

Work groups and knowledge sharing in a global organization

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Abstract

Groups incur a number of internal costs when members work in different geographic locations and represent different functional areas. For example, it can be difficult for distributed group members to develop a common understanding of the task, or for cross-functional group members to reconcile dissimilar points of view. Relatively little scholarly attention, however, has been given to the external benefits that distributed or cross-functional group members have available to them. These include access to diverse sources of knowledge, such as customers in a variety of locations or non-group employees from different functions. Past studies have shown a positive relationship between external knowledge sharing and work group performance. This paper extends previous research by examining whether distributed or cross-functional groups benefit from external knowledge sharing more than co-located or functionally homogeneous groups. I surveyed 182 work groups in a Fortune 500 corporation to assess how often members shared general overviews, specific requirements, analytical techniques, progress reports, and project results within and outside of the group. Members were located around the world, they represented numerous functional areas, and they worked on tasks ranging from product development to manufacturing operations. Senior managers in the company rated each work group on their performance. I hypothesized and found that both internal and external knowledge sharing were positively related to group performance. Building on social network theory, I also hypothesized and found that as geographic distribution and cross-functionality increased, the relationship between external knowledge sharing and group performance became even stronger. These results suggest that external networks can provide distributed or cross-functional group members with access to unique task information, know-how, and feedback.

Introduction

The goal of this paper is to offer insight into how geographic distribution and cross-functionality affect the relationship between knowledge sharing and work group performance. Consider, for a moment, examples of knowledge that members of the following distributed, cross-functional groups shared during their projects in a Fortune 500 corporation:

– A product development group, with nine members spread across the US, Israel, and Singapore, was charged with the task of creating a new electronics device. Members represented the functional areas of computer-aided design, applications software, and electrical engineering. Instead of designing a chip from scratch for use in the device, the group modified a chip design borrowed from another group in the same location as one of the members. Toward the end of the project, the group presented a technical paper on the results at an intra-company conference.

– A service improvement group, with ten members spread across two cities in China, was charged with the task of upgrading a wireless network. Members represented the functional areas of project management, quality assurance, and field engineering. Instead of conducting their own consumer research, the group gathered satisfaction data from a marketing employee who was in the same division as one of the members. Shortly thereafter, the group held a face-to-face meeting with the customer to discuss ways to improve the existing network infrastructure.

– A process management group, with eight members spread across three buildings in Illinois, was charged with the task of establishing a performance evaluation program. Members represented the functional areas of human resources and information technology. Instead of coming up with a program on their own, the group solicited best practices for performance evaluation through email from other human resource managers throughout the corporation. After synthesizing the responses, group members built a website for disseminating the best practices.

– A manufacturing operations group, with nine members spread across Ireland and Scotland, was charged with the task of converting a production facility in Ireland from pagers to cell phones. Members represented the functional areas of materials planning, product quality, and test engineering. Instead of generating their own documentation for steps to be taken, the group used another factory in Scotland for benchmarking every stage. Then, once the conversion was under way, the group made suggestions to the company for improving the overall process, such as alternative equipment specifications and training regimens.

The above examples highlight both the different kinds of knowledge that work group members share and the different relations through which task information, know-how, and feedback is provided and received. The examples also illustrate how work groups in global organizations are often structured to accomplish their specialized tasks: Members are distributed across different locations and they represent different functional areas. These features, geographic distribution and cross-functionality, are two of the many ways that companies compose work groups to maximize the knowledge, skills, and abilities of their employees. While the changing nature of organizations appears to favor greater diversity in work groups (DeSanctis & Monge, 1999; Jarvenpaa & Leidner, 1999; Maznevski & Chudoba, 2000), what are the costs and benefits of diversity for knowledge sharing and work group performance?

In this section, I first argue that diversity is a mixed blessing for work groups. That is, despite being able to accomplish specialized tasks, distributed or cross-functional groups often incur much greater internal communication costs than co-located or homogeneous groups. Second, I review the organizational literature on task communication and knowledge sharing within work groups, showing that previous research supports the importance of both internal and external knowledge sharing for group performance. Finally, I suggest that distributed or cross-

functional groups may benefit from knowledge sharing to an even greater extent than co-located or functionally homogeneous groups because of the access to diverse information and resources that being in different geographic locations and representing different functional areas provides.

The mixed blessing of diversity in work groups

An increase in the reliance on work groups has been documented repeatedly in the organizational literature (Cohen & Bailey, 1997; Guzzo & Dickson, 1996; Sundstrom, De Meuse, & Futrell, 1990). Groups are often used as the foundation of work because organizations want to take advantage of the diverse perspectives, talents, and ideas members have to offer. A variety of group effectiveness models emphasize group structures and processes that foster members working together (Gladstein, 1984; Hackman, 1987; McGrath, 1984). All agree that effectiveness arises out of a well-specified task, appropriate composition of membership, and a supportive organizational milieu. However, even a superbly designed work group will not be successful if members cannot create a common understanding of both the organizational context and the task itself through communication about their work (cf. process losses, Steiner, 1972).

Popular press and practitioner writings on distributed groups have been optimistic about the potential for high performance in “virtual teams” (Lipnack & Stamps, 1997; O'Hara-Devereaux & Johansen, 1994; Townsend, DeMarie, & Hendrickson, 1998). Members of these groups span physical distances and organizational boundaries, often communicating through computer technologies to complete their work across multiple locations. However, a number of past researchers have examined the negative consequences of physical distance for group processes, such as information exchange, interpersonal friendship, and work satisfaction (Allen, 1977; Conrath, 1973; Monge, Rothman, Eisenberg, Miller, & Kirste, 1985). In a vividly descriptive account, Cramton (in press) illustrates “the mutual knowledge problem” for

distributed work groups, which includes failures to discuss contextual information, uneven communication among members, and discrepancies in how quickly information is accessed. Being in different places simply makes communication more difficult for members who are geographically distributed rather than co-located (Kiesler & Cummings, in press; Van den Bulte & Moenaert, 1998).

Numerous researchers have also touted the importance of having members in cross-functional groups, emphasizing their ability to improve coordination and integration, to cut across organizational boundaries, and to accelerate cycle time for new product development (Griffin & Hauser, 1992; Denison, Hart, & Kahn, 1996; Eisenhardt & Tabrizi, 1995). Cross-functional work groups may benefit from creativity through increased task conflict, given that members have diverse opinions regarding how to proceed with the work (Jehn, Northcraft, & Neale, 1999; Pelled, Eisenhardt, & Xin, 1999). Unfortunately, the potential for bringing fresh viewpoints to bear on the task is not always realized (McGrath, Berdahl, & Arrow, 1996; Williams & O'Reilly, 1998). The communication challenges for cross-functional groups are often too difficult, especially when members cannot bridge different "thought worlds" to successfully develop new products or services (Dougherty, 1992).

Another popular form of diversity over the past few decades has been the matrix organization (Burns, 1989; Davis & Lawrence, 1977; Ford & Randolph, 1992). In matrix organizations, employees report through two command systems, one normally related to a corporate function such as engineering or finance, and another often associated with a company product, like automobiles or televisions. There are several potential benefits to this form of organization, including increased lateral communication channels, capacity for information processing, and flexibility of resource use. However, on the negative side, matrix organization

can increase role ambiguity, conflict among managers, and insecurity of employees through reduced autonomy. Researchers have found that it is difficult for organizations to reply effectively on the matrix structure, and generally recommend for work groups that all members report to the same manager (Sundstrom and Associates, 1999, p. 8). It is increasingly often the case, though, that different members of work groups report to different supervisors.

Work groups and knowledge sharing

For over 50 years, organizational scholars have been fascinated by the communication required for group members to do their work effectively (Katz & Kahn, 1978; March & Simon, 1958; Thompson, 1967). Communication messages have been characterized along a number of dimensions, such as informality – formality, spontaneous – planned, and socio-emotional – task-related (Bales, 1950; Guetzkow, 1965). For example, Stohl & Redding (1987) distinguish interpersonal influence, or gaining compliance or attempting to influence others, from information exchange, or requesting information and formulating messages that inform others. Frequent information exchange, or task communication, seems crucial for getting work accomplished in many groups and helping them perform well (Allen, 1977; Ebadi & Utterback, 1984; Pelz & Andrews, 1966). Task communication is akin to knowledge sharing in this paper.

Polanyi's (1966) early discussion of the tacit dimension of knowledge and Nelson and Winter's (1982) later discussion of knowledge embodied in organizational routines raised awareness about the importance of the exchange of task-specific knowledge in organizations. Recent issues of the *Strategic Management Journal* (Spender & Grant, 1996) and *Organizational Behavior and Human Decision Processes* (Argote, Ingram, Levine, & Moreland, 2000) have featured knowledge sharing as a form of task communication in groups and organizations. Current theory is that knowledge resides in people as well as in products or procedures of the

corporation, and this knowledge can be imitated, copied, or transferred through communication (Zander & Kogut, 1995). Knowledge sharing is not constrained to exchanges within and across employees of a company, but can occur between employees and customers, other organizations, or firms in entirely different industries (von Hippel, 1988).

Knowledge sharing is defined here as the provision or receipt of task information, know-how, and feedback regarding a product or procedure. Given this definition, sharing is explicitly conceived of as a communication process involving the task. In the research described below, knowledge sharing is measured as the frequency that work group members report providing or receiving general overviews, specific requirements, analytical techniques, progress reports, and project results to others within or outside of the group. Knowledge sharing is part of task communication as used in prior research, but is meant to pertain to exchanges of artifacts in addition to verbal work communication. In the manufacturing operations group described above, for example, members shared knowledge by exchanging electronic documents regarding the factory benchmarking, physically observing the training regimens of another work group, and sending paper copies of the equipment specifications for installing machinery.

Internal and external knowledge sharing

In a review of the literature on geographic distribution in work groups, there appeared to be no evidence supporting a direct (positive or negative) effect of distance on performance. Rather, as noted above, geographically distributed members had a more difficult time with various group processes, such as informal communication with one another (Allen, 1977; Conrath, 1973; Monge, Rothman, Eisenberg, Miller, & Kirste, 1985). Therefore, a prediction regarding the direct impact of geographic distribution on performance is not made. However, knowledge sharing may be affected by geographic distribution, though not as strongly as social

or informal communication. Knowledge sharing is typically purposeful through planned events such as scheduled presentations or phone conferences and can include sharing concrete artifacts through email attachments or documentary videotapes. Though given the greater challenges that distributed group members face, one might expect that groups with more geographically distributed members would share less knowledge internally, compared with members of geographically co-located groups.

Hypothesis 1: As geographic distribution increases, internal knowledge sharing will decrease.

Past research on cross-functionality in work groups has yielded mixed findings regarding a direct effect on performance. On the one hand, Ancona & Caldwell (1992) and Pelled, Eisenhardt, & Xin (1999) found significant negative correlations between cross-functionality and performance; while on the other hand, Jehn, Northcraft, & Neale (1999) found a significant positive correlation between cross-functionality and performance (see also a review by Williams & O'Reilly, 1998, for an argument in favor of a positive correlation based on the potential informational advantages of cross-functional groups). Therefore, a prediction regarding the direct impact of cross-functionality on performance is not made. Compared to the impact on performance, it appears much clearer that members representing different backgrounds have a more difficult time discussing their functional areas (Dougherty, 1992; McGrath, Berdahl, & Arrow, 1996). However, knowledge sharing may not be affected by cross-functionality as strongly as functional discussion, given that knowledge sharing is specific to the task, which all members are more familiar with than a particular function. Given the greater obstacles that cross-functional groups must confront, though, one might expect that groups with cross-functional members would share knowledge less than members of functionally homogeneous groups.

Hypothesis 2: As cross-functionality increases, internal knowledge sharing will decrease.

Though the primary emphasis is on geographic distribution and cross-functionality in work groups, predictions are made regarding the number of different supervisors that members report to in their groups. As mentioned before, it is increasingly unlikely that all group members will report to the same supervisor; rather, different members have different supervisors. For the reasons described above for geographic distribution and cross-functionality, there is no evidence to suggest a direct effect of having different supervisors on performance. But, when members do not have the same supervisor, they run the risk of encountering increased role ambiguity, conflict among managers, and insecurity through reduced autonomy (Burns, 1989; Davis & Lawrence, 1977; Ford & Randolph, 1992). For example, if a work group has a project milestone to meet, but the supervisor of one of the members also has a competing deadline on another project that needs the assistance of the member, then tension is sure to arise. Furthermore, members who report to different supervisors are also going to have less opportunity to interact, given that their respective supervisors likely hold different weekly meetings or project reviews. One might expect, then, that members of groups with different supervisors would share knowledge less than members of groups with the same supervisors.

Hypothesis 3: As the number of different supervisors increases, internal knowledge sharing will decrease.

Knowledge sharing among group members is necessary for executing their group task. Past studies have demonstrated the importance of task communication within work groups (Allen, 1977; Katz & Tushman, 1979; Tushman, 1978). For example, Katz & Tushman (1979) found that intra-project administrative and problem-solving communication were positively associated with performance for research projects. Along with helping to create a common

understanding of the work being done, internal knowledge sharing can also increase the awareness of who knows what in the group (Moreland & Myaskovsky, 2000; Liang, Moreland, & Argote, 1995). As work group members share what they know with one another over the course of a project, they should become more efficient at solving problems and allocating responsibilities for the task. The fourth Hypothesis follows:

Hypothesis 4: Internal knowledge sharing will be positively related to performance.

Previous research on external group activity has focused on the information gathering, feedback seeking, and resource negotiating that members engage in outside of the group (e.g., Ancona, 1990; Ancona & Caldwell, 1992a, 2000). At least two mechanisms exist through which knowledge sharing outside of the work group can improve performance. One mechanism occurs when members talk about current work products with non-group employees or the customer. This sort of external knowledge sharing or information exchange can reduce uncertainty in a changing environment (Brown & Utterback, 1985; Tushman, 1979; Tushman & Katz, 1980). Members with ties outside of the group can solve problems by gathering and processing technological and market information, such as consumer research from another divisional employee (as in the case of the service improvement group described earlier). Another mechanism occurs through contact with upper management in order to promote group achievements, regulate manager expectations, and secure valuable task information (Ancona, 1990; Ancona & Caldwell, 1992a; Pfeffer & Salancik, 1978). Members can actively probe their surroundings by either disclosing evidence of success or influencing the opinions of decision-makers as in the case of the process management group searching for performance evaluation information derived from senior manager best practices. The fifth Hypothesis follows:

Hypothesis 5: External knowledge sharing will be positively related to performance.

Knowledge sharing in distributed or cross-functional work groups

Most of the work groups in past studies did not have members who interacted regularly with each other at far distances or whose members were from numerous disciplines. For example, the research program of Thomas Allen, Ralph Katz, and Michael Tushman (e.g., Allen, 1977; Katz & Allen, 1982; Katz & Tushman, 1979; Tushman, 1978, 1979; Tushman & Katz, 1980) investigated how factors such as task communication predicted project success in an R&D laboratory. They gathered strong evidence in support of the critical role of internal and external communication for work group effectiveness. However, their work was limited to groups with members who were in the same location and who represent similar functions. No research has yet examined whether diversity from geographic distribution and cross-functionality interacts with knowledge sharing to improve performance. I argue that external knowledge sharing with people at different locations and in different functions should improve group performance. Distributed or cross-functional work groups, which are inherently diverse, should benefit most from external knowledge sharing because of their access to different sources of knowledge.

Past studies on social network structure illustrate how diverse work groups can benefit from external knowledge sharing (e.g., Burt, 1992; Granovetter, 1973, Krackhardt, 1992).¹ Social network theories predict that by maximizing differences in their external networks, group members can enhance the performance of their group. One reason is that group members often need to discuss the latest work procedures with a variety of former colleagues or potential clients. The non-redundancy or uniqueness of these ties, in turn, can provide non-redundant or unique resources and information that work group members could leverage for competitive

¹ Though the social network literature distinguishes between at least three types of network benefits from weak (Granovetter, 1973) or non-redundant ties (Burt, 1992), for purposes of this thesis I combine them to focus only on the uniqueness of information. For example, while Friedkin (1982) focuses on the amount of potential help from

advantage (Burt, 1992; Friedkin, 1982; Granovetter, 1973; Lin, Ensel, & Vaughn, 1981). For instance, group members can bridge areas of knowledge by visiting members from other groups to observe and to compare operations with their own (as in the case of the manufacturing operations groups described earlier). Another reason to expect enhanced performance is that by tapping non-overlapping areas of expertise, group members elicit diverse ideas and insights from others regarding the task (Ancona & Caldwell, 1992b; Cohen & Levinthal, 1990; Hansen, 1999). For example, applications software and electrical engineering members in a product development group can increase their likelihood of creativity or innovativeness by capitalizing on novel task information acquired through their separate external networks.

For geographically distributed groups, the “eyes and ears” of members are in different environments, which increases member exposure to potentially relevant task information. As the distance between members increases, the novelty of the members’ settings also increases. This expanse may introduce new opportunities for knowledge acquisition and use by the members. Distributed work group members are also more likely to have different social networks outside of the group because members run into different people in the hallways, see different people at meetings, and communicate with different people socially. For members who utilize these diverse external social networks, the prospects of accessing unique knowledge are strengthened for them. However, member access to external sources of knowledge alone is not enough to guarantee positive results for distributed work groups. Group members need to communicate with those in their external networks about the task because other group members are often not in the immediate vicinity. It may sometimes be necessary for distributed members to communicate

having weak ties; Granovetter (1973) and Burt (1992) focus on the advantages of having diversity in ties; and Lin, Ensel, & Vaughn (1981) focus on the benefits of having weak ties with greater resources.

about work-related issues with non-group members in their geographic location. Following the above discussion about the non-redundant ties that distributed members can have externally:

Hypothesis 6: As geographic distribution increases, external knowledge sharing will be more strongly related to performance.

In cross-functional groups, members have training and experience in a number of specialized areas. Thus, cross-functionality increases the likelihood that the group will improve performance if members share knowledge outside of the group. The breadth of perspective in the work group, which derives from the different functions, can improve the reception and transmission of knowledge within the group. For example, a group member whose specialty is manufacturing may discover cost-saving machinery modifications that assist the group member whose specialty is accounting. Members of cross-functional groups also have more opportunities than members of functionally homogeneous groups because each has ties to people in different domains (Ancona and Caldwell, 1992b). Of course, access to external sources of knowledge alone is not enough to guarantee positive results for cross-functional work groups. Group members need to exchange knowledge with their ties outside of the group. In line with the argument that cross-functional members can have non-overlapping areas of expertise externally:

Hypothesis 7: As cross-functionality increases, external knowledge sharing will be more strongly related to performance.

Because members in different geographic locations or members of cross-functional groups are unlikely to have the same supervisor, it also means that group members with different supervisors have access to diverse external networks. In other words, group members with different supervisors have the potential to receive unique information that comes down from upper management or through other parts of the organization. These additional connections for

members hold the possibility of easing knowledge acquisition and transfer from outside the group, since their reach in the organization is greater.

Hypothesis 8: As the number of different supervisors increases, external knowledge sharing will be more strongly related to performance.

In this paper, I propose a model for how knowledge sharing within and outside of work groups affects performance when members are geographically distributed or represent different functions (see Figure 1). The field study of work groups and knowledge sharing reported here finds that work group effectiveness is positively related to knowledge sharing both inside and outside of the group. Second, it finds that work group effectiveness is more strongly related to external knowledge sharing when group members differ by geographic locations and functional areas. Data used to test hypotheses come from a sample of 182 work groups and include (a) 20 group interviews, (b) 182 surveys of group leaders, (c) 957 surveys of group members, and (d) senior manager's ratings of group performance. Through extending ideas about social network structure to distributed or cross-functional groups, this investigation contributes to research on the importance of group context for effectiveness (Alderfer & Smith, 1982; Ancona & Caldwell, 1992a; Hackman, 1987).

Methodology

The field study was part of a corporate-wide knowledge management initiative in a Fortune 500 telecommunications firm. The goal of the initiative was to improve knowledge sharing in a company that produces, among other things, communication technologies such as cellular phones, digital pagers, and two-way radios. At the time of the research, the global organization employed over 100,000 individuals, 40% of whom were engineers. Five divisions were organized by product-market segments, operated fairly autonomously, and were responsible

for development, manufacturing, and sales. Each division was also spread over different regions worldwide; members in the sample were from recently completed projects across United States/Canada (63%), Latin/South America (3%), Europe (15%), Middle East/Africa (5%), India/China (5%), and Japan/Korean/Malaysia (9%).

I studied work groups that carried out projects throughout the company. Two corporate senior managers sponsored the research and division managers provided critical background information on the nature of the work groups I examined. For example, a majority of the projects in the organization are divided into groups, including product development and manufacturing operations. Though most employees only work on one group at a time, there are a number of employees who are on two, even three projects at a time. In addition, projects tend to last one to two years, but not more than three, depending on market conditions and customer demand. After I agreed not to disclose the corporation identity, they gave me permission to contact the work groups used in this study.

Sample

Work groups in the sample were part of a corporate-wide reward and recognition program. The goal of the program was to publicly acknowledge the best-performing work groups in the company. General managers nominated work groups from regional sites around the world to participate in a corporate-wide competition. Each group was asked to make a 20-30 minute presentation to a panel of judges (ranging from 5 to 12 senior managers) who were given specific instructions and training regarding the judging process. In most cases, judges were unfamiliar with the projects before they made their ratings, given the large size of the corporation.

Managers first rated 280 groups at over 20 regional events worldwide. The 122 groups at each of the events who were judged the highest advanced to five division-level events, where a

different panel of judges again rated the groups. The 21 division-level groups that were judged the highest moved on to a final corporate-level event, where they made presentations to the company CEO and senior vice-presidents. Background information could not be found for 98 of the 280 work groups, so this sample includes 84/137 (61%) of groups participating in the regional events, 77/122 (63%) of groups participating in the division-level events, and 21/21 (100%) of groups participating in the corporate-level event.

There are clear disadvantages and advantages to using a convenience sample of work groups. The sample represents better performing groups, on average, than would a random sample of work groups in the company. Furthermore, the convenience sample does not permit generalizing to all work groups in the organization. On the other hand, the sponsors of the research provided extensive access to members of these groups as well as performance ratings made by senior managers.

The 182 groups in the sample met the following criteria of work groups in the literature: they had intact social systems with boundaries and differentiated roles, performed at least one task with measurable output, and operated within an organizational context (Hackman, 1987). Accordingly, each work group had a “group name,” 4 to 12 members (average was 8), and a specific project assigned to the group. The groups had a designated group leader, a general manager responsible for providing resources, and an identifiable customer (64% of whom were internal to the corporation). Members of work groups generally came from within the same division (5% of groups reported having a member from another division); almost all were company employees (8% of groups reported having one customer participate, including those with internal customers).

The groups worked on projects ranging from product development (e.g., design handheld scanning device for shipping company) to service improvement (e.g., convert client platform for car phones from analog to digital) to process management (e.g., execute separation and sale of business unit to another stakeholder) to manufacturing operations (e.g., modify existing factory to support new production of pagers). The type of project most often determined the composition of the work groups, and it was usually either the general manager or a group leader who decided which employees should be on which groups. In this sample, ninety-four percent of the projects started and ended between January 1998 and January 2000 (average project length was 15 months). For illustration, Table 1 provides project descriptions from six work groups, including (fictitious) group names and other project characteristics.

Qualitative and quantitative evidence. Division managers provided archival data on the groups, including project documentation, presentation slides, and other available written materials. Exploratory interviews were conducted with all members of 20 work groups from one division to learn about the nature of the projects and to develop surveys used later. I then contacted group leaders to verify project descriptions as well as member names, geographic locations, functional areas, and contact information. After gathering background information on the 182 work groups in the sample, I created a survey with four main parts: Overall communication with each member of the group, functional discussion about each function represented in the group, knowledge sharing about five activities, and member-rated performance. I pre-tested the survey on employees in the corporate office before sending it out in June 2000 as an email attachment to each group member who had a valid email address (1315/1474 or 89%). It took approximately 20-30 minutes to complete, and included a cover letter describing the purpose of the study and ensuring confidentiality. The response rate for

those who were sent an email survey, including two follow-up reminders, was 73% (957/1315).² At least one person responded from each group; 86 groups had greater than a 75% response rate; 63 groups had between a 50% and 75% response rate; 28 groups had between a 25% and 50% response rate; and 5 groups had less than a 25% response rate. The survey was sent an average of six months after groups had completed their projects. Finally, participants viewed a preliminary analysis of the survey data, and commented on the findings.

Measures

Measures used in the analyses below are written in CAPITAL letters and higher values correspond with the variable names (e.g., name represents 1 in dichotomous (0,1) measures).

Geographic Distribution. All participants were asked to indicate in the survey whether each group member: (1) “worked immediately next to you,” (2) “worked on the same floor and on the same hallway as you,” (3) “worked on the same floor, but on a different hallway than you,” (4) “worked on a different floor than you,” (5) “worked in a different building than you in the same city,” (6) “worked in a different building than you in a different city,” or (7) “worked in a different building than you in a different state or country.” A geographic distribution index was created by averaging the non-linear distances between members within each group (Allen, 1977). For example, Table 1 shows that Group 1, Error Detection, has four group members located in one building in Israel, whose group distribution index is 2.67. For the sample of work groups in this paper, the index ranged from 1.00 to 6.47 (GEOGDIST: Mean = 3.42; SD = 1.13).

Cross-Functionality. The functional areas, as defined by company database codes,

² Two selection bias analyses were conducted at the group level of analysis (N = 182). Correlations were computed between group size, project length, available resources, environmental uncertainty, geographic distribution, cross-functionality, performance and (1) the percentage of members with a valid email address and (2) the percentage of members who responded to the survey. Neither analysis revealed significant associations with group size, available resources, environmental uncertainty, and geographic distribution. However, greater cross-functionality ($r = .18$, $p < .05$) was associated with more valid email addresses and project length ($r = .21$, $p < .01$), cross-functionality ($r = .17$, $p < .05$), and performance ($r = .24$, $p < .01$) were associated with a higher percentage of survey responses.

included Engineering (29%), Manufacturing (20%), Technical Operations (14%), Quality (7%), Marketing/Strategy (5%), Customer Service (4%), Project Management (4%), Information Technology (4%), Administrative Support (3%), Sales (3%), Human Resources (2%), Finance (2%), Business Administration (2%), and Purchasing (1%). The number of different functional areas that all group members represented was used to compute an entropy-based index (Teachman, 1980).

$$H = -\sum_{i=1}^s P_i (\ln P_i)$$

According to Ancona & Caldwell (1992b), “if there are N possible states {s} in which the system can be, {and} P_i is the probability that the system will be found in state i , then the formula can be used to index the heterogeneity {H} in the system...the only exception occurs when a {state} is not represented. In this case, the value assigned that state is zero” (p.328). The greater the distribution of group members across functional areas, the higher the score on the index (the theoretical maximum is dependent on the number of states). Table 1 shows that for Group 5, Business Separation, there are eight group members, one who is in technical operations, six who are in information technology, and one who is in human resources, yielding a score of .74. In the sample of groups, the index ranged from 0 to 1.89 (CROSFUNC: Mean = 0.90; SD = 0.47).

Different Supervisors. The number of different supervisors that group members reported to in each group, as defined by company database codes, was used to compute an entropy-based index (Teachman, 1980). The greater the distribution of group members across supervisors, the higher the score on the index. Table 1 shows that for Group 3, Platform Conversion, there are 9 group members who report to 8 different supervisors, yielding a score of 2.04. In the sample of groups, the index ranged from 0.38 to 2.48 (DIFSUPER: Mean = 1.74; SD = 0.41).

Knowledge Sharing. Three steps went into developing the measures of knowledge sharing reported here. First, 20 face-to-face interviews were conducted with group members to assess the different kinds of knowledge that they shared during their projects. Though the original goal was to measure dimensions of knowledge sharing such as tacit/explicit or simple/complex (e.g., Winter, 1987), many of the group members were unsure how to rate these dimensions, even with extensive definition and explanation. However, they had an easy time identifying how often they shared certain kinds of knowledge, such as project overviews or progress reports.

In the second step, I reviewed previous research and analyzed the group member interviews. Together, they suggested five activities that characterize knowledge sharing in work groups. All activities were measured on a 5-point scale (1:never, 2:rarely, 3:sometimes, 4:regularly, 5:a lot), and participants were asked “On average, how often did you share each kind of knowledge during the project...”: (a) with group members (internal), (b) with non-group employees inside your division (external), (c) with non-group employees outside your division (external), and (d) with the customer (external). These five measures make up the internal and external knowledge sharing scales used in the analyses below.³ Table 2 provides additional examples of internal and external knowledge sharing for each of the activities.

General overviews. A useful knowledge-sharing activity for work groups is being able to articulate what they are doing and to benefit from what others are doing (Tushman & Katz, 1980). Members interviewed in the sample reported having budget guidelines that allowed them to track their own expenses or a business plan that they could discuss with others. Group

³ For purposes of reliability, members were asked questions about knowledge sharing during the planning phase and the completion phase of their projects (Eisenhardt & Tabrizi, 1995). Preliminary analyses did not reveal any knowledge sharing by phase interactions, so responses for the planning phase and completion phase were averaged to assess overall knowledge sharing (average correlation for knowledge sharing between phases was $r = .83$).

members were asked to rate on the survey how often they shared “general overviews, such as project goals, milestone estimates, or member responsibilities.”

Specific requirements. Another critical knowledge-sharing activity entails gathering or providing specific pieces of information that enable groups to proceed with their work (Ancona & Caldwell, 1992a). Group members interviewed in this study mentioned reformulating particular work flow processes for their own advancement or generating specialized analyses for the customer. Group members were asked to rate on the survey how often they shared “specific requirements, such as numerical projections, market forecasts, or order requests.”

Analytical techniques. Sharing knowledge within and outside the group about “know-how” is necessary for project completion, because it is this knowledge that enables members to solve problems (Hansen, 1999). Members interviewed in the sample indicated training each other in necessary problem-solving skills or soliciting advice from corporate experts. Group members were asked to rate on the survey how often they shared “analytical techniques, such as statistical tools, detailed methods, or testing procedures.”

Progress reports. Work group feedback plays a significant role in a group’s ability to adapt to changes in the environment (Ancona & Caldwell, 1992a). Work group members interviewed in the sample recalled holding regular internal meetings to stay abreast of new developments or keeping the general manager informed as to how things were going. Group members were asked to rate on the survey how often they shared “progress reports, such as status updates, resource problems, or personnel evaluations.”

Project results. The most common conception of knowledge sharing includes the transfer of technology or “best practices” from one person or group to another (Allen, 1977;

Szulanski, 1996; Teece, 1977). Work group members interviewed in the sample reported here described holding end-of-project summits to reflect on key learnings or exchanging task resolutions at intra-company conferences. Group members were asked to rate on the survey how often they shared “results, such as preliminary findings, unexpected outcomes, or clear recommendations.”

The third step I took to calculate the knowledge-sharing measures was to average across the five activities to form internal and external knowledge-sharing scales. A factor analysis (using varimax rotation) indicated that all activities loaded onto one factor with acceptable reliability for internal knowledge sharing ($\alpha = .84$; INT KS: Mean = 3.90; SD = 0.39) and for external knowledge sharing ($\alpha = .97$; EXT KS: Mean = 2.38; SD = 0.58). The reliability for external knowledge sharing is very high because many employees reported sharing little external knowledge. In fact, 39% (371/957) of group members reported sharing knowledge outside of the group “rarely” (rating of 2/5) or less during their projects. The external networks (non-group employees inside the division, non-group employees outside the division, and the customer) also loaded reliably onto one factor ($\alpha = .78$). See Table 3 for the means and standard deviations of knowledge-sharing content by network, which shows that significantly more knowledge sharing took place within, relative to outside of the group ($t(181) = 37.54, p < .001$).

Other measures of communication. In order to compare knowledge sharing with two forms of communication studied in the past, additional measures were taken of overall communication (e.g., Tushman & Katz, 1980) and functional discussion (e.g., Ancona & Caldwell, 1992). For the measure of internal overall communication, each group member was asked to indicate “How frequently did you communicate with X during the project?” on a 5-point scale (1:never, 2:monthly, 3:weekly, 4:daily, 5:hourly) where X represented the name of every

other member ($\alpha = .77$; INT OC: Mean = 3.01; SD = 0.42). For the measure of internal functional discussion, each group member was asked to indicate “How much did you discuss Y during the project?” on a 5-point scale (1:never, 2:rarely, 3:sometimes, 4:regularly, 5:a lot) where Y represented the name of every function represented in the group ($\alpha = .65$; INT FD: Mean = 3.84; SD = 0.44). For the measures of external overall communication ($\alpha = .67$; EXT OC: Mean = 2.01; SD = 0.46) and external functional discussion ($\alpha = .69$; EXT FD: Mean = 2.52; SD = 0.66), the same question was asked, except the targets were (a) division employees, (b) non-division employees, and (c) the customer ($\alpha = .73$ external overall communication; $\alpha = .76$ external functional discussion).

Work Group Performance. Work groups in the company-wide reward and recognition program were rated by senior managers on seven dimensions: (1) teamwork, (2) clearly defined problem selection, (3) appropriateness of method used to solve problem, (4) innovativeness of remedies used to solve problem, (5) quality of impact from results, (6) institutionalization of solution, and (7) clarity of presentation. A sample analysis of an event (N=12 judges and N=33 groups) revealed that judges were able to reliably rate overall performance ($\alpha = .88$ across judges), and provided evidence of a halo effect, whereby all seven dimensions loaded onto one factor ($\alpha = .80$ across dimensions). Ratings of work group performance varied across regions and divisions, and manager ratings for 228/280 (81%) of the work groups were destroyed immediately following the events in order to avoid the possible legal ramifications of identifying managers who rated groups poorly. Therefore, the 182 groups were given a ranking of 1 (regional level, N = 84), 2 (division level, N = 77), or 3 (corporate level, N = 21) (PERFORM: Mean = 1.65; SD = 0.68), which is used as the dependent variable below.⁴

⁴ To evaluate the broader significance of the performance measure, additional data were collected on the retention of

Control Variables. Previous research on work groups suggests that task type, group size, project length, availability of project resources, and environmental uncertainty may influence group performance. In addition, psychological closeness and knowledge-sharing difficulty may influence knowledge sharing. These factors were measured as control variables.

Task type. Consistent with labels used in the corporation, tasks were categorized as: (1) Product Development (25%) (PRODUCT: Mean = .25; SD = .43): in the projects, groups developed new hardware or software products such as alphanumeric pagers, device drivers, digital phones, and high frequency radios; (2) Service Improvement (25%) (SERVICE: Mean = .25; SD = .43): in the projects, groups improved company services such as billing automation, inventory tracking, product upgrades, and repair service; (3) Process Management (25%) (PROCESS: Mean = .25; SD = .43): in the projects, groups changed work practices or other management processes such as business forecasting, human resource programs, media relations, and work flow integration; and (4) Manufacturing Operations (26%) (OPERATIONS: Mean = .26; SD = .44): in the projects, groups modified operations for manufacturing products such as capacity expansion, equipment implementation, preventive maintenance, and scrap recycling. Because the four task types account for all 182 groups in the sample, only PRODUCT, SERVICE, and OPERATIONS are used in the analyses below. However, PROCESS is included in the correlation matrix, and does not change results when entered in the analyses.

Group size. Group leaders indicated the number of members in the group (Ancona & Caldwell, 1992b; Hansen, 1999) (SIZE: Mean = 8.10; SD = 1.94).

employees nine months after senior managers assessed group performance. Participants who made it to the corporate-level event (99.5%) were more likely to stay with the company than division-level event participants (97.5%), who were more likely to stay with the company than regional-level event participants (90.0%) ($F_{\text{linear contrast}}(1, 1473) = 25.32, p < .001$). While intriguing, it is unclear from this data, for example, whether high performance was related to increased commitment, or whether low performance was related to increased dissatisfaction.

Project length. Group leaders indicated the number of months from the start of the project to the end (Ancona & Caldwell, 1992a; Hansen, 1999); or in the case of groups not completing their projects (<6%), when they expected to finish (LENGTH: Mean = 14.96; SD = 10.53).

Project resources. Group leaders rated the availability of three project resources (Ancona & Caldwell, 1992b; Gladstein, 1984): “On average, to what extent did the project have available resources...”: (a) financial, (b) personnel, and (c) equipment (10-pt scale; 1: not very available, 5: average, 10: very much available), which reliably loaded onto one factor ($\alpha = .80$; RESOURCES: Mean = 6.22; SD = 2.04).

Environmental uncertainty. Group leaders rated environmental uncertainty (Brown & Utterback, 1985; Tushman, 1979), that is, “On average, to what extent did the project need skills or information that were stable or rapidly changing” (10-pt scale; 1: stable, 5: average, 10: rapidly changing) (higher value indicates greater uncertainty) (UNCERTAIN: Mean = 5.66; SD = 2.49).

Psychological closeness. Group members rated how close they felt to each other person in the group (1-5 scale; 1: acquaintance, 2: friend, 3: close friend, 4: very close friend, 5: confidant), which was averaged across the group to assess psychological closeness (Burt, 1992; Krackhardt, 1992) (CLOSENESS: Mean = 1.81; SD = 0.46).

Knowledge-sharing difficulty. Group members rated the difficulty of sharing (1-5 scale; 1: very easy, 2: easy, 3: moderate, 4: difficult, 5: very difficult) for each activity (general overview, specific requirements, analytic techniques, progress reports, and results). All five ratings loaded onto one factor with acceptable reliability ($\alpha = .85$; DIFFICULTY: Mean = 2.71; SD = 0.36), which were averaged to measure knowledge-sharing difficulty (Teece, 1977).

Results

Preliminary Analyses

Before using regression analyses to test the eight hypotheses proposed above, preliminary analyses were conducted on the data. First, descriptive statistics revealed that all variables were normally distributed except for project length (which was skewed toward longer projects), thus the natural log of project length is used in the analyses. Second, average intra-class correlations computed for the group-level measures of internal and external knowledge sharing were .84 ($p < .01$) and .95 ($p < .01$), respectively. This suggests that it is reasonable to aggregate individual level measures. Third, correlations were calculated for the main variables in the study (see Table 4). One observation is that geographic distribution and cross-functionality were modestly related ($r = .20$, $p < .05$), while both were significantly related to having different supervisors (geographic distribution, $r = .34$, $p < .01$; cross-functionality, $r = .35$, $p < .01$). Another is that having more geographic locations ($r = .02$, $p > .10$), functional areas ($r = .07$, $p > .10$), or different supervisors ($r = .05$, $p > .10$) were unrelated to external knowledge sharing.

Finally, to address concerns regarding the uncertain effects on performance of group design decisions made by managers before groups were invited to participate in the study, geographic distribution (Model 1), cross-functionality (Model 2), and different supervisors (Model 3) were regressed on the control variables (see Table 5). This analysis indicates whether known factors predict the extent of diversity in the work groups. Furthermore, in the section below, internal knowledge sharing (Model 1), and external knowledge sharing (Model 2) were regressed on the control variables as well as geographic distribution, cross-functionality, and different supervisors (see Table 6). This analysis indicates whether known factors predict the extent of knowledge sharing within and outside of work groups. Though the focus of this paper

is primarily on the relationship between knowledge sharing and work group performance, these analyses may yield some of the antecedents of diversity and knowledge sharing.

The first ordinary least squares model (see Table 5) with geographic distribution as the dependent variable revealed that manufacturing operations groups, which were often situated in a single facility, were more likely to be co-located ($b = -.51, p < .05$). The second regression model with cross-functionality as the dependent variable indicated that service improvement groups, which often included engineers as well as quality assurance and customer support employees, were more likely to be cross-functional ($b = .24, p < .05$). The third regression model with different supervisors as the dependent variable indicated that service improvement groups were more likely to report to the same supervisor ($b = -.12, p < .10$). Also, there was a significant association between group size and having different supervisors ($b = .09, p < .01$).

Hypothesis Testing

The first three hypotheses, that geographic distribution, cross-functionality, or having different supervisors would be negative related to internal knowledge sharing, were not supported. Geographic distribution ($r = -.08, p > .10$), cross-functionality ($r = -.11, p > .10$), or having different supervisors ($r = -.10, p > .10$) did not have a significant negative association with internal knowledge sharing, although the relationships were in the expected direction. However, consistent with previous research, geographic distribution ($r = -.41, p < .01$) and having different supervisors ($r = -.31, p < .01$) were significantly negative correlated with overall communication, and cross-functionality was significantly negatively correlated with functional discussion ($r = -.37, p < .01$).

Two ordinary least squares regression analyses were also conducted with internal and external knowledge sharing as the dependent variables (see Table 6). The first model with

internal knowledge sharing as the dependent variable revealed that greater psychological closeness ($b = .18, p < .01$) and external knowledge sharing ($b = .22, p < .01$) were positively related to internal knowledge sharing. The second regression model with external knowledge sharing as the dependent variable indicated that greater psychological closeness ($b = .23, p < .05$) and internal knowledge sharing ($b = .56, p < .01$) were positively related to external knowledge sharing. However, greater knowledge-sharing difficulty was negatively related to external knowledge sharing ($b = -.27, p < .05$). As expected, internal and external knowledge sharing were positively related ($r = .41, p < .01$).

Table 7 (Column 1) shows the results of the regression analysis with group performance as the dependent variable, and geographic distribution and cross-functionality as the independent variables, along with all of the controls.⁵ The analyses indicated that group size ($b = .06, p < .05$) was the only control variable significantly related to performance. The fourth and fifth hypotheses, that internal and external knowledge sharing would be positively related to performance, were supported. Table 7 (Column 2) shows that internal knowledge sharing ($b = .38, p < .01$) and external knowledge sharing ($b = .32, p < .01$) were significantly associated with performance. The variable group size ($b = .06, p < .05$) was the only other significant predictor in the second model. The change in R^2 from Model 1 (.09) to Model 2 (.21) was significant ($\Delta R^2 = .12; F = 13.72, p < .01$).

The sixth hypothesis, that the strength of the relationship between external knowledge sharing and performance would increase as geographic distribution increased, was supported.

Table 7 (Column 3) also shows that the interaction of external knowledge sharing and

⁵ Though ordered logit analyses were more statistically appropriate given the nature of the dependent variable (see Appendix A), Table 7 reports hypothesis testing using ordinary least squares regression analyses. The significance of the coefficient estimates are identical to those reported for the ordered logit analyses, and provide an easier interpretation of the beta coefficients and amount of variance explained in the model.

geographic locations, controlling for project characteristics, was a modestly significant predictor of performance ($\underline{b} = .11, \underline{p} < .05$). The interaction plot shows that greater geographic distribution was related to better performance when external knowledge sharing was high (see Figure 2). The variables group size ($\underline{b} = .06, \underline{p} < .05$), internal knowledge sharing ($\underline{b} = .39, \underline{p} < .01$), and external knowledge sharing ($\underline{b} = .33, \underline{p} < .01$), were also significant predictors in the third model. The change in R^2 from Model 2 (.21) to Model 3 (.24) was marginally significant ($\Delta R^2 = .03; \underline{F} = 2.51, \underline{p} < .10$).

The seventh hypothesis, that the strength of the relationship between external knowledge sharing and performance would increase as cross-functionality increased, was supported. Table 7 (Column 4) also shows that the interaction of external knowledge sharing and functional areas, controlling for project characteristics, was a significant predictor of performance ($\underline{b} = .15, \underline{p} < .01$). The interaction plot shows that greater cross-functionality was related to better performance when external knowledge sharing was high (see Figure 3). Internal knowledge sharing ($\underline{b} = .33, \underline{p} < .05$), external knowledge sharing ($\underline{b} = .33, \underline{p} < .01$), and group size ($\underline{b} = .06, \underline{p} < .05$) were also significant predictors in the fourth model. The change in R^2 from Model 2 (.21) to Model 4 (.25) was significant ($\Delta R^2 = .04; \underline{F} = 3.69, \underline{p} < .05$).

The eighth hypothesis, that the strength of the relationship between external knowledge sharing and performance would increase as the number of different supervisors increased, was supported. Table 7 (Column 5) also shows that the interaction of external knowledge sharing and different supervisors, controlling for project characteristics, was a significant predictor of performance ($\underline{b} = .14, \underline{p} < .05$). The interaction plot shows that a greater number of different supervisors was related to better performance when external knowledge sharing was high (see Figure 4). Internal knowledge sharing ($\underline{b} = .41, \underline{p} < .01$), external knowledge sharing ($\underline{b} = .32, \underline{p} <$

.01), and group size ($b = .06, p < .05$) were also significant predictors in the fourth model. The change in R^2 from Model 2 (.21) to Model 5 (.25) was significant ($\Delta R^2 = .04; F = 4.41, p < .05$).

When all main effects and interactions are entered into the model, none of the interactions are significant. Similarly, the three-way interaction of external knowledge sharing X geographic distribution X cross-functionality was also not significant.

Comparison with communication measures

To test the discriminate validity of knowledge sharing, internal knowledge sharing was significantly correlated with internal overall communication $r = .48 (p < .01)$ and with internal functional discussion $r = .44 (p < .01)$ (overall communication and functional discussion were significantly correlated $r = .31, p < .01$). This suggests that even though the variables are related, knowledge sharing within the group captures something different than overall communication or functional discussion. For example, overall communication includes social communication and functional discussion includes specific personal expertise not necessarily related to the task. However, a different pattern arises for external knowledge sharing. External knowledge sharing was significantly correlated with external overall communication $r = .77 (p < .01)$ and with external functional discussion $r = .67 (p < .01)$ (overall communication and functional discussion were significantly correlated $r = .66, p < .01$). This indicates that when group members share knowledge, communicate, or have discussions outside of the group, it is likely to be task-related.

Two supplementary analyses were conducted in which overall communication and functional discussion were substituted for knowledge sharing. First, when comparing knowledge sharing with overall communication, in terms of the relationship with performance, we see a slightly different pattern of results (see Table 8). The main effects of internal and external overall communication on performance are significant, though the magnitude of strength is larger for

internal compared with external. Moreover, the interactions of external overall communication with diversity are much weaker. Second, when comparing knowledge sharing with functional discussion, in terms of its relationship with performance, we again see a different pattern of results (see Table 9). The main effect of external (though not internal) functional discussion on performance was significant, and the interactions of external functional discussion with diversity are somewhat weaker (with the exception of cross-functionality).

Discussion

This paper began with examples of distributed or cross-functional groups that shared different kinds of knowledge through different relations. Based on the results of this study, I argue that groups perform effectively if they share critical knowledge about the task with the customer and other non-group employees in the company. Members in different locations who represent different functions can capitalize on diverse external networks, thus accessing diverse sources of task information, know-how, and feedback. While research has focused on the internal challenges that distributed or cross-functional work groups face, there appear to be great external opportunities for improving performance.

There are three themes that characterize the findings of this dissertation. First, knowledge sharing is similar to, yet different than overall communication and functional discussion. Contrary to the first three hypotheses, geographic distribution, cross-functionality, and having different supervisors did not significantly negatively influence knowledge sharing to the extent that they influenced overall communication and functional discussion. Second, in support of the fourth and fifth hypotheses, both internal and external knowledge sharing are important for performance in work groups. Third, in support of the sixth, seventh, and eight hypotheses,

geographic distribution, cross-functionality, and having different supervisors provided opportunities for group members to benefit from unique knowledge outside of the group.

When asked why external knowledge sharing was helpful for performance, respondents said that “external point of views were needed to ensure that multiple areas would benefit from our project,” “interaction provided a broader view of the situation and it was easier to evaluate what needed to be done,” and “it was important to obtain the opinion of those who would be using the group’s end product.” When asked about the advantages of geographic distribution and external knowledge sharing for performance, members responded that “for the project to be successful it required the cooperation, hence group participation, of different departments who were located in different factories within the site,” “we wanted to combine different perspectives,” and “it provided a broader view with different aspects of the problem.” Finally, when asked about the benefits of cross-functionality and external knowledge sharing, members provided comments such as “cross-functional group members added important insight on the usage of our program by shedding light on standardization for areas that were significantly different from other areas,” “it was important because we each had a common technical understanding of the issues that needed to be resolved,” and “cross-functional group members were helpful in order to bring the perspective of each area to the table.”

Going back to the examples presented at the beginning of this paper, each one illustrates how geographic distribution, cross-functionality, and having different supervisors provided access to sources of knowledge that may have otherwise been unavailable. In the product development group, a member was able to borrow a chip design from another organizational group because she was located in the same place as one of the other group members. In the service improvement group, a member was able to gather satisfaction data from a marketing

employee because they were in the same division. Lastly, in the manufacturing operations group, they were able to use another factory in Scotland for benchmarking because one of the supervisors was familiar with this operation.

Previous work has found that geographic distribution and cross-functionality are related to more external task communication (e.g., Ancona & Caldwell, 1992b). However, on average, members of distributed or cross-functional groups in this study did not share more external knowledge than members of co-located or functionally homogeneous groups. Even though members were in different locations or represented different functions, this did not guarantee that they would share more knowledge outside of the group. As alluded to earlier, it may be that knowledge sharing is purposeful and therefore less likely to occur spontaneously or informally as does task communication. Moreover, distributed groups did not perform better than co-located groups, and cross-functional groups did not perform better than functionally homogeneous groups. This finding reinforces the importance of group process for effectiveness. In other words, when designing groups, managers are not ensured better performance by employing distributed or cross-functional work groups. The chances of better performance increase by encouraging knowledge sharing between those group members and others in their external social networks.

Alternative Explanations

There are several alternative explanations for why external knowledge sharing was beneficial for performance when groups were diverse. First, one might expect that sharing some kinds of knowledge externally would be better than sharing others. Rather, it was sharing a combination of the general overview, specific requirements, analytical techniques, progress reports, and project results that predicted performance. Individually, each type of knowledge was not a significant factor, suggesting that the measurement of knowledge sharing likely did not

allow for fine distinctions among content. Future research should explore different measures of knowledge sharing activities. Second, one might also expect that sharing knowledge through some external networks would be more effective than sharing through others. However, analyses with the sum were more strongly related to performance than any of the individual targets of external knowledge sharing alone. Future research should also examine different measures of knowledge sharing networks.

Finally, performance was rated at each of the regional, division, and corporate events roughly six months before group members completed the surveys. Although managers did not give detailed feedback to groups regarding their performance, all groups knew whether or not they advanced to the next level. Participants could have responded to the survey in a way that conformed to their intuitions about performance, hence their reports of knowledge sharing could have been a result of their performance. Similarly, work groups with better performing members may have shared more knowledge because of opportunities they created for themselves, thus it may not have been that knowledge sharing resulted in better performance but rather that better performance resulted in more knowledge sharing. However, in either case, the data reported here are cross-sectional, and claims about causality cannot be substantiated.

Limitations

There are also several limitations of this field study. The sample was chosen opportunistically; there is no documented information on how representative the work groups are in size, membership, or capabilities. One reason for the low R^2 in the regression analyses (which ranged from .09 and .25, see Table 7) may be that variance was restricted on the dependent variable because only moderately to highly successful groups were examined. The next concern involves the measurement of knowledge sharing. The self-report survey raises concerns about

measurement error. Because surveys were administered an average of six months after the projects, members were unable to distinguish between time periods, kinds of activities, and types of external networks. The development of better metrics for capturing knowledge sharing are needed, such as ways for members to count actual conversations, documents, or transfers of information. Similarly, this study only examined one aspect of the many kinds of interactions people can have in the workplace. Interactions other than task communication and knowledge sharing are unaccounted for here. Evidence is also missing on the quality of the knowledge being shared. It is likely that diverse external networks matter more when the knowledge is timely, scarce, or relevant.

In addition, it remains indeterminate under what conditions it is better to be the source or recipient of knowledge, and which kinds of knowledge-sharing behaviors can have a negative impact on performance. Surely all knowledge is not critical to have, and sometimes it is better to give than to receive. It is also uncertain how knowledge sharing would occur under conditions of competition or hostility among groups in the corporation. The culture of this organization may also be unique in that it encouraged diversity and knowledge sharing in work groups, whereas other companies may not be as forward-thinking. Replicating these findings in other organizations is certainly recommended to assess the generalizability of the results. Future research will need to address these concerns to fully understand the role of knowledge sharing in global organizations.

Next Steps

There are several next steps which would enhance our understanding of why diversity is particularly beneficial for work groups when knowledge is shared externally. First, it remains unclear what role social or non-task communication plays in knowledge sharing outside of work

groups. It may be the case that ties outside of work groups need to be nurtured and fostered through extracurricular activities before knowledge sharing is possible. Surveying work group members about non-task communication is an important extension of this work. Second, it is not known whether the most qualified group members in terms of functional expertise also have the strongest ties outside of the group. Group interviews as well as supplementary analyses suggest that external knowledge sharing is maintained by a small number of successful group members, though more data are needed about whether these group members are also the experts.

Manager's ratings of member expertise would be a necessary addendum to the surveys. Third, better means for assessing external knowledge sharing during different stages of the work group life-cycle will help to determine when members benefit from diverse information and resources. In this survey, group members did not distinguish very well between early and late in the project, thus external knowledge sharing appeared to equally important at both stages. Finally, group satisfaction and other non-performance consequences of external knowledge sharing may reinforce this behavior. There may be other personal benefits for members who share knowledge externally that were not measured here, such as education or learning.

Conclusion

A theoretical goal for this paper was to identify a more precise mechanism for how knowledge should be shared outside of work groups to improve performance. Knowledge sharing seems to be particularly vital for group members in large firms because the coordination of work requires task information, know-how, and feedback that a single individual does not often have. It is also clear that knowledge sharing both within and outside of work groups is important for performance. This paper found that external knowledge sharing is more important for distributed or cross-functional groups. Because group members are not located near one

another or represent dissimilar functions, it is necessary to communicate about the work with non-group employees or customers who are located nearby or who represent similar functions.

A managerial goal of designing groups to include members with external social networks to improve performance is also important for managers who have to make choices about the design of work groups. The implications of these findings are wide-ranging, given that having a diverse group only makes a difference for performance when members have external ties. The power of this study is not the main effect of external knowledge sharing on performance, but in the significance of two interactions between external knowledge sharing and groups with members (1) who are in different geographic locations and (2) who represent different functional areas. These different sources provided members with access, much like a portal, to unique knowledge outside of the group. Managers who design work groups should take advantage of these opportunities.

There is still a lot to learn about knowledge sharing and work groups in a global organization. This paper extends a long tradition of basic and applied research on the factors related to group performance. On the one hand, the statistical analyses suggest that many of the variables that scholars and managers care about, such as task type, project length, and availability of resources, were unrelated to group performance in this field study. On the other hand, despite growing challenges to effective teamwork such as globalization and specialization, the importance of task communication and knowledge sharing remains fundamental. Not only is sharing knowledge about the task critical within the group, but work-related communication outside of the group is also essential. For multinational corporations that want to have successful work groups well into the 21st century, external knowledge sharing through distributed or cross-functional group members is a fruitful possibility.

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Table 1. Project descriptions from six work groups, including (fictitious) work group name, group size, number of geographic locations and buildings in each location, the distribution index value, number of functional areas and members in each function, the cross-functional index value, number of different supervisors, the different supervisors index value, and project length in months.

#	Work Group Name	Size	Locations (buildings)	GeogDist Index	Functions (members)	CrosFunc Index	Supervisors (number)	DifSuper Index	Project description	Length (mo.)
1	Error Detection	4	Israel(1)	2.67	Engineer(3) Support(1)	0.56	4	1.39	Developed utility for detecting wiring errors on electrical boards	10
2	Handheld Design	10	Georgia(1) Tennessee(1) Illinois(2) Israel(3) Arizona(1)	6.29	Engineering(1) Manufacture(1) Quality(1) Proj. Mgmt(4) Cust. Srvc(1) Marketing(1) Sales(1)	1.75	10	2.30	Designed handheld scanning device for shipping company	25
3	Platform Conversion	9	Illinois(3)	3.67	Engineer(1) Quality(2) Proj. Mgmt(2) Marketing(2) Finance(1) Sales(1)	1.89	8	2.04	Converted client platform for car phones from analog to digital	9
4	Subscriber Requirements	6	China(3)	4.37	Engineer(3) Quality(1) Proj. Mgmt(2)	1.01	6	1.79	Enhanced phone system performance to meet subscriber requirements	7
5	Business Separation	8	Arizona(4)	4.54	Tech. Ops(1) Info Tech(6) HR(1)	0.74	7	1.91	Executed separation/ sale of business unit to another stakeholder	4
6	Factory Modification	9	Ireland(1) England(1)	4.74	Engineer(3) Manufacture(5) Quality(1)	1.21	9	2.20	Modified existing factory to support new production of pager	8

Note: Work groups #1,#2-product development; #3,#4-service improvement; #5-process management; #6-manufacturing operations

Table 2. Examples of internal and external knowledge sharing in five different work groups by activity.

#	Activity	Work Group Name	Project Description	Internal Knowledge Sharing	External Knowledge Sharing
1	General Overviews	Material Bonding	Invented material with more reliable bonding during production	Created a planning document with timeline	Made presentations to other units in division with need for material
2	Specific Requirements	Circuit Cost	Cut cost of circuit wafers used in radios and base stations	Assessed availability of supplies for use in circuit	Consulted customer about appropriate size of circuit wafers
3	Analytical Techniques	Capacity Expansion	Expanded capacity of production line using modified equipment	Established a procedure for testing the equipment	Evaluated performance metrics with other work groups in facility
4	Progress Reports	Process Integration	Re-designed fabrication process by integrating less costly materials	Had weekly update through telephone conference	Reported to general manager to help stay on schedule
5	Project Results	Mobile Manufacturing	Built, tested, and manufactured mobile product in short time	Wrote a white paper describing the process	Presented preliminary findings at company conference on mobility

Table 3. Means and standard deviations for amount of knowledge sharing (general overviews, specific requirements, analytical techniques, progress reports, and project results) by network (within group, with non-group employees inside the division, with non-group employees outside the division, and with the customer) (N=182 work groups).

Network Amount	Within Group (Internal)	Within Division (External)	Outside Division (External)	Customer (External)	Average (External)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Knowledge Sharing					
General Overviews	4.15 (.47)	3.04 (.57)	2.10 (.75)	2.47 (.92)	2.60 (.68)
Specific Requirements	3.70 (.59)	2.71 (.58)	1.94 (.66)	2.19 (.85)	2.33 (.64)
Analytical Techniques	3.81 (.66)	2.72 (.64)	1.93 (.64)	2.08 (.82)	2.29 (.62)
Progress Reports	4.00 (.51)	2.85 (.65)	1.97 (.51)	2.25 (.91)	2.41 (.67)
Project Results	4.09 (.48)	2.94 (.65)	2.04 (.71)	2.36 (.89)	2.53 (.66)
Average	3.95 (.42)	2.86 (.54)	2.00 (.66)	2.27 (.84)	2.43 (.62)

Note: 5-point scale for knowledge sharing is 1:never, 2:rarely, 3:sometimes, 4:regularly, 5:a lot.

Table 4. Correlation matrix with main study variables (N = 182 work groups).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Product	---																		
2. Service	-.33	---																	
3. Process	-.33	-.33	---																
4. Operations	-.34	-.34	-.34	---															
5. Size	-.10	-.03	.02	.11	---														
6. Length	.10	-.01	.02	-.11	-.05	---													
7. Resources	.22	.02	-.18	-.06	-.08	.01	---												
8. Uncertainty	.07	.16	-.16	-.08	.06	-.05	.08	---											
9. Closeness	.00	.02	-.15	.13	-.14	-.02	.09	.05	---										
10. Difficulty	-.12	.02	-.08	.17	.10	.06	-.21	-.03	.06	---									
11. Geog.Dist.	-.02	.11	.12	-.21	.15	-.08	-.09	.14	-.08	-.11	---								
12. Cros.Func.	-.20	.25	.02	-.07	.26	.04	-.02	.02	-.03	-.06	.20	---							
13. Diff.Super.	-.04	-.05	.10	-.01	.54	-.14	-.04	.04	-.23	.07	.34	.35	---						
14. Int. OC	.02	.02	-.16	.12	-.20	-.09	.20	.08	.43	-.10	-.41	-.11	-.31	---					
15. Ext. OC	.08	.11	-.12	-.06	.04	-.11	.22	.12	.24	-.13	.00	.05	.03	.40	---				
16. Int. FD	.04	-.08	.01	.03	-.12	-.08	.09	.13	.26	-.03	-.08	-.37	-.13	.31	.18	---			
17. Ext. FD	.02	.00	-.07	.04	.08	-.11	.20	.01	.23	-.09	.08	.00	.11	.28	.66	.38	---		
18. Int. KS	.04	-.02	-.06	.03	-.13	-.01	.12	-.06	.40	-.05	-.08	-.11	-.10	.48	.28	.44	.31	---	
19. Ext. KS	.04	-.05	-.10	.11	.06	-.09	.16	.00	.30	-.18	.02	.07	.05	.35	.77	.24	.67	.41	---
20. Perform	.07	-.05	-.05	.02	.19	-.04	.11	.06	.08	-.04	.06	.14	.13	.21	.28	.11	.25	.27	.36

Note: $r > .12$, $p < .10$; $r > .15$, $p < .05$; $r > .18$, $p < .01$; OC–overall communication, FD–functional discussion, KS–knowledge sharing

Table 5. Regression analyses predicting geographic distribution (GEOGDIST), cross-functionality (CROSFUNC), and different supervisors (DIFSUPER) (N = 182 work groups).

Model (DV)	1 (GEOGDIST)		2 (CROSFUNC)		3 (DIFSUPER)	
Variables	B	SE	B	SE	B	SE
Constant	3.14	0.89	0.05	0.38	0.66	0.27
Product	-0.15	0.23	-0.14	0.09	0.01	0.07
Service	0.04	0.23	0.24*	0.09	-0.12 ^t	0.07
Process	---	---	---	---	---	---
Operations	-0.51*	0.23	-0.01	0.09	-0.04	0.07
Size	-0.02	0.05	0.02	0.02	0.09**	0.01
Length	-0.06	0.12	0.08	0.05	-0.08*	0.04
Resources	-0.06	0.04	0.00	0.02	0.01	0.01
Uncertain	0.05	0.03	-0.01	0.01	0.00	0.01
Closeness	0.07	0.18	0.07	0.07	-0.14	0.05
Difficulty	-0.38	0.22	-0.15	0.09	0.12 ^t	0.07
GeogDist			0.02	0.03	0.09**	0.02
CrosFunc	0.13	0.19			0.21**	0.05
DifSuper	0.95**	0.25	0.38	0.10		
df	11		11		11	
R ²	.17		.20		.36	

Note: ^tp < .10, *p < .05, **p < .01

Table 6. Regression analyses predicting internal knowledge sharing (INT KS), and external knowledge sharing (EXT KS) (N = 182 work groups).

Model (DV)	1 (INT KS)		2 (EXT KS)	
Variables	B	SE	B	SE
Constant	2.68	0.35	0.26	0.64
Product	0.04	0.08	0.04	0.12
Service	0.02	0.07	-0.01	0.12
Process	---	---	---	---
Operations	-0.03	0.07	0.16	0.11
Size	-0.01	0.01	0.03	0.02
Length	0.01	0.04	-0.06	0.06
Resources	0.00	0.01	0.02	0.02
Uncertain	-0.01	0.01	0.00	0.02
Closeness	0.18**	0.06	0.23*	0.10
Difficulty	0.03	0.07	-0.27*	0.11
GeogDist	0.01	0.02	0.02	0.04
CrosFunc	0.22	0.22	0.22	0.22
DifSuper	0.06	0.06	0.09	0.09
Int. KS			0.56**	0.12
Ext. KS	0.22**	0.05		
df	13		13	
R ²	.36		.28	

Note: †p < .10, *p < .05, **p < .01

Table 7. Regression analyses predicting work group performance (N = 182 work groups).

Variables	Controls		Hypotheses 4-5		Hypothesis 6		Hypothesis 7		Hypothesis 8	
	B	SE	B	SE	B	SE	B	SE	B	SE
Constant	0.58	0.60	-1.40	0.73	-1.41	0.73	-1.37	0.72	-1.64	0.72
Product	0.13	0.15	0.09	0.14	0.07	0.14	0.13	0.14	0.10	0.14
Service	-0.07	0.15	-0.08	0.14	-0.09	0.14	-0.07	0.14	-0.06	0.14
Process	---	---	---	---	---	---	---	---	---	---
Operations	0.04	0.15	-0.01	0.14	-0.02	0.14	0.00	0.14	0.01	0.14
Size	0.06*	0.03	0.06*	0.03	0.06*	0.03	0.06*	0.03	0.07*	0.03
Length	-0.03	0.08	-0.02	0.08	-0.03	0.07	-0.01	0.08	-0.03	0.07
Resources	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Uncertain	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.02
Closeness	0.15	0.12	-0.11	0.12	-0.10	0.12	-0.02	0.12	-0.09	0.12
Difficulty	-0.05	0.15	0.08	0.14	0.05	0.14	0.05	0.14	0.08	0.14
GeogDist	0.01	0.05	0.02	0.05	0.03	0.05	-0.01	0.05	0.02	0.05
CrosFunc	0.17	0.12	0.19	0.12	0.14	0.12	0.22	0.11	0.20	0.11
DifSuper	0.03	0.17	-0.05	0.16	-0.01	0.16	0.04	0.16	-0.03	0.15
Int. KS			0.38**	0.14	0.39**	0.14	0.33*	0.14	0.41**	0.14
Ext. KS			0.32**	0.09	0.33**	0.09	0.33**	0.09	0.32**	0.09
GeogDist X Int. KS					0.01	0.05				
GeogDist X Ext. KS					0.11*	0.05				
CrosFunc X Int. KS							-0.05	0.05		
CrosFunc X Ext. KS							0.15**	0.06		
DifSuper X Int. KS									0.00	0.05
DifSuper X Ext. KS									0.14*	0.06
df	12		14		16		16		16	
R ²	.09		.21		.24		.25		.25	

Note: [†]p < .10, *p < .05, **p < .01

Table 8. Regression analyses predicting work group performance (With overall communication instead of knowledge sharing) (N = 182 work groups).

Variables	Controls		Hypotheses 4-5		Hypothesis 6		Hypothesis 7		Hypothesis 8	
	B	SE	B	SE	B	SE	B	SE	B	SE
Constant	0.58	0.60	-1.25	0.76	-1.36	0.77	-1.24	0.75	-1.46	0.76
Product	0.13	0.15	0.10	0.14	0.08	0.14	0.12	0.14	0.09	0.14
Service	-0.07	0.15	-0.12	0.14	-0.12	0.14	-0.13	0.14	-0.10	0.14
Process	---	---	---	---	---	---	---	---	---	---
Operations	0.04	0.15	0.03	0.14	0.02	0.14	0.03	0.14	0.06	0.14
Size	0.06*	0.03	0.06*	0.03	0.06*	0.03	0.06*	0.03	0.07*	0.03
Length	-0.03	0.08	0.02	0.08	0.01	0.08	0.02	0.08	0.03	0.08
Resources	0.03	0.03	0.01	0.03	0.02	0.03	0.01	0.02	0.01	0.02
Uncertain	0.01	0.02	0.00	0.02	0.00	0.02	-0.01	0.02	-0.01	0.02
Closeness	0.15	0.12	-0.05	0.12	-0.05	0.12	0.02	0.12	0.01	0.12
Difficulty	-0.05	0.15	0.05	0.14	0.05	0.14	0.03	0.14	0.02	0.14
GeogDist	0.01	0.05	0.08	0.05	0.10	0.05	0.06	0.05	0.09	0.05
CrosFunc	0.17	0.12	0.16	0.12	0.13	0.12	0.17	0.12	0.13	0.12
DifSuper	0.03	0.17	0.05	0.16	0.05	0.16	0.06	0.16	0.07	0.16
Int. OC			0.41**	0.15	0.43**	0.16	0.39**	0.15	0.43**	0.15
Ext. OC			0.26*	0.12	0.26*	0.12	0.26*	0.12	0.26*	0.12
GeogDist X Int. OC					0.05	0.05				
GeogDist X Ext. OC					0.03	0.06				
CrosFunc X Int. OC							0.05	0.05		
CrosFunc X Ext. OC							0.11*	0.05		
DifSuper X Int. OC									0.05	0.05
DifSuper X Ext. OC									0.12*	0.06
df	12		14		16		16		16	
R ²	.09		.17		.18		.21		.21	

Note: [†]p < .10, *p < .05, **p < .01

Table 9. Regression analyses predicting work group performance (With functional discussion instead of knowledge sharing) (N = 182 work groups).

Variables	Controls		Hypotheses 4-5		Hypothesis 6		Hypothesis 7		Hypothesis 8	
	B	SE	B	SE	B	SE	B	SE	B	SE
Constant	0.58	0.60	-0.25	0.76	-0.27	0.76	0.01	0.75	-0.46	0.77
Product	0.13	0.15	0.14	0.15	0.13	0.15	0.18	0.15	0.16	0.15
Service	-0.07	0.15	-0.07	0.15	-0.09	0.15	-0.07	0.14	-0.06	0.15
Process	---	---	---	---	---	---	---	---	---	---
Operations	0.04	0.15	0.04	0.15	0.04	0.15	0.06	0.14	0.04	0.15
Size	0.06*	0.03	0.06*	0.03	0.06*	0.03	0.05*	0.03	0.06*	0.03
Length	-0.03	0.08	-0.01	0.08	-0.02	0.08	-0.04	0.08	-0.02	0.08
Resources	0.03	0.03	0.02	0.03	0.02	0.03	0.02	0.03	0.02	0.03
Uncertain	0.01	0.02	0.01	0.02	0.01	0.02	-0.01	0.02	0.01	0.02
Closeness	0.15	0.12	0.04	0.12	0.06	0.12	0.17	0.12	0.08	0.12
Difficulty	-0.05	0.15	-0.01	0.14	-0.02	0.14	0.00	0.14	0.01	0.14
GeogDist	0.01	0.05	0.01	0.05	0.01	0.05	-0.01	0.05	0.01	0.05
CrosFunc	0.17	0.12	0.24'	0.13	0.22'	0.13	0.25'	0.13	0.24'	0.13
DifSuper	0.03	0.17	-0.03	0.16	-0.02	0.16	0.03	0.16	0.00	0.17
Int. FD			0.15	0.14	0.15	0.14	0.04	0.14	0.15	0.14
Ext. FD			0.18*	0.09	0.18*	0.09	0.20*	0.08	0.19*	0.09
GeogDist X Int. FD					0.05	0.05				
GeogDist X Ext. FD					0.05	0.06				
CrosFunc X Int. FD							0.01	0.05		
CrosFunc X Ext. FD							0.20**	0.06		
DifSuper X Int. FD									-0.02	0.05
DifSuper X Ext. FD									0.10'	0.06
Df	12		14		16		16		16	
R ²	.09		.13		.14		.19		.15	

Note: 'p < .10, *p < .05, **p < .01

Figure 1. Model of knowledge sharing within and outside of work groups.

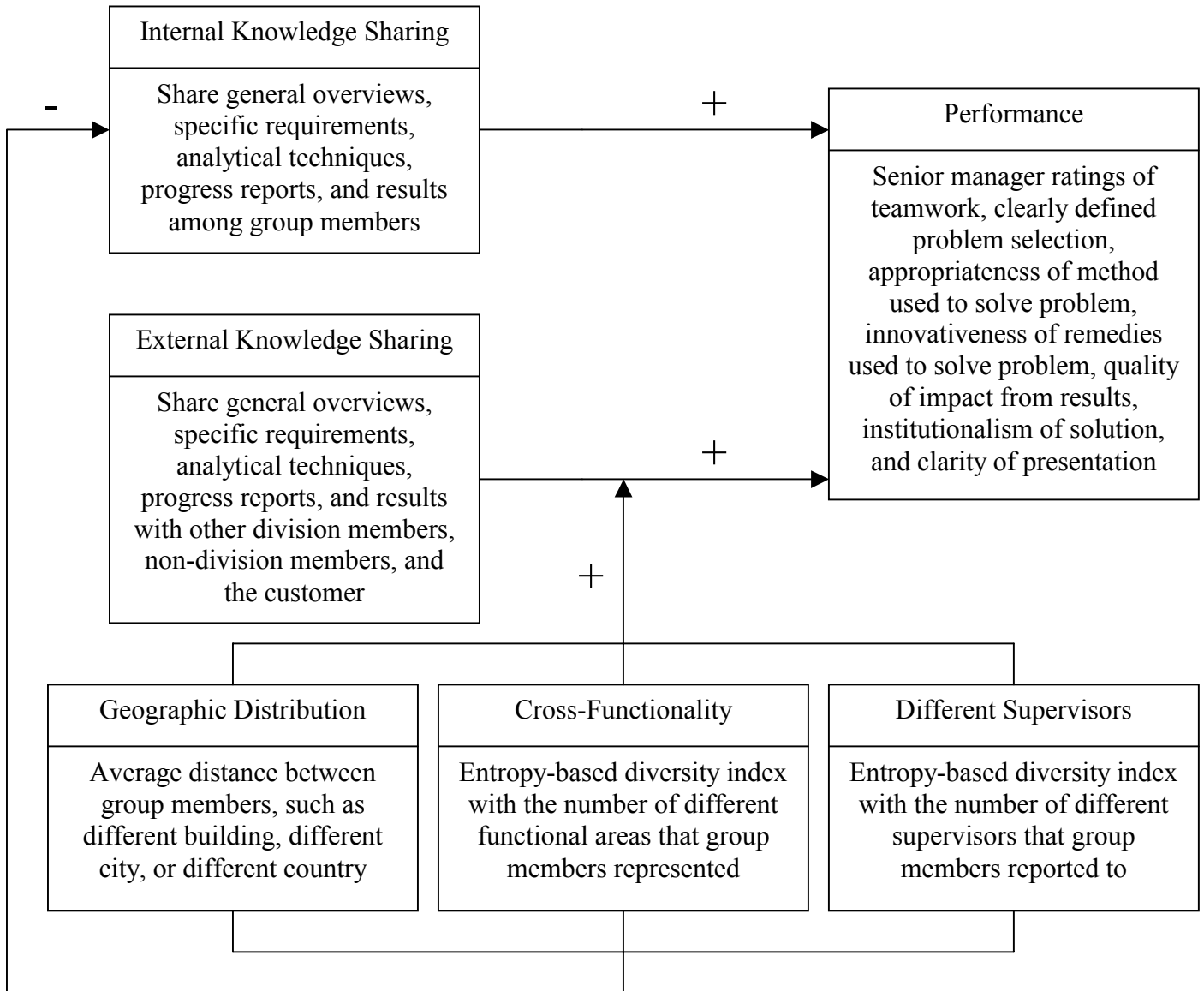


Figure 2. Interaction plot of external knowledge sharing and geographic distribution.

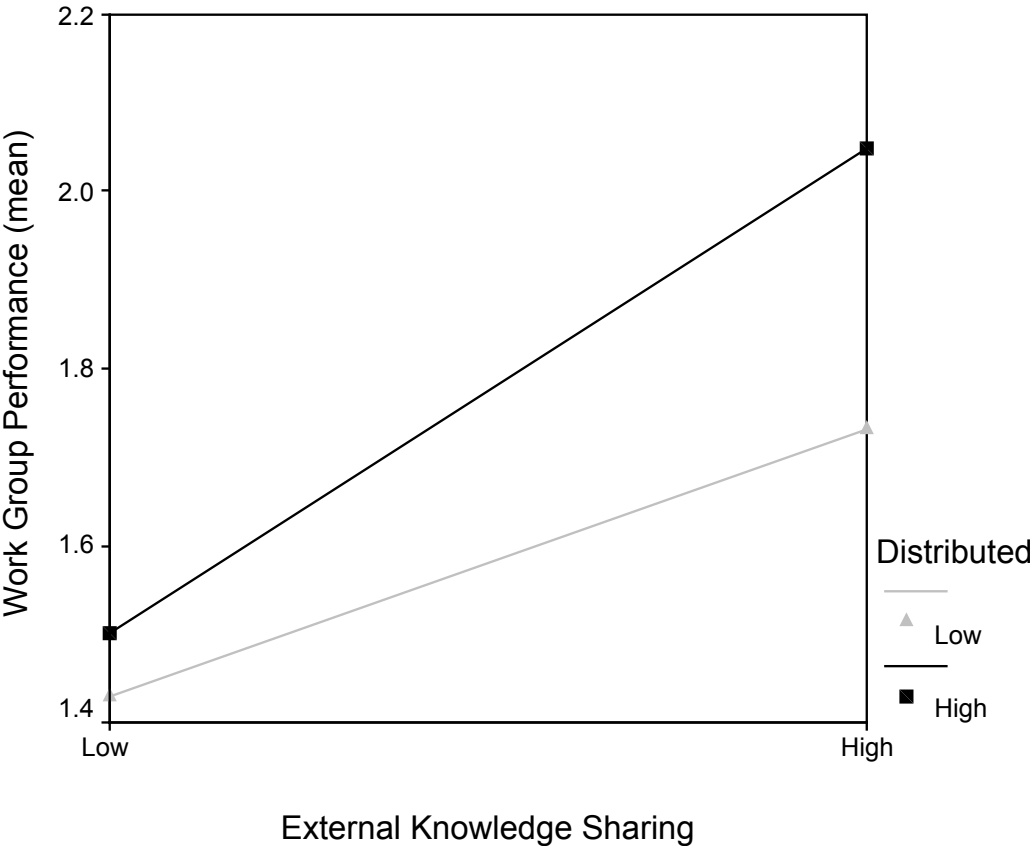


Figure 3. Interaction plot of external knowledge sharing and cross-functionality.

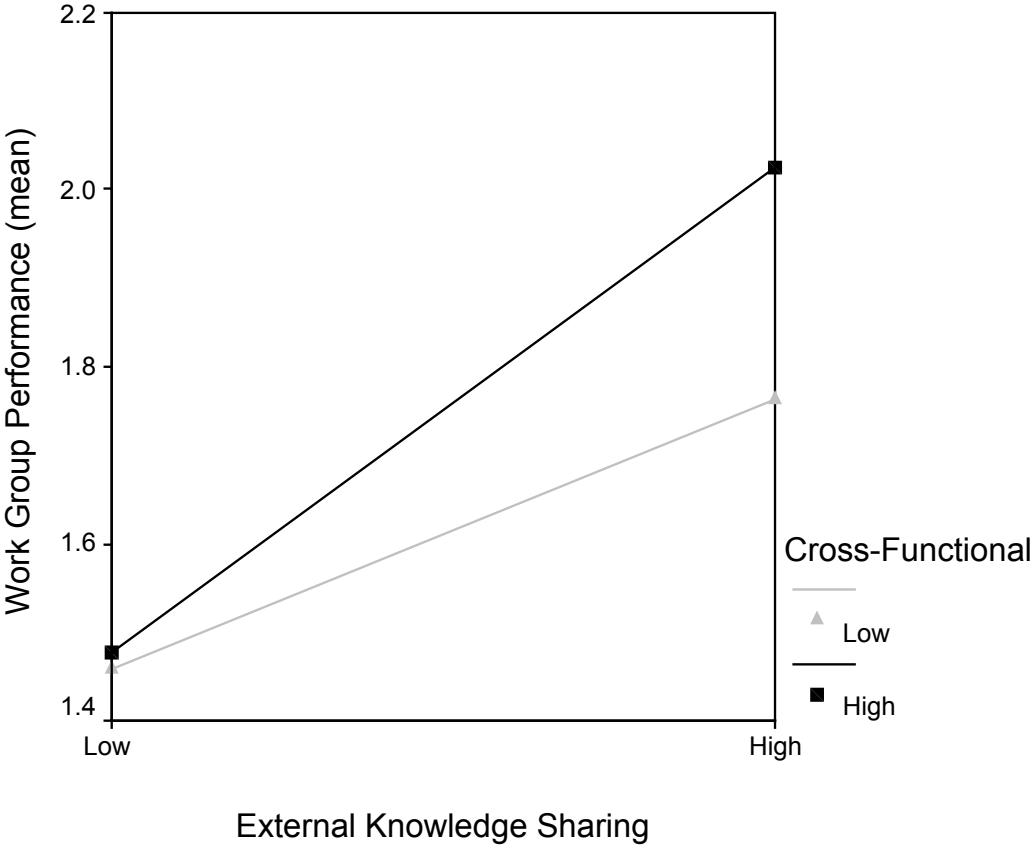
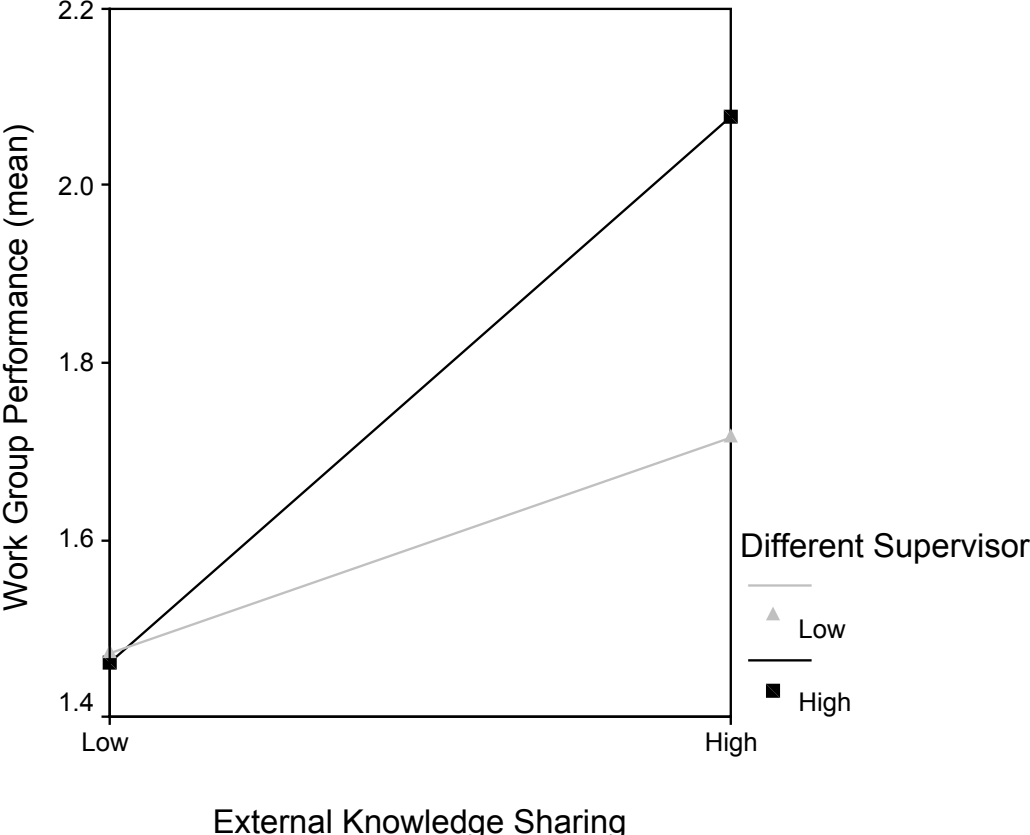


Figure 4. Interaction plot of external knowledge sharing and different supervisors.



Appendix A. Ordered logit analyses predicting work group performance (N = 182 work groups).

Variable	Controls		Hypotheses 4-5		Hypothesis 6		Hypothesis 7		Hypothesis 8	
	B	SE	B	SE	B	SE	B	SE	B	SE
Intercept 1	-2.76	1.76	-9.85	2.53	-9.90	2.53	-10.14	2.56	-10.97	2.57
Intercept 2	-5.10	1.79	-12.45	2.60	-12.58	2.60	-12.86	2.64	-13.72	2.66
Product	.41	.44	.36	.46	.27	.46	.47	.46	.37	.46
Service	-.19	.44	-.23	.46	-.30	.46	-.20	.46	-.14	.46
Process	---	---	---	---	---	---	---	---	---	---
Operations	.19	.43	.05	.45	.02	.45	.08	.45	.10	.46
Size	.19*	.09	.21*	.10	.20*	.10	.21*	.10	.25*	.10
Length	-.11	.23	-.10	.24	-.15	.25	-.07	.25	-.11	.25
Resources	.11	.08	.08	.08	.09	.08	.09	.08	.07	.08
Uncertainty	.02	.06	.04	.06	.04	.06	.03	.06	.03	.06
Closeness	.41	.34	-.34	.40	-.36	.40	-.06	.42	-.27	.40
Difficulty	-.25	.43	.16	.46	.11	.46	.09	.45	.18	.46
Geog. Dist.	.05	.15	.09	.15	.10	.15	.01	.15	.13	.15
Cros. Func.	.44	.36	.53	.38	.38	.39	.60	.38	.56	.38
Diff. Super.	.11	.48	.13	.51	.01	.51	.14	.52	.10	.51
Int. KS			1.32**	.48	1.36**	.48	1.21*	.49	1.45**	.48
Ext. KS			.97**	.31	1.02**	.31	1.00**	.32	1.00**	.32
Geog. Dist. X Int. KS					.02	.18				
Geog. Dist. X Ext. KS					.38*	.19				
Cros. Func. X Int. KS							-.16	.17		
Cros. Func. X Ext. KS							.51**	.19		
Diff. Super. X Int. KS									-.02	.18
Diff. Super. X Ext. KS									.52**	.20
df	12		14		16		16		16	
χ^2	16.20		42.34**		47.18**		49.53**		51.88**	

Note: †p < .10, *p < .05, **p < .01