Leveraging expertise in global software teams: Going outside boundaries

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Abstract

In order to take advantage of lower costs and wider availability of talent, managers often staff software development projects globally. While this practice may be economically appealing there are often hidden costs. This paper reports the results of a study that used social network analysis to study how people in three global software teams acquired and used available expertise through communication and acquisition strategies. We found that frequency of communication was associated with awareness and familiarity of the other person especially awareness of the person’s current work. When it came to acquiring information, members of these teams were more likely to seek specific technical information or administrative help from people outside their software team. People use others on their team with whom they have strong ties to exploit preexisting knowledge but they go to people they know uniquely outside the team for innovative ideas. We discuss the implications of these results for tools that encourage transparent work and for work and management practices.

1. Introduction

For the past several years it has become common for US companies to staff software development projects offshore. A recent study [4] reports that more than 70% of US firms have outsourced some kind of business process. But, cross-site communication and coordination issues can cause substantial delay and increase the amount of time for individual work [15, 16]. Distributed work items can take more than twice as long as co-located work items to complete, in part because time zone differences reduce opportunities for real-time collaboration, and response time increases considerably when working hours at remote locations do not overlap [28]. Global software development has several drawbacks: there is less opportunity for informal communication, a lack of shared work and shared cultural context resulting in communication breakdowns, poorer conflict resolution, and an inability to coordinate work or leverage available expertise. Distance reduces the communication richness when people experience problems that they try and resolve with communication tools rather than face-to-face [32]. As a result, members of distributed teams are less likely than members of co-located teams to perceive themselves as part of the same team [14].

Less well studied is how people in global software teams acquire and leverage the information and knowledge they need to carry out their work. Knowledge acquisition and sharing in global teams is challenging because individual members often do not have the set of common beliefs and attitudes that guide the communication process [6]. This can make it difficult to identify the appropriate expertise at a remote site and therefore to identify the right person to contact with a question [13]. While developments in information technology can overcome communication over distance, the lack of physical proximity has negative impacts on knowledge sharing [25]. Studies of expertise location in collocated software development teams, point to the importance of knowledge coordination rather than the mere presence of expertise as the critical variable in team performance [8].

This paper reports the results of a study on information acquisition and sharing. The study assumes that there is some information and knowledge exchange when people on a team communicate with each other. Accordingly the study set out to examine a) who people communicate with frequently on the team and what factors influence their choice (information sharing), b) what type of information people seek from within the team and from people external to the team (information acquisition) and c) how people use internal and external to the team to create opportunities to create new knowledge and to leverage existing knowledge (learning and innovation).
1.1. Information sharing

Several studies have suggested that coordination of work in distributed software teams is accomplished most effectively through spontaneous, informal communication [1]. When informal interactions do occur, they enhance trust and rapport between remote counterparts [18]. However, an important precursor to this informal communication is awareness of other people and the work they are doing, which can be impaired when team members are not collocated. Previous research has noted that distributed teams can suffer from four types of awareness problems [9] – (a) lack of awareness about others’ activities (what are they doing), (b) lack of awareness about each other’s availability (when can I reach them), (c) lack of awareness about process (where we are in the project), and (d) lack of perspective awareness (what are they thinking and why). Some researchers have argued that software developers on distributed open source projects maintain awareness of one another as well as of the team as a whole. When members are aware of one another’s jobs, roles, and expertise, they develop shared conceptions of task-related knowledge that have the potential to positively influence group coordination and performance [22].

We predict that each of these factors will be related to the frequency of communication. The present study extended the research on awareness by focusing on aspects of awareness most relevant to software development projects, and, the effect of variations in awareness on communication. Specifically, we looked at: (1) awareness of the availability of another person, (2) awareness of what someone else might know, (3) awareness of what someone else is working on and (4) familiarity with someone else from prior work history.

1.2. Information acquisition

Software developers acquire information and knowledge for their project through source code [33] as well as other programming artifacts [11] or from other people on the team who can be the source for specific project and system information, design rationale and history of previously solved problems [31]. Current literature on teams points to permeable boundaries between people who are considered to be within the team and people who are outside the team [24]. One way in which these boundaries are permeable is with regard to information acquisition. In particular each team member has a personal network that extends well beyond their boundaries of their current project, and is a source of valuable and important information.

The present study sought to examine what kind of information was acquired from teammates and what kind of information might be acquired from people outside the team.

1.3. Learning and innovation

Taking the notion of external vs. internal knowledge acquisition further, group learning – the knowledge acquisition, sharing and combination activities of team members [2] has been found to enhance team performance [7], coordinate members’ thoughts and actions and promote team development. Group learning can occur with individuals in the immediate team (internal learning), and with individuals external to the team (external learning). Internal learning helps to build shared understanding and aligns collective actions, whereas external learning helps in the acquisition and development of novel knowledge as the source of innovation [12]. Most teams do not possess all required knowledge within their formal boundaries and must rely on linkages to external individuals to acquire knowledge. They benefit from external network connections because they gain access to new information, expertise, and ideas not available locally, and can interact informally. Learning that is focused on exploiting preexisting knowledge enhances efficiency, while learning that is focused on exploring new knowledge promotes innovativeness. Thus, team members are likely to access and create more similar knowledge in internal learning, and more diverse knowledge in external learning.

The present study examined effects of proximity and density of ties on the perception of whether learning takes place internally or externally. We expect there will be high internal learning when there is a high density of ties and low internal learning when there is a low density of ties. We also examined when external learning, an important ingredient in bringing new ideas into the group, takes place by looking at the size of the external network and the overlap in ties. We expect that those people who are linked to more people outside the teams and who know few people in common with their teammates inside the team will be the source of innovative ideas.

2. Methods

The study was conducted with three teams who were developing custom software solutions for clients. These teams were project based; they came together for a project and then disbanded when the project was completed. Some of the projects were a distinct phase of on-going projects or were projects going on in parallel with other related projects often for the same client.
The teams were selected for us by an advisory board made up of senior people from within the organization who were overseeing this and other unrelated projects. The selection criteria they were given were that (1) the teams should be using some offshore resources, (2) they should have started the design of the software but not yet completed development and (3) have between 20 and 75 people. There were 3 teams who matched or came close to matching these criteria and who were available to us, called Team1, Team2 and Team3. Team1 was building a new workforce application for a large technology client; Team2 was building an e-commerce solution for a retail client and Team3 was using existing software packages to build a set of applications for customer care and billing for a telecommunications client. All teams represented one phase of larger projects. The leader of each team, who was usually the project manager, furnished us with the names, email addresses and roles of all the people known to be officially connected with the project. Team members included project managers, designers, business analysts and application testers as well as the core engineering team made up of application developers, architects and UI designer/developers. We had a 77% response rate from Team1 (n=30/39), a 79% response rate from Team2 (n = 15/19) and an 83% response rate from Team3 (n=66/79).

Although performance was not one of our criteria all teams were successful as indicated by two independent measures. First, all teams met or exceeded their budgets. Second, for each team, we also had two people who were outside the team but familiar with the work, a total of 6 raters, rate the team’s performance, as compared with a highly successful comparable team, on a 5 point Likert scale. We adapted this scale from one that had been used previously for a similar study [8].

- Efficiency of team operations
- Amount of work the team produces
- Team’s adherence to schedules
- Team’s adherence to budgets
- Quality of work the team produces
- Effectiveness of team’s interactions with people outside the team
- Team’s ability to meet project goals
- Ability to do the work faster with the same quality
- Speed of meeting goals

The average rating received by the three teams was 1.85 (1 is high) with all teams being scored by the raters at about the same level on each scale.

2.1. Data Collection

Data were collected through an online survey administered to each team independently between June and July 2005. The survey consisted of 31 items including questions on demographics (length of time in the firm, length of time with the team, level in the organization, primary location, time on the project, primary role on the project, and self-assessed level of expertise), technology use and perception of team interaction. The survey included a question inviting respondents to give their ideas about the challenges of working remotely. We also conducted phone or face-to-face interviews with 2-3 people from each team.

We examined the effect of awareness on communication by asking respondents to indicate their awareness of availability, general awareness, current awareness and familiarity of each of their teammates in addition to their frequency of communication and general level of importance of communication.

- **Communication.** How often have you communicated with this person about requirements or design for this project over the past 3 months? (5 point scale: Not at all, Less than once a month, At least once a month, At least once a week, Daily)

- **Availability.** How easy is it for you to reach this person when you need help or information related to this project? (4 point scale: Very hard to reach – Very easy to reach)

- **General awareness.** How aware are you of this person’s professional background and how his/her skills could help you in your work on this project? (4 point scale: Very unaware – Very aware)

- **Current awareness** How aware are you of the current set of tasks that this person is working on? (4 point scale: Very unaware – Very aware)

- **Familiarity.** How closely did you work with this person on your last project together? (5 point scale: This is the first project I have worked with this person, We communicated directly less than once a month, at least once a month, at least once a week, at least once a day)

- **Importance.** How important is it for you to interact with this person in order to get your work done for the project? (4 point scale: Very Unimportant – Very Important)

We used the same relational approach to find out which people on the team provided help or information by asking, “What kind of help or information do you normally seek from this person?” Responses were:

- I have not sought information from this person
• General software development issues
• Specific technical information and help related to coding/programming
• Help in finding expertise and resources
• Administration in connection with the project
• Other information

To assess where people are going for information, these same questions were also asked of each respondents' personal network outside the team. The following question was used as a name generator, “please identify the names of up to 15 additional people that you communicate with at least once a week in connection with the project.”

3. Results

Table 1 shows the location information for the respondents in each team. Only those people who responded to the survey are included. Members of Team1 worked out of different offices in the US including people who split their time between working at home and working in the main office (home and office). Team2 was mostly based in the US but included members who worked offshore in India. Team3 was split between the UK and India with almost all the team working from an office in India. For purposes of analysis we used India as the main office and the UK as offshore for Team3 to reflect the location of the majority of people.

<table>
<thead>
<tr>
<th>Team</th>
<th>Main Office</th>
<th>Home Office</th>
<th>Other Home/Office</th>
<th>Offshore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team1 (n=30)</td>
<td>13%</td>
<td>40%</td>
<td>10%</td>
<td>30%</td>
</tr>
<tr>
<td>Team2 (n=19)</td>
<td>79%</td>
<td>_</td>
<td>_</td>
<td>21%</td>
</tr>
<tr>
<td>Team3 (n=79)</td>
<td>85%</td>
<td>_</td>
<td>_</td>
<td>15%</td>
</tr>
</tbody>
</table>

Table 1: Primary work location of respondents

3.1. Information Sharing

We analyzed the data using traditional statistical methods as well as statistical methods associated with Social Network Analysis [3]. Network data were represented as adjacency matrices, with both columns and rows representing team members, and the cells representing self-report survey responses of the extent of dyadic communication, awareness, work history, and availability respectively for each informal network. We tested the communication network model statistically using network correlation and regression analyses. As social network data are not independent and do not satisfy assumptions of statistical inference in traditional regression, we used special procedures such as QAP and MRQAP [3, 20] to run the correlations and multiple regressions. We did a regression analysis of these network factors (availability, importance, familiarity, general and current awareness) on communication. To ensure that the results were not affected by missing responses, we replaced missing data with average values for each informal network. We dichotomized the data for each network at these levels:

• Communication (communicate at least weekly/daily)
• Availability (easy/very easy to reach)
• Importance (important/very important)
• Familiarity (worked together in previous projects and communicated at least weekly/daily)
• General awareness (aware/very aware)
• Current awareness (aware/very aware)

Table 2 provides the QAP correlations between each informal network and the communication network for all three teams. There was no appreciable difference in the results between the three teams (t=0.06, p>0.10), so we combined the data in the regression analyses.

<table>
<thead>
<tr>
<th>Variable</th>
<th>beta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall r^2</td>
<td>0.57**</td>
</tr>
<tr>
<td>Availability network</td>
<td>-0.01</td>
</tr>
<tr>
<td>General awareness network</td>
<td>0.03*</td>
</tr>
<tr>
<td>Current awareness network</td>
<td>0.24**</td>
</tr>
<tr>
<td>Familiarity network</td>
<td>0.25**</td>
</tr>
<tr>
<td>Importance network</td>
<td>0.34**</td>
</tr>
</tbody>
</table>

n = 137  * p < 0.05  ** p < 0.001

Table 2: Regression of awareness variables on communication network

The main predictions are supported. All aspects of awareness, except for availability, are correlated with communication although general awareness was not as strong as other factors. There was no effect of availability which could reflect the broad availability of communication technologies including instant messaging as well as email and phone. As expected there is also more communication when people attach importance to the communication.

We further analyzed the effect of location on awareness. It was clear from some of the comments we received that even with technology, it can be hard to feel connected with remote people on the team. For
instance, one person commented on the difficulty of establishing interpersonal connections with remote people by saying, “Communication with people whom we have never met is a problem”. Another pointed out “Personalities are missing. Tough to tell through an instant message whether some one understands. A "K" is not a substitute for a facial expression.” Another said, “Without having worked together (co-located) in the past it is harder to establish a working relationship based on modern communications media. I also feel less inclined to initiate the type of informal communication (question comment etc) via say a phone call that I would with someone sitting next to me working on the same issue.” And “People in remote locations most often have different work cultures and it sometimes becomes difficult to adjust.”

We examined whether awareness declines when people are not collocated by coding pairs of people as collocated if they were both working in the main office or both working in the offshore office, since each team only had one offshore office. We coded people as remote if one person was in any office and the other person was offshore. To accommodate those people who were working within the U.S. but not in the main office we coded any combination of one person in the main office and the other person in an office other than the main or offshore office as distributed meaning that were not working out of the same office but they were not offshore either. Data from all three teams were combined after first examining the data from each team individually and determining that they were similar. The resulting analysis (n = 137) revealed that there was a significant decline in communication (r = 0.15, p < 0.05), availability (r = 0.19 p < 0.05), general awareness (r = 0.14, p < 0.05) and current awareness (r = 0.26, p < 0.05) over distance. There was no significant decline in familiarity over distance. These data highlight the importance of awareness for communication in software teams and confirm previous studies showing that awareness can be impaired when team members are not collocated.

Collocation is important because it affords the opportunity for face to face communication which is often necessary to build rapport and trust. One of the participants said, “Face to face does provide benefits in that multiple sources of information can be easily consulted and used to develop discussions to solve issues.” Another said, “It sometimes takes longer to get information / decisions / agreements when you’re not face to face.” Even when the teams were working remotely they had met each other.

Despite the challenges of working with people from different countries, time zones and cultures, these groups were able to find ways to engage in productive work which let them transcend some of the challenges of distributed work. Our first indication that the teams were working well together was that they gave high scores on a series of questions designed to elicit their values and norms as indicators of their social climate. The respondents were asked to indicate their agreement with statements about the team using a 5-point Likert scale (5 high). There were no significant differences between the groups.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems are discussed openly and honestly in this team</td>
<td>4.42</td>
</tr>
<tr>
<td>This team’s communication is effective in meeting project goals</td>
<td>4.35</td>
</tr>
<tr>
<td>Diverse perspectives are valued in this team</td>
<td>4.04</td>
</tr>
<tr>
<td>Our team explores one another’s ideas to invent new or better ways we might perform our task</td>
<td>3.57</td>
</tr>
<tr>
<td>Our team seeks ideas/expertise from people external to the team</td>
<td>3.27</td>
</tr>
</tbody>
</table>

Table 3: Perception of team cohesion

Our second indication came from an analysis that showed the indirect effects of communication on team climate. Using the communication data, we ran a regression analysis, based on centrality in a network, on the perceived communication effectiveness and team climate. We found a correlation between communication effectiveness and centrality in the communication network (r = 0.41, p <0.001) and in the current awareness network (r = 0.34, p <0.001). Individuals who are more central can exert more influence by virtue of being connected with other powerful individuals in the network, and have access to more resources than less central counterparts. An individual’s structural position also influences their interpretations of events, perceptions, cognitions, and behaviors [27]. Individuals in structurally central position can benefit from others’ experiences and perceptions, and are likely to influence team outcomes, especially in the context of distributed software teams where information sharing is critical. Our findings support this research. We found that individuals who are central in the communication and peripheral awareness networks are also more likely to perceive that the team is communicating effectively which in turn can lead to a more positive climate for all members of the team.

In addition, we learned through interviews, that some of the teams engaged in intentional actions to facilitate communication and identity amongst distributed team members. At least one team developed

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In addition, we learned through interviews, that some of the teams engaged in intentional actions to facilitate communication and identity amongst distributed team members. At least one team developed
a very strong culture of behaving as a single team. This orientation was reinforced by the practice of having the developers, local and remote, meet the client face-to-face onsite. Although this is common practice in many software development teams, this team took the practice one step further by also arranging for the client to travel to India to meet the developers. The practice of meeting face to face in both locations had a huge effect on the team and reinforced notions of partnership and mutual accountability between the client and developer, a concept that was regularly emphasized in the leadership style of the project managers.

3.2. Information Acquisition

To understand where team members go to find information and expertise, we included a question in the survey that asked respondents to generate the names but asking them to “identify the names of up to 15 additional people that you communicate with at least once a week in connection with the project”. Most respondents (84%) provided at least one name for this question. Respondents in Team1 generated an average of 2.8 names, Team2, 3.2 names and Team3, 7.1 names. To assess what type of information was sought from teammates and from people outside the team, we analyzed responses to the question, “What kind of help or information do you normally seek from this person”. There were 6 options including “I do not seek information from this person”. Respondents selected one option for each team member they knew, and, independently, one response for each of the names they generated. The response rates for internal (within team) and external (outside team) are shown in Table 4. We had a total of 95 respondents across the 3 teams who provided data for both internal and external sources.

We compared internal and external responses for each respondent as a within-subjects design. Overall, people sought information from just over half their teammates with general software development questions being the most common. By contrast, the same people sought some kind of information from almost 90% of their personal network outside the team ($t_{94} = 9.13, p < 0.001$). In terms of the type of information sought, respondents were more likely to get specific technical information ($t_{94} = 3.45, p < 0.001$) externally which was also the most common type of information sought overall except for “Other”. Although some of the differences we found could be an artifact of the larger number of people known in the teams than in the external networks there remains a different distribution of responses between internal and external sources.

<table>
<thead>
<tr>
<th></th>
<th>Internal</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average no people known</td>
<td>29.5</td>
<td>4.4</td>
</tr>
<tr>
<td>No help sought</td>
<td>47%**</td>
<td>11%</td>
</tr>
<tr>
<td>General software development</td>
<td>16%</td>
<td>12%</td>
</tr>
<tr>
<td>Specific technical information and help related to coding/programming</td>
<td>13%</td>
<td>26%**</td>
</tr>
<tr>
<td>Finding expertise and resources</td>
<td>5%</td>
<td>7%</td>
</tr>
<tr>
<td>Administrative help in connection with project</td>
<td>8%</td>
<td>13%*</td>
</tr>
<tr>
<td>Other information</td>
<td>12%</td>
<td>29%**</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

*p < 0.10; ** p < 0.001

Table 4: Type of information sought internally (within team) and externally (from people outside the team)

It is less surprising that people outside the team should be a good source for specific technical information when one considers the use of broadcast messages that often have a subject line starting with, “Who knows…”. Previous research [5] demonstrated that people use this method to get quality technical advice, from those they don’t know or only know indirectly but who are in the same organization (weak ties). Given the use of weak ties for specific technical information one might expect the strong ties of the personal network to be a good source of general information. However, our results indicated the opposite effect. People were much more likely to use their personal network for specific technical information than for general software development ($t_{94} = 2.4, p < 0.001$).

In our study, people are going to outside sources, because those people often have specific technical expertise that may not be present in the team. For instance one of the developers, who was doing a lot of web development, told us, “Sometimes there are unresolved issues that no one within the internal network has the solution for. It may be easier to seek help from an external expert rather than spend much time trying to figure out the answer on my own.”

After they generated the names, respondents were also asked to indicate the location of each person. Interestingly, respondents did not just name people who were in the same office or even local to them. In fact proportionally more of the people named by the respondents were offshore than were the other people on their team. The location of people external to the team, relative to the respondent is shown in Table 5.
3.3. Learning and innovation

To understand the extent of distance and communication effects on internal and external learning, we included the following questions in the network survey:

- **Internal Learning.** Our team explores one another’s ideas to invent new or better ways we might perform our task. (5 point Likert scale: Strongly Disagree – Strongly Agree)
- **External Learning.** Our team seeks ideas/expertise from people external to the team. (5 point Likert scale: Strongly Disagree – Strongly Agree)

We examined the effects of proximity and communication on internal learning. The responses for internal learning were regressed with spatial proximity (a measure of the physical distance between team members, i.e. whether they are collocated, partially collocated with a mixture of home and local office, in the same geographical region within the same country, in different geographical regions within the same country, or in remote offices across national boundaries) and communication density (a measure of the number of ties in one’s communication network). As expected, the findings suggest that teams that have high physical proximity and dense communication ties tend to engage in more local internal learning. However, it is interesting to note that teams that are geographically apart might overcome some of the distance problems and have high levels of internal learning if they have strong and dense communication ties between individuals. Proximity has little impact on internal learning when the density of the teams’ communication network is low. The results seem to suggest that internal learning takes places when individuals are embedded in strong communication networks within the team, and information sharing within the team is easier to occur between members who are collocated than with members who are in offshore locations. While we found earlier that a major percentage of team members are not seeking help from one another, those who seek either general or specific technical information and expertise often acquire and share knowledge with members who they are physically closer and often communicate with in the team. The results are depicted by the surface plot of the relationships between proximity, communication and internal learning in Figure 1. The external learning results are responses for the teamwork question in the survey (Our team seeks ideas/expertise from people external to the team). The surface plot is comprised of data points from the survey responses. Each data point represents the aggregated responses of a subgroup of people. The “size of external network” is determined by the total number of people in the personal network of the subgroup, and the "overlap in external network" is computed as the number of times that a common person exists in the responses of the subgroup. The interpretation of the external learning is like a correlation analysis on how both factors (size and overlap) influence the survey responses for external learning.

<table>
<thead>
<tr>
<th>Team1 (n= 26)</th>
<th>Same Office</th>
<th>Local (within 1 hr drive)</th>
<th>Same country</th>
<th>Off-shore</th>
</tr>
</thead>
<tbody>
<tr>
<td>6%</td>
<td>6%</td>
<td>53%</td>
<td>36%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Team2 (n= 13)</th>
<th>Same Office</th>
<th>Local (within 1 hr drive)</th>
<th>Same country</th>
<th>Off-shore</th>
</tr>
</thead>
<tbody>
<tr>
<td>19%</td>
<td>5%</td>
<td>67%</td>
<td>9%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Team3 (n= 52)</th>
<th>Same Office</th>
<th>Local (within 1 hr drive)</th>
<th>Same country</th>
<th>Off-shore</th>
</tr>
</thead>
<tbody>
<tr>
<td>65%</td>
<td>6%</td>
<td>6%</td>
<td>22%</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Primary work location of identified people outside the team relative to respondent

**Figure 1: Surface Plot of Proximity (P), Density of Communication Network (D), and Internal Learning (IL)**

Figure 2 highlights the associations between external learning, overlap of team members’ communication ties to people external to the teams, and size of an individual’s external personal network. Our findings suggest that people who are linked to more people outside their teams and have little overlap with their fellow team members in relationships to these external people are more likely to bring
innovative new knowledge into the team. Higher levels of external learning are observed for teams with bigger external networks but fewer overlaps in these external ties between individual team members. The overlap in external network ties has very little impact on external learning when the size of the external network is small. The results suggest that external learning takes place when one maintains strong relationships with a large group of experts in one’s personal networks outside the team, but it is important that each team member is linked to different external people who might inject innovative ideas and new knowledge into the team. As we found earlier, team members are likely to go to external people for specific technical information and help in technical issues, those who seek more information from people that are not already in their own team members’ personal networks are more likely to have access to a wealthy pool of external knowledge that benefits the team.

Summary of Results

<table>
<thead>
<tr>
<th></th>
<th>High S</th>
<th>Low S</th>
</tr>
</thead>
<tbody>
<tr>
<td>High OT</td>
<td>Medium EL</td>
<td>Low EL</td>
</tr>
<tr>
<td>Low OT</td>
<td>High EL</td>
<td>Low EL</td>
</tr>
</tbody>
</table>

Figure 2: Surface Plot of External Network Size, Overlap in External Ties (OT), and External Learning (EL)

4. Discussion

Given the current economic climate and technical affordances of widely available communication tools, we should expect to see continuation of globally staffed software development teams. Although there are many advantages of these teams they also face challenges associated with the distribution of members across time zones, cultures and languages. These challenges affect many aspects of the software development process, most especially the informal communication that is an integral part of coordinating code development, negotiating changes and resolving conflicts. This paper reports the results of a study that sought to examine how people on global software teams overcome the challenges to find, leverage and extend the information needed to accomplish their work.

We first examined information sharing by studying who people talk to on of the team. We found that people communicate frequently with someone when they are aware of what that person is working on, have some awareness of the person’s general knowledge and skills or when they are familiar with that person from a prior project. But we also found that people are less aware of people who are remote than people who are in the same office. If we make the assumption that people share information and knowledge when they communicate, it is important that software teams in general but especially global teams improve their awareness and familiarity of other team members by making the work they do more transparent and accessible to all team members. One approach is to use some kind of synchronous shared environment that supports persistent and contextual chat [17, 29] or through mailing lists and chat systems as is the case with open source development projects [11]. Although it is not unusual to staff software development projects with people who have worked together on previous projects, the current study suggests that it is a good practice for teams to adopt intentionally as a way of establishing some of the informal linkages that are necessary for communication and collaboration. People who already know each other, provided that the relationship is positive, can provide some organizational persistence which could speed the adoption of a teamwork culture and way of working.

People on global software teams also face the challenge of locating the right person for advice and information on technical matters. In this study we found that people are more likely to turn to the people they know outside the team especially for technical information related to coding and programming. Moreover, these people were not necessarily physically closer than other people on the team. This result is surprising if one sees software teams as intact units that not only provide the resources for doing the work, but also as the main repository of technical expertise. But, as this study and a growing body of research points to, team boundaries are often permeable [24, 30].

When people join a software development or any other team they bring with them, their own personal network of connections whom they often turn to for information and advice often on technical issues that arise in the course of the project. Managers of global
Software teams can improve information access and learning by encouraging rather than discouraging people from reaching out to colleagues outside the team, and by rewarding people from bringing in external information and ideas. Although practices and tools that can mitigate the potential disadvantages of remote software development, we believe that it remains important for members of the team to meet face to face with their remote colleagues once in a while.

As further elaboration of the relevance of external resources we explored how people on a global software team use a combination of internal and external sources to acquire and learn new ideas and knowledge. Our analysis of the responses to a pair of questions about internal and external source of ideas coupled with measures of density and the overlap in personal networks revealed that high internal learning that exploits preexisting knowledge, came from people who were physically close and had a lot of strong ties. External learning, which is focused on new knowledge and innovation, came from people who had a relatively unique and large personal network.

We need to be somewhat cautious in how broadly we interpret our results. Although we obtained consistent results from three unrelated teams, the sample size is still small and as such includes data and results that may be idiosyncratic to the particulars of these teams and the work they were doing. All the teams were using offshore resources but these resources were a minority, so we can’t extrapolate to teams where there is a more equal distribution of people onshore and offshore. Moreover, all teams were successful and productive not only in reaching their goals but also from the viewpoint of the team members. We conjecture that they were productive in part because they had evolved a positive climate of work which in turn was influenced by the attitude and behaviors of some of the informal team leaders.

Previous studies have often highlighted the negative effects of global software projects. Although research makes it clear that collocated work is generally more productive, it is helpful to consider how we can improve upon some of the negative effects of distributed work. The results from this study begin to make a contribution to that line of research by using social network analysis to focus on factors influencing informal communication and information acquisition.

Software projects require a clear set of processes that are consistently executed, a robust technology infrastructure and set of shared development tools. But team members also need to engage in informal communication with their peers to coordinate their code development, negotiate changes and resolve conflicts. In this paper we have tried to outline some of the elements of that informal communication in terms of how it is affected by awareness and familiarity with other people, the role of leadership and the affective dimensions of team behavior and the role of people inside and outside the team as sources of important knowledge and information.

5. References


