Occurrence and Effects of Leader Delegation in Virtual Software Teams

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Abstract

Virtual teams are an important work structure in software development projects. However, little is known about what constitutes effective virtual software team leadership, in particular, the amount of leader delegation that is appropriate in a virtual software-development environment. This study investigates virtual software team leader delegation and explores the impact of delegation strategies on virtual team performance mediated by team motivation, team flexibility and team satisfaction with the team leader. This research is a report of a pilot study run on student teams that was carried out to refine and test the research constructs and research model for a larger study run in corporations. The study found that virtual team leaders delegate more to competent virtual teams and that such delegation is positively correlated with team member satisfaction with their leader and with team member motivation. Overall, the work provides important information for software-based organizations interested in developing virtual team leadership skills.

1 Introduction

Virtual teams are composed of geographically distributed coworkers linked through information technologies to achieve an organizational task (Townsend et al., 1998). Virtual teams are a popular structure in software development for several reasons: they provide access to lower-cost labor as well as access to a range of disciplines and technical specialties (Curtis et al., 1988). While software team leaders and managers are now frequently given virtual teams to manage, they have not been given clear directions on how to effectively manage such teams. One important issue regarding virtual software team management is when and how team leaders should delegate authority and responsibility to the team.

Delegation means that one has been empowered by one’s superior to take responsibility for certain activities, which were originally reserved for the superior (Ashton & Kramer, 1980; Bass, 1990). In traditional leadership studies, delegation is widely acknowledged to be an essential element of effective management (Yukl, 2002), and effective delegation offers a number of potential benefits, both to the manager and the subordinates. However, to the authors’ knowledge, only a few studies have been conducted to investigate delegation as a distinct component of global virtual team leadership. In the limited number of conceptual works and empirical studies in
which delegation is not the direct focus, delegation has been a controversial issue. Some researchers argue for the benefits of delegation: Eveland & Bikson, 1988; Jarvenpaa et al. 1998; Jarvenpaa & Leidner, 1999 report that an effective leader of a virtual team needs to be more flexible to accommodate the complexities and volatility of the virtual team environment, and to be willing to let others take the lead when necessary. Furthermore, they suggest that virtual team leadership should focus on facilitating and empowering team members to take action on their own. In contrast, Paré & Dubé, (1999) argue that, due to the distributed nature of virtual teams, management by observation is simply not possible, and that much more discipline and control is required in a virtual setting. Additionally, team effectiveness in virtual environments may be hindered by excessive autonomy coupled with exclusive reliance on electronic communication and lack of face-to-face interaction.

This paper aims to address the research gap regarding delegation to a virtual software team by investigating the occurrence and effects of leader delegation in such teams. Finding out how and why leaders do or do not delegate to virtual teams and the impact of the leaders’ delegation behaviors on the teams will help industry practitioners to better frame their strategy for managing distributed software teams and will also add to the field’s knowledge about virtual team leadership.

The focus of the paper is on software teams, in part, because it is felt that the global software team phenomenon has several unique characteristics that may not apply to virtual teams in general. Unlike other activities that have been outsourced or offshored, work activities cannot be as easily compartmentalized because of the high integration of the software product. Thus, there is a need for communication and working together in a structured fashion, which demands good leadership. In addition, software developers expect to have a high degree of independence in their work. Therefore, the degree of delegation by a leader may differentially affect these virtual teams.

Collaboration in software development also demands the ability to communicate highly detailed specifications and questions. This requires communication skills that may not be needed in other types of virtual teams, skills which may be influenced by a team member’s knowledge of English, the common language for many of these teams. Therefore, good management of the communication structure and media is likely to be an important leadership trait. Finally, the new countries that are now being included in global software development have relatively young team members. As such, the distribution of corporate knowledge and software skills is uneven.
Thus, leadership and delegation in this type of environment is likely to be different for software than for other tasks carried out by virtual teams.

The paper is structured as follows: first, an overview of the research model is presented to give readers a sense of the focus of the paper; then, based on a review of the literature, conceptualizations of leader delegation are presented and specific research hypotheses regarding virtual team leader delegation are explained; finally, the pilot study testing the model is presented. A discussion section presents the contributions and limitations of this research, and a final section discusses the implications for virtual team management.

2 Research Model

Before beginning a detailed discussion of the variables used in this study, we present the overall research model and briefly describe the relationships that are hypothesized to exist between the variables. A key focus of the model is the amount of delegation that virtual software teams receive from their leaders. It behooves us therefore to describe the management structures that are being studied.

![Figure 1. Proposed Model of Delegation Effects on Global Software Teams](image)

When we talk about virtual teams, the structure that is typically in place does not constitute virtuality for each and every team member but rather distributed teams in which some subsection of the software development team is co-located and other sections are virtual. For example, a portion of the team may be located in the U.S. and a second and third portion in India and China, respectively. The overall team is working on the same software
product, but the work has typically been compartmentalized in some way so that each co-located portion of the team has specific assignments. However, the work is such that there is a need for continued communication between each of the non-co-located portions of the team to resolve integration issues.

Management of these teams comes from several sources. First, there is typically a local manager who handles personnel issues. Then there is a technical manager who oversees the project. Finally, there is a technical head of the particular subsection of the project who is directing the work of both virtual and co-located sub teams. Management of the work is the purview of this leader, and this is where delegation typically occurs. This management is located with one sub team and virtual to the other sub teams. Traditionally, management is located in the home of the parent company, but it also may be at a customer site.

Because at least, one part of the software team is distant from the manager, less is likely to be known about the competence of that part of the team by the manager, and therefore, he or she is likely to delegate in a manner so that more control of the technical issues rests with that portion of the team that is co-located with the manager. The research model being put forward in this paper suggests that perceived team competence predicts the amount of delegation that will occur but that this delegation will have an effect on key team variables such as satisfaction, motivation and flexibility. It is argued that these three variables are primary in affecting team performance. Figure 1 presents our research model.

An elemental part of this model is that team competence not only affects the decision of the team leader on whether to delegate or not but also affects the impact of the delegation, that is, teams with less competence, are likely to desire less delegation and to be unhappy and unmotivated with less direction from the leader. This occurs primarily because the team members do not know how to perform their tasks completely, yet wish to succeed in these tasks. However, the only way they can succeed is if they receive tighter direction from the leader. As we shall see with our analysis, we did not necessarily find that less competent teams wanted more delegation. The measure of perceived competence that we used had difficulties with the student teams used in this research. All student teams perceived themselves to be highly competent. Rather than treating this as a problem, it is a result that we believe has an impact on virtual team management.

Virtual sub teams are not able to ascertain their competence in comparison to their distant counterparts because they lack the proximity required for an accurate comparison. They are, therefore, likely to perceive themselves as competent and desire more delegation. Culture may also have an impact in that many cultures worry
about “face,” that is, how they appear to others. These cultures would also perceive themselves as competent, possibly due to team members’ advanced education in their country or membership in a high social class. Whatever the reason, they are likely to desire more delegation even when it is unwarranted. This issue will be further addressed in the paper’s discussion section.

The next sections present prior research on the relations posited in our model and detailed definitions of each of the variables used in the model plus support from the literature on the validity of the constructs we have developed for the variables.

### 3 Literature and Hypotheses

#### 3.1 Delegation

As mentioned earlier delegation is a state or condition in which one has been empowered by one’s superior to take responsibility for certain activities, which were originally reserved for the superior (Ashton & Cramer, 1980). There is a rich body of studies in traditional leadership research investigating delegation, mostly as a feature of leadership style or as a combination of related leader behaviors. Very few studies investigated delegation as a distinct management practice (Yukl & Fu, 1999; Zhang et al., 2006). Because of this, we cannot ascertain the effect size of delegation (as a distinct leadership component) on possible variables of interest.

Another major limitation of previous delegation and leadership studies is the failure to focus on what types of responsibilities and activities a leader delegates. Only the global delegative style of the leader was assessed. This limitation seriously undermines the practical value of these studies, as their findings do not inform software team managers where they can and cannot delegate nor does it tell them what they can delegate. Leadership is a multifaceted process, particularly so in virtual teams, given the technological, cultural and organizational complexities of a virtual team environment. Therefore, it is important to examine the leadership and managerial functions originally assigned to leaders to determine which of these can be delegated to followers. To that end, studies that describe leadership and managerial functions are reviewed in this section, and a list of leader delegation categories is generated.

For classical management theorists like Davis (1942) and Urwick (1952), the functions of the manager-leader in a formal organization were orderly planning, organizing and controlling. To address the overlapping needs
of the organization, team and individuals, Coffin (1944) modified the classical functions as follows: formulation (planning), execution (organizing), and supervision (persuading).

MacKenzie (1969) proposed a well-known leader-manager model that illustrated the great variety of activities that a typical manager performs. He proposed that the central management functions relate to management of people, ideas and things, which form the three basic components of every organization with which managers must work. Three functions (the analysis of problems, decision-making and communications) are important at all times and in all aspects of the jobs held by managers, and therefore permeate the entire work process. To carry out these functions, the leader-manager needs to execute these leader activities: planning, organizing, staffing, directing and controlling. A factor analysis reported by Dunnette (1986) of 65 managerial activities yielded seven factors: monitoring the business environment, planning and allocating resources, managing individual performances, instructing subordinates, managing the performance of groups, representing groups and coordinating groups.

Janz et al. (1997) identified four distinct facets in which a leader could give the team autonomy: planning (e.g., scheduling the team’s work), product (e.g., suggesting new products or services), people (e.g., recruiting and hiring members) and process-related (e.g., specifying the development method a team should use).

Hertel et al. (2005) reviewed a collection of empirical works on the management of virtual teams and summarized the management functions of virtual team leaders at various phases in the team’s lifecycle. They proposed that virtual team leaders are generally engaged in such activities as Personnel selection, Task design, Team initiation, Performance management, Training and team development, Disbanding and re-integration.

The studies mentioned above categorize leader functions in different ways and use different labels for these leader functions. Integrating these different categorizations, Table 1 summarizes four major leader function categories which can be delegated to virtual team members. These four areas are the overlapping important leader-manager functions identified in the above studies. The first leader delegation category consists of planning-related team management and leadership activities that a virtual team leader can possibly delegate to the team. The second category consists of people-related team management and leadership activities that a virtual team leader can delegate, such as team staffing and team member training. The third category consists of process-related team management and leadership activities (or teamwork process management). The fourth is control-related team management and leadership activities. This category relates to the leader’s functions and activities that control the work progress and quality of a virtual team.
To keep the categorization parsimonious, the key activities in each delegation category may incorporate more than one of the leader functions identified in the previous studies. For example, “determining operating procedures and work instructions” incorporates two virtual leader functions in MacKenzie’s model: standardize methods and decide how to achieve goals. Some of the manager activities are not included because they either cannot be assigned to the team through leader delegation or are already tasks that are done by team members, e.g., suggesting new products or services.

**Table 1** Four-dimensional Leader Delegation Framework

<table>
<thead>
<tr>
<th>Delegation Aspects</th>
<th>Key Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning-related</td>
<td>Scheduling the team’s work</td>
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<tr>
<td></td>
<td>Setting the team’s long-term goals</td>
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<td></td>
<td>Setting the team’s short-term objectives</td>
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<tr>
<td></td>
<td>Setting the team’s budget</td>
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<tr>
<td>People-related</td>
<td>Selecting team members</td>
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<td></td>
<td>Removing members from the team</td>
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<td></td>
<td>Determining team members’ training needs</td>
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<tr>
<td>Process-related</td>
<td>Assigning work to team members</td>
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<td></td>
<td>Selecting the tools team members will use in their work</td>
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<tr>
<td></td>
<td>Determining the team’s operating procedures and work instructions</td>
</tr>
<tr>
<td>Control-related</td>
<td>Evaluating the progress of the team’s work</td>
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<td></td>
<td>Evaluating team product quality</td>
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<td></td>
<td>Determining corrective actions when performance objectives are not met</td>
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### 3.2 Delegation in Virtual Software Teams

The issue of productivity loss is very important when global software team leaders weigh the benefits and costs of delegation. A software team is often formed for completing certain tasks within a limited time period. The short-term nature of the project requires avoidance of any productivity loss. In a longitudinal study using 18 student information system development (ISD) teams, Nicholson et al. (2002) confirmed the importance of avoiding productivity loss in distributed teams. The researchers attempted to identify the characteristics/behaviors of effective ISD project team leaders/managers. Their exploratory analysis revealed that face-to-face (ftf) and virtual ISD team members valued different ingredients of leadership in different phases of the ISD project. They found that a key ingredient for virtual team leadership was having a realistic leader who managed time efficiently. Global
virtual teams involved in ISD are temporary structures that are very focused on the development of the information system application. These teams have tremendous time constraints. The role of a virtual project team leader is hence to remain practical, in terms of the goals set and the deliverables promised, and to manage the time allocated to each task efficiently. Therefore, to avoid productivity loss, global software leaders are likely to delegate more to competent teams than to incompetent teams. A competent virtual software team has the knowledge, attitudes and expertise required to perform the team tasks and is more likely to plan well and manage their work efficiently (Faraj & Sambamurthy, 2006). A competent team can quickly apply their expertise to the delegated task and reduce productivity loss to a minimum. In contrast, delegation to incompetent teams means that leaders have to spend additional time giving feedback and monitoring the execution of delegated tasks to ensure that performance standards are met. Otherwise managerial anxiety over loss of control can be overwhelming. However, in the distributed global team environment, close monitoring and timely feedback is difficult as “management by walking around” can not be used as a strategy (Pare & Dube, 1999). Due to increased temporal distances, possible increased cultural distances and the lean nature of computer-mediated communication in virtual teams (Bell & Kozlowski, 2002), leaders will need to spend much more time and effort in coordinating, monitoring and coaching team followers in the delegated tasks.

Besides the need to manage time efficiently, the matrix organizational structure of global software teams is often another reason why team leaders delegate more to competent team members. Developing subordinates’ skills and confidence is the biggest reason why leaders delegate or consult their followers, especially when followers’ skill sets are still to be developed (Yukl & Fu, 1999). The potential growth of the followers is likely to be the major benefit leaders obtain from delegation to an incompetent team. However, virtual teams are often designed to cross geographical and organizational boundaries to allow dispersed organizations to maximize their expertise without having to physically relocate individuals. The required expertise for a given task or project may be dispersed at multiple locations throughout the organization; however, a global software team may facilitate the ‘pooling’ of this talent to provide focused attention to a particular problem without having to physically relocate individuals (Kayworth & Leidner, 2000). Therefore, global software teams are often dispersed in cities or even countries and, very commonly, the team followers do not report to the team leader in a direct organizational line. Due to the typically short-term nature of the team and the complexity of the reporting relationship, global software team managers are more likely to be evaluated on their success in achieving project goals, rather than on their
development of team members. In delegating to incompetent teams, global software team managers—unlike line managers who may treat the costs of delegation as an investment to be redeemed later—are faced with the cost of sacrificing team performance, which determines the manager’s own promotion and career growth. As managing a matrix structure is already challenging for virtual team leaders (Oertig & Buergi, 2006), the costs associated with delegating to an incompetent team would tend to deter virtual team leaders from this management strategy. Based on the above arguments, the following hypothesis is proposed:

**Hypothesis 1:** Leader delegation will be positively correlated with global software team competence.

### 3.3 The Effects of Team Leader Delegation

In this section, three variables, motivation, team flexibility and team member satisfaction with their software team leader are each discussed. An argument is made as to why each of these variables is expected to be affected by team leader delegation and also why each of these variables is a primary determiner of overall team performance.

**Motivation:** According to Herzberg’s (1968) motivation theories, recognition fulfills workers’ esteem needs and can significantly improve employee’s performance. A competent virtual team typically expects the team leader to recognize the team’s competency by delegating more responsibility. Leader delegation will then improve the team’s sense of self-worth and motivate the team to work more effectively. An empirical study found that the autonomy of virtual team members in determining work objectives and methods improved the intrinsic motivation of the team (Kirkman et al., 2004). They investigated the relationship between team empowerment and virtual team performance and the moderating role of the extent of face-to-face interaction using 35 sales and service virtual teams in a high-technology organization. They found that team members are more intrinsically motivated when they believe they have high *performance capability* (competence), *high responsibility* and *authority* to carry out work (*delegation*), and a *meaningful task* that could impact the organization. Piccoli and Ives (2003) found that student virtual teams were more motivated and satisfied with less behavior control. Also a team’s acceptance of a decision is highest when the decision is made by the group (Curtis, et al, 1988). Therefore, we posit that delegation to a competent virtual team would increase the team’s motivation.

On the other hand, delegation to less competent virtual teams will put the team in a difficult situation. Due to their low competence level, they need close monitoring and constant coaching from the leader or other experts,
which is difficult and costly to obtain in dispersed virtual teams. Kayworth and Leidner’s (2002) observation of a dichotomy between inexperienced members wanting and expecting strong directive leadership and team leaders who, faced with the practical constraints of distance and the lack of a direct management line, would prefer members to be self-managing. Such dichotomy hurts the team members’ motivation and performance. In addition, the relatively short-term nature of virtual teams, which are often formed dynamically to cope with emerging projects or tasks, also means that the team has less time to learn on the job. Instead of desiring delegation, less competent virtual teams want detailed directions from the leader.

Therefore, we posit that delegation to less competent virtual teams may not improve team motivation. Based on these arguments, Hypothesis 2a is put forth:

**Hypothesis 2a**: Delegation to competent virtual software teams will improve team motivation more than delegation to less competent virtual software teams.

**Team performance**, as with individual performance, is a function of ability and motivation (Jarvenpaa et al., 1998). Sridar et al. (2007) have shown that team member motivation and trust affect performance in student teams distributed between the U.S. and India. Significant improvement in team performance is therefore expected from motivated teams. Based on this argument, Hypothesis 2b is put forth:

**Hypothesis 2b**: Virtual team leader delegation indirectly improves team performance through improving virtual team motivation.

**Flexibility**: Team flexibility refers to how flexible a virtual team is in responding to environmental and personnel changes. Most virtual teams are knowledge-based teams which are formed to solve customer problems or to develop new products (Kirkman et al. 2004). The complex, knowledge-based tasks many virtual teams perform require behaviors such as planning and executing, managing team performance, improving team processes, and influencing organization-level direction and resource allocations (Mohrman et al., 1995). In conducting these activities, teams have to make sense of their tasks, improvise their work processes, and adjust how they make progress toward agreed upon goals. Therefore, flexibility is important to virtual team performance and team leaders should delegate to competent virtual teams to allow them to flexibly adapt to their immediate situations and opportunities. Remote team leaders may not be able to understand the work context or to appreciate the consequences of the changes occurring in the distributed locations. Delegation, therefore, puts this task in the hands of the competent virtual team members. These members can also make decisions in a more timely matter than the
leader. Having appropriate authority delegated to them, they can proactively influence team leaders’ decisions or even their own decisions instead of passively waiting for managerial permission before taking actions. Therefore, delegation to competent virtual teams will increase team flexibility. In contrast, delegation to less competent virtual teams may not improve team flexibility since less competent team members may not have the skills to make decisions and form action plans. Based on this argument, Hypothesis 3a is put forth:

**Hypothesis 3a**: Delegation to competent virtual software teams will improve team flexibility more than delegation to less competent virtual software teams.

When a virtual team flexibly adapts to its work situations and is free to respond to situations in a timely manner, it will be more risk-taking and learn from experience to continuously improve its work processes and to perform in more efficient ways. Based on this argument, Hypothesis 3b is put forth:

**Hypothesis 3b**: Virtual team leader delegation indirectly improves team performance through virtual team flexibility.

**Satisfaction with Software Team Leader**: Delegation to competent virtual teams represents the leaders’ recognition of their competence. Delegation allows the competent team to utilize their capabilities to adapt to the immediate opportunities and changes without waiting for decisions to be made by the distant leader. Therefore, delegation to a competent virtual team should improve the team’s satisfaction level with the leader.

On the other hand, delegation to a less competent virtual team may decrease the team’s satisfaction with the leader. In a global virtual team study consisting of undergraduates as followers and experienced MBA graduate students as team leaders, Kayworth and Leidner (2002) found that the inexperienced undergraduate followers were more satisfied with leaders who gave clear detailed instructions and feedback. Faraj and Sambamurthy’s (2006) study of 65 software development teams found similar results. Their study showed that empowering leadership has an important positive impact on team performance but only under conditions of high task uncertainty or high team expertise. In the software teams they studied, when team members have significant levels of professional experience with software development, they are more likely to possess the relevant expertise and experience for managing their project activities. For such teams, an empowering leadership approach might be more appropriate since members may need less direct control and coordination and possibly possess as much relevant task expertise as the team leader. In contrast, when teams have low professional experience, a directive leadership might be more appropriate because the members look to the leader to provide needed directions and guidance about their work activities.
As software team distance increases, the work context exhibits increased complexities, for example, cultural misunderstandings, communication difficulties, etc. This makes virtual teamwork more daunting for a less competent team. Under such circumstances, the team needs to attain confidence and a sense of direction from a strong leader. Based on this argument, Hypothesis 4a is put forth:

**Hypothesis 4a**: Delegation to a competent virtual team will improve the team’s satisfaction with their team leader more than delegation to a less competent virtual team.

When the virtual software team members are satisfied with the team leader, the team leader will be more able to influence the members to work towards team goals and therefore to improve team performance. This has been confirmed in empirical studies (e.g. Zeffane, 1994).

Based on this argument, Hypothesis 4b is put forth:

**Hypothesis 4b**: Virtual team leader delegation indirectly improves team performance through improving virtual team’s satisfaction with the team leader.

4 Research Study

4.1 **Study Design and Sample**

A full-scale study with industry software development teams is currently underway to explore the above presented research hypotheses. We report here on the pilot study conducted to test the validity and reliability of the constructs that were formed for this research and the viability of our research model. Although many of the questions that were used came from studies that had already tested their validity and reliability, there were modifications made to the questions to (a) fit the virtuality nature of the teams being studied and (b) to fit the software development environment. For example, the constructs of team competency and leader delegation were adapted to describe competency in terms of software skills and portions of leader delegation in terms of the assignment of software tasks.

Student teams were used to pilot the research survey because the diversity of the student teams closely matched the software development team populations that the final survey is intended for. The student teams are part of a computer science and information systems program at an American East Coast University that has one of the most diverse student bodies in the U.S. The students come primarily from China, India, the Middle East, Brazil, and Pakistan.
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. The software teams are part of the ABET accredited Capstone course designed to have students working in teams on real software projects before they matriculate. This is a course most students take in their last year of school. Companies are solicited for software projects and present their projects to the class. A team leader volunteers for a software project and then interviews and accepts members for his or her team. Teams normally have four members but some teams have three or five members. Teams then meet with the company representative and develop requirements, a budget, a design and a deliverable tested product. Reports are due, including a management report with assigned team roles, at regular intervals. Thus, the teams are set up to behave as much as possible like typical software development teams. Our interviews with corporate management in software companies indicates that projects rarely last for more than six months and that when new teams form, the membership is also new, so our student teams represent this type of project assignment.

The research instrument is designed to work with virtual teams. Thus, it may be asked, how can this student population constitute a virtual team? Almost any team at the university studied is partially virtual because of the nature of the university. All capstone classes are held in the evenings because team members usually are part time students. The university is a commuter university with many classes online or partially online so that students may come to the university once a month. Thus, many of the teams meet virtually and much of the team work is done by email, instant messaging and teleconferencing. It was felt that with the more mature students, seniors, the partial virtuality and member multi-culturism presented a population suitable for piloting the research.

The survey was given near the end of the semester so the team members had worked together for about three months.

In a second administration 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 five to six 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 of these teams reported meeting face-to-face once a week. The other teams did not report meeting face-to-face during the team project and may never have met each other face-to-face. This second set of teams was also different from the first in that they were working on a report rather than developing software. Thus, they met the requirement of being virtual for our pilot study but not of being a software development team. We use this second team to determine if the difference in virtuality might have an influence.

After the survey, open-ended interviews with six members from two software-development teams were conducted face-to-face. Each interview was conducted by two researchers and videotaped with the interviewee’s permission. The interview results are reported in Section 4.4 and 4.5.

4.2 Survey Measurement

In this section each of the constructs used in the research is described in more detail, in particular, its source for validity and reliability verification are cited along with a sample question that presents the intent of the measure.

**Delegation:** The four categories of virtual team leader delegation were measured by thirteen 7-point Likert-scale items in the survey. Section 3.1 introduced the conceptualization of the four categories. A sample question statement is “how much is your team able to schedule team work?” (completely – not at all)

**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 instrument of virtual team efficacy (2006). A sample question is “The team has past experience related to the team job.” (strongly agree – strongly disagree). In the second round, six seven-point Likert scale 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?” (extremely high – extremely low)

**Team Motivation:** Four seven-point Likert scale 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.” (strongly agree – strongly disagree).

**Team Flexibility:** Three seven-point Likert-scale items were created by the research team consisting of five researchers with extensive virtual team research experience to measure this variable. A sample question is “This team quickly responds to new opportunities.” (strongly agree – strongly disagree).
**Team’s Satisfaction with the Team Leader:** Three seven-point Likert-scale items were created by the research team to measure this variable. A sample question is, “I am dissatisfied with the way the team leader manages this project.” (strongly agree – strongly disagree).

**Team Performance:** Team performance is measured by five seven-point Likert-scale items adapted from Henderson and Lee’s (1996) study. This is a composite measure which reflects five important areas of software team work outcomes including: the amount of work the team produces, the efficiency of team operations, the team's adherence to schedules, and the team's adherence to budgets, the quality of work the team produces. This measurement was examined by five experienced researchers and three IT managers with extensive virtual team experience and was considered by them to provide a valid and comprehensive view of software team outcomes. A sample question of this measurement is “Compared to other projects you have served on or observed, how do you evaluate your team’s performance on adherence to schedules.” (Extremely high – extremely low)

**Other Contextual Variables:** In addition to the above constructs, the study also captured data on another two variables: trust towards other team members, and interdependence of tasks performed by team members, which were found to moderate the impact of leader delegation (Yukl & Fu, 1999) Trust is measured with four seven-point Likert scale items from Jarvenpaa et al.’s study (1998). A sample question measuring trust is “If I had my way, I would not let the other team members have any influence over issues that are important to the project.” (strongly agree – strongly disagree) Task interdependence is measured by two items adapted from Campion et al (1993). A sample question is “To what extent do the team members have to share work materials to get the project done?” (strongly agree – strongly disagree). Finally, team background information such as team member’s age, year in school, how often the team met and how they met (remotely or face-to-face) was also gathered. This information is used in the post-hoc analysis to help us in our interpretation of the resulting relationships uncovered in the research model.

### 4.3 Preliminary Data Analysis

**Delegation Construct Structure:** A principle component analysis (PCA) was conducted to test if delegation is a four-dimensional variable. However, in the pilot study, the student teams did not have budget constraints and were not allowed to change their membership once the teams had been established. Therefore, the four leadership and management function measurements are not included in the data analysis done with PCA because students answered these questions as not applicable. PCA results show that all the remaining 9 items measuring delegation
load on one component instead of three unique components. This indicates that virtual team leader delegation in the student teams is not multi-dimensional counter to our predictions.

**Measurement Validity:** The numbers in the study were too small to conduct a factor analysis, but wherever possible, the questions used for the constructs were drawn from previously validated surveys. We also checked the constructs for face validity by reviewing the questions with twenty experts from the countries where the virtual teams for the full study were located. In addition, a card sorting test was performed on the constructs using twenty respondents. Ninety-five percent of the questions were sorted correctly supporting a case for acceptable construct validity. Finally, external validity is a concern because students were used in the study. We treat this issue in the discussion on this research’s limitations.

**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 (half the scale range). There was a high level of within-group agreement in more than 85% of the 44 teams on all constructs in the research model. Therefore, individual team member’s responses are averaged to get team-level data.

### 4.4 Test of Hypotheses

Multiple regression testing was chosen to analyze the data as the data met normality and homogeneity of variance requirements (An arcsine transformation was carried out on the team competence and performance measure to achieve these assumptions). Structured equation modeling was not used because of the small sample size and the intent of the study (pilot). Although a PLS model is more likely to have more accurate beta scores, it also has a greater chance of a Type I error (Goodhue et al., 2006). Since this was a pilot study, we wanted to bias it against possible spurious results.

**Hypothesis 1 Test:** Hypothesis 1 predicts that virtual team leaders delegate more to competent virtual teams than to less competent virtual teams. A multiple regression analysis was conducted to test this hypothesis. The test results shown in Table 2 support Hypothesis 1. Delegation is positively correlated with Team Competence.
Table 2: Hypothesis 1 test results in both report writing and software development teams.

<table>
<thead>
<tr>
<th>Delegation Regressed on Team Competency</th>
<th>Software Development Teams</th>
<th>Report Writing Teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardized Coefficient</td>
<td>0.508***</td>
<td>0.706***</td>
</tr>
<tr>
<td>R-Square</td>
<td>0.258</td>
<td>0.498</td>
</tr>
<tr>
<td>F-Overall</td>
<td>8.706***</td>
<td>9.913***</td>
</tr>
</tbody>
</table>

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

Hypotheses 2, 3 and 4 Tests: Hypothesis 2a predicts that leader delegation to competent virtual teams will improve team motivation more than delegation to less competent virtual teams. Hypotheses 3a and 4a predict the effects of virtual team leader delegation on team flexibility and on a team’s satisfaction with team leader respectively. The three hypotheses were tested by stepwise regression with the outcome variables regressed on delegation, team competency and the interaction term of delegation and team competency.

Table 3: Hypotheses 2a, 3a, and 4a test results in software-development teams

<table>
<thead>
<tr>
<th>Delegation</th>
<th>Motivation</th>
<th>Flexibility</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competency</td>
<td>1.536***</td>
<td>1.423***</td>
<td>1.708***</td>
</tr>
<tr>
<td>Delegation X Competency</td>
<td>0.11</td>
<td>-0.153</td>
<td>-0.231</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R-Square</th>
<th>F-Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75</td>
<td>21.93***</td>
</tr>
<tr>
<td>0.54</td>
<td>7.91***</td>
</tr>
<tr>
<td>0.65</td>
<td>9.94***</td>
</tr>
</tbody>
</table>

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

Table 3 presents the test results in the software-development teams. Hypotheses 2a and 3a are not supported, as no significant interaction effects were found. Therefore, the effects of delegation on team motivation and team flexibility were not found to change as team competence varied. Regarding Hypothesis 4a, the results show that leader delegation improves the team’s satisfaction but such effects do not change as team competence varies. In addition, team competence was found to significantly improve team motivation, flexibility and team satisfaction with the leader (p<0.05).

Table 4 shows the Hypotheses 2a, 3a, and 4a test results in the report-writing teams. Regarding Hypothesis 2a, Team leader delegation significantly improves team motivation (p=0.006). However, the effects of leader delegation on team motivation did not differ as team competence level varied. Hypotheses 3a and 4a are supported by the regression results. The interaction effects of delegation and team competence are significant such that leader
delegation to competent virtual teams improves team flexibility and team satisfaction with the leader more than
delegation to less competent virtual teams.

Table 4: Hypotheses 2, 3 and 4 test results in report-writing teams

<table>
<thead>
<tr>
<th></th>
<th>Motivation</th>
<th>Flexibility</th>
<th>Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delegation</td>
<td>0.782***</td>
<td>0.216</td>
<td>1.502***</td>
</tr>
<tr>
<td>Competency</td>
<td>0.126</td>
<td>0.069</td>
<td>1.708***</td>
</tr>
<tr>
<td>Delegation X Competency</td>
<td>-0.433</td>
<td>0.102***</td>
<td>-0.231***</td>
</tr>
<tr>
<td>R-Square</td>
<td>0.531</td>
<td>0.687</td>
<td>0.561</td>
</tr>
<tr>
<td>F-Overall</td>
<td>12.263***</td>
<td>21.912***</td>
<td>11.502***</td>
</tr>
</tbody>
</table>

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

Hypotheses 2b, 3b, and 4b Tests: Hypotheses 2b, 3b and 4b predict leader delegation indirectly improves virtual team performance through improving team motivation, flexibility and satisfaction with leader respectively. A Sobel test determines the significance of the indirect effect of the mediator by testing the hypothesis of no difference between the total effect and the direct effect. This method is used because its superiority of reducing Type 1 error and increasing power (Mackinnon et al., 2002). Due to the small sample size of the study, a bootstrapping Sobel test was performed.

Table 5: Sobel Test Results on Hypothesis 4b in Student Software-development Teams

<table>
<thead>
<tr>
<th>Sobel Statistic</th>
<th>F Value</th>
<th>Percentage of Total Effects that are Mediated</th>
<th>Ratio of the Indirect Effects to the Direct Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.868</td>
<td>0.004</td>
<td>77.34</td>
<td>3.412</td>
</tr>
</tbody>
</table>

For the software development teams, the tests did not find delegation improved motivation and flexibility. Consequently, the effect of delegation motivation and flexibility improvements on virtual team performance was not testable and therefore, Hypotheses 2b and 3b are rejected. Hypothesis 4b is supported by Sobel test results, as shown in Table 5. Therefore, delegation improves team performance partly through improving team satisfaction with the leader.

For the report-writing teams, Hypothesis 2b is not supported by regression test results, as shown in Figure 2. Regression tests did not find that motivation had a significant positive impact on performance. Therefore, delegation was not found to improve team performance indirectly through improving team motivation. Previous tests on Hypotheses 3a and 4a did not find that delegation improved team flexibility and satisfaction with the leader.
Consequently, delegation cannot be tested as to whether it improves virtual team performance through improving team flexibility and satisfaction with leader. Therefore, Hypotheses 3b and 4b are not supported either.

Figure 2: Hypothesis 2b Test in Report-writing Teams

4.5 Interview Data Analysis

The interviews were analyzed in two steps. First, two Ph.D. students and two professors with extensive research experiences watched the videos of the interviews and discussed what they found relevant to this study in a group meeting. Each of them explained his/her findings to the group and the group discussed the validity and implications of these findings. These discussion results were recorded in writing. Second, one Ph.D. student summarized these group discussion results and combined them into a set of statements. Then she watched the interview videos for the second time. She put down quotes from the interviewees related to each statement, examined these quotes to judge how they supported or disproved the categories of findings and modified the results of the analysis accordingly. This two-step procedure does not transcribe the interview data but roughly follows the process of creating a coding scheme, coding the data, iteratively improving the coding scheme and drawing conclusions. This procedure uses insights made by multiple researchers who separately viewed the interview videos and therefore should be adequately rigorous for a small-scale pilot study.

The interview data analysis found overall that delegation was an important part of team leadership and affected team outcomes in various ways. The following paragraphs present the detailed findings:

First, team leaders were aware of the importance of delegation, and engaged in delegation for a variety of reasons. One team leader learned from his previous military training that leaders should teach their subordinates to do their job so that they can take over if the leader is not available. The other reason both team leaders gave for delegating to the team was a belief that the team had the capabilities to perform the work. This belief in the team’s competence came from knowledge about team members’ past performance and their professional experiences. Also, one team leader recognized that competent team members have egos and decided that being too controlling would
hurt such egos. Lastly, at least one team leader felt that delegating tasks to incompetent team members with the added support of fellow team members could be a way to build up a team member’s self-confidence and skills.

Second, as the team develops, a leader’s delegation style may change. In both teams the author interviewed, the leaders’ style changed from one of controlling to that of delegating as team member’s competence increased. In one team, members reported that at the beginning of the project, the team leader “tried to control everyone and everything in the project.” When the leader was traveling, he sent team members detailed emails that specified the work to be done and the precise methods to use. As his team members demonstrated their capability and produced several deliverables ahead of deadlines, the leader “eased off in the middle.” Near the end of the project, the team leader was very trusting and allowed the team members to self-lead. One of the most competent members in the team even led the team for two weeks when the leader was on vacation in a foreign country.

Third, delegation happened with monitoring and coaching. After certain tasks or functions were delegated, the leaders monitored how the team performed and coached the team members when needed. One team leader, for example, suggested books for the team members to read and advised the team on available development tools.

Fourth, delegation affects team motivation and a team’s satisfaction with the leader. Within one team, a team member missed the first deadline and produced very low-quality deliverables. The team leader took action and became very directive setting detailed work schedules for the team, making detailed work assignments to team members and closely monitoring the work quality and progress of the team. Such non-delegation drove the team members to work harder. In this case team members appreciated the team leader’s direction and effort to get their project started. In the other team, team members had adequate professional experience and the skills needed to perform the project tasks. In the beginning the team leader was very controlling and the team members complained and even had a confrontation with the leader. However, as the team leader became aware that he was directing a competent team, he switched to negotiating with team members when making decisions. With this change, the team members felt his trust in their abilities and became more satisfied with the leader.

4.6 Discussion

The following hypotheses were supported by the study. First, virtual team competence predicted leader delegation behaviors. This implies that virtual team leaders should carefully evaluate a team’s competence before delegating tasks, especially before delegating important tasks. Second, leader delegation improved the satisfaction and motivation of team members. The effects of delegation on flexibility and satisfaction were more prominent in
competent report-writing teams than in less competent report-writing teams but these effects were small. Other hypothesized results were not found. None of the intermediate outcome variables (flexibility, motivation, satisfaction) mediated the effects of delegation on team performance. Instead, tests results indicated that delegation directly improves virtual team performance. Figure 3 presents the model supported by the study results.

Figure 3. Delegation effects on student teams. (Bold lines indicate supported hypotheses. The double line indicates a new result showing a direct link between delegation and team performance.)

Comparing the results found in the two types of teams, one will observes 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 or, as suspected, the degree of virtuality of the team. 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. This suggests that leader delegation is likely to be a very significant factor in managing virtual teams.

4.7 Limitations of Study
One of the major limitations of this study is that the teams were student teams working on class projects. In particular, some of the questions that were designed for corporate virtual teams were not applicable. Student teams do not typically assign salaries, manage finances or hire and fire personnel. Only the planning part of the delegation
construct showed differences between teams. The other parts were scored as not applicable (one of the possible answers) so that the results were pooled into one construct called Delegation which consisted mostly of items that addressed planning delegation.

In addition, the software and report writing teams did not represent the distributed teams that the survey was prepared for. There were some examples of distributed teams, e.g., one-half of the team lived in the southern part of the state and the other half lived in the northern part, but, by and large, teams consisted of members who were individually virtual but also met face-to-face occasionally. The report writing teams were the most virtual with some team members never having seen each other.

It can also be argued that student teams do not give representative answers that parallel those of individuals working in companies although there is evidence that this is not always so. Hughes and Gibson (1991) found that MBA students made decisions comparable to managers in an Executive MBA program, but Ashton and Kramer (1986) in their literature review, note that attitude questions are answered differently by individuals in the workforce than by students. Briggs et al. (1995) found students to be valid predictors of managerial technology adoption and Remus (1989) found graduate students to be more representative of industry personnel than undergraduates. In particular, studies show that students are not representative because of their lack of experience in the workforce and because of their youth. Because most of the students in our study were part time students and had full-time jobs, because the age of the students in the teams was higher than normal for university undergraduates and because the students represented the cultural mix that we wanted to assess, it was felt that this study’s population was representative of the industry group our study targeted.

We did find, however, evidence that suggests that students were responding differently than a workforce population might. Student groups uniformly evaluated their team competence and team performance highly with more spread on this evaluation in the report-writing teams (Masters students). We also found that we were not able to obtain any viable reliability on what is considered a highly reliable trust measure that we borrowed from the literature. We therefore did not include trust in our models. We also remade the competence measure into a formative construct for the survey of the report writing team. This helped to fix the skewness in the distribution of these results.

As mentioned earlier, the skewed evaluations of team competence and performance may be an artifact of student teams, but they also might be an artifact of virtual teams in some cultures. Thus, an additional variable to collect and
compare to self report of team performance is a team leader’s report of team performance in addition to other related variables such as subproject completion times. We continue to strive to obtain measures of performance from team leaders, but, to date, the descriptions of how management scores performance for their distributed teams lead us to believe that self-report of perceived performance is not any worse a measure than managerial reports. In particular, the cultural and temporal distances are likely to affect a leader’s perception of performance.

The trust measure may have been highly unreliable because student team members have a different social relationship than workforce team members. One trust question asked if a team member would like to control the work of the other team members. This is socially out of the question in a student team where fellow team members are independent individuals more than members of some greater whole such as a company. Thus, team members are likely to respond negatively to this question. A second question asked if a team member felt uncomfortable with the work of the other team members. A team member could answer positively in a socially acceptable way to this question. Thus, the reliability of a construct that works fine in a company environment falls apart in the student context. However, this failure of the trust construct could be applicable to virtual teams where their non-co-located counterpart may also feel that they have no right to control or monitor the work that the distant team performs even if they feel uncomfortable with this lack of control. This is likely to be true of teams in China and India where new hires are continually being added to the workforce. None of these younger team members would feel that they should control the work of their team members in Europe or North America, but their recent training may also make them feel uncomfortable with the work being done in these places.

The above discussion notes that the literature demonstrates that student teams can provide reliable answers that represent industry situations if the groups are appropriately chosen, but it also suggests that the very nature of student teams might be more appropriate for studying virtual teams across cultures in that their responses might represent similar cultural responses.

The small sample size also limits the generalizability of the study findings. We analyzed the teams separately because of inherent differences in their virtuality and work assignments. We also performed a separate analyses so that we could examine the effects of virtuality although confounded with task and a more senior student population. This made the sample sizes small. Approximately 200 software teams were asked to fill in the survey but only 30 responded. The response rate was extremely low, in particular, because many of the students were in their final year, already had jobs that reduced the importance of the payment incentive we offered and were quite busy with class
projects. The response rate was significantly higher for the report writing teams (about 50 percent) but the class size was small. We also choose to analyze all of the teams, even those with only one respondent because the response rate was low. Thus, there were 12 software teams that only had one member. For the report writing teams, only teams with 2 or more respondents were used in the analysis. The problem with a single team member responding constitutes another analysis problem because that single member could have been an outlier generating data unrepresentative of the team. Studies now in progress with a larger number of industry teams will yield more conclusive findings related to virtual team leader delegation.

5 Contributions and Future Work

This study addressed an important yet under-researched area regarding leader delegation practice in virtual software teams. It provides statistically sound conclusions which reduce the confusion arising from the conflicting findings of prior case studies. Some virtual software team managers claim that the increased distance make self-management necessary while others question whether excessive autonomy will produce negative effects in a complex virtual team environment. A pressing question for industry practitioners is when and how much authority and responsibility should be delegated to remote team members. Our findings suggest that delegation is an important virtual team management strategy that positively affects team performance. In particular, the results from the student teams imply that a team leader will delegate in response to his or her sense of how competent the team is. However, the real world situation affects this delegation with a push and pull effect, that is, management will want to delegate more because the task of managing a global virtual team means more communication, odd hours of work scheduled for communication and care needed to avoid miscommunications. This is the push to delegate. However, the pull effect is that a team leader because of the lack of information on the global virtual team stemming from language difficulties, cultural differences and simply not being able to observe team behavior because of the distance will not want to delegate to the team. The findings suggest that team leaders need to be trained to ignore these effects and perform their delegation based on real information about the team, perhaps by visiting the virtual team or setting up viable measures for team performance.

The tendency of the student teams to give self-reports of high competence and high performance suggests leadership guidelines for industry. In particular, it would be wise to give team leaders training in the cultures they are interacting with so that they can better judge the self-reports they are obtaining.
Our findings also suggest that delegation is a good thing in that it increases a team’s satisfaction with its leader, a team’s flexibility to adjust the project to local needs and a team’s motivation. The findings, however did not find a strong mediating relationship between these values and team performance. Earlier discussion on the limitations of the study suggest that the performance measures captured were corrupted by the use of student teams. Flexibility, motivation and satisfaction have been shown to affect performance in face-to-face teams so there is good reason to believe that obtaining better measures of performance would find moderation by these variables. This is future work that needs to be performed.

Overall, more delegation was found to be a positive behavior for a team leader, but with the youth and newness of team members joining virtual teams in many of the companies that offshore or outsource, this is likely to be a poor strategy unless measures are taken to bring up the skill sets of the offshore team members.

Due to high team member turnover in some countries, especially with the constantly increasing wages in these countries, companies are reluctant to invest in training for these team members. However, as we have been told by team managers from India, this training is precisely one of the mechanisms used to reduce turnover. This is another variable that clearly needs evaluating in future work.

Overall, the pilot study findings suggest useful recommendations for virtual software team leadership as to when and how much they should delegate to the team based on the team’s degree of virtuality and competence. However, the hypotheses of this study were mainly based on software team literature and the pilot study was done mainly with student software teams. Future work with real industry teams with varied types of companies and a variety of organizational models needs to be performed to verify these findings. Currently a full-scale survey and interview has been conducted with the global software testing teams of a Fortune 100 company. Future data analysis will be performed to compare the industry team findings with the findings of this pilot study.

6 References


