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Abstract

Partially distributed global teams form an important work structure in software development projects. However, little is known about the challenges such team structures create in supporting team members' motivation and maintaining member job satisfaction. This study investigates the effects of leader delegation, task significance and trust between local and distributed members of a team on team member motivation and job satisfaction. The paper also proposes a research model and a set of hypotheses regarding these effects. A pilot study performed on student teams is described which tests portions of the research model. The study found that distributed software team leaders delegate more to competent teams and that delegation is positively correlated with team member satisfaction with their leader and with team member motivation. The results form this work suggest both that global team leaders need to assess team competence when delegating tasks and also that organizations putting together global teams should strive to create highly competent teams since member distribution entrains higher delegation.

Keywords: global software team, trust, leader delegation, motivation

1. Introduction

Using global teams is an increasingly popular way of offshoring software development from high-cost economies such as the U.S., and U.K. to lower-cost economies such as India, China, and Russia. Global software development teams provide access to lower-cost labor as well as a range of disciplines and technical specialties (Curtis et al. 1988). To handle large and complicated projects, global software development teams often consist of several collocated sub-teams, each working on a particular part of the project. Members of each sub-team typically reside at one site and use electronic media to interact and collaborate with other sub-teams residing at other sites. Virtual team literature suggests that this type of partially distributed team structure presents unique challenges to improving team emotional outcomes such as team members' motivation and job satisfaction due to in-group/out-group effects and lack of trust between sub-teams (Bos et al., 2004; Huang & Ocker,

2006). However, few studies have explored the effects of a partially distributed team structure on global project management and inter-team dynamics. In addition, while improving team members' motivation and job satisfaction are important to global software project performance and to retaining valuable IT talents, current studies have been largely focused on issues such as team process loss and team performance issues (e.g. Cramton 1997; Meadow 1996).

This paper aims to address these gaps in the current literature by investigating the impact of leader delegation on a sub-team, the impact of inter-team trust and the impact of sub-team task assignment on team members' motivation and satisfaction in partially distributed global software teams.

The paper is structured as follows: first, based on a review of the literature, specific research hypotheses are explained; then, a graphical model that illustrates these research hypotheses is presented; and finally, the pilot study testing key parts of the model is described. The final section of this paper concludes with a summary, a set of contributions and a list of limitations of this research.

2. Leader Delegation

Delegation means that one has been empowered by one's superior to take responsibility for certain activities, which were originally reserved for the superior (Bass 1990). Very few studies, though, have investigated delegation as a distinct management practice (Yukl & Fu 1999). One important limitation of previous delegation studies is that little differentiation has been done as to which aspects or activities the leader delegates. To overcome this limitation, this study delineates four major categories of management functions that can be delegated. The four delegation categories are based on different existing taxonomies of leader management functions (e.g. Komaki et al. 1986; Mackenzie 1969). The four categories are as follows:

- Planning related functions (e.g., setting objectives, setting policies)
- People related functions (e.g., hiring team members, firing team members)
- Process related functions (e.g., determining work method)
- Control functions (e.g., monitoring team progress, determining corrective actions)

In global software teams, the distances between the team leader and a sub-team will impact the level of leader delegation, but in a negative way. The distances (geographical, cultural, temporal and organizational) reduce the frequency and the effectiveness of the communication between the leader and a sub-team (Krumar et al., 2004) and make it difficult to judge the quality and skill of technical staff at another site (Herbsleb et al. 2005). Meadows' (1996) research also suggests that managers lack the direct and nuanced connectivity to subordinates common in collocated situations. These issues will make the team leader reluctant to give control to the remote sub-team and thus the following hypothesis is proposed:

Hypothesis 1a: *Geographical distance, cultural distance, organizational distance and temporal distance between a sub-team and the project management team (or project manager) will lower the delegation the project management gives to this sub-team.*

The degree to which leader delegates to a sub-team in a global software project also depends on the competence level of the sub-team. Sub-team competence is related to the knowledge and skills of the members and also to the amount of previous experience they have had with respect to the current team task.

Developing subordinates' skills and confidence is the biggest reason why leaders delegate or consult their followers when followers' skill sets are still being developed (Yukl & Fu 1999) The potential growth of the followers, however, cannot be achieved without cost. First, delegation to incompetent followers comes at the expense of a short-term performance loss (Moore 1982). Second, in the distributed global software team environment, close monitoring and timely feedback is difficult because "management by walking around" cannot be used as a managerial strategy (Pare & Dube 1999). Due to increased temporal distances, cultural distances and the lean nature of computer-mediated communication, leaders will need to spend much more time and effort coordinating, monitoring and coaching team followers on the delegated tasks. Third, in delegating to incompetent followers, unlike line managers who may treat the costs of delegation as an investment to be redeemed later, global software team managers are faced with the costs of sacrificing team performance, which may determine the manager's own promotion and career growth. Based on this argument, Hypothesis 1a is put forth:

> **Hypothesis 1b**: *The competence of a virtual team predicts the delegation behaviors of its leaders such that virtual team leaders will not delegate or will delegate little when they deem that the team is incompetent.*

The reluctance of central management to delegate to sub-teams is not rare in software engineering projects and may produce negative consequences. One consequence is that due to a lack of understanding about the activities and cultures in the sub-team, the central management may not manage the sub-team effectively as a local manager or self-managed sub-team would. The following quotes from Meadow's (1996) study demonstrates this point:

> "A common mistake of on-site managers is not letting the off-site manager manage the off-site people. The off-site manager knows the situation minute-to-minute and is from the same culture, able to understand all the nuances of what the team members will and will not say outright"

In contrast, delegation will increase the autonomy of the sub-teams and reduce the need for cross-site collaboration (Treinen & Miller-Frost, 2006) and thus reduce the complexities and difficulties the remote sub-team members might experience in virtual interaction. This may lower levels of overload, which frequently affects IT professionals. Delegation will cause the sub-teams to feel a sense of being trusted by their leader and to enjoy the autonomy in day-to-day work. Team members will be able to structure tasks in ways that are intrinsically motivating (Wrzesniewski & Dutton 2001). Based on these arguments, Hypothesis 2a and 2b are put forth:

> **Hypothesis 2a**: *The more delegation a sub-team gets, the more motivated sub-team members will be in the project.*
> **Hypothesis 2b:** *The more delegation a sub-team gets, the more satisfied sub-team members will be in the project.*

3. Significance of Sub-team's Task

Treinen and Miller-Frost (2006) found that mutual responsibility and shared goals are very important and that no sub-team should be put in a secondary position in a global software project. However, this easily happens to remote teams. Assigning mundane or non-significant tasks to a sub-team will reduce the team members' motivation and make them feel less valued by the organization. Working on challenging and significant tasks is an important way for IT professionals to climb up the career ladder and will make them do their best in the project (Levina, 2006). Kirkman et al. (2004) also found that the more impact a virtual team can make, the more empowered and motivated the team members may feel. In addition, there often exists competition between sites for higher organizational power and more organizational resources. Performing significant tasks improves offshore team's position and power (Holmstrom et al. 2006). Therefore, the importance level of a sub-team's tasks will influence the motivation and the satisfaction of a sub-team member in the project as presented in the following hypothesis:

> **Hypothesis 3a:** *The significance of a sub-team's task will improve the sub-team members' motivation*
> **Hypothesis 3b:** *The significance of a sub-team's task will improve the sub-team members' satisfaction in the project.*

4. Trust between Sub-Teams

Trust has been defined as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (Mayer et al., 1995, p. 712). Past studies have emphasized the difficulty of building trust and the importance of trust in virtual teams (Javenpaa & Leidner, 1999). The issue of trust is especially acute in partially distributed teams as the collocated sub-team members tend to collaborate and form relationships and have the "them vs. us" mentality (Bos et. al., 2005). This paper identifies three factors that impact trust between members from different sub-teams in a global software project: competence of a sub-team, distance between sub-teams, and communication quality between sub-teams.

The competence of a sub-team determines how much members of other sub-teams will trust this team. Technical capability is frequently mentioned as an important factor in building and maintaining trust in offshore partners engaged in global software projects (Nguyen et al., 2006).

> **Hypothesis 4a**: *the more competent a sub-team is, the more members of other sub-teams will trust this team.*

However, boundaries in global software projects like geographic distance and cultural differences may make it difficult to develop trust (O'Hara-Devereaux &

Johansen, 1994; Handy, 1995; Lee & Kim, 1999) between sub-teams. In studying nine global software projects, Herbsleb & Bass (2005) found that it is very difficult to judge the quality and skill of technical staff at remote sites due to the distances between sites and the consequent communication difficulties. The distances between the teams results in the "them vs. us mentality" and forms the in-group/out-group effect (Bos et al., 2004; Bos et al., 2005; Huang & Ocker, 2006) which seriously undermines the trust members of a sub-team might have towards the other sub-teams.

Hypothesis 4b*: Geographical distance, cultural distance, organizational distance and temporal distance between sub-teams will lower the trust between the sub-teams*

Distances between sub-teams also limits the possibilities for sub-teams to interact with each other, and the limited communication may cause the sub-teams to negatively stereotype each other (Bos et al. 2005; Huang & Ocker 2006). For example: language barriers as part of cultural distances cause reduced project participation from non-native speakers, less frequent communications, longer times to communicate, and more misunderstandings (Espinosa, 2006); time zone distances (temporal distance) impede real-time communication; geographic distances reduce chances for face-to-face communication. A collocated team, given the same short time frame, is more likely to provide members with the feedback and information necessary to establish trust. As teamwork continues, additional feedback and social interactions create situational trust. The ability to comprehend the situation, and thus, form situational trust, is constrained in virtual teams, leaving virtual team members to rely on the more fragile swift trust and/or dispositional trust. Therefore improving communication between members of the sub-teams, especially the face-to-face interactions, is important to overcome the communication barriers brought by team distances in order to promote trust building and trust maintenance between members of the sub-teams. High quality communication such as frequent responsive communication and the ability to convey complex abstract concepts is important to demonstrate one's capability to the remote team, clear up misunderstandings and build trusting relationships (Huang & Ocker 2006). Levina (2006) also found that frequent cross-boundary communication improves the relationship and trust between members separated by geographical and organizational boundaries.

Hypothesis 4c: *Higher quality communication between sub-teams improves trust between sub-teams.*

If one's sub-team is trusted by other sub-teams, it means that this team's capabilities are recognized by other teams and that this team engages in trusting enjoyable relationships with other teams. If one could trust other sub-teams, one could be confident in other sub-teams' commitment and capabilities to collaborate on the project and be confident that other sub-teams would not slow down the project or take a free ride on the work needing to be accomplished. Also, trust reduces the costs of controlling and monitoring efforts in distributed teams (Kanawattanachai & Yoo 2002). Therefore, trust between sub-teams can be expected to improve one's motivation and satisfaction in the project.

Hypothesis 5a*: Trust between sub-teams will improve sub-team members' motivation in the project.*

Hypothesis 5b: *Trust between sub-teams will improve sub-team members'* *satisfaction in the project.*

5. Team Performance

Finally, team performance, as with individual performance, is a function of ability and motivation (Janz et al. 1997). Significant improvement in team performance is expected from motivated teams members. If team members were very motivated and satisfied with the project, they would work harder and therefore improve the team's performance in the project.

> **Hypothesis 6a**: *Sub-team members' motivation in the project will improve the sub-team's performance in the project.*
>
> **Hypothesis 6b**: *Sub-team members' satisfaction in the project will improve the sub-team's performance in the project.*

6. Research Model

Based on the propositions presented in previous sections, the authors propose the following conceptual model:
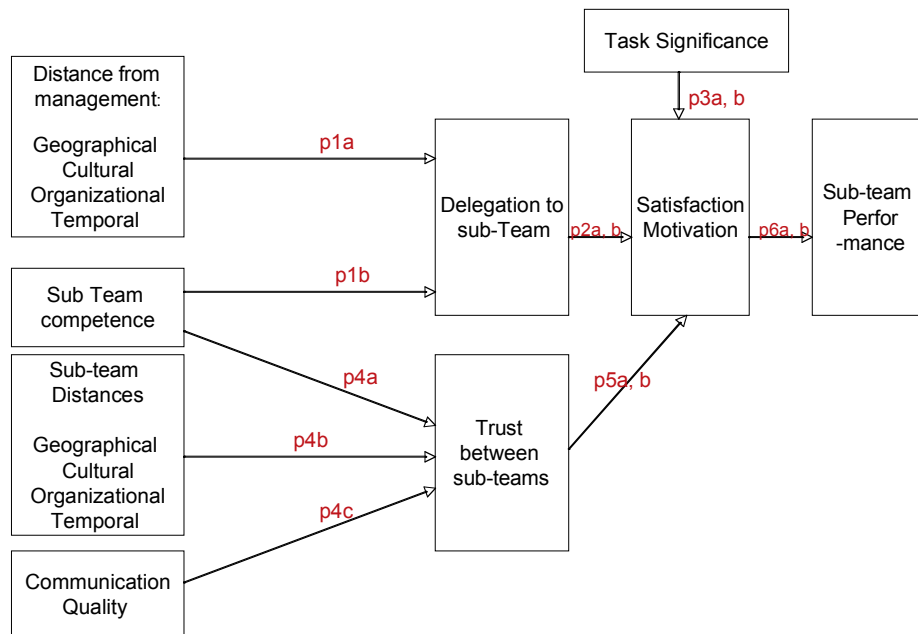

Figure 1: Research Model

7. Pilot Study

Before the planned full-scale study, the authors conducted pilot studies for a preliminary test of the research hypotheses. This section will report findings from one of the pilot studies. As the research model of this study involves multiple constructs and hypotheses, the pilot study reported in this paper only tests parts of the research model related to leader delegation. A full-scale study with global software development teams from two large-scale IT companies is currently underway to explore the research hypotheses.

7.1. Pilot Study Design and Sample

Forty-eight students in 30 software-development teams took an online survey that requested information about the variables presented in the hypotheses. Thirty-two males and 16 females; 3 graduate students and 45 undergraduate students participated. All participants were involved in teams that were engaged in developing a single software program for the entire semester. Team size ranged from 3-5 members, with a team leader elected by team members. The survey was given near the end of the semester so the team members had worked together for about three months. For all teams, the entire team met face-to-face at least once a week but conducted much of their business virtually through email and online chats.   .

In the second round of the survey, 34 graduate students from 14 report-writing teams took the online survey. The team task was to analyze an industry case study and write a team report based on the case study results. The teams consisted of 5 to 6 members with team leaders elected by the team members. The survey was given after the team finished their first case study project. These 14 teams were taking a 2-month summer online management information systems course. Only two teams reported meeting face-to-face once a week. The other teams did not meet face-to-face during the team project.

The teams in this pilot study were distributed and relied heavily on communication technology instead of face-to-face interaction for team collaboration.

7.2. Survey Measurement

Delegation: The four categories of virtual team leader delegation were measured by thirteen Likert-scale items in the survey. Seven of the items were adapted from Janz et al.'s study (1997) and six were created by the study panel. A sample question statement is "how much is your team able to schedule team work."

Team Competence: In the first round of the survey, six questions were used, which are adapted from the situational leadership measurement of follower ability (Hersey & Blanchard 1988) and Hardin et al's (2006) instrument of virtual team efficacy. A sample question is "The team has past experience related to the team job." In the second round, six questions were used to assess specific skills important to team tasks. A sample question is "how do you evaluate your team on its critical analysis skills?"

Team Motivation: Four items measuring this construct are adapted from situational leadership theory (Hersey & Blanchard 1988). A sample question is "The team is motivated to take on additional responsibilities if needed to finish the project."

Team's Satisfaction: In the full-scale study, satisfaction is composed of satisfaction with team management, satisfaction with distant sub-teams, and satisfaction with the project setting. However, as this pilot study only concerns leader delegation, only a team's satisfaction with the team leader is measured. Three Likert-scale items were created by the panel of this research project to measure this variable. A sample question is "I am dissatisfied with the way the team leader manages this project."

Team Performance: Team performance is measured by five Likert-scale items adapted from Henderson and Lee's (1992) study. A sample question is "Compared to other projects you have served on or observed, how do you evaluate your team's performance on adherence to schedules."

In addition to the constructs in the research model, the study also captured team background information such as how often they met and a control variable: *Task Interdependence*, which was measured by two items adapted from Campion et al. (1993).

7.3. Data Analysis

7.3.1. Basic Data Analysis

Delegation Construct Structure: A principle component analysis (PCA) was conducted to test if delegation is four-dimensional. However, in the pilot study teams, team members were mostly assigned to teams by the course instructor and the student team projects did not have budget constraints. Therefore, these four leadership and management function measurements are not included in the data analysis done with PCA. PCA results show that all the remaining 9 items measuring delegation load on one component instead of three unique components. This means that virtual team leader delegation in the student teams is not multi-dimensional as predicted.

Measurement Reliability: Except for trust ($\alpha=0.409$), the Cronbach alphas of other construct measurements are above the level of 0.8. Trust is therefore not included in further data analyses.

Within-team agreement: Due to the small sample size, a simple measure was used to judge within-team agreement level: individual team members' responses were considered to have an adequate level of within-team agreement and were averaged to obtain a team score if the difference between the highest score and the lowest score in a team was less than 2.5. There was a high level of within-group agreement in more than 85% of the 44 teams on all the constructs in the research model. Therefore, individual team member's responses are averaged to get team-level data.

Zero-order correlations: Table 1 and 2 show the zero-order inter-correlations between the variables in the software-development teams and the report-writing teams respectively.

Table 1: Zero-order Inter-correlations of Variables in Software-development Teams

	1	2	3	4	5	6	7	8
Interdependence								
GPA	.375(*)							
Delegation	0.301	0.139						
Competency	.587(**)	0.241	.508(**)					
Motivation	.494(**)	0.209	0.339	.840(**)				
Flexibility	0.32	0.272	0.3	.737(**)	.752(**)			
Satisfaction	.464(*)	0.184	.435(*)	.776(**)	.658(**)	.639(**)		
Performance	.448(*)	0.204	.390(*)	.761(**)	.850(**)	.834(**)	.616(**)	1

*$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Zero-order Inter-correlations of Variables in Report-writing Teams

	1	2	3	4	5	6	7	8
Interdependence								
GPA	-0.113							
Delegation	.769(**)	0.241						
Competency	.872(**)	-0.07	.706(*)					
Motivation	0.517	-0.071	.813(**)	0.46				
Satisfaction	.720(**)	-0.025	.654(*)	.739(**)	0.562	.735(**)		
Performance	.718(**)	0.187	.711(**)	.752(**)	0.569	.758(**)	.734(*)	1

*$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

7.3.2. Hypotheses Testing

Hypothesis 1a Test: Hypothesis 1 predicts that global software team leaders delegate more to competent sub-teams than to incompetent virtual teams.

A multiple regression analysis was conducted to test this hypothesis. The test results shown in Table 1 support Hypothesis 1a. Therefore, delegation is positively correlated with Team Competence.

Table 3: Hypothesis 1a Test Results

Delegation Regressed on Competency		
	Software-development Teams	Report-writing Teams
Standardized Coefficient	0.508***	0.706***
R Square	0.258	0.498
F-Overall	8.706***	9.913***

*$p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Hypotheses 2a and 2b Tests: Hypothesis 2a predicts that leader delegation to sub-teams will improve team members' motivation. Hypotheses 2b predicts that leader delegation to sub-teams will improve team members' satisfaction with the leader. The two hypotheses were tested by stepwise regression with the outcome variables regressed on delegation, team competency and the interaction term of delegation and team competency.

In *software-development teams*, *Hypothesis 2a* is not supported, that is, delegation did not improve team motivation. However, hypothesis *2b* is supported (p<0.1). Regression results show that leader delegation improves the team's satisfaction

In *the report-writing teams*, *Hypothesis 2a* is supported. Team leader delegation significantly improves team motivation (p=0.006). *Hypotheses 2b* is also supported by the regression results. Team's satisfaction with the leader increased with leader delegation.

Hypotheses 6a and 6b Tests: Hypotheses 6a and 6b predict virtual team performance is improved by team motivation and satisfaction with leader respectively. The hypotheses are tested by regressing team performance against team motivation and satisfaction with the leader.

For the *software development teams*, *hypothesis 6a and 6b* are supported by regression tests (p<0.1).

For the *report-writing teams*, *Hypothesis 6a* is not supported by the regression results. However, *hypothesis 6b* is supported by regression test results (p<0.001).

A second round of regression tests were conducted with control variables such as task interdependence and GPA included. However, no significant changes in regression results were found and, therefore, are not reported in detail.

8. Conclusions, Contributions and Limitations

The study provided mixed support for the hypotheses related to leader delegation. First, virtual team competence predicted leader delegation behaviors. This implies that virtual team leaders should carefully evaluate the team's competence before delegating tasks, especially before delegating important tasks. Second, leader delegation improved satisfaction and motivation of team members. The effects of delegation on satisfaction and motivation were more prominent in competent report-writing teams than in incompetent report-writing teams. This means that delegation is an important virtual team management strategy and organizations should train the virtual team leaders on the importance and effects of delegation.

Comparing the results found in the two types of teams, one will observe that first, delegation exerted deeper influence on the report-writing teams than the software-development teams. It is suspected that the differences in delegation effects may arise from the differences in the number of times the teams met face-to-face. In contrast to the software development teams which met face-to-face at least once a week, the report-writing teams barely met. Students in the report-writing teams were in an online summer course and, throughout the project, only two teams met face-to-face once a week. As collaboration and communication processes suffer from lack of face-to-face contact, the leader's role in team coordination and communication becomes more important. Therefore, leader delegation produced deeper effects in the more virtual report-writing teams. The implication for virtual software team practitioners is that delegation strategies should be carefully crafted when the team members are distributed and have fewer opportunities to meet face-to-face. Increased delegation

can potentially improve team members' motivation and satisfaction with the leader to a great extent in these situations.

The study also found that virtual team competence significantly improves virtual team motivation and satisfaction with the leader. Therefore, virtual team management should closely monitor the technical expertise and task experience accumulation of the team members and take steps such as giving proper training when lack of experiences or deficiency of technical skills is identified.

This pilot study has several limitations. First, it only tests parts of the research model. Second, the pilot study did not use partially distributed global software teams. Therefore the pilot study only serves as a preliminary test of the research model. Third, a major limitation of this study is that the teams were student teams working on class projects. The team leader was not able to execute or delegate certain leadership functions. Therefore, much of the delegation data being collected was "not applicable" to the team situation. Also, the small sample size limits the generalizability of the study findings. Future studies with a larger number of industry teams may yield more conclusive findings related to virtual team leader delegation.

Overall, the research in this paper and the pilot study findings suggest useful guidance for virtual team management. This paper raises important research questions, which could inspire future global software team research, and the research model of this study, if proved, would provide specific guidance to the global software team management and development. This pilot study serves as a starting point for this research. The organizational virtual team leadership training may use the insights from the pilot study to coach team leaders as to when and what they should delegate to the team based on the team's degree of virtuality and competence.

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