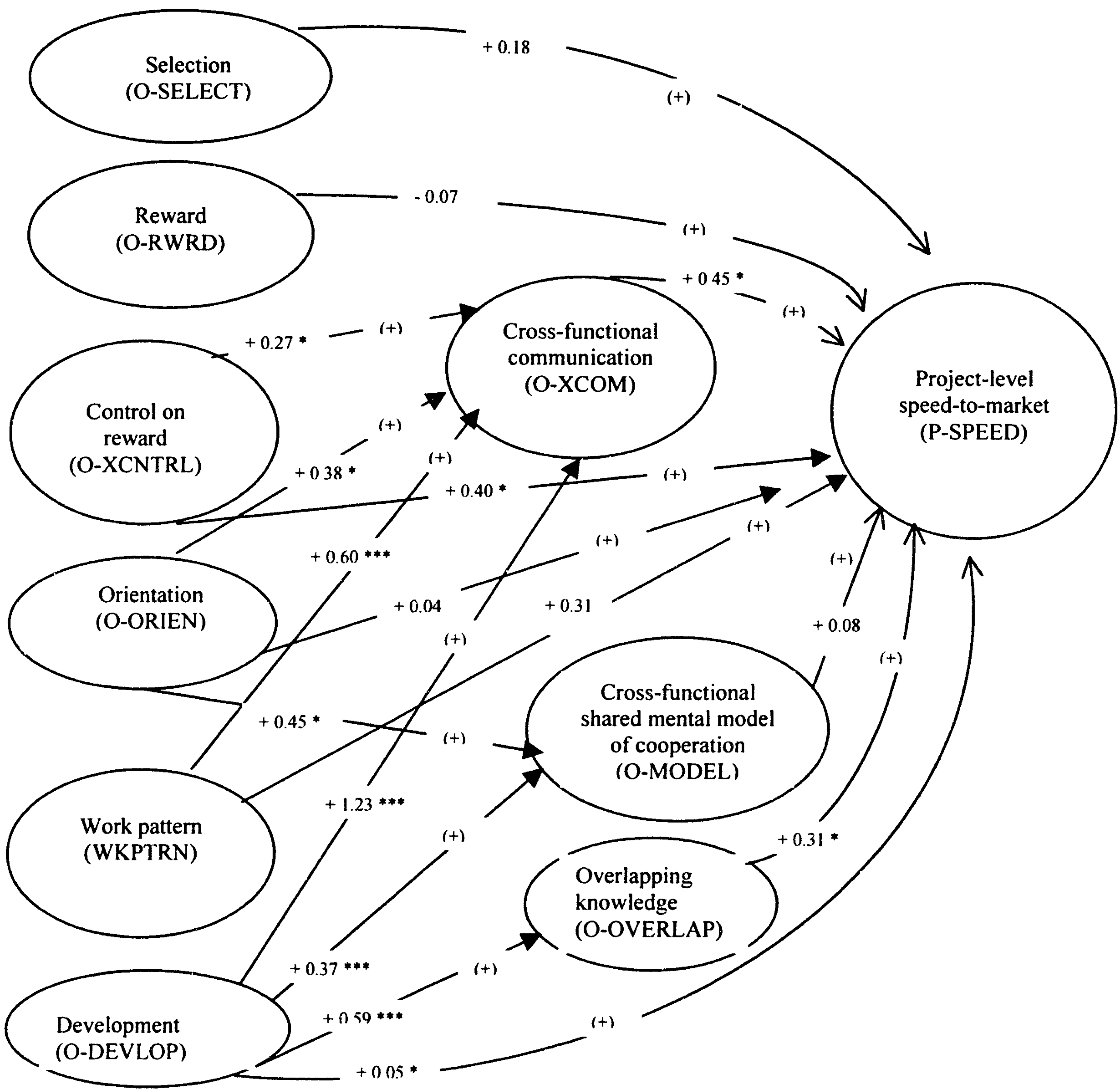


Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. Controlled for the following variables: industry (C-INDUS1, C-INDUS2) and country of origin of companies (C-JAPAN).

FIGURE 6.7

Path analyses for developing the capability to mobilize and create knowledge for innovation:

Project-level Speed-to-Market (P-SPEED)

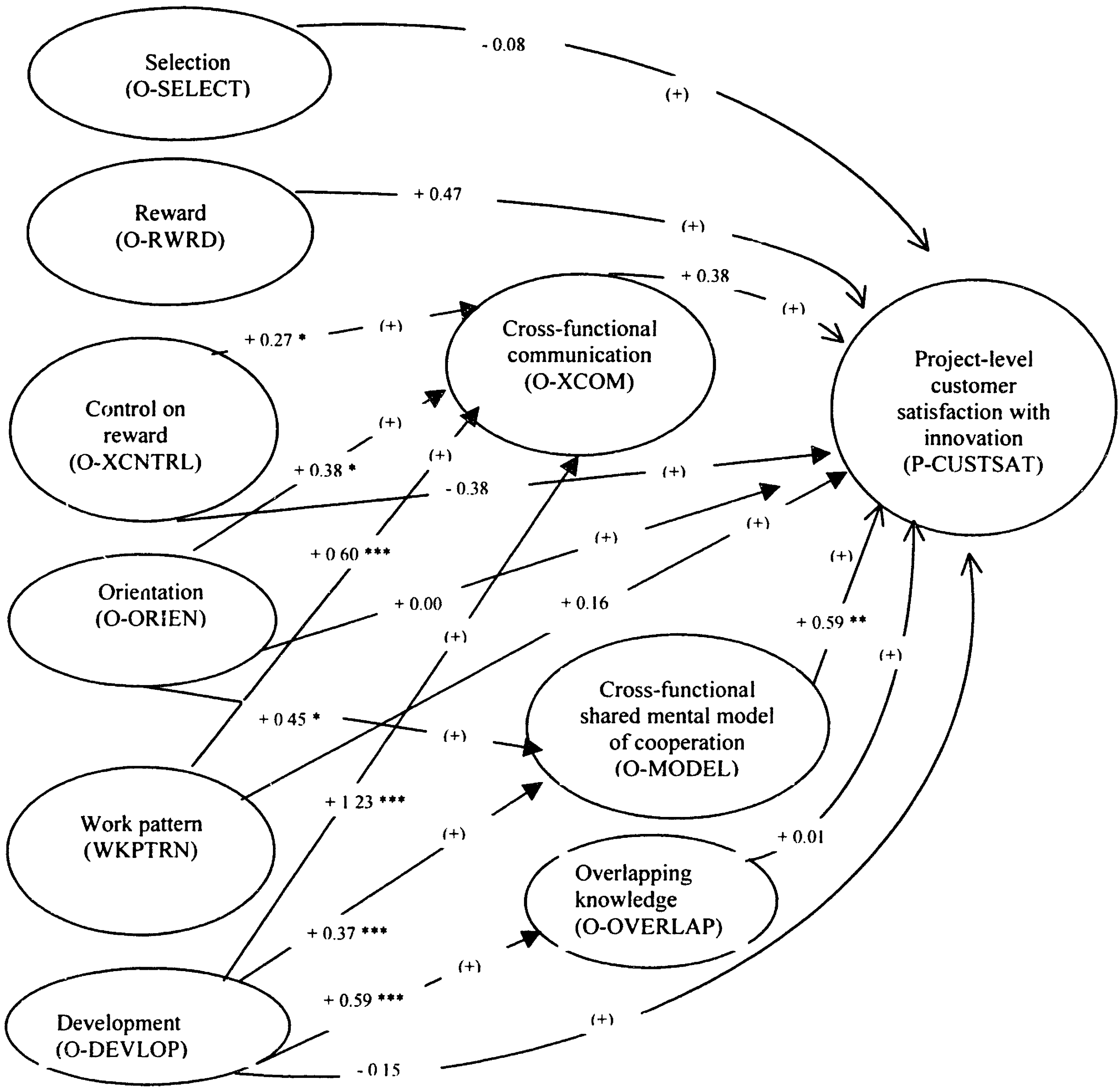


Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. Controlled for the following variables: industry (C-INDUS1, C-INDUS2) and country of origin of companies (C-JAPAN).

FIGURE 6.8

Path analyses for developing the capability to mobilize and create knowledge for innovation:

Project level Customer Satisfaction with the Innovation (P-CUSTSAT)

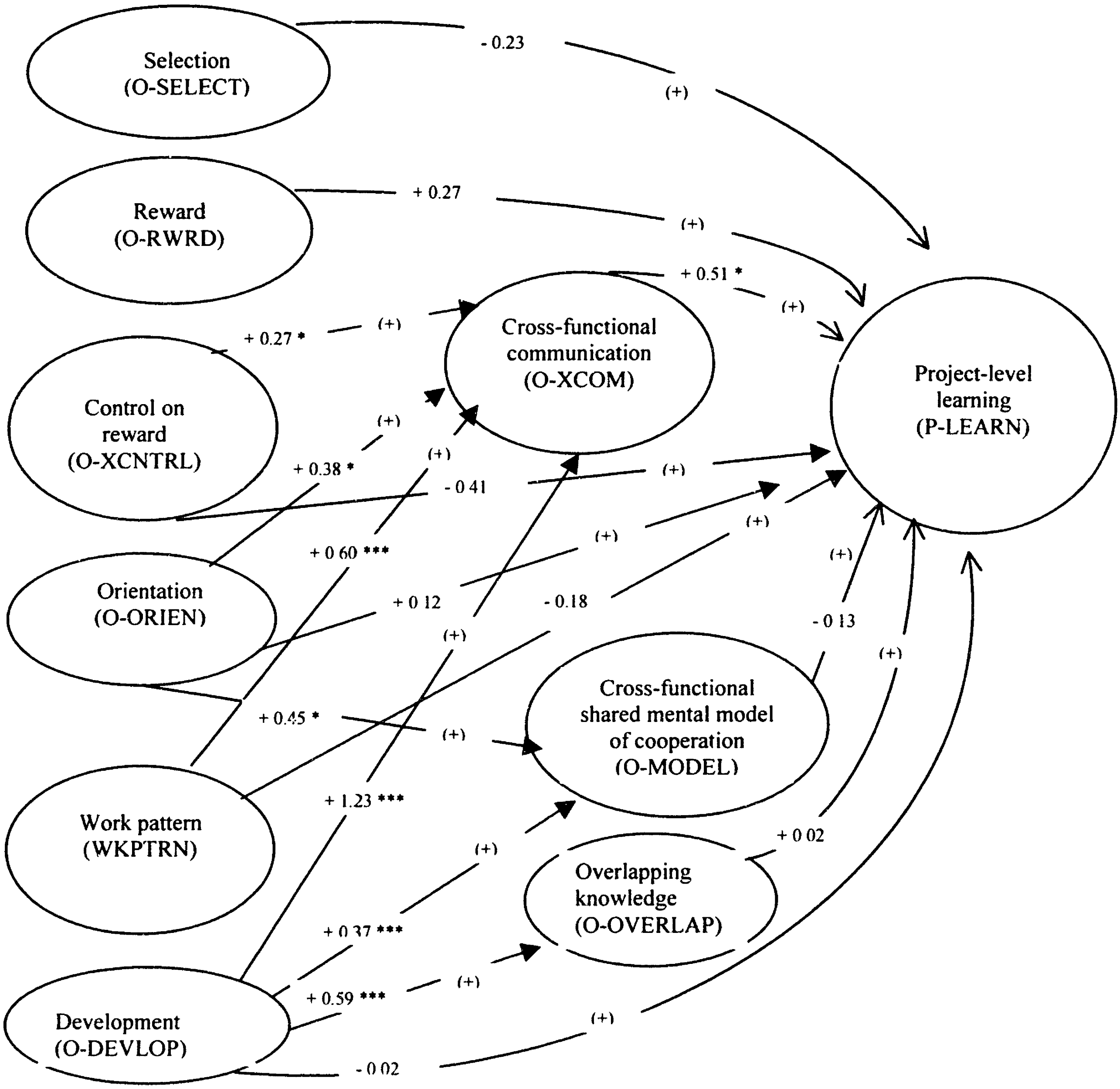


Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. Controlled for the following variables: industry (C-INDUS1, C-INDUS2) and country of origin of companies (C-JAPAN).

FIGURE 6.9

Path analyses for developing the capability to mobilize and create knowledge for innovation:

Project-level Learning (P-LEARN)



Note: Hypothesized signs in parentheses. Significance: ***0.001, **0.01, *.05, †0.1. Controlled for the following variables: industry (C-INDUS1, C-INDUS2) and country of origin of companies (C-JAPAN).

Table 6.6 summarizes the results of the analysis of hypotheses and propositions. The results show that innovation as an outcome of the capability to mobilize and create knowledge for innovation is supported by organization-level human resource processes. Specifically, cross-functional communication frequency and overlapping knowledge support innovation. Cross-functional communication frequency also supports other outcomes of this capability such as efficiency, speed-to-market, and learning. 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 organization-level human resource 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, this is not supported by the control of project manager over individuals' rewards and cross-functional work pattern. However, the control of the project manager over individuals' rewards supports other outcomes of this capability at the project level, namely 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.

TABLE 6.6

Summary of the propositions and hypotheses supported

Proposition	Hypotheses	Expected relationships	Results
P4. Organization-level processes support the capability to mobilize and create knowledge for innovation	H4a. Organization-level cross-functional communication frequency and innovation	+	**Supported**
	H4b. The organization-level shared mental model of cross-functional cooperation and innovation	+	**Supported**
	H4c. The organization-level overlapping knowledge and innovation	+	**Supported**
P5. Organization-level human resource management practices support the capability to mobilize and create knowledge for innovation	H5a. Selection and innovation	+	**Supported**
	H5b. Reward and innovation	+	**Supported**
	H5c. Control over individuals' rewards and innovation	+	Not supported
	H5d. Cross-functional orientation and innovation	+	**Supported**
	H5e. Cross-functional development and innovation	+	**Supported**
	H5f. Work pattern and innovation	+	Not supported
P6. Organization-level human resource management practices have an indirect effect on the capability to mobilize and create knowledge for innovation by affecting the organization-level processes	H6a. Cross-functional orientation and cross-functional communication frequency	+	**Supported**
	H6b. Cross-functional orientation and organization-shared mental model of cross-functional cooperation	+	**Supported**
	H6c. Project manager's control over individuals' rewards and cross-functional communication frequency	+	**Supported**
	H6d. Work patterns and cross-functional communication frequency	+	**Supported**
	H6e. Cross-functional development and overlapping knowledge in organization	+	**Supported**
	H6f. Cross-functional development and cross-functional communication frequency	+	**Supported**
	H6g. Cross-functional development and shared mental model of cross-functional cooperation	+	**Supported**

Moreover, human resource management practices also support this capability indirectly by supporting the organization-level processes that 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. Furthermore, cross-functional development enables companies to accumulate overlapping knowledge that enhances a wide range of outcomes of this capability. The downside of these practices seems 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 Figure 6.3), although it supports customer satisfaction at the project level (see Figure 6.8).

6.4. DISCUSSION AND CONCLUSIONS

This chapter demonstrates the specific organization-level factors and management practices that facilitate knowledge mobilization and creation, and therefore the capability to mobilize and create knowledge for innovation. However, the way in which this capability is developed is not as simple as it may seem. Since we cannot measure capability directly, but only its outcomes (Godfrey and Hill, 1995), 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 (Lukus and Ferrel, 2000; Cristiano, Liker, and White, 2000; Goffin, 1998) and the factor that facilitates creation is overlapping knowledge (Nonaka, 1994; Iansiti, 1998), in particular, the redundancy among R&D, manufacturing, and sales/marketing. The management practices that seem to support knowledge mobilization are, first, selection of employees based not only on their individual potential performance, but also on their character traits that are conducive to knowledge sharing and cooperation in organization (Ichniowski et al., 1997; Lincoln and Kalleberg, 1996). Second, reward is based not only on their individual explicit output, but also on behavioral factors such as cooperation (Aoki, 1988). In addition, cross-functional orientation (Nohria and Ghoshal, 1997) and development (Westney and Sakakibara, 1986) seem to be 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 firms that view process innovation as critical, cross-functional communication frequency appears to be detrimental. One of the reasons could be that process innovation requires different types of knowledge sets, particularly deeper functional knowledge and intra-departmental rather than cross-functional communication.

Fourth, for companies that place high value on efficiency, cross-functional communication frequency and overlapping knowledge are important. On 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, first, reward based in part on behavioral factors; second, the division of control over individuals' rewards between functional and project managers; third, cross-functional orientation; fourth, the use of team-based work patterns; and finally, cross-functional development.

Fifth, 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. Cross-functional communication frequency also seems to be important for learning.

In summary, it seems that organization-level cross-functional communication frequency (Beer and Eisenstat, 2000) and overlapping knowledge (Nonaka, 1994) 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 organization-level 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 capability to mobilize and create knowledge for innovation 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.

The results discussed so far show two main approaches to developing the capability to mobilize and create knowledge for innovation. In Chapter 5 I presented the project team-level factors, while in this chapter I discussed the organization-level factors. The next chapter links the team-level and organization-level processes and tests whether teams are a mirror image of their organizations. Because of this, all key constructs and variables have similar names. However, in order to differentiate the team-level from the organization-level as indicated before, the prefix "P-" represents the team-level variables, and the prefix "O-" indicates the organization-level variables.

7. THE MIRROR IMAGE BETWEEN THE PROJECT TEAM-LEVEL PROCESSES AND THEIR ORGANIZATION-LEVEL PROCESSES

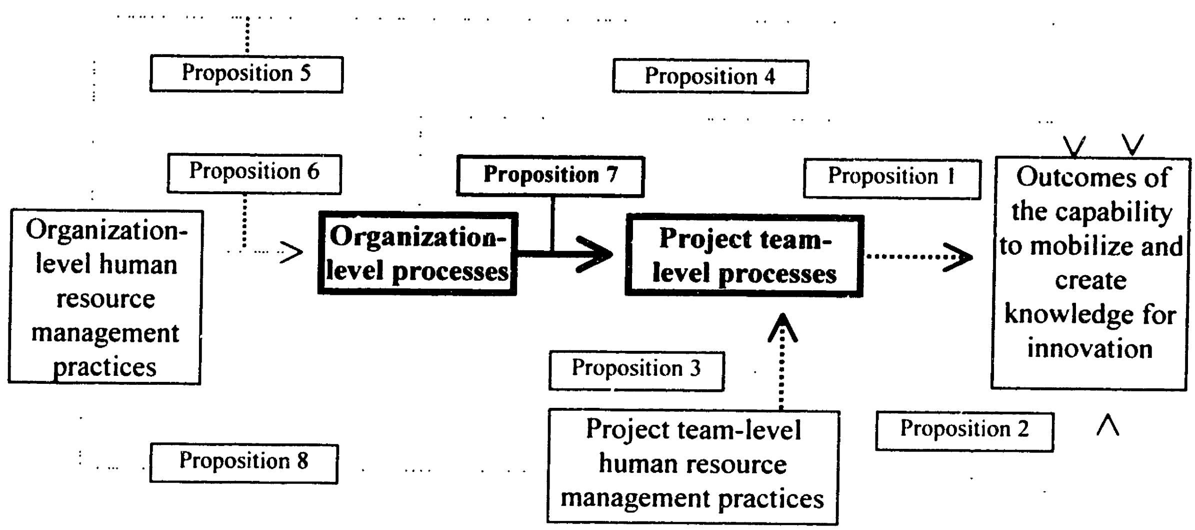
In this chapter I analyze whether the team-level processes are a mirror image of their organization-level processes in developing the capability to mobilize and create knowledge for innovation. In so doing, I test Proposition 7, which argues that the organization-level processes – organization-level cross-functional communication frequency, organization-level shared mental model of cross-functional cooperation, and organization-level overlapping knowledge–support the capability to mobilize knowledge and create new knowledge indirectly by supporting the project-team level processes – project team-internal communication frequency, project team-external communication frequency, project team shared mental model of cross-functional cooperation, and project team overlapping knowledge. Figure 7.1 presents the theoretical model tested in this chapter within the general framework of the thesis. The constructs and relationships analyzed are highlighted in bold.

As in the previous chapters, I present the hypotheses first, followed by a brief description of the research design used specifically for this chapter, and based on the data described in Chapter 4. I then discuss the analysis and results, followed by the conclusions.

FIGURE 7.1

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

Propositions and relationships analyzed in the chapter are highlighted.



7.1. THEORY AND HYPOTHESES: THE PROJECT TEAM-LEVEL PROCESSES AS A MIRROR IMAGE OF THEIR ORGANIZATION-LEVEL PROCESSES

This chapter integrates two bodies of literature on innovation that focus on the organization-level and project team-level, suggesting that project teams are embedded in the organization, and are therefore subject to the ongoing organization-level processes. Thus, in organizations where the organization-level processes, particularly organization-level cross-functional communication frequency, organization-level shared mental model of cross-functional cooperation, and organization-level overlapping knowledge, are institutionalized and embedded in their routines (Nelson and Winter, 1982), I argue that these factors occur automatically on project teams. Organizations that already have these processes in place may thus find it less necessary to develop project team-level processes to generate the processes to support knowledge mobilization and creation for innovation. However, organizations that do not have organization-level cross-functional communication frequency, organization-level shared mental model of cross-functional cooperation, and organization-level overlapping knowledge institutionalized in their organizations, may find it necessary to develop the project team-level processes to achieve innovation.

7.1.1. Analyzing Proposition 7: The organization-level processes support the capability to mobilize knowledge and create new knowledge indirectly by supporting the project-team level processes

Clark and Wheelwright (1992) suggest that, regardless of team structures used in the process of innovation, team members remain embedded in their daily context within the organization. According to these authors, there are four types of team structures used in the process of innovation: functional, lightweight, heavyweight, and autonomous. It is the first three structures that are used most frequently. In functional project team structures, all team members remain completely embedded in their daily routines, performing their routine tasks, while also performing an additional assigned task, which is related to the project. There is no clear team leader coordinating the different parts of the project. In the lightweight project team structures, 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 in the structure of the functional project team, members are guided by a clearly defined team leader, who coordinates and acts as a liaison with various project team members. In the heavyweight project team structures, project team members also remain embedded in their daily contexts. The role of the team leader is the most important differentiating factor between the lightweight and heavyweight structures. In the heavyweight project team structure, the team leader actively coordinates and plans the various tasks, making sure that the project is on schedule, and actively searches for and acquires 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 a project team. Simply stated, most team members at any given time have "one foot" in the project team and the other in their daily context within the organization. As project teams remain embedded in the daily context of the organization, they are subject to the ongoing organization-level processes, particularly organization-level cross-functional communication routines, organization-level shared commitment and shared vision of achieving organizational goals (or lack thereof), and organization-level overlapping knowledge. Hence, project team-level processes are influenced by organization-level processes.

Organization-level cross-functional communication frequency and project team communication frequency. Because project teams are embedded in the organization, they are subject to the patterns and frequency of communication in the organization, all other factors being equal. The frequency of communication in the organization shapes the frequency of internal communication on the team, and between team members and their external links, as demanded by the team task. In an organization where the communication pattern is both vertical within the same function and horizontal across functions, communication is seen to be more frequent. As communication frequency is a measure of resources exchanged (Ghoshal and Tsai, 1998), organizations with both horizontal and vertical communication patterns are expected to exchange more resources across different functions than organizations whose communication patterns tend to be mostly vertical (Galbraith, 1977). Morrill (1995) suggests that communication patterns and frequency are formed in the daily context of the organization. Over time, patterns and frequency are institutionalized and are taken for granted by organization members. Because they become "second nature" to organization members, they occur automatically when individuals are organized to perform other tasks outside their routines. Morrill (1995), who studied conflict management among executives, found that when conflict arises in organizations where communication tends to be vertical between superior and subordinates of the same function, communication occurs vertically to resolve that conflict, with no communication outside of that function. In organizations that have cross-functional communication, similar conflict is resolved through communication across different functions, as well as within the same function. Therefore, this study suggests that similar patterns are to be expected between organization-level cross-functional communication frequency and internal and external communication frequency on project teams, as they are composed of members from different functions.

The case studies presented in Chapter 3 also suggest that project team-level factors are a mirror image of organization-level factors in a given organization. Organizations that have higher cross-functional communication frequency, shared mental model of cross-functional cooperation, and overlapping knowledge, also have these same patterns in their project teams. In Commune, where cross-functional communication in the daily context of organization is more frequent, team-internal and external communication also appear to be more frequent, as needed by the project team. Additionally, the shared-mental model of cross-functional cooperation and overlapping knowledge found at the organizational level are also found at the project team level. Party, which lacks these factors in the larger context of the organization, also lacks them in project teams. Similar patterns were found in Tribe. These patterns lead to the hypotheses that:

H7a: The organization-level cross-functional communication frequency is positively related to project team-internal communication frequency.

H7b: The organization-level cross-functional communication frequency is positively related to project team-external communication frequency.

Organization-level shared mental model of cross-functional cooperation and project team-level shared mental model of cooperation. As teams are embedded in the organization, organization members' views of the organization, shared vision, commitment, and the understanding of how knowledge embedded in different disciplines fits together as a system (or lack thereof), are carried over to the project teams (Staw et al., 1981). Previous studies of innovation that requires the exchange and integration of different types of functional knowledge (e.g., Dougherty, 1987; Griffin and Hauser, 1992) suggest that the main barriers to the exchange and integration process are the differences in thought worlds held by team members represented by different disciplines or communities of practice (Brown and Duguid, 1991). Schein (1996) also suggests at least three distinct subcultures that constrain communication in the process of innovation. Roth and Klein (1996), in their study of cross-functional product development teams in companies analyzed by Schein (1996), which excluded examination of the organizational level processes, showed that team representatives from different functions had different visions and degrees of commitment, and could not understand who would contribute what in completing the team task. These findings are not surprising, since individuals who are brought together to work on the team bring with them the way of thinking, the knowledge and the capabilities they have acquired from the larger context of the organization in which they are embedded (Staw et al., 1981). This argument leads to the hypothesis that:

H7c: The organization-level shared mental model of cross-functional cooperation is positively related to the project team shared mental model of cooperation.

Organization-level overlapping knowledge and project team-level overlapping knowledge. Differences exist between firms' overlapping knowledge across different functions. The study by Westney and Sakakibara (1986) suggests that the level of overlapping knowledge among organization members differs, depending on how members are trained and developed throughout their careers. The authors found that Japanese firms, in contrast to firms located in the United States, developed their engineers so that they would have overlapping knowledge in other functions. The R&D engineers were rotated to manufacturing engineering in order to develop manufacturing knowledge and an understanding of the way in which it is linked to the R&D knowledge they had already acquired in the R&D function. Henderson (1992) also argues that Japanese firms, when compared to their US and European competitors, strategically invest in development of architectural knowledge that enhances integration of different types of knowledge in the innovation process, thereby developing the overlapping knowledge. These findings correlate with the findings of Nonaka and Takeuchi (1995:77), namely, that on cross-functional project teams working on innovation projects in Japanese firms, there is some overlapping knowledge represented on the team among its core members. This leads to the hypothesis that:

H7d: Organization-level overlapping knowledge is positively related to project team overlapping knowledge.

7.2. RESEARCH DESIGN

Data analyzed in this chapter are based on the surveys of 38 companies and their 182 cross-functional project teams working on product and process innovations using external market information. The companies are the largest in the computer, photo imaging, and automobile industries. Data sources, selection criteria, and data collection procedures are described in research design in Chapter 4.

7.2.1. Variables and measures

The variables and measures are based on two constructs: organization-level processes and project team-level processes. Table 7.1 summarizes the variables and measures analyzed in this chapter. I performed a reliability test (Crombach α) for those variables that are composites of several indicators. The rule of thumb is that the indicators are reliable when Crombach α is above 0.60 (Willett, 1998). Organization-level variables are preceded by O-, project team-level variables start by P-, and controls are headed by C-.

TABLE 7.1

Summary of variables and measures analyzed in this chapter

Constructs	Variables		Descriptions	Measures	*Reliability Test: Crombach α*
Organization-level factors	*Facilitators of knowledge mobilization*	O-XCOM	Cross-functional communication frequency	-Cross-functional communication frequency formally (work-related) and informally (not work-related and on personal time. e g coffee breaks. after work)	0 83
		O-MODEL	Organization shared mental model of cross-functional cooperation	-Shared vision across functions toward achieving organizational goal -Shared commitment across functions toward achieving organizational goal	0 78
	Facilitator of knowledge creation	O-OVERLAP	Cross-functional overlapping knowledge	-Cross-functional on-and off-the-job development. job rotation of engineers in sales/marketing. R&D. and manufacturing Add 1 for each	0 77
Project team-level factors	*Facilitators of knowledge mobilization*	P-NCOM	Project team-internal communication	-Communication frequency among core team members using face-to-face meetings. phone. electronic mail. and video conferencing (average by company)	0.81
		P-XCOM	Project team-external communication	- Communication frequency between team members and their external links. using face-to-face meetings. phone. electronic mail (average by company)	0 76
		P-MODEL	Project team shared model	-Shared commitment among team members -Shared understanding of who contributes what on team (average by company)	0 85
	Facilitator of knowledge creation	P-OVERLAP	Project team overlapping knowledge	-Overlapping knowledge among core team members based on their prior work experiences in other function. Add 1 for every overlap of functional past experience redundancy (average by company)	--
Control variables	C-P-DEVLOP		Development for the particular project	-Development provided to team for completing a particular project (average by company)	--
	C-P-RWRD		Reward for completing the particular project	Team performance impacted team members' salary. bonus. job assignment. promotion (average by company)	0 74
	C-P-SELECT		Team membership selection on cross-functional knowledge	Membership selection based on: -Cross-functional job experience -Cross-functional education (average by company)	0.73
	C-P-SIZE		Team size	Number of core team members on team (rated by team leaders) (average by company)	--
	C-P-TENURE		Tenure diversity in team	Average tenure divided by standard deviation (rated by team leaders) (average by company)	--
	C-P-NUMDIS		Number of functions in team	Total number of functions represented on team by core members (average by company)	--
	C-P-SUPORT		Management support	Score of necessary resources provided by management for this task (average by company)	--
	C-INDUS1		Computer industry	Dummy variable. computer industry equals 1; otherwise 0	--
	C-INDUS2		Photo-imaging industry	Dummy variable. photo-imaging industry equals. otherwise 0	--
	C-JAPAN		Japanese subsidiary	Dummy variable. subsidiary of a Japanese firm equals 1; otherwise 0	--

Organization-level processes. Organization-level cross-functional communication frequency (O-XCOM) is measured by cross-functional formal communication frequency (dealing with work-related issues) and informal communication frequency (not work related and on personal time, e.g., coffee breaks, after work) among management and non-management rank employees (α = 0.83). For organization-level shared mental model of cross-functional cooperation (O-MODEL), the measure is the extent to which employees in different functions share the vision of the company and the commitment toward achieving it, as opposed to an individual functional goal (α = 0.78). For this variable, I seek to determine whether an organization has functions that operate as coalitions of interests (Cyert and March, 1963) or as a cooperative system (Barnard, 1938). For organization-level cross-functional overlapping knowledge (O-OVERLAP), the measures deal with the amount of cross-functional on-the-job and off-the-job development, and job rotation of engineers in sales/marketing, R&D, and manufacturing.

Project team-level processes. The project team-level processes that impact the capability to mobilize and create knowledge for innovation are the following: project team-internal communication frequency, project team-external communication frequency, project team shared mental model of cross-functional cooperation, and project team overlapping knowledge. Project team-internal communication frequency (P-NCOM) (Griffin and Hauser, 1992) is measured by the frequency of communication among team members using face-to-face meetings, phone conversations, and e-mail, both formally and informally (α = 0.81). Project team-external communication frequency (P-XCOM) (Ancona and Caldwell, 1992a) is measured by the frequency of team member communication with people outside the team, using face-to-face meetings, phone conversations, and electronic mail (α = 0.76). Project team shared-mental model of cross-functional cooperation (P-MODEL) (Cannon-Bowers et al., 1993) is measured by the level of shared commitment in accomplishing the project, and shared understanding of who will contribute which knowledge and information from various functions to accomplish the task (α = 0.85). Project team overlapping knowledge (P-OVERLAP) is measured by the total amount of overlapping knowledge among core team members, based on their past and current work experience. All the project-team level variables are averages across the organization.

Control variables. The first set of control variables consists of project team-level human resource management practices, as they are potential alternative explanations to the hypothesized relationships. Project team-level human resource management practices are: (1) project team development (P-DEVLOP) for working on the project; (2) project team reward (P-RWRD), which is the reward received based on project team performance, and which could be in the form of bonus payment, salary increase, favorable job assignment, and/or promotion (α = 0.74); (3) project team membership selection (P-SELECT), which deals with team members based on their project-related expertise, cross-functional knowledge, and job experiences (α = 0.73). Other control variables at the project team-level are team size (C-P-SIZE) (Smith et al., 1994; Ancona and Caldwell, 1992a; Bantel and Jackson, 1989), tenure diversity of team members (C-P-TENURE), functional diversity (C-P-NUMDIS), and management support (C-P-SUPORT). Tenure diversity is measured by team tenure standard deviation, divided by its average (Bantel and Jackson, 1989). Functional diversity (Ancona and Caldwell, 1992b) is measured by the number of functions represented on the team. Prior shared experience working on team (Janis, 1972) is measured by whether the particular project team is designated to work on the type of problem posed. Management support is measured by whether the team receives enough resources from management to accomplish the project. I also control for industry and country of origin.

7.2.2. Methods of analysis

The Tobit method is used to analyze the data, since the dependent variables were constrained to an interval. The hypothesized relationships between the organization and project-team level processes are tested using the following specifications:

H7a: $P\text{-}NCOM = \alpha + \beta_1 \cdot O\text{-}XCOM + \beta_2 \cdot P\text{-}DEVLOP + \beta_3 \cdot P\text{-}RWRD + \beta_4 \cdot P\text{-}SELECT + \beta_5 \cdot C\text{-}P\text{-}SUPORT + \beta_6 \cdot C\text{-}INDUS1 + \beta_7 \cdot C\text{-}INDUS2 + \beta_8 \cdot C\text{-}JAPAN + \varepsilon$

H7b. $P\text{-}XCOM = \alpha + \beta_1 \cdot O\text{-}XCOM + \beta_2 \cdot P\text{-}DEVLOP + \beta_3 \cdot P\text{-}RWRD + \beta_4 \cdot P\text{-}SELECT + \beta_5 \cdot C\text{-}P\text{-}SUPORT + \beta_6 \cdot C\text{-}INDUS1 + \beta_7 \cdot C\text{-}INDUS2 + \beta_8 \cdot C\text{-}JAPAN + \varepsilon$

H7c. $P\text{-}MODEL = \alpha + \beta_1 \cdot O\text{-}MODEL + \beta_2 \cdot P\text{-}DEVLOP + \beta_3 \cdot P\text{-}RWRD + \beta_4 \cdot C\text{-}P\text{-}SIZE + \beta_5 \cdot C\text{-}P\text{-}SUPORT + \beta_6 \cdot C\text{-}INDUS1 + \beta_7 \cdot C\text{-}INDUS2 + \beta_8 \cdot C\text{-}JAPAN + \varepsilon$

H7d. $P\text{-}OVERLAP = \alpha + \beta_1 \cdot O\text{-}OVERLAP + \beta_2 \cdot P\text{-}SELECT + \beta_3 \cdot C\text{-}P\text{-}SIZE + \beta_4 \cdot C\text{-}P\text{-}TENURE + \beta_5 \cdot C\text{-}P\text{-}NUMDIS + \beta_6 \cdot C\text{-}INDUS1 + \beta_7 \cdot C\text{-}INDUS2 + \beta_8 \cdot C\text{-}JAPAN + \varepsilon$

7.3. ANALYSIS AND RESULTS

Table 7.2 presents the descriptive statistics and correlation analysis. The correlation coefficients among the organization-level, processes-level and project team processes suggest that there are potential relationships between organization-level cross-functional communication frequency and project team-internal communication frequency, organization-shared mental model of cross-functional cooperation and project team shared mental model of cross-functional cooperation, organization-level overlapping knowledge and project team overlapping knowledge.

TABLE 7.2

Descriptive statistics and correlation matrix

	Mean	*Stdev.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1. P-NCOM	*2.94*	*0.44*	1.00												
2. P-XCOM	*2.63*	*0.53*	0.50	1.00											
3. P-MODEL	*4.10*	*0.45*	0.24	0.04	1.00										
4. P-OVERLAP	*2.87*	*1.47*	-0.13	0.37	0.24	1.00									
5. O-XCOM	*3.93*	*1.22*	0.53	0.16	0.09	0.19	1.00								
6. O-MODEL	*3.74*	*0.67*	-0.17	0.14	0.36	-0.01	0.31	1.00							
7. O-OVERLAP	*1.52*	*1.16*	0.10	0.15	0.26	0.72	0.16	0.12	1.00						
8. P-DEVLOP	*2.91*	*0.74*	0.34	0.46	0.35	-0.09	-0.03	0.10	0.14	1.00					
9.P-RWRD	*0.53*	*0.39*	0.28	0.33	0.06	0.31	-0.09	0.14	-0.08	0.42	1.00				
10. P-SELECT	*2.88*	*0.58*	0.29	0.42	0.11	0.11	-0.08	0.02	0.27	0.20	-0.15	1.00			
11. C-P-SIZE	*9.33*	*1.38*	-0.09	-0.18	-0.06	0.46	0.22	0.08	0.13	-0.02	0.07	-0.11	1.00		
12.C-P-TENURE	*3.40*	*1.26*	-0.41	-0.16	-0.54	0.42	0.14	-0.20	0.26	0.02	-0.09	0.16	-0.20	1.00	
13.C-P-NUMDIS	*3.63*	*0.31*	-0.09	-0.19	-0.06	0.17	0.09	0.07	0.17	0.07	-0.27	0.06	-0.10	0.11	1.00
14.C-P-SUPORT	*4.58*	*0.26*	0.38	0.05	0.31	-0.17	0.14	0.14	-0.09	0.08	-0.02	0.09	0.02	0.04	-0.09

Note: Correlation coefficients above 0.32 are statistically significant at $p \leq 0.05$.

7.3.1. Testing Proposition 7: The organization-level processes support the capability to mobilize knowledge and create new knowledge indirectly by supporting the project-team level processes

Table 7.3 presents the results from testing hypotheses H7a-H7d, which relate the organization-level and project team-level processes. The results support only H7a, H7c and H7d.

Model 1, which tests hypothesis H7a, shows that organization-level cross-functional communication frequency (O-XCOM) is positively related to project team-internal communication frequency (P-NCOM). This result suggests that organizations that have a higher frequency of cross-functional communication are more likely to have a higher frequency of internal communication in project teams organized for innovation. This analysis yields another interesting result: the control variable project team development (P-DEVLOP) has a stronger effect on team internal communication frequency than does cross-functional communication frequency (O-XCOM). This result is interesting in that, despite controlling for project team development, the organization-level cross-functional communication frequency (O-XCOM) still has an effect on project team-internal communication frequency (P-NCOM), although it is slightly weaker than the project team development (P-DEVLOP) effect.

Model 2 tests hypothesis H7b, that organization-level cross-functional communication is positively related to project team-external communication frequency. The results show that this hypothesis is not supported. One of the reasons for this finding is that there are two types of external communication, which are not discussed in the literature but are found in this study: project team-external communication frequency within the same function and project team-external communication frequency across different functions. When these two types of communication frequency are separated, the organization-level cross-functional communication frequency (O-XCOM) has a positive effect on the project team-external communication frequency across functions, and no effect on the project team-external communication frequency within the same functions.

Model 3 tests hypothesis H7c, which claims that the organization-level shared mental model of cross-functional cooperation (O-MODEL) is positively related to the project team shared mental model of cross-functional cooperation (P-MODEL). The result of this analysis suggests that organizations in which different functions have shared commitment and shared vision in achieving organizational goals (as opposed to functional goals), have project teams that are also more likely to have shared commitment and objective in achieving the project goal.

Model 4 tests hypothesis H7d, that organization-level overlapping knowledge (O-OVERLAP) is positively related to project team-level overlapping knowledge (P-OVERLAP). The analysis supports H7d. The results show that organizations that have overlapping knowledge at the organization level are also more likely to have overlapping knowledge at the project team level. Although some of the control variables-particularly selection of team members for cross-functional overlapping knowledge (P-SELECT), team size (P-SIZE), and tenure diversity (P-TENURE)-also predict cross-functional overlapping knowledge on project teams, organization-level overlapping knowledge (O-OVERLAP) has a greater effect than these variables.

TABLE 7.3

Results from testing the effect of organization-level processes on project team-level processes and controls

		Project team-internal communication frequency (P-NCOM)	Project team-external communication frequency (P-XCOM)	Project team shared mental model of cross-functional cooperation (P-MODEL)	Project team overlapping knowledge (P-OVERLAP)
	Model	Model 1	Model 2	Model 3	Model 4
VARIABLES	Intercept	-0.24 * (0.11)	-0.76 *** (0.11)	-1.45 *** (0.21)	0.27 (0.18)
	Cross-functional communication frequency (O-XCOM)	0.79 *** (0.13)	-0.02 (0.04)	-	-
	Shared mental model of cross-functional cooperation (O-MODEL)	-	-	0.27 ** (0.04)	-
	Overlapping knowledge (O-OVERLAP)	-	-	-	0.49 *** (0.02)
CONTROLS	Project team development (P-DEVLOP)	0.81 *** (0.26)	0.43 ** (0.17)	0.38 *** (0.07)	0.32 (0.32)
	Project team reward (P-RWRD)	0.57 *** (0.17)	0.20 * (0.08)	0.30 *** (0.08)	0.24 (0.33)
	Project team selection (P-SELECT)	0.57 *** (0.19)	0.35 ** (0.11)	-0.34 (0.22)	0.06 (0.06)
	Size (C-P-SIZE)	-0.32 ** (0.08)	-0.00 (0.12)	0.04 (0.20)	0.27 ** (0.07)
	Tenure diversity (C-P-TENURE)	-0.46 *** (0.10)	-0.15 (0.15)	-0.17 (0.12)	0.43 ** (0.07)
	Number of disciplines (C-P-#DISCIP)	-0.16 † (0.08)	-0.09 (0.13)	0.01 (0.13)	0.12 (0.06)
	Management support for project (C-P-SUPORT)	0.27 ** (0.09)	0.13 (0.13)	0.38 ** (0.10)	-0.24 (0.19)
	C-INDUS1	0.28 *** (0.01)	0.86 *** (0.12)	1.23 *** (0.13)	-0.61 ** (0.22)
	C-INDUS2	0.01 (0.13)	-0.03 (0.14)	0.54 ** (0.15)	-0.08 (0.11)
	C-JAPAN	0.13 (0.08)	0.94 *** (0.28)	0.40 *** (0.09)	0.46 * (0.16)
	N	38	38	38	38
	Log Likelihood	-126.63	-142.78	-139.86	-79.04
	Chi Square	112.30 ***	162.7 ***	133.54 ***	116.44 ***
	Pseudo R2	0.40	0.30	0.43	0.54

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

Table 7.4 summarizes the results of the analysis of the hypotheses and propositions. The overall results support the proposition that the organization-level processes not only impact the capability to mobilize knowledge and create new knowledge directly, but also indirectly, by affecting the project team-level processes that enhance knowledge creation and mobilization for innovation. Furthermore, the results show that in organizations where cross-functional communication frequency is high, their project team-level internal communication frequency is also likely to be higher than in project teams in organizations that have low cross-functional communication frequency. The results also indicate that organizations that have a certain level of organization-level shared commitment and shared goal in achieving the organization's objectives across different functions, have project teams that are more likely to possess shared commitment and a shared goal to accomplish the project. Moreover, organizations that have a certain level of overlapping knowledge across different functions built within the larger context of their organizations, are more likely to have these resources on their project teams than organizations that do not have this overlapping knowledge. The effect of organization-level cross-functional communication frequency on project teams' external communication frequency is unclear, unless we differentiate between external communication within the same function and across different functions. When these factors are examined, we see an effect of organization-level cross-functional communication frequency on project team-external communication frequency across different functions but no effect on project team-external communication frequency within the same functions. In conclusion, these findings suggest that organizations that have the supporting organization-level processes for knowledge mobilization and new knowledge creation for innovation may find it less necessary to develop the project team-level processes that enhance innovation.

TABLE 7.4

Summary of the propositions and hypotheses supported

Proposition	Hypotheses	Expected relationships	Results
P7. The organization-level processes support the capability to mobilize knowledge and create new knowledge indirectly by supporting the project team-level processes	H7a: The organization-level cross-functional communication frequency and project team-internal communication frequency	+	**Supported**
	H7b: The organization-level cross-functional communication frequency and project team-external communication frequency	+	Not supported
	H7c: The organization-level shared mental model of cross-functional cooperation and project team shared mental model of cross-functional cooperation	+	**Supported**
	H7d: The organization-level overlapping knowledge and project team overlapping knowledge	+	**Supported**

7.4. DISCUSSION AND CONCLUSIONS

This chapter provides the alternative view that as project teams are embedded in the larger context of the organization (Clark and Wheelwright, 1992), they are subject to ongoing organization-level processes, particularly organization-level cross-functional communication frequency (Nohria and Ghoshal, 1997), organization-level shared mental model of cross-functional cooperation (Prahalad and Hamel, 1990), and organization-level overlapping knowledge (Leonard-Barton, 1995) that support knowledge mobilization and creation for innovation. The study finds that organization-level cross-functional communication frequency supports project team-level internal communication frequency, thereby enhancing knowledge mobilization and creation for innovation at the project team-level. It does not find support for project team-external communication frequency, in part, because project team-external communication has two components, external communication frequency within and across different functions. As discussed in Chapter 6, cross-functional communication frequency at the organization level affects external communication across functions, but does not affect external communication frequency within the same functions. Additionally, organizations that share a sense of commitment and vision in achieving the collective goal (as opposed to the goals of functions represented on the team), are more likely to have project teams that have a sense of shared commitment and vision in achieving the project goal. Moreover, organizations that have higher organization-level overlapping knowledge are more likely to have overlapping knowledge in their project teams (Staw et al., 1981).

In conclusion, this chapter shows that if organizations have the supporting organization-level processes built into the organization, these processes may occur more often on project teams, and therefore, the organizations may find it less necessary to use the additional management practices at the project team level. Organizations that lack these supporting organization-level processes may find it crucial to use the additional project team management practices, particularly project team development, in order to achieve similar performance. Therefore, organizations may either invest up front in developing the necessary processes at the organizational level (Nonaka, 1994; Aoki, 1988; Lincoln and Kalleberg, 1990), or develop them only as needed when organizing into project teams for innovation (Ancona and Caldwell, 1992a; Roth and Kleiner, 1996). However, since the capability to mobilize and create knowledge for innovation requires both knowledge mobilization and conversion, factors that facilitate both these things seem to be important. Since cross-functional overlapping knowledge takes time to develop, it is developed regardless of when organizations channel their resources into project teams for mobilizing and creating new knowledge for innovation. Therefore, although team-level factors and management practices facilitate knowledge mobilization, creation of new knowledge probably requires the development of overlapping knowledge at the organizational level (Westney and Sakakibara, 1986; Henderson, 1992).

In the next chapter, I test for the existence of the three strategies used to develop this capability and explain why classifying firms based on the practices they use to manage their employees into strategies or why providing archetypes for companies in terms of what they do is important. In doing so, I link the project team-level and the organization-level human resource management practices.

8. THREE STRATEGIES FOR CAPABILITY DEVELOPMENT AND PERFORMANCE

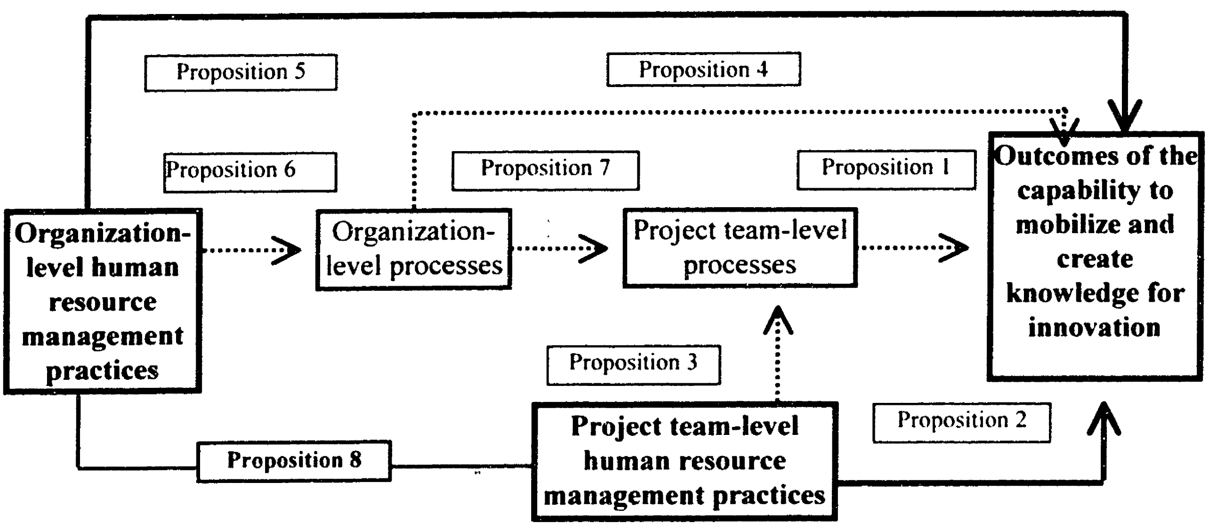
In this chapter I conduct four analyses. First, I analyze Proposition 8, which argues that companies use one of three strategies –organization, project team or mixed– to develop the capability to mobilize and create knowledge for innovation. As discussed in Chapter 3, companies that follow the organization strategy develop their employees such that the organization-level processes that support innovation are generated regardless of when they are used in the process of innovation. Companies that follow the project team strategy develop their employees only as needed in the process of innovation. Companies that use the mixed strategy develop their employees at both levels. In the second analysis, I examine the effects of industry and country of origin of the company on the different strategies that companies use to develop this capability. In the third analysis, I test efficacy of performance of each strategy in terms of the capability developed. Finally, I conduct tests of variance to determine the explanatory power of capability development strategies for performance, in terms of capability developed and financial performance. Figure 8.1 presents the underlying model of capability development strategies within the general framework of the thesis. The constructs and relationships analyzed in this chapter appear highlighted in bold.

Before conducting any of these analyses, I explain the importance of classifying or using archetypes based on the practices that companies follow and the associated outcomes of these practices. There are several advantages to classification of the practices that constitute strategies to mobilize and create knowledge for innovation. As mentioned in Chapter 2, all three bodies of literature –organizational capability in the resource-based theory of the firm, team-level innovation literature, and organization-level innovation literature– analyze the same phenomenon but cannot tell us the characteristics of companies that have this capability. Moreover, as discussed in Chapter 2 and shown in Chapter 3, companies use a set or system of practices in managing their employees, which is the key determinant of organizational capability. In fact, as shown in Chapter 3, there appear to be three systems of practices that might relate to the organizational capability differently. Therefore, the classification of companies according to their salient underlying dimensions, in this case their human resource management practices, enables us to describe a system of practices of companies which have this capability and those which do not. Additionally, the use of archetypes reduces complexity of the phenomenon such that we can analyze it more effectively (Bailey, 1994: p. 12), i.e., test their strategies against their capability and performance.

FIGURE 8.1

Framework for developing the capability to mobilize and create knowledge for innovation

Propositions and relationships analyzed in the chapter are highlighted.



8.1. THEORY AND HYPOTHESIS: THREE STRATEGIES FOR CAPABILITY DEVELOPMENT AND PERFORMANCE

8.1.1. Analyzing Proposition 8: Companies use one of three strategies –organization, project team or mixed– to develop the capability to mobilize and create knowledge for innovation

In the theoretical discussion in Chapter 2, I show that the team-level innovation literature acknowledges the impact of context on team processes and outcomes. The literature indicates that there are essentially two ways that firms may develop the capability to mobilize and create knowledge for innovation. First, firms can develop this capability by managing their employees such that the supporting organization-level processes for both knowledge mobilization and creation are generated and embedded in the organization, regardless of when they are used for generating new resources (Nonaka and Takeuchi, 1995). I refer to this method of organizational capability development as the organization strategy. Second, firms can develop these processes only as needed when organizing employees into project teams for creating new resources (Dougherty, 1987; Ancona and Caldwell, 1992b; Clark and Wheelwright, 1992), using a set of project team management practices. I refer to this model of capability development as the project team strategy.

The case study in Chapter 3 suggests that there is a third strategy for developing the same capability: the mixed strategy. Firms that follow this strategy develop their employees at both the organizational and at the project team levels. This discussion leads to the hypothesis that:

H8a. Companies use one of three strategies –organization, project team or mixed– to develop the capability to mobilize and create knowledge for innovation.

I maintain that there is an order of effectiveness among the alternative strategies, with the mixed strategy being the most effective, followed by the organization strategy, and finally the team strategy. The organization strategy is probably more effective than the team strategy since, although team management practices facilitate knowledge mobilization on team, they are limited in supporting knowledge creation that requires overlapping knowledge, which demands the acquisition of knowledge in different functions prior to team participation. Since this process takes time (Dierickx and Cool, 1989), if some employees are not developed to establish redundant knowledge (Madhaven and Grover, 1998; Leonard-Barton, 1995) at the organizational level, regardless of when such knowledge is needed, and even if team membership selection is based partially on this factor, individual knowledge conversion into organizational knowledge will be problematic (Nonaka and Takeuchi, 1995). Therefore, it seems that in order for an organization to have the capability to mobilize knowledge and create new resources, the organization strategy is probably more effective than the team strategy. The mixed strategy is probably more effective than the organization strategy, and the project team strategy, because it combines the benefits of both. Although the results of the case analysis show that Commune, which follows the organization strategy, was able to generate a greater quantity of innovations than Tribe, which follows the mixed strategy, and Party, which uses the project team strategy, the results from the large sample study suggest a different order. As shown in Chapter 5, project team development directly and indirectly supports a wide range of outcomes of the capability to mobilize and create knowledge for innovation. Moreover, in Chapter 6 we see that cross-functional development of employees at the organizational level also directly and indirectly facilitates a wide range of outcomes of this capability, at both the organizational and project levels. Hence, I hypothesize that:

H8b. Among the three strategies, there is hierarchy of effectiveness in the development of the capability to mobilize and create knowledge for innovation, with the mixed strategy being the most effective, followed by the organization strategy and, finally, by the team strategy.

8.2. RESEARCH DESIGN

Data analyzed in this chapter use external market information and are based on surveys of 38 companies and their 182 cross-functional project teams working on product and process innovations. The companies are the largest in the computer, photo imaging, and automobile industries. Data sources, selection criteria, and data collection procedures are described in the research design in Chapter 4.

8.2.1. Variables and measures

The variables and measures are based on the following constructs: outcomes of the capability to mobilize and create knowledge for innovation, organization-level human resource management practices, and project-team level human resource management practices. Table 8.1 presents the summary of variables and measures used in this analysis. I performed a reliability test (Crombach α) for those variables that are composites of several indicators. The rule of thumb is that the indicators are reliable when Crombach α is above 0.60 (Willett, 1998). As indicated before, variables preceded by O- are organization-level variables, while those starting with P- are project team-level variables.

The capability to mobilize and create knowledge for innovation. The construct capability to mobilize knowledge and create new knowledge is represented by its outcome, innovation, since this intangible capability is not measurable directly but only through its effects (Godfrey and Hill, 1995). Innovation (O-PRODNOV) follows the definition of Van de Ven (1986) and Nohria and Gulati (1995). Innovation is measured by the firm's level of success in incorporating external customer feedback from its worldwide operations into new product development and product modification as well as by the number of products developed within the last five years (α = 0.84). Another organization-level variable is the level of customer satisfaction with the innovations (O-CUSTSAT). This variable is measured by ratings published by JD Power & Associates for the automobile industries, PC World Magazine for the computer industry, and an external marketing research company for the photo-imaging industry (α = 0.87). Organization-level financial performance is measured using the return on sales (O-LNROS), return on assets (O-LNROA), and return on equity (O-LNROE).

At the project team-level, project team innovation (P-PRODNOV) is measured by the extent to which projects using customer feedback led to new product development and improvement (0.87). Project team process innovation (P-PROCESS) is measured by the extent to which projects using customer feedback led to process improvement. Efficiency (P-EFFIC) is measured by project team labor and financial resources used in the process of innovation (α = 0.70). Customer satisfaction with the innovation (P-CUSTSAT), is measured by how satisfied the customers are with the innovation the project team provided. Project team-level learning (P-LEARN) derived from this innovation is measured by application of the innovation created in one part of the organization in other relevant parts of the organization.

Organization-level human resource management practices and project team-level human resource management practices. In order to capture the human resource management practices more realistically, an in-depth comparative analysis of three companies, two located in the United States and one in Japan, was conducted, assisting our understanding of how companies develop the capability to mobilize and create knowledge for innovation. The results are discussed in Chapter 3. The human resource management practices analyzed in this study are therefore based not only on previous research, but also on my extensive interviews and observations of these companies. The measures for selection were obtained from evaluation forms used by the company recruiters. The measures for reward were obtained from company performance evaluation forms, and from my discussions with personnel and functional managers about the factors that are critical in determining salary increases, promotion, and bonus payment. I also conducted interviews about the control over individuals' rewards, particularly the degree of influence over rewards that functional, project and personnel managers and peers had. I also asked personnel managers about their orientation, training, and career development practices. In order to capture daily work patterns, I observed how daily tasks were performed in the R&D, sales/marketing, manufacturing, and customer service organizations. I obtained the measures for project team management practices through interviews with project team members of the three companies. I designed the surveys based on these qualitative data.

TABLE 8.1

Summary of variables and measures

Constructs	Variables	Descriptions	Measures	α
Outcome of the capability to mobilize and create knowledge for innovation	O-PRODNOV	Product innovation	-Success in incorporating customer feedback in new product development -Success in incorporating customer feedback in product improvement -Number of new products that customer service organization helped develop in the last five years	0 84
	O-CUSTSAT	Customer satisfaction	External rating on product appeal, dependability, quality provided by JD Power & Associates, PC World	0.87
	O-LNROS	Return on sales	Natural logarithm of net income/total sales	--
	O-LNROA	Return on assets	Natural logarithm of net income/total assets	--
	O-LNROE	Return on equity	Natural logarithm of net income/total equity	--
	P-PRODNOV	Project team-level product innovation	-Project team led to new product development -Product modification -Process improvement	0.82
	P-PROCESS	Project team-level process innovation	-Project team led to process improvement	--
	P-EFFIC	Project team-level efficiency	-Financial resources used -Staff hours used (more than, less than, or same as expected by management)	0.68
	P-SPEED	Project team-level speed	Time-to-market expected by customers	--
	P-CUSTSAT	Customer satisfaction with innovation	Level of satisfaction with innovation created by the team	--
	P-LEARN	Project team-level learning	Application of innovation in other relevant parts of organization	--
Organization-level human resource management practices	O-HRM	Organization-level human resource management system	Composite of O-SELECT, O-RWRD, O-PRJINFLU, O-ORIEN, O-DEVLOP, O-WKPTRN	0.81
	O-SELECT	Select team-based behaviors	-Select on ability to work on team -Select on willingness to cooperate	0 73
	O-RWRD	Reward for team-based behaviors	Cooperative behaviors impacted salary increase, bonus payment, promotion, and job assignment	0 79
	O-XCNTRL	Control of project manager	Control of project manager over individual reward (salary increase, job assignment, promotion)	0.91
	O-ORIEN	Cross-functional orientation	Policy on cross-functional orientation at corporate and operational levels, yes equals 1, otherwise 0	0.81
	O-WKPTRN	Cross-functional work patterns	Team-based job design, level of participation on cross-functional teams (i.e., quality circles)	0.73
	O-DEVLOP	Cross-functional development	Total cross-functional training of white-collar workforce (engineers, sales/marketing, customer services) in R&D, manufacturing, sales/marketing, customer services, adding 1 for each function	0 76
Project team-level human resource management practices	P-HRM	Project team-level human resource management system	Composite of P-DEVLOP, P-RWRD, P-SELECT	0 60
	P-DEVLOP	Training for the particular project	Training received by project team for performing a particular project	--
	P-RWRD	Reward for performing the particular project	Project team performance impacted team members' salary, bonus, job assignment, promotion	0.73
	P-SELECT	Team membership selection	Membership selection based on cross-functional job experience, knowledge, and expertise for project	0 75

Factor analyses of all management practices suggest that the practices belong to two different groups: the organization-based human resource management system (O-HRM), and the project team management system (P-HRM). The O-HRM, which has an overall reliability score of ($\alpha = 0.81$), consists of: (1) selection based on ability to work in a team and the willingness to cooperate; (2) the reward structure in this system, which is determined by assessing the extent to which cooperative behaviors have any impact on individual salary increase, award of bonus payment, promotion, and job assignment; (3) control over individuals' rewards, which is measured by determining how much control the project manager, human resource manager, and peers have over individual salary increase, promotion, and job assignment; (4) cross-functional orientation, which is measured by examining whether companies put new professional employees through cross-functional orientation at both the operational and corporate levels; (5) work pattern, which is measured by examining whether daily tasks require the use of the team, and by the level of participation of employees on cross-functional teams (i.e., quality circles); (6) cross-functional training and development, which were determined by assessing whether companies put their engineers through on-the-job training and job rotation in other functions, particularly R&D, sales/marketing, and manufacturing.

The project team-level human resource management system (P-HRM) ($\alpha = 0.60$) is composed of: project team training (training provided for performing tasks on a particular project); reward (either for individual performance on team, or team performance or both) in terms of salary increase, bonus, job assignment, and promotion; and project team membership selection based on cross-functional job experience, knowledge, and expertise relevant to the project. The lower reliability score for the project team-level human resource management system is consistent with the qualitative data, which suggest that, although team-based incentive and other practices are institutionalized in the production organization for performing daily tasks (Ichniowski et al., 1997), these practices are not institutionalized for the white-collar workforce. In some cases, the reward is in the form of a favorable job assignment and promotion, while in others it is in the form of bonus and salary increase.

The second-order factors are used to form these systems in order to give each set of practices a more equal weight. If individual measures are used directly, each of the management practices, (e.g., project team reward (P-RWRD)) which consist of several measures, will have greater weight than, for example, P-DEVLOP, which only has one measure. Therefore, by combining measures under each practice, (i.e., selection, reward, training, and development), the weights are more evenly distributed for the purpose of conducting the cluster analysis.

8.2.2. Method

Since the main goal of this study is to understand the different types of strategies that firms use to develop the capability to mobilize and create knowledge for innovation, and to gauge the effectiveness of each strategy, the first analysis used is the cluster analysis. This analysis groups companies according to their similarity in how they manage their employees.

Once the clusters that define the strategies have been identified, it is possible to conduct a comparison of the means of independent and dependent variables (using both the T-tests and Tamhane's T2 multiple comparison methods), without assuming equal variance, in order to determine which strategy is more effective at developing the capability to mobilize and create knowledge for innovation. The same procedures are used to determine which strategy is associated with higher financial performance. The T-test allows comparisons to be made between variables, (i.e., two strategies at a time), while Tamhane's T2 allows simultaneous comparisons of more than two variables. The reason for conducting both tests is that while any three variables might not be significantly different from each other, they could be significantly different from any given two variables. This understanding is especially valuable when comparing specific practices across strategies, industries, and companies with different country of origin. For instance, although a given practice may not be significantly different across all three industries, a significant difference between two industries yields information about the nature of the two industries. The main reason for conducting these tests on specific practices is to understand the intensity or level of emphasis firms place on different strategies, in different industries and in different countries.

Finally, I use the OLS regression analyses to determine the explanatory power of capability development strategies on performance with the necessary controls, particularly the industry and the company's country of origin. In these analyses, each strategy is indicated by a dummy variable. I use two dummy variables, setting the mixed strategy as a base for comparison since it has some elements of both.

8.3. ANALYSIS AND RESULTS

8.3.1. Testing Proposition 8: Companies use one of three strategies –organization, project team or mixed– to develop the capability to mobilize and create knowledge for innovation

Figure 8.2 shows the results from the cluster analysis. The results show that companies follow one of three strategies: the organization, project team, and mixed. The three cluster strategies are selected because they have high face validity and the distances between clusters are about equal.

The only significant differences between firms are in their organization-based human resource management system (O-HRM), which deals with developing employees at the organizational level, and their project team management system (P-HRM), which deals with developing employees at the project team level. This result is important, as previous studies tend to discuss only the organization-based human resource management and project team-level human resource management practices as facilitators of the capability to mobilize and create knowledge for innovation. The differences in the O-HRM and P-HRM used by companies determine the differences in strategies used to develop the capability to mobilize and create knowledge for innovation.

FIGURE 8.2

Hierarchical cluster analysis of human resource and project team management systems:

Cluster 1 mixed, Cluster 2 organization, Cluster 3 project team

```
      Dendrogram using average linkage (between groups)
                  Rescaled distance cluster combine

C A S E     0         5        10        15        20        25
  Label Seq +---------+---------+---------+---------+---------+

        30   -+---------+
        38   -+         +-----------+
         2   -----------+           I
        24   -+-----+               I
        25   -+     +---------+     +-------------------------+
        15   -+     I         I     I                         I
  M     35   -+-----+         I     I                         I
  I     12   -+               I     I                         I
  X      5   -+               +-----+                         I
  E     21   -+               I                               I
  D      1   -+               I                               I
         3   -+-+             I                               I
        26   -+ +-----+       I                               I
        10   -+-+     +-------+                               I
        23   -+       I                                       I
         4   ---------+                                       I
        13   ---+-----------+                                 I
  O     32   ---+           +---------------------------+     I
  R      7   ---+---+       I                           I     I
  G      8   ---+   +-------+                           I     I
         6   -------+                                   I     I
        29   ---+-----+                                 I     I
        31   ---+     +-------+                         +-----+
        27   ---+---+ I       I                         I
  P     34   ---+   +-+       +---------+               I
  R     16   -------+         I         I               I
  O     28   -----------------+         I               I
  J     22   -+-+                       I               I
  E     36   -+ +-----+                 +---------------+
  C     20   -+-+     I                 I
  T     33   -+       +-----------+     I
        19   -+-----+ I           I     I
  T     37   -+     +-+           I     I
  E      9   -+-----+             +-----+
  A     11   -+                   I
  M     14   -+-----------+       I
        17   -+           +-------+
        18   -------------+
```

Table 8.2 presents the results of a comparison of the means of firms' human resource management systems in the three clusters. The results show that companies follow one of three different strategies in developing the capability to mobilize and create knowledge for innovation, and that these strategies are distinct in the human resources management practices used. The three strategies are referred to as: (1) the organization strategy, whereby employees are developed at the organizational level regardless of when they will be used in the process of innovation; (2) the project team strategy, whereby employees are developed only as needed when employees are organized into project teams; (3) the mixed strategy, whereby employees are developed both at the organizational and at the project team level. Choice of strategies is not constrained by industry or country of origin.

TABLE 8.2

Human resource management systems of the three strategies: Cluster 1 mixed strategy, Cluster 2 organization strategy, and Cluster 3 project team strategy

Clustering variables	Cluster 1 Mixed (N=16)	Cluster 2 Organization (N=5)	Cluster 3 Project team (N=17)	T-tests			Tamhane's T2
				1 vs. 2	1 vs. 3	2 vs. 3	1 vs.2 vs. 3
Organization-level human resource management system (O-HRM)	3.42 (0.94)	4.33 (0.91)	0.83 (0.99)	*	***	*	*
Project team-level human resource management system (P-HRM)	2.31 (1.16)	0.66 (0.91)	3.54 (0.49)	**	***	***	*

Note: means, standard deviation in parentheses. Significance: ***0.001, **0.01, *0.05, †0.1.

The mixed strategy. Cluster 1 consists of 16 companies. Of the 16 companies, four are Japanese and 12 are American. Ten of the companies are in the computer industry, two are in the photo-imaging industry, and four are in the automobile industry. These companies are designated as following the mixed strategy. Companies in this cluster have a higher mean for the organization-level human resource management system (O-HRM) than firms that follow the project team strategy, but a lower mean than firms that follow the organization strategy. Additionally, firms that follow the mixed strategy have a lower mean for their project team-level human resource management system (P-HRM) than firms that follow the project team strategy; but these firms have a higher mean compared to firms that follow the organization strategy.

The organization strategy. Cluster 2 contains five companies that are classified as following the organization strategy in developing the capability to mobilize and create knowledge for innovation. Of the five companies, two are Japanese and the other three are American. Three are in the computer industry, one is in the photo-imaging industry, and one is in the automobile industry. Compared to firms following the other two strategies, these companies use the organization-level human resource management system (O-HRM) more, and the project team-level human resource management system (P-HRM) the least.

The project team strategy. Cluster 3 contains 17 firms, four of which are Japanese and 13 of which are American. Seven companies are in the computer industry, three are in the photo-imaging industry, and six are in the automobile industry. This group of firms is described as following the project team strategy, as they do not focus on developing their employees at the organizational level, but only as needed when organizing employees into project teams for innovation. Their mean for project team-level human resource management system (P-HRM) is the highest amongst the three groups of firms. The mean for their organization-level human resource management system (O-HRM) is the lowest of the three groups of firms.

Table 8.3 shows the specific characteristics of the three strategies for developing the capability to mobilize and create knowledge for innovation, and also shows the factors that differentiate them. The practices that differentiate all three strategies are: project managers' control over rewards given to individuals (O-XCNTRL), organization-level cross-functional development (O-DEVLOP), and team-level development (P-DEVLOP).

TABLE 8.3

Human resource management practices of the three strategies: Cluster 1 mixed strategy, Cluster 2 organization strategy, and Cluster 3 project team strategy

Clustering variables	Cluster 1 Mixed (N=16)	Cluster 2 Organization (N=5)	Cluster 3 Project team (N=17)	T-tests			Tamhane's T2
				1 vs. 2	1 vs. 3	2 vs. 3	1 vs. 2 vs. 3
Organization-level HRM practices							
Select team-based behaviors (SELECT)	2.33 (2.28)	2.00 (2.73)	0.83 (1.91)		**	**	
Reward behavioral factors (RWRD)	3.00 (2.58)	3.05 (2.73)	2.44 (2.50)				
Control of project manager (O-XCNTRL)	2.66 (2.73)	4.00 (2.23)	1.66 (2.42)	*	*	*	*
Cross-functional orientation (ORIEN)	0.42 (0.36)	0.50 (0.32)	0.44 (0.31)				
Cross-functional work pattern (WKPTRN)	2.96 (2.58)	4.00 (2.23)	3.05 (2.50)	*		*	
Cross-functional development (DEVLOP)	2.71 (1.75)	3.27 (2.23)	0.83 (0.38)		*	***	*
Project team-level HRM practices							
Project team training (P-DEVLOP)	3.00 (2.53)	2.00 (2.73)	4.38 (2.13)	***		**	*
Project team reward (P-RWRD)	2.67 (2.88)	1.00 (1.55)	4.00 (2.23)	*	*	*	
Project team selection (P-SELECT)	3.66 (2.44)	3.10 (2.23)	3.44 (2.50)				

Note: means, standard deviation in parentheses. Significance: ***0.001, **0.01, *.05, †0.1.

The results of this comparison of the two groups suggest some differences at the level of individual practices. There are several specific practices that differentiate firms following the mixed and the organization strategies. Firms that follow the organization strategy, on average, give significantly more control over individuals' rewards to project managers than do firms that follow the mixed strategy (mean of 4.00 vs. 2.66). At the project level, however, firms that follow the mixed strategy provide a significantly higher level of development and reward to their project teams than do firms that follow the organization strategy (mean of 3.00 vs. 2.00 for P-DEVLOP and mean of 2.67 vs. 1.00 for P-RWRD).

Moreover, firms that follow the mixed strategy differ from firms that follow the project team strategy in the following ways. First, firms that follow the mixed strategy give project managers more control over individuals' rewards than do firms that follow the project team strategy (mean of 2.66 vs. 1.66). Second, unlike firms that follow the project team strategy, they provide cross-functional development to their engineers at the organizational level through job rotation between R&D and manufacturing, and through off-the-job training in sales/marketing, regardless of when they are organized into teams for creating new knowledge for innovation (2.71 vs. 0.83). Third, they provide additional development and reward to their employees when organized into project teams for mobilizing and creating new knowledge for innovation, but at a lower level than the firms that follow the project team strategy (mean of 3.00 vs. 4.38 for P-DEVLOP and 2.67 vs. 4.00).

There are greater differences between firms that follow the organization strategy and firms that follow the project team strategy than there were in the previous comparisons with firms that follow the mixed strategy. In comparison with firms that follow the project team strategy, firms that follow the organization strategy put significantly higher emphasis on selecting employees based on behavioral factors conducive to knowledge mobilization (mean of 2.00 vs. 0.83), and give more control to project managers over individuals' rewards (mean of 4.00 vs. 1.66). In addition, they provide cross-functional development to professional employees (mean of 3.27 vs. 0.83), which facilitates the acquisition of redundant knowledge, supporting knowledge creation, regardless of when employees are organized to mobilize and create knowledge for innovation. However, they do much less than firms that follow the project team strategy at the project level when organizing employees into project teams for innovation (mean for P-DEVLOP is 2.00 vs. 4.38 and for P-RWRD 1.00 vs. 4.00).

Table 8.4 shows the results of testing the effects of industry on the specific practices companies use to develop the capability to mobilize and create knowledge for innovation. The only significant difference across all three industries is the way in which they reward their project teams. Automobile companies seem to put the strongest emphasis on rewarding their project teams, followed by companies in the computer and photo-imaging industries. Other factors that might differentiate the three industries are selection (O-SELECT) and reward (O-RWRD). Firms in the photo-imaging industry tend to put higher emphasis on selection based on behavioral factors conducive to knowledge mobilization, followed by firms in the automobile and computer industries. Moreover, firms in the photo-imaging industry seem to put more emphasis on rewarding behavioral factors, followed by firms in the computer and automobile industries.

TABLE 8.4

Human resource management practices of the three industries: Computer, photo-imaging, and automobile

Clustering variables	Industry 1 Computer (N=20)	Industry 2 Photo imaging (N=6)	Industry 3 Automobile (N=12)	T-Test 1 vs. 2	T-Test 1 vs. 3	T-Test 2 vs. 3	Tamhane's T2 1 vs. 2 vs.3
Organization-level HRM practices							
Select team-based behaviors (SELECT)	3.25 (2.45)	4.10 (0.56)	3.33 (2.46)	†		†	†
Reward behavioral factors (RWRD)	3.00 (2.51)	3.33 (2.58)	2.08 (2.57)		†	*	†
Influence of project manager (O-XCNTRL)	2.75 (2.55)	0.83 (2.04)	2.50 (2.61)	*		*	
Cross-functional orientation (ORIEN)	2.75 (2.55)	3.33 (2.58)	2.18 (2.57)				
Cross-functional work pattern (WKPTRN)	2.00 (2.51)	1.67 (2.58)	1.25 (2.26)				
Cross-functional development (DEVLOP)	4.25 (1.83)	4.17 (2.04)	3.33 (1.46)		*		
Project team-level HRM practices							
Project team training (P-DEVLOP)	3.00 (2.11)	1.61 (2.38)	2.25 (2.26)	*	*		
Project team reward (P-RWRD)	3.00 (2.58)	2.29 (1.78)	4.25 (2.26)		*	*	*
Project team selection (P-SELECT)	4.29 (1.78)	4.50 (1.58)	4.58 (1.44)				

Note: means, standard deviation in parentheses. Significance: ***0.001, **0.01, *.05, †0.1.

When we make a simultaneous comparison of practices between two industries, we see more significant differences. Among the organization-level practices, photo-imaging firms put significantly higher emphasis on selecting and rewarding employees based on behavioral factors that are more conducive to knowledge mobilization, and on providing project managers more control over individuals' rewards, than do firms in the automobile industry. Apart from differences in selection and reward, there are no significant differences between firms in the computer industry and those in the photo-imaging industry in terms of cross-functional orientation, work patterns, and cross-functional development. However, firms in the computer industry put significantly higher emphasis on giving project managers some control over individuals' rewards than do firms in the photo-imaging industry. Moreover, firms in the computer industry put significantly higher emphasis on cross-functional development than do companies in the automobile industry.

The main differences among firms in these industries are found at the project level. Firms in the computer industry place significantly higher emphasis on developing their employees when organizing personnel into project teams for innovation than do firms in the photo-imaging industry. However, there are no significant differences between firms in the computer and automobile industries in terms of developing their employees at the project level. Firms in the automobile industry appear to put higher emphasis on project team reward (P-RWRD) than do firms in the computer and photo-imaging industries. However, no significant differences appear among firms in different industries in terms of project team membership selection.

Table 8.5 shows the results of a test of the effect of country of origin on the specific practices companies use to develop the capability to mobilize and create knowledge for innovation. We see that there are significant differences among some of the practices, both at the organization and project levels. In particular, Japanese firms tend to emphasize more of the practices that are conducive to knowledge mobilization and creation at the organizational level, particularly through selection and reward, and provide project managers some control over individuals' rewards. They also use cross-functional work patterns, and cross-functional development of professional employees. However, they put less emphasis on project team management practices when organizing personnel into project teams to mobilize and create knowledge for innovation. These results are consistent with the results found in the case analysis and in the literature on the processes of innovation in Japanese firms (Nonaka, 1994; Clark and Fujimoto, 1991; Clark and Wheelwright, 1992).

TABLE 8.5

Human resource management practices of firms with different national origins: United States and Japan

Clustering variables	United States (N=28)	Japan (N=10)	T-test US vs. Japanese
Organization-level HRM practices			
Select team-based behaviors (SELECT)	3.39 (2.37)	4.00 (2.11)	†
Reward behavioral factors (RWRD)	2.50 (2.55)	3.50 (2.42)	*
Control of project manager (O-XCNTRL)	2.50 (2.55)	3.00 (2.58)	†
Cross-functional orientation (ORIEN)	2.68 (2.54)	2.50 (2.64)	
Cross-functional work pattern (WKPTRN)	2.86 (2.52)	3.50 (2.42)	†
Cross-functional development (DEVLOP)	2.89 (1.95)	3.50 (1.58)	†
Project team-level HRM practices			
Project team development (P-DEVLOP)	2.32 (2.54)	1.00 (2.11)	*
Project team reward (P-RWRD)	2.61 (2.38)	2.00 (2.58)	*
Project team selection (P-SELECT)	4.29 (1.78)	2.50 (1.58)	**

Note: means, standard deviation in parentheses. Significance: ***0.001, **0.01, *.05, †0.1.

However, it seems inconsistent that organization strategy, which is frequently suggested as followed by Japanese companies, does not perform as well. When I referred to the qualitative data presented previously, one interesting explanation emerged. The "team development" practice appears to have different meanings for US and Japanese companies, and even for the Japanese companies based in the United States.

For US companies, team development is a formalized process whereby individuals external to the team, e.g., in the case of Tribe, a corporate trainer specializing in facilitating teamwork, intervenes at the beginning of the project to help set up the processes in accomplishing the task. Party, which is another American company, uses external experts to develop teams. In contrast, in my interviews with American managers working for Japanese operations located in the United States, and going back to three team leaders in Commune, what Americans call "team development" is conducted by the team leader rather than someone external to the team. The team leader takes on the role of the facilitator, the same roles as those taken by the corporate trainer in Tribe and consultants in Party. The team leaders try to achieve what they refer as "alignment" before the project begins. They set up the agenda to meet about the tasks, dividing them up and sharing ideas about where and how to acquire the necessary resources for the project. Moreover, as we saw in Tribe and Party, external facilitators also help to resolve conflicts among team members. In Japanese companies, the team leaders have to resolve these conflicts. In short, if we take into account the informal activities that occur on teams, Japanese companies appear to use a "mixed" strategy but one that is slightly different from those used by their US counterparts. In many ways, the project team leaders in Japanese companies are considered to be "heavyweight" (Clark and Wheelwright, 1992).

8.3.2. Strategies and the capability to mobilize and create knowledge for innovation

Table 8.6 presents the results of testing the effectiveness of the strategies to develop the capability to mobilize and create knowledge for innovation. The only significant differences among the three strategies were found in the following outcomes of capability: overall organization-level product innovation (O-PRODNOV), customer satisfaction with the innovation (O-CUSTSAT), return on sale (LNROS), product innovation at the project level (P-PRODNOV), efficiency at the project level (P-EFFIC), and speed-to-market of the innovation (P-SPEED). For the overall product innovation of the company (O-PRODNOV), the organization strategy seems to be most effective, followed by the mixed and the project team strategies. For overall customer satisfaction with the company's innovation (O-CUSTSAT), for product innovation at the project level (P-PRODNOV), and for efficiency at the project level (P-EFFIC), the mixed strategy seems to be most effective, followed by the project team and the organization strategies. For speed-to-market of the innovation (P-SPEED), the project team strategy appears to be most effective, followed by the mixed and the organization strategies. However, for financial performance in terms of return on sale (LNROS), we also see that the mixed strategy is most effective, followed by the project team and organization strategies.

When we compare companies that follow the mixed and project team strategies, we see that the mixed strategy is more effective than the project team strategy for the following outcomes: overall company product innovation (O-PRODNOV), customer satisfaction with the company's innovation (O-CUSTSAT), product innovation at the project level (P-PRODNOV), process innovation (P-PROCESS), and, potentially, efficiency at the project level (P-EFFIC). The project team strategy seems to be more effective for learning (P-LEARN). With other outcomes of capability, the different strategies do not yield significant differences. For financial performance in terms of return on sale (LNROS), return on assets (LNROA), and return on equity (LNROE), the mixed strategy seems to be more effective than the project team strategy.

TABLE 8.6

Outcomes of the capability to mobilize and create knowledge for innovation and the three strategies: Cluster 1 mixed strategy, Cluster 2 organization strategy, and Cluster 3 project team strategy

Performance	Cluster 1 Mixed (N=16)	Cluster 2 Organization (N=5)	Cluster 3 Project team (N=17)	T-Test			Tamhane's T2
				1 vs. 2	1 vs. 3	2 vs. 3	1 vs. 2 vs. 3
Organization-level							
Product innovation (O-PRODNOV)	0.79 (0.47)	0.83 (0.57)	0.27 (0.57)		**	*	*
Customer Satisfaction (O-CUSTSAT)	1.32 (0.28)	0.08 (1.51)	0.87 (1.33)	*	*	*	*
Return on Sales O-LNROS	1.34 (0.98)	0.08 (1.51)	0.87 (1.33)	**	*	*	*
Return on Assets O-LNROA	0.77 (1.31)	0.99 (1.52)	0.29 (1.91)		*	*	†
Return on Equity O-LNROE	1.09 (1 68)	1.31 (1.63)	0.29 (1.91)	†	*	*	†
Project team-level							
Product innovation (P-PRODNOV)	3.92 (0.53)	2.75 (0.35)	3.61 (0.65)	*	*	*	*
Process innovation (P-PROCESS)	3.67 (1.25)	3.46 (1.47)	3.25 (1.51)		*	†	
Efficiency (P-EFFIC)	1.92 (0.27)	1.50 (0.70)	1.67 (0.39)	*	†		*
Speed-to-market (P-SPEED)	3.28 (0.56)	3.00 (0.10)	3.29 (0.35)	*		*	*
Customer satisfaction (P-CUSTSAT)	3.23 (1.21)	3.42 (1.41)	3.25 (1.61)				
Learning (P-LEARN)	3.87 (1.23)	3.67 (1.18)	3.94 (0.63)		†	*	

Note: means, standard deviation in parentheses. Significance: ***0.001, **0.01, *.05, †0.1.

When we compare the effectiveness of the mixed and organization strategies, we see that the mixed strategy is associated with higher performance on the following outcomes of capability: overall customer satisfaction with the company's innovation (O-CUSTSAT), project level product innovation (P-PRODNOV), efficiency (P-EFFIC), and speed-to-market of the innovation (P-SPEED). Moreover, for financial performance in terms of return on sale (LNROS), we also see that the mixed strategy is associated with higher performance than the organization strategy. However, for return on equity (LNROE), the organization strategy is associated with potentially higher performance.

When we compare the performance of the project team and the organization strategies, we see that the project team strategy is more effective for the following outcomes of capability: overall customer satisfaction with the company's innovation (O-CUSTSAT), project level product innovation (P-PRODNOV), speed-to-market of the innovation (P-SPEED), and learning (P-LEARN). Moreover, for financial performance, we see that the project team strategy is associated with higher performance in terms of return on sale (LNROS). However, the organization strategy is associated with higher performance than the project team strategy on the following outcomes: overall company-level product innovation (O-PRODNOV) and potentially process innovation at the project level (P-PROCESS). In terms of financial performance, we see that for return on assets (LNROA) and return on equity (LNROE), the organization strategy is associated with higher performance.

Table 8.7 shows the results from Tobit analyses of capability development strategies and different outcomes of capability at both the organizational level and project team level, controlling for the effects of industry and country of origin of companies. Overall, the results are consistent with the previous analyses using comparison of means that did not control for these effects. Model 1 and Model 2 suggest that the mixed strategy has a higher positive effect on both product innovation and customer satisfaction with the innovation, followed by the organization and project team strategies. Model 3, which tests the capability development strategies on product innovation (P-PRODNOV) also shows that the mixed strategy is most effective, followed by the organization and project team strategies. Model 4 is not statistically significant. Model 5, which tests the efficacy of the capability development strategies on efficiency at the project level (P-EFFIC), suggests that the organization strategy is most effective, followed by the mixed strategy. Since the project team strategy is not statistically significant, we cannot say anything about its efficacy in relation to the other two strategies. In Model 6, the three strategies are tested against speed-to-market of the innovation (P-SPEED). The project team strategy seems to be more effective, followed by the mixed strategy. In Model 7 we see that the mixed strategy is associated with higher performance in terms of customer satisfaction with the innovation, followed by the organization and project team strategies. Lastly, in Model 8, testing the effects of the capability development strategies on learning (P-LEARN), the results again suggest that the mixed strategy is associated with higher performance, followed by the organization and the project team strategies.

TABLE 8.7

Tobit analysis of strategies on outcomes of the capability to mobilize and create knowledge for innovation at the organization level and project team level

	Organization-level		Project team level					
	Product innovation (O-PRODNOV)	**Customer satisfaction (O-CUSTSAT)**	**Product innovation (P-PRODNOV)**	**Process Innovation (P-PROCESS)**	**Efficiency (P-EFFIC)**	**Speed-to-market (P-SPEED)**	**Customer satisfaction (P-CUSTSAT)**	**Learning (P-LEARN)**
Model	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Intercept	0.95 * (0 36)	1.34 *** (0.09)	2.69 *** (0.28)	3.05 *** (0.27)	1.78 *** (0.14)	2.98 *** (0.18)	3.65 *** (0.22)	3.63 *** (0.19)
Organization	-2.87 * (1.31)	-0.81 * (0.30)	-0.81 * (0.36)	0.25 (0.92)	0.96 ** (0.49)	-0.07 (0.61)	-0.91 ** (0.34)	-0.79 * (0.35)
Project team	-1.70 * (0.73)	-0.77 † (0 38)	-0.91 * (0.37)	-0.71 (0.73)	-0.89 * (0 37)	1.36 * (0.49)	-0.95 * (0.42)	-0.83 * (0.41)
C-INDUS1	1.55 (1.64)	-0.31 (0.30)	-1.02 (0.97)	0.07 (0.93)	-1.32 * (0.49)	0.40 (0.62)	-0.75 (0.75)	0.09 (0.65)
C-INDUS2	0.68 (0.80)	-0.14 (0.15)	-0.52 (0.49)	0.82 † (0 47)	-0.25 (0.23)	0.46 (0.31)	0.19 (0.37)	-0.01 (0.33)
C-JAPAN	0.27 (0 58)	0.02 (0 10)	0.22 (0.33)	-0.09 (0.32)	0.17 (0.16)	0.27 (0.21)	0 04 (0.26)	-0.09 (0 22)
N	38	38	38	38	38	38	38	38
Log Likelihood	-40.54	-30 74	-50.65	-49.55	-26.57	-35.07	-41.20	-36 50
Chi Square	24.12 *	21.74 **	29.29 *	12.85 †	11.29 *	24.63 *	26.65 *	23.60 **
Pseudo R^2	0 29	0 27	0.28	0.25	0 27	0 28	0.27	0.29

Note Standard errors in parentheses. Significance: ***0.001, **0 01, * 05, †0.1.

8.3.3. Tests of variance of capability development strategies on performance

Table 8.8 presents the results from tests of variance of the strategies for capability development on performance at the organizational level in terms of the capability developed as measured by different outcomes. For organization-level product innovation capability (O-PRODNOV) and customer satisfaction with the innovation (O-CUSTSAT), the results shown in Model 1a and Model 2a indicate that the effects of industry and company's country of origin explain less than 10% of the variance in these performance measures. Model 1b and Model 2b indicate that, without controlling for the effects of industry and country of origin of companies, the strategies explain 18% and 22% of the variance respectively. With the controls, as shown in the full models, Model 1c and Model 2c, the explanatory power increases to 28% and 30% accordingly.

TABLE 8.8

Regression analyses of strategies on outcomes of the capability to mobilize knowledge and create new knowledge for innovation at the organization-level

Organization-level performance	**Product Innovation (O-PRODNOV)**			**Customer Satisfaction (O-CUSTSAT)**		
Model	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
Intercept	1.35 *** (0.09)	0.82 (0.27)	0.71 *** (0.17)	1.35 *** (0.16)	1.39 *** (0.14)	1.34 *** (0.09)
Organization	-	0.71 * (0.30)	0.82 ** (0.37)	-	0.37 * (0.16)	0.32 * (0.14)
Project team	-	-0.69 * (0.26)	-0.68* (0.33)	-	0.76 ** (0.19)	0.84 ** (0.24)
C-INDUS1	-0.03 (0.10)	-	0.62 † (0.32)	-0.13 (0.10)	-	0.60 † (0.30)
C-INDUS2	-0.10 (0.14)	-	0.31 † (0.16)	-0.04 (0.06)	-	0.33 † (0.17)
C-JAPAN	0.02 (0.10)	-	0.11 (0.20)	-0.00 (0.10)	-	0.03 (0.11)
N	38	38	38	38	38	38
F	2.28 *	3.37 *	2.69 *	2.19 †	3.46 *	2.87 *
Adj. R2	0.09	0.18	0.28	0.07	0.22	0.30

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

Table 8.9 presents the results from regression analyses testing the effect of capability development strategies on financial performance. As in the previous case, the effects of industry and company's country of origin, as shown in Model 1a, Model 2a, and Model 3a, explain less than 10% of the variance for each measure. In contrast, Model 1b, Model 2b, and Model 3b, which do not control for the effects of industry and country of origin of companies, indicate that the capability development strategies explain between 11% and 19% of the variance in financial performance. When we add the controls, as shown in Model 1c, Model 2c, and Model 3c, the explanatory power of the variance increased to between 19% and 23%.

TABLE 8.9

Regression analyses of capability development strategies on financial performance

Organization-level performance	**Return on Sales (O-LNROS)**			**Return on Assets (O-LNROA)**			**Return on Equity (O-LNROE)**		
Model	1a	1b	1c	2a	2b	2c	3a	3b	3c
Intercept	1.48 *** (0.91)	1.36 *** (0.60)	1.47 *** (0.39)	-1.88 * (0.92)	0.45 (0.82)	2.39 *** (0.34)	0.26 (1.01)	1.47 * (0.56)	1.54 *** (0.14)
Organization	-	0.77 ** (0.27)	0.86 * (0.33)	-	-0.78 (0.91)	-0.79 (1.15)	-	1.19 † (0.57)	1.13 * (0.49)
Project team	-	0.63 * (0.30)	0.79 * (0.37)	-	-0.88 (0.42)	-0.45 * (0.22)	-	1.27 ** (0.15)	0.45 * (0.19)
C-INDUS1	0.43 (1.33)	-	1.13 (1.35)	0.85 (0.59)	-	-0.10 (1.16)	0.06 (0.65)	-	0.88 † (0.49)
C-INDUS2	0.31 (1.07)	-	0.27 (0.68)	0.58 (0.38)	-	0.35 (0.58)	0.30 (0.42)	-	-0.14 (0.25)
C-JAPAN	-0.30 (0.61)	-	0.30 (0.46)	0.89 (0.59)	-	0.65 (0.40)	0.59 (0.65)	-	0.30 † (0.17)
N	38	38	38	38	38	38	38	38	38
F	2.89 *	3.22 *	3.02 **	2.53 *	3.21 *	2.44 †	2.41 †	2.60 *	2.89 *
Adj. R2	0.09	0.16	0.23	0.07	0.19	0.25	0.07	0.11	0.19

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

Table 8.10, Table 8.11, and Table 8.12 show the results from the regression analyses of capability development strategies on outcomes of capability at the project team level. Table 8.10 illustrates the results from testing the variance of capability development strategies on product innovation (P-PRODNOV) and process innovation (P-PROCESS). As Model 1a and Model 2a indicate, the effects of industry and company's country of origin explain only 5% and 7% of the variance respectively, compared with the capability development strategies, which explain 19% and 11% of the variance (see Model 1b and Model 2b). In Model 1c and Model 2c, we see that the full models explain 21% and 12% of the variance in product and process innovations.

TABLE 8.10

Regression analyses of capability development strategies on outcomes of the capability to mobilize and create knowledge for innovation at the project team-level

Project-level performance	**Product innovation (P-PRODNOV)**			**Process innovation (P-PROCESS)**		
Model	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
Intercept	3.66 *** (0.26)	3.51 (0.20)	2.68 *** (0.29)	3.02 *** (0.26)	3.26 *** (0.21)	3.04 *** (0.27)
Organization	-	0.85 ** (0.29)	1.69 ** (0.67)	-	0.16 (0.41)	0.23 (0.93)
Project team	-	0.83 † (0.42)	0.84 * (0.38)	-	-0.56 * (0.26)	-0.70 * (0.34)
C-INDUS1	0.32 (0.31)	-	-0.96 (0.98)	0.16 (0 33)	-	0.07 (0.94)
C-INDUS2	-0.31 (0.41)	-	-0.44 (0.49)	0.64 (0.42)	-	0.82 † (0.47)
C-JAPAN	0 16 (0.31)	-	-0.20 (0.33)	-0.53 (0.33)	-	-0 07 (0.32)
N	38	38	38	38	38	38
F	2.55 *	3.68 **	2.76 *	2.10	2.60 *	2.21 †
Adj. R2	0.07	0.19	0.21	.05	0.11	0.12

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

Table 8.11 shows the results from the regression analyses of the strategies for capability development at the project team level, particularly efficiency in terms of resources used (P-EFFIC) and speed-to-market of the innovation (P-SPEED). Similar to the previous analyses, as shown in Model 1a and Model 2a, the effects of industry and company's country of origin explain less than 10% of the variance in these outcomes. The capability development strategies, however, explain more of the variance as presented in Model 1b and Model 2b: 15% for product innovation (P-EFFIC) and 26% for speed-to-market (P-SPEED). The full models, Model 1c and Model 2c, explain 25% and 35% of the variance in efficiency and speed-to-market respectively.

TABLE 8.11

Regression analyses of capability development strategies on outcomes of the capability to mobilize and create knowledge for innovation at the project team-level

Project-level performance	**Efficiency (P-EFFIC)**			**Speed-to-market (P-SPEED)**		
Model	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
Intercept	1.81 *** (0.14)	1.77 *** (0.10)	1.81 *** (0.13)	3.64 *** (0.22)	3.70 *** (0.16)	2.98 *** (0.19)
Organization	-	0.30 * (0.15)	1.11 * (0.44)	-	-0.49 * (0.23)	-0.87 ** (0.24)
Project team	-	0.31 (0.22)	0.39 (0.35)	-	0.70 * (0.33)	0.46 * (0.21)
C-INDUS1	-0.19 (0.17)	-	-1.09 * (0.44)	0.23 (0.26)	-	0.70 † (0.44)
C-INDUS2	-0.17 (0.22)	-	-0.28 (0.22)	0.13 (0.34)	-	0.47 (0.32)
C-JAPAN	0.15 (0.16)	-	0.37 * (0.15)	0.39 (0.25)	-	0.58 * (0.22)
N	38	38	38	38	38	38
F	2.58 *	2.68 *	2.49 *	2.07	3.67 *	2.91 **
Adj. R2	0.07	0.15	0.25	0.08	0.26	0.35

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

Table 8.12 presents the results from the regression analyses testing the explanatory power of capability development strategies on the last two outcomes of capability at the project team level, customer satisfaction with the innovation (P-CUSTSAT) and learning (P-LEARN). Model 1a and Model 2a indicate that the effects of industry and company's country of origin explain less than 10% of the variance in these measures. In fact, Model 1a is not even statistically significant. The strategies for capability development explain 16% and 21% of the variance in these measures as presented in Model 1b and Model 2b. The full models, Model 1c and Model 2c, explain 27% and 29% of the variance in these measures.

TABLE 8.12

Regression analyses of strategies on outcomes of the capability to mobilize and create knowledge for innovation at the project team-level

Project-level performance	**Customer satisfaction (P-CUSTSAT)**			**Learning (P-LEARN)**		
Model	Model 1a	Model 1b	Model 1c	Model 2a	Model 2b	Model 2c
Intercept	2.97 *** (0.18)	3.20 *** (0.14)	3.64 *** (0.21)	3.43 *** (0.23)	3.75 *** (0.18)	3.43 *** (0.23)
Organization	-	0.18 (0.21)	0.74 (0.70)	-	-0.59 * (0.27)	-0.47 * (0.20)
Project team	-	-0.10 (0.31)	-0.27 (0.56)	-	-0.78 † (0.39)	-0.72 * (0.34)
C-INDUS1	0.27 (0.22)	-	-0.59 (0.71)	0.28 (0.27)	-	0.80 (0.80)
C-INDUS2	0.36 (0.28)	-	0.20 (0.36)	0.58 (0.36)	-	0.78 † (0.40)
C-JAPAN	0.29 (0.21)	-	0.02 (0.24)	0.31 (0.27)	-	0.69 * (0.27)
N	38	38	38	38	38	38
F	2.22	2.86 *	3.01 **	2.53 *	2.66 *	2.59 *
Adj. R2	0.06	0.16	0.27	0.07	0.21	0.29

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

In summary, the mixed strategy, whereby employees are developed both at the organizational and the project team levels when organizing to create new resources for the firm, and the division of control over individual's reward between functional and project managers, seems to support a wide range of outcomes of capability. Specifically, it supports overall customer satisfaction with company products, and product innovation, efficiency, and learning at the project level. Moreover, companies that follow this strategy also seem to have higher levels of financial performance. However, for speed-to-market of the innovation, the project team strategy seems to be more effective than the mixed strategy. For other outcomes of the capability, any of the strategies may lead to similar results. These capability development strategies also explain some of the variance in performance across firms, not only in terms of the capability developed, but also in terms of financial performance.

8.4. DISCUSSION AND CONCLUSIONS

This chapter develops the resource-based theory of the firm and bridges the gap between the two bodies of literature, as discussed in Chapter 2, by showing that companies follow one of three distinct strategies in developing the same capability. In addition to the organization and project team strategies suggested by previous research, companies also follow the mixed strategy. Instead of developing their employees at either level, in such a way that facilitators of knowledge mobilization such as cross-functional communication and cooperation are embedded in their daily context, or developing them as needed when personnel are organized for innovation, some companies seem to do a little of both. In particular, the mixed strategy involves the developing of their employees so that not only facilitators of knowledge mobilization are embedded in the organization, but that the facilitator of knowledge creation or overlapping knowledge (Madhaven and Grover, 1998; Nonaka, 1994), is also available at the organizational level. Moreover, when personnel are organized into project teams for innovation, companies also provide some development in terms of teaching teams how to work together to accomplish a task (Beer and Eisenstat, 1996).

This chapter shows that the mixed strategy is associated with a wider range of outcomes of this capability and better financial performance than the other two strategies. In particular, it supports overall customer satisfaction with company's products, product innovation at the project level, and efficiency in terms of resources used in achieving the innovation. The main reason is that the capability to create new resources for firms, i.e., innovation that satisfies the demands of external customers, seems to require both knowledge mobilization of customer preferences, and design and production (Lukus and Ferrel, 2000; Cristiano, Liker, and White, 2000; Goffin, 1998; Tebbe, 1998; Jamison, 1999), as well as the factor that facilitates the conversion and transformation of these knowledge sets (Leonard-Barton, 1995; Nonaka, 1994; Madhaven and Grover, 1998; Carlile, 1997). This facilitator seems to be the absorptive capacity for different knowledge being shared. Since this redundant knowledge is acquired through cross-functional development, the critical organization-level factor is this practice. Furthermore, since different innovation projects require different individuals with different knowledge sets (Iansiti, 1998), even if there is overlapping knowledge available at the organizational level, additional development, whereby team leaders or corporate trainers facilitate the organization of the work processes of project teams, seems to be most effective.

The different strategies that companies use to develop the capability to mobilize knowledge and create new resources are not explained by the industries in which they compete. This result suggests that companies can choose the strategy they want to use to develop this capability (Child, 1972), although companies in certain industries tend to emphasize certain practices more than companies in other industries (Lawrence and Lorsch, 1967).

The differences in company's country of origin do not appear to determine the different strategies that MNEs use to develop the capability to mobilize and create new resources. This finding supports the argument that companies operating in a foreign institutional environment face the isomorphic pressures of their local environment, and tend to have practices that resemble the practices used by their host country competitors (Westney, 1993). At the same time, they also face the pressures from their home country operations to maintain practices used in their home country, because of their administrative heritage, routines, and/or the need to be strategically coherent (Bartlett and Ghoshal, 1989) with the rest of the firm. This is the reason why we see some elements of both home and host country practices.

In the next chapter, I summarize the main findings of the thesis. I then discuss the limitations of the study. I conclude by describing its contributions to theory and managerial practice, and indicate future directions of research that this research project has opened.

9. SUMMARY AND CONCLUSIONS

This study asks the question, How do companies develop the capability to mobilize and create knowledge for innovation? In answering this question, I integrate three bodies of literature, all of which discuss innovation: the organizational capability literature based in the resource-based theory of the firm, team-level innovation literature, and organization-level innovation literature.

I organize this chapter as follows. First, I present the summary of key results and then several caveats regarding them. I then discuss the contributions, followed by the future directions of this research.

9.1. KEY RESULTS

The study involves two phases with two sets of results, which are organized by level of analysis. In the first phase, the comparative case studies of 24 innovation teams in three companies provide us with an empirically grounded theory and a set of propositions about how companies develop the capability to mobilize and create knowledge for innovation. In the second phase, these propositions are tested using a large sample of companies, in order to enhance the external validity of claims about the effectiveness of strategies, and the specific processes and management practices that support the development of this capability.

Capability development at the project team level. The development of the capability to mobilize and create knowledge for innovation at the project team level is supported by project team-level processes and project team level management practices separately. The project team-level processes that facilitate this capability are project team-internal communication frequency, external communication frequency, project team shared mental model of cooperation, and overlapping knowledge. The analyses reveal that project team-internal communication frequency facilitates product and process innovation, efficiency in terms of resources used in achieving the innovation, and learning from the processes of creating the innovations. External communication frequency supports product innovation, customer satisfaction with the innovation, and learning. Project team shared mental model of cooperation has a negative effect on product innovation, but supports efficiency and speed-to-market, while it has a decreasing return on process innovation, customer satisfaction with the innovation, and learning. This finding suggests that creative abrasion is important for product innovation. Overlapping knowledge between manufacturing and R&D engineering team members has a decreasing return on product innovation and speed-to-market, but has a positive effect on efficiency. This finding also suggests that although overlapping knowledge facilitates knowledge conversion, up to a point, it minimizes the "creative abrasion" that is also necessary for product innovation.

Project team-level management practices support the capability to mobilize and create knowledge for innovation not only directly, but also indirectly, by influencing project team-level processes. First, project team development directly supports product and process innovation, speed-to-market, customer satisfaction with the innovation, and learning, and also supports them indirectly, by facilitating internal and external communication. However, this practice also facilitates the development of project team shared mental model of cooperation, which reduces creative abrasion, thereby hurting product innovation, and has a decreasing return on process innovation. Second, project team reward has no effect on either process or product innovation, nor on efficiency, but has a positive effect on speed-to-market, customer satisfaction with the innovation, and learning. This finding is contrary to the discussion in the literature (e.g., Wageman, 1995; Wageman and Baker, 1997). This difference may be explained by the fact that previous studies tend to analyze the effect of incentive in isolation from other human resource management practices at the project level. Furthermore, the nature of the teams may also be different. The teams used in research may have been studied in laboratory settings (Wageman and Baker, 1997) or may have been teams consisting of individuals from the same function (Ichniowski et al., 1997). Project team membership selection based on cross-functional knowledge and the fit between expertise and the nature of the project has no effect on innovation and a negative effect on all other outcomes of this capability. One of the explanations for this finding is that the managers or team leaders who formed the teams did not possess accurate information about team members' prior job experiences, as team tenure diversity and size explain more of the variance in overlapping knowledge than selection based on this factor.

Capability development at the organizational level. There are also several key organization-level processes and management practices that separately support the development of this capability. Among the organization-level processes, cross-functional communication frequency and overlapping knowledge are key facilitators for developing the capability to mobilize and create knowledge for innovation, since they support a wide range of capability outcomes: product innovation, customer satisfaction, efficiency, speed-to-market with the innovation, and learning. While cross-functional communication frequency facilitates knowledge mobilization in organization, overlapping knowledge supports the process of new knowledge creation.

A few crucial organization-level human resource management practices support the capability to mobilize and create knowledge for innovation, as well as some of the organization-level processes that support this capability. Specifically, cross-functional development of professional employees facilitates a wide range of outcomes of this capability: product innovation, customer satisfaction, efficiency, speed-to-market with the innovation, and learning. Moreover, it indirectly supports this capability by facilitating cross-functional communication frequency and the accumulation of cross-functional overlapping knowledge. Other management practices, particularly the division of control over individuals' rewards between functional and project managers, cross-functional orientation, and the use of cross-functional 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 facilitates the knowledge creation process.

Linking the project teams to their organizations. In linking project teams to their organizations, this study shows that there is a mirror image between project teams and their organizations. Organizations that have supporting processes built into the larger context of their organizations, when they organize personnel into project teams for new resources creation, i.e., innovation, are likely to have these processes automatically reflected in their project teams. Therefore, organizations that have these processes built in at the organizational level may find it less necessary to use the additional project team management practices to generate the necessary processes at the project team level. However, organizations that lack these processes at the organizational level may find it necessary to use these project team management practices to facilitate the necessary project team-level processes that support innovation. Therefore, organizations can either invest up front in developing the necessary processes at the organizational level, or develop them only as needed when organized into project teams for innovation. However, since the capability to mobilize and create knowledge for innovation requires both knowledge mobilization and conversion (Nonaka, 1994), factors that facilitate both knowledge mobilization and creation are important. Since cross-functional overlapping knowledge takes time to develop, it is developed at the organizational level, regardless of when the company channels their resources into project teams for mobilizing knowledge and creating new knowledge for innovation. Therefore, although team-level factors and management practices facilitate knowledge mobilization, for knowledge creation, companies also require the development of redundant knowledge at the organization level.

Finally, the study identified three general strategies for developing the capability to mobilize and create knowledge for innovation: organization, project team, and mixed. The organization strategy deals with developing employees such that the supporting organization-level processes –cross-functional communication frequency, a shared sense of cooperation, and overlapping knowledge- are available at the organizational level regardless of when personnel are organized for innovation; the project team strategy requires the development of employees only as needed to generate similar processes that are lacking at the organizational level; and the mixed strategy requires development at both levels. Although there is no single best way to develop this capability, the mixed strategy seems to be the best of the three, because it supports a wider range of outcomes of this capability and results in better financial performance, followed by the project team and the organization strategies. However, for certain outcomes of this capability, particularly in terms of speed-to-market of the innovation, the project team strategy seems to be more effective than the mixed strategy. For other outcomes of this capability-particularly process innovation, customer satisfaction with the innovation, and learning, any of the three strategies offer similar results. Therefore, in order to develop the capability to mobilize and create knowledge for innovation, employees are developed regardless of when they are organized into project teams for innovation, or they are developed as needed. However, it is not as simple as it may seem to determine which strategies are important for firms. The overall strategies that firms use are not explained by either the industry or the company's country of origin, although firms in certain industries and with different country of origin put more emphasis on certain practices than others in developing this capability.

9.2. LIMITATIONS OF THIS STUDY

The main limitations of this study relate to the following issues: 1) nature of the sample, 2) sample size, and 3) nature of the data. First, all the companies in this study are among the largest in their industries, and therefore, we cannot be certain that the results from this sample can be generalized to smaller companies. Furthermore, the whole sample consists of manufacturing companies with a clear set of functions such as sales/marketing, manufacturing, R&D, and customer services, and therefore, it is possible that the results cannot be generalized to companies in the service industries.

Second, the sample size poses a limitation. Since this is part of a larger study, which initially set out to study organizational capability development of MNEs, it is constrained to a small population of companies that fulfilled the selection criteria. Therefore, although the sample of 38 companies enables us to conduct many analyses and answer the research question, it limits our ability to test for higher order interactions between different levels of analysis, particularly team activities and industry and team activities and companies with different countries of origin.

Lastly, an important shortcoming of this study is the fact that the data is cross-sectional, and represents only a snapshot of organizational life. However, in the case study analysis, I captured the motion picture of the organizational life by observing and analyzing the processes of developing the capability to mobilize and create knowledge for innovation. Moreover, I tried to capture any unusual changes that were made to their employment policies and processes at both the organizational and the project team levels, using both the questionnaires and interviews. The respondents did not indicate any drastic changes made to their organizations within the last five years.

9.3. CONTRIBUTIONS

Overall, the thesis expands and integrates three bodies of literature to provide a holistic view of how companies develop the capability to mobilize and create knowledge for innovation. Beyond contributing theoretically, this study makes a practical contribution to the management field, offering some key recommendations on strategies and practices to develop the capability to mobilize and create knowledge for innovation. The implementation of these strategies and practices, however, is beyond the scope of this research.

9.3.1. Contributions to theory

The study expands the resource-based theory by addressing the following limitations: (1) the treatment of the capability to mobilize knowledge vs. the capability to create new knowledge in the discussions of organizational capabilities as sources of competitive advantage, (2) level and unit of analysis, (3) measurement, and (4) empirical tests of how to develop them.

First, most of the discussions about organizational capabilities in the resource-based view are about knowledge (resource) mobilization, and not about knowledge creation, while this study analyzes both. The existing literature assumes that the higher the mobilization, the better the outcome for creation. This study suggests that organizational capability requires both knowledge mobilization and creation. Knowledge mobilization is a necessary but insufficient condition for knowledge creation, and the processes of mobilization and creation are supported by different factors. While mobilization deals with the motivation for knowledge sharing, the creation process deals with the idea that knowledge that is being shared is not automatically absorbed and converted into organizational knowledge without the absorptive capacity of the recipients to do so. When knowledge that is being shared is not absorbed by the recipients, individual knowledge conversion into organizational knowledge in the form of innovation is problematic. Therefore, in order to develop this capability, facilitators of knowledge mobilization and creation are necessary. Therefore, the implication is that employees are managed and developed such that they are motivated to share their individual knowledge, and will have some overlapping knowledge in different disciplines.

Second, the thesis deals with the problematic issue of level and unit of analysis, which has been overlooked in other studies, showing that organizational capability's level of analysis is the organization but project team is the unit of analysis as teams are mechanisms for knowledge mobilization and creation for innovation. Thus, the two levels of analysis can be integrated to understand how this capability is developed. Theoretically and empirically, I show that the organization-level and team-level can be integrated by suggesting that regardless of the team structures used in the process of innovation, team members remain embedded in their daily context of the organization, meaning that teams are subject to the ongoing organization-level processes. Thus, in organizations where the supporting organization-level processes are built into the organizational context, we see similar elements of these processes on project teams.

Third, this research addresses the challenge of the measurement of organizational capability by introducing the team-level innovation and organization-level innovation literatures to the resource-based theory of the firm. From the team-level innovation literature, we have efficiency in terms of resources used in the process of achieving innovation, effectiveness in terms of speed-to-market of the innovation, and customer satisfaction with the innovation, which are also important. From the organization-level innovation literature, we have product and process innovation, and learning.

Fourth, the thesis provides an empirical analysis of different ways that companies develop this capability, and how these different strategies lead to different performance in terms of the capability developed and financial performance. This study shows that firms that use the mixed strategy in developing this capability have higher capability for certain outcomes and better financial performance than firms that follow the project team or organization strategy.

The thesis expands the team-level innovation literature by unraveling the following shortcomings of this literature: 1) it acknowledges the importance of context, but it does not specify which aspects of existing organization-level processes influence team-level processes and how; and 2) it claims that team performance impacts competitiveness of companies, but does not test this proposition.

First, this study shows that there exists a mirror image between teams and their organizations in terms of the processes they employ that affect this capability. In particular, it shows that for project teams that are organized for innovation in organizations that already have the supporting organization-level processes and attributes, these factors are found more readily on the project teams. This study then raises the question of whether firms that already have these processes need to use additional management practices to achieve the same performance. Therefore, this study enriches this body of literature by including the role of context in which these teams are formed to share and create new knowledge for innovation.

Second, the thesis maintains that team-level performance affects the competitiveness of their companies but does not test this claim. In this study, I link the team-level performance to the company-level performance by showing that companies that follow the mixed strategy, or that develop their organizational processes and team processes when organizing for mobilizing knowledge in order to create new knowledge, outperform companies that only focus on the project team-level factors.

This study contributes to the organization-level innovation literature, which often follows the differentiation-integration framework for developing innovation, by addressing the following limitations in this literature: 1) it analyzes knowledge mobilization and assumes creation occurs; and 2) it does not specify who is involved in the innovation process.

First, this study extends the organization-level innovation literature by suggesting that the process of innovation requires both knowledge mobilization and creation, and factors that facilitate both processes. Organizational design that integrates different parts of the organization, i.e., matrix organization, facilitates knowledge mobilization through communication, but does not necessarily facilitate the creation process. Broadening the scope of this body of literature, this study shows that knowledge mobilization is facilitated by various integrative mechanisms, such as division of the control over individuals' rewards between functional and project managers, the use of cross-functional work patterns, and cross-functional socialization. However, for the creation process, the facilitating factor is overlapping knowledge across the functions involved in the innovation process, and it is developed through the acquisition of knowledge in different functions via job rotation.

Second, this study expands this body of literature by showing that project teams are mechanisms through which individual knowledge is mobilized and new knowledge is created, and that this knowledge results in innovation. Firms also develop these supporting processes, particularly communication and cooperation, only as needed when organizing for innovation, in order to compensate for what is lacking at the organizational level by using a set of project team management practices, particularly team development and reward.

9.3.2. Managerial contributions

The study makes direct contributions to managerial practice regarding key processes and management practices that top managers should keep in mind in developing the capability to mobilize and create knowledge for innovation. However, the implementation of results from this study is much more complicated, and is beyond the scope of this thesis.

Specifically, this study shows that in order to assess whether a company has the capability to mobilize and create knowledge for innovation, it is necessary to examine both the company's organizational context, and what it does when it organizes its personnel into project teams for innovation.

Essentially, there are three strategies that companies can use to develop this capability: (1) the organization strategy, whereby companies develop employees at the organizational level such that the supporting organization-level processes are built into the organization, regardless of when they are used for innovation; (2) the project team strategy, whereby companies use a set of project team management practices, such as team development and reward, to develop the necessary processes; (3) the mixed strategy, whereby companies do a little of both. The mixed strategy, which consists of developing personnel at both the organizational and the project level, and allocating control over individual's rewards between functional and project managers, appears to be most effective in supporting a wide range of outcomes of capability. These practices entail cross-functional development of professional employees, especially the engineers, in order to establish overlapping knowledge between R&D and manufacturing through job rotation, and through off-the-job training in sales/marketing. When organized into project teams to create knowledge for innovation, some initial development of the team is necessary. Moreover, some control over individual's rewards should be given to the project managers. This practice entails having team leaders, as in the case of Japanese companies, or internal trainers or external experts, as in the case of US companies, facilitate the work processes of the team in performing the project. In particular, they may help organize who does what on the team, set the goal and deadlines for the project and meetings, provide ideas of where in the organization to find the necessary resources, and deal with management.

More specifically, in order to have this capability, companies first need to determine whether they have the facilitators of knowledge mobilization and creation. Knowledge mobilization, cross-functional communication frequency and some shared sense of cross-functional cooperation are built into the context of the organization. These factors are facilitated by cross-functional orientation of professional employees and the use of cross-functional work patterns in performing daily tasks, i.e., quality circles. The main reason that these factors facilitate knowledge mobilization across functions is that by exposing individuals to others from different functions, social ties are formed, and these ties encourage workers to talk to one another.

For knowledge creation, which requires the absorption of individual knowledge from these functions and its conversion and transformation in order to create organizational knowledge in the form of innovation, companies need to develop their employees, specifically the engineers, to have some overlapping knowledge in different functions. The reason is that personnel need to have some absorptive capacity for different types of knowledge in order to capture the knowledge that is being shared. In particular, employees need to be rotated between R&D and manufacturing, and they need to be provided some off-the-job training in sales/marketing. Interestingly, this practice also provides the benefits of cross-functional orientation and the use of cross-functional work patterns. By rotating these employees in different functions, they develop social ties that encourage communication and understanding across functions. But there is also a downside to this practice. Excessive shared sense of cooperation across these functions could hurt product innovation, as it potentially reduces creative conflict, which is also important for product innovation.

Alternatively, when organized into project teams for innovation, facilitators for mobilization may be developed using project team development. However, without developing employees to have some overlapping knowledge at the organizational level, the overlapping knowledge between these functions which is necessary to facilitate the creation process will be lacking at the project level. Therefore, the project team strategy is not a perfect substitute for the other strategies.

There is no single best way to develop this capability, and managers may choose different processes and management practices depending on the outcomes of capability they prefer. First, for firms that consider product innovation to be important, the organization-level process that facilitates knowledge mobilization is cross-functional communication frequency, and the factor that facilitates creation is overlapping knowledge, particularly 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 on 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 on behavioral factors such as cooperation. In addition, cross-functional orientation and development are important.

Second, for firms that compete on customer satisfaction with their innovation, cross-functional communication and overlapping knowledge are important. However, companies need to be cautious with the organization shared mental model of cross-functional cooperation. Too much cooperation may perhaps 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 firms that find process innovation to be important, cross-functional communication frequency actually has a detrimental effect on this. One of the reasons could be that process innovation requires different types of knowledge sets, particularly deeper functional knowledge and intra-departmental communication rather than communication across functions.

Fourth, for firms that compete on efficiency, cross-functional communication frequency facilitates knowledge mobilization and overlapping knowledge, which, in turn, support knowledge creation, which appears to be important. Among the management practices that facilitate knowledge mobilization and creation is reward which is based, in part, on behavioral factors, including the division of control over individuals' rewards between functional and project managers. Cross-functional orientation, the use of team-based work patterns, and cross-functional development also facilitate knowledge mobilization and creation.

Fifth, if speed-to-market is critical, then similar factors and practices are also considered. Cross-functional communication frequency and overlapping knowledge are important, and the specific practices include division of control over individuals' rewards between functional and project managers. Cross-functional development of professional employees is another practice that supports this outcome. For learning, cross-functional communication frequency is also important.

Overall, it seems that organization-level cross-functional communication frequency and overlapping knowledge are the most important factors in supporting knowledge mobilization and creation, as they facilitate a wide range of outcomes of this capability. As found in the case analysis, cross-functional communication facilitates knowledge mobilization, while overlapping knowledge facilitates the knowledge creation process. Furthermore, although various management practices facilitate cross-functional communication frequency, only cross-functional development facilitates both cross-functional communication frequency and overlapping knowledge. Therefore, it seems that the most critical factor in developing the capability to mobilize and create knowledge for innovation 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. When organized into project teams for knowledge mobilization and creation of new resources, team development is important. Moreover, team performance should be recognized by allowing the project managers to have some influence on team members' rewards. This practice entails teaching the team how to organize their teamwork processes in order to accomplish the project.

9.4. FUTURE DIRECTIONS

Both the levels of analysis examined in this study, project team and organizational, can be explored further. First, at the project team level, we could expand our understanding of different types of external communication and their impact on team-level performance, as suggested by this study. We could also explore types of shared mental model other than cooperation, particularly those that relate to creativity and constructive conflict in generating innovations. Third, in terms of project team reward, we need to compare the effectiveness of reward that is based on individual performance on the team and reward that is based on the overall team performance as examined in this study. Fourth, as Hackman (2000) pointed out, we still do not know how teams are formed, who forms teams within organizations, or their consequences on team performance.

At the organizational level, one direction of future research is to differentiate the impact of formal and informal cross-functional communication on performance, because they have different implications for the study of organization and management practice. The study by Aoshima (1996), for instance, shows that innovation teams of Japanese companies located in Japan tend to communicate informally more frequently than formally. Lastly, the different types of overlapping knowledge, e.g., overlapping knowledge of non-engineers with one another, overlapping knowledge of non-engineers and engineers, and overlapping knowledge acquired from outside, e.g., engineers with MBAs in marketing or finance, affect performance. Up to this point, we assumed that firm-specific knowledge is more effective in facilitating knowledge creation because of the argument behind tacit knowledge.

In the immediate future, however, this framework is expanded to study knowledge mobilization and creation for the development of new resources in firms having operations in multiple institutional contexts, or in multinational enterprises (MNEs) (Lessard and Zaheer, 1998; Westney, 1993; Westney and Ghoshal, 1993), which was my original intent. I would argue that for MNEs that prefer to transfer or mobilize knowledge or technology across different subsidiaries, without creating new resources in collaborative processes, facilitators related to incentives and social ties may perhaps be adequate. However, for creation, overlapping knowledge in these institutional contexts may be necessary.

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