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Leadership and Trust in Partially Distributed Software Development Teams

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ABSTRACT

Partially distributed teams (PDTs) are common as organizations collaborate across distances. A PDT has at least one collocated subteam and at least two geographically dispersed subteams. We describe a large-scale experiment that examines student global PDTs working on software requirements for an emergency MIS; the teams comprised one U.S. subteam and one Dutch subteam. Leadership configuration was varied so that some teams had only a team leader; some had only subteam leaders; and some had both. However most teams chose to select subteam leaders, regardless of instructions. Trust has been found to be important for team functioning in traditional and virtual teams. This paper focuses on the experimental results related to leadership and trust in PDTs. Results indicate that while there is no evidence that trust varies by leadership configuration, the type of leader (subteam/team) matters and that trust is associated with leader effectiveness and perceptions of team and subteam performance.

KEYWORDS

Partially distributed teams, PDTs, virtual teams, trust, leadership.

INTRODUCTION

Distributed teams, and their variant, *globally* distributed teams, are an increasingly common means of accomplishing work in today's corporate arena that depends more and more on international interactions and exchanges (Connaughton & Shuffler, 2007; Cramton & Hinds, 2007; Dvorak, 2007; Gibson & Gibbs, 2006; Hardin, Fuller, and Davison, 2007; Maznevski & Chudoba, 2000). When organizations collaborate, or when distributed departments of an organization collaborate, they often do so in partially distributed teams (PDTs). A PDT is a hybrid team that has at least one collocated subteam but where the collocated subteam is geographically distant from another subteam and they communicate primarily by electronic media (Huang and Ocker, 2006, Ocker, Huang, Benbunan-Fich and Hiltz, 2008).

Prior research has identified inhibitors to global distributed team effectiveness, but it suffers from a lack of differentiation among team configurations (Lojeski Reilly, and Dominick, 2006; O'Leary and Cummings, 2007; Pinsonneault and Caya, 2005). PDTs, by nature, use both centralized (F2F /local) and decentralized networks of communication (electronic/remote in time and space) that make studying the effect of its configuration on performance challenging. Given the prevalence of PDTs, there is a pressing need to understand and address the unique demands of this particular configuration (Connaughton and Shuffler, 2007). For example, recent research indicates that global PDTs are prone to *in-group team dynamics* (increased interaction with and preferential behavior towards members in one's subteam; reduced trust and team cohesiveness as well as increased conflict between remote subteams (Panteli and Davison, 2005; Polzer, Crisp, Jarvenpaa, and Kim, 2006; Plotnick, Ocker, Hiltz, and Rosson, 2008). Members of PDT subteams conduct much of their team work face-to-face. The shared physical context coupled with the rich social cues present in face-to-face collaboration fosters cohesion, the development of a shared identity, and better conflict management *within* subteams. However, *in-group team dynamics between* subteams threaten team cohesiveness and development and can have dire consequences on team performance (Armstrong and Cole, 2002; Hinds and Mortensen, 2005; Ocker, Huang, Benbunan-Fich, and Hiltz, 2008).

Role differentiation in teams is core in stabilizing and maintaining social order. Empirical research demonstrates that role differentiation shapes the flow of communication itself and therefore influences performance and satisfaction. Research

conducted in face-to-face or fully distributed situations has shown that the communication network directly influences psychological and sociological metrics (e.g., group cohesion, agreement, structure, and pattern of in-group interpersonal attraction) (Leavitt, 1951, Moscovici, Doise, and Dulong, 1972). However, little is known about leadership issues in PDTs, which include what type of leadership (team and/or subteam) configuration is most effective as well as where those leaders should reside.

Trust has been shown to be important for effective and/or efficient functioning of teams. In a PDT, the challenge for a leader to develop trust may be especially significant. The next two sections of this paper review the literature on trust in distributed teams and leadership. We then describe the design of the experiment, followed by a description of our methods and measures, results, discussion, and plans for future research.

TRUST

Trust has been defined a number of different ways (e.g., Mayer, Davis, and Schoorman, 1995; Morris, Marshall, and Rainer, 2002). We use “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 pg. 712). Trusting relationships in any team reduce transaction costs, increase cooperation, and promote a respect for authority that enables distant management (Kramer, 1999). Trust is especially important in virtual and PDTs, where a leader is not collocated with his or her charges. However, while leadership has been studied in both collocated traditional and fully distributed virtual teams (e.g., Jarvenpaa, Knoll, and Leidner, 1998) it has yet to be fully explored in PDTs.

For example, trust in virtual teams often takes the form of “swift trust” (Meyerson, Weick, and Kramer, 1996), a form of trust that develops quickly and is based not on prior experience but on other cues such as the role the member plays in the team. The development, strengthening, and maintenance of trust in virtual teams are challenged by the lack of face-to-face interaction found in traditional teams. But, a PDT has subteams that are collocated and therefore *trust within subteams* may develop as it does in traditional teams while *trust between subteams* may develop more like the trust in fully distributed teams. Leaders are challenged to develop trust both within and between subteams that is strong and lasting. If the trust between subteams is weaker than that within the subteams, a situation conducive to in-group/out-group effects may develop.

LEADERSHIP

In a traditional team the leader is collocated with his/her members and there are multiple cues that make the members aware of the leader’s presence and position (Zigurs, 2002). Many of these cues unavailable in a virtual team so the leader must develop other ways to project presence and position (“telepresence”). A leader is also challenged to choose technologies that enable him/her to express leadership and develop suitable processes (Zigurs, 2002).

Leaders in virtual teams face challenges resulting from the specific characteristics of distance. For example, teams that are distributed across time are more likely to be out of touch with the overall environment requiring the leader to monitor the environment and keep the team informed (Bell and Kozlowski, 2002). Cultural differences are a significant issue facing virtual leaders, and an additional challenge for virtual team leadership is that extra effort must be made to establish and maintain clear and accessible communication (Cascio and Shurygailo, 2002).

For PDTs, these issues are especially important. Leaders are likely to be collocated with some members while they will need to develop telepresence with others. To avoid the in-group/out-group effects that can result from some members having closer contact with the leader(s), leaders must make a concerted effort to keep the lines of communication open with distributed members and make explicit their roles and responsibilities while working to build a team identification that encompasses the entire team.

HYPOTHESES

The independent variable in this experiment is leadership configuration. A PDT may have any of a number of configurations of team and subteam leaders. For example, there may be an overall team leader and no subteam leaders, a team leader and subteam leaders, no team leader but subteam leaders, no leaders (self-managed team), or any combination thereof. For this research we examine three of the most common configurations: Centralized, Decentralized, and Hierarchical. The Centralized condition has an overall team leader but no subteam leaders. The Decentralized condition has no overall team leader, but a leader for each subteam. In the Hierarchical condition there is an overall team leader and subteam leaders for each subteam.

Communication is a key element for building trust (Coppola, Hiltz, and Rotter, 2004; Jarvenpaa and Leidner, 1999). A leader of a team may influence trust building by such measures as increasing communication, trust building exercises, and expressing his or her feelings of trust. Local, collocated leadership behaviors are likely to be more salient to members of a team than leadership located in geographically distant locations. Thus, collocated subteam leaders' efforts at building trust and the communication that engenders trust may be more effective than the efforts of a distant leader. Additionally, although a team leader is likely to be collocated with one subteam, s/he may feel distant from even the collocated subteam if his/her focus is on the entire team rather than the subteam. Since leadership influences the building of trust, this leads to the following hypothesis:

H1: Leadership configuration will impact trust such that teams with distributed leadership (i.e. hierarchical and decentralized) will develop higher levels of trust than teams with centralized leadership.

High trust has been shown to lead to better outcomes (Hung, Dennis, and Robert, 2004). However, studies suggest that trust, while associated with better perceptions of outcomes, is not associated with objective performance (Aubert and Kelsey, 2003; Jarvenpaa, Shaw, and Staples, 2004). In a PDT there are multiple possibilities for trust to be expressed. Trust can exist within a subteam and/or for the entire team. However, it is possible that trust will exist within a subteam and not for the entire team (i.e., not between subteams). This situation may occur when in-group/out-group effects are strong; it is proposed that in such a case there will not be a perception of high team performance. Therefore, we hypothesize that:

H2: Trust will be associated with subteam and team perception of performance, respectively, as a function of the distribution of the team (collocated/in-group vs. distributed/intergroup.)

Effective leaders are able to promote trust (Coppola et al., 2004). However, in a PDT, leaders may be team leaders or subteam leaders. An effective team leader will focus on the team and build trust for the entire team. A subteam leader's responsibilities are to manage his or her subteam. Therefore, an effective subteam leader will focus his or her efforts on building trust within his or her subteam. Therefore, we hypothesize that:

H3: There is an association between trust and perceptions of leader effectiveness.

H3a: Effective team leadership will be more positively associated with team trust than with subteam trust

H3b: Effective subteam leadership will be more positively associated with subteam trust than with team trust

However, since the subteam leader is collocated with all of his/her charges while the team leader is distant and must develop telepresence with at least some subordinates, there may be a difference in how salient the efforts of the leader are to his or her subordinates. If so, efforts of a subteam leader to build trust may be more effective than efforts of a team leader. Therefore, we also hypothesize that:

H3c: Effective subteam leadership will be more positively associated with both subteam and team trust than will effective team leadership.

RESEARCH METHOD AND PROCEDURES

The study described in this paper is part of an extended set of studies examining PDTs in which the independent variables include leadership configuration and distance across student teams. In this study, conducted late in 2007, distance was held constant as all teams were comprised of subteams from two countries (U.S. and NL), while leadership condition (Decentralized, Hierarchical, Centralized) was varied.

Subjects

Three hundred sixty (360) undergraduate students from three universities in two countries (US and Netherlands) were placed into 39 teams of 7 to 11 members each. Each team consisted of two subteams. Each subteam within a team was from a different university and country. Each subteam, however, was from the same face-to-face or hybrid class and so the members of the subteam were collocated with each other and yet distant from their teammates in the other subteam.

Task

The primary task was to develop a written report in response to a Request for Proposal (RFP) for a Grassroots Resource Repository (GRRR) which was to be an emergency preparedness information system for a specified country. The participants had four weeks to prepare the report as if they were analysts in a multi-national consulting company bidding on the RFP. The final reports were to specify the functional requirements of the GRRR, the users, and the policies needed to manage it. Reports were graded by a teaching assistant who followed a grading rubric designed by the researchers.

Communication Medium

Each team was provided private space on the asynchronous PDT System, a customized wiki that was not configured to allow open editing. Members could, however, post discussions, create pages, and upload files. The participants were not required to use the PDT System for communication although all deliverables had to be posted in their private PDT System space.

Procedures

Teams were assigned to either the Centralized, Decentralized, or Hierarchical leadership condition. In each team's private PDT system space were links to instructions and surveys, a calendar, and templates for the deliverables. While all participants performed the task and received class credit, the experimental instruments (e.g., pre and post surveys) were completed by participants who volunteered to do so and received extra credit for their efforts. During the first two weeks, the participants engaged in social activities that acquainted them with their remote teammates, instructed them on how to use the system, and informed them of some of the issues of working in a PDT. Work on the task began in week 2. Research participants completed a weekly personal reflection on team processes.

Team Structure Manipulation

Teams were requested to choose leaders that put them in one of three leadership conditions: Centralized, Hierarchical, and Decentralized, as described above. Although each team was requested to enact a particular leadership structure, this was a field experiment in which the teams chose their leaders. Thus, teams could choose to ignore the suggestion and select leaders that placed them in a different structure. A manipulation check was done by examining the team contracts. These contracts revealed that most teams *did not* follow the specified leadership instructions -- they did not select only the types of leaders they were requested to choose. Instead, the teams tended to create leadership structures that were examples or variations of the Decentralized condition.

Thus, most teams seemed more comfortable in the Decentralized condition or a variation of that condition (two co-subteam leaders were selected per subteam) than either the Centralized or Hierarchical conditions. For the purposes of analysis, team leadership condition was taken to be the actual condition as indicated by the team contract, rather than the assigned condition. This resulted in 28 teams in the Decentralized condition, 7 teams in the Hierarchical condition and 4 teams in the Centralized condition. Because the manipulation check was performed early in the four-week period, we were able to adjust the surveys to accommodate the possibility of co-subteam leaders. However, our methods for collecting survey data did not allow us to identify which leader was intended as the referent for rating scale responses in such cases. Therefore, in cases where there were two subteam leaders chosen for a single subteam, the scores were averaged to arrive at a single subteam leader score.

MEASURES, RELIABILITY, AND VALIDITY

Perceptions of subteam and team performance were each measured by six 7-point semantic differential items adapted from Mortensen and Hinds (2001). Each item reflects one of six dimensions of team and subteam performance: efficiency, quality, creativity, adherence to schedule, coordination of effort, and communication. Reliability was high with Cronbach's alphas above .90.

To measure perceptions of team and subteam leader effectiveness, a single 10-point semantic differential question was used.

Trust was measured by 10 items in the post survey. Four were modified from Jarvenpaa and Leidner (1999) and six were modified from Cummings and Bromiley (1996). The scale was repeated so that trust was measured for trust of members of "my team" and for the "other subteam." Reliability of the scale was adequate with Cronbach's alpha of .859 for the scale as applied to "my subteam" and .849 for the scale as applied to the "other subteam."

However, a factor analysis of the trust scales, with negative items reversed, uncovered two factors in each case. All the positive items loaded on one factor we call "trust", and the negative items loaded on a factor we call "distrust". The literature suggests that sometimes a factor analysis will show one factor for positive items and one for negative items when there are not two underlying factors, but rather a single dimension that is contaminated by response set. When that is suspected, it is recommended that correlations between the two factors and theoretically related external variables be made (Carmines and Zeller, 1979). If there are indeed two underlying factors, then the correlations should differ for at least some of the external variables.

Correlations were conducted between trust/distrust and variables that are theoretically associated with trust. Perceived ability, benevolence, and integrity of the trustee have been demonstrated in the literature (Jarvenpaa et al., 1998) to be antecedents of trust. The post survey had three items measuring ability modified from Jarvenpaa et al. (1998). Factor

analysis showed that the items loaded on one factor each. Scale reliability was achieved as Cronbach's alpha for ability of the subjects' subteammates was .929; for ability of the other subteam members it was .925. Other exogenous variables used in this analysis were team/ subteam performance and subteam/team leader performance.

All of the correlations were in the same direction and significant ($p \leq .001$). If trust and distrust were separate factors, one might expect that for at least one exogenous variable the correlation between trust and that variable would differ from that between distrust and the variable. Therefore, there is evidence that despite the loading of trust items on two factors, there is but one underlying factor. Thus, for the purposes of this analysis, the trust scale will be treated as a single theoretical construct, "trust."

ANALYSIS AND RESULTS

Data were analyzed at the individual level, so that the N for a test represents the number of respondents. In anticipation of performing an ANOVA to test whether trust varied by condition (H1), an analysis was performed on the variables of trust for "my subteam" and trust for the "other subteam." In both cases, the data were not normally distributed and attempts at transformations (e.g., log, exponent) to achieve normality were unsuccessful. Therefore, nonparametric tests (Kruskal-Wallis) which do not require normality were performed instead of ANOVA. The result for a test of leadership configuration impacting trust of "my subteam" is not significant at the .05 level of significance ($X^2 = .5603$, $p = .7557$, $N = 268$). Similarly, an insignificant result was found for the nonparametric test of the impact of leadership configuration on trust of the "other subteam" ($X^2 = .6935$, $p = .7070$, $N = 268$). That is, the tests did not show significant differences between trust under the different leadership configurations (Centralized, Decentralized, or Hierarchical). Therefore, Hypothesis 1 is not supported.

To test Hypothesis 2, a correlation of perceptions of trust within a subteam (i.e., trust for "my subteam") and perceptions of subteam performance was performed. The test result ($r = .28478$, $p < .0001$, $N = 268$) is significant at the .05 level. Thus, Hypothesis 2 is supported for trust within a subteam. Then a correlation of perceptions of trust between subteams (i.e., trust for the "other subteam") and perceptions of team performance was performed. The test result ($r = .27380$, $p < .0001$, $N = 268$) is also significant at the .05 level. Thus, Hypothesis 2 is also supported for trust between subteams.

Correlations were performed to test Hypothesis 3, which proposes relationships between perceived leader effectiveness and trust. Effective leadership as measured by perceived leader performance was positively correlated for both team and subteam leaders vs. team and subteam trust, thus supporting H3. Perceived team leader performance was positively associated with both trust within a subteam ($r = .2673$, $p = .0264$, $N = 69$) and trust between subteams ($r = .4412$, $p = .0001$, $N = 69$). The higher correlation of team leader trust with team performance supports H3a. Perceived subteam leader effectiveness was also positively associated with both trust within a subteam ($r = .40564$, $p < .0001$, $N = 164$) and trust between subteams ($r = .30464$, $p < .0001$, $N = 164$). Since Pearson's r for the correlation with trust within a subteam is higher than the r for team trust (trust between subteams), and the level of significance for both is very high ($p < .0001$), Hypothesis H3b is supported. Subteam leader performance and subteam trust were more significantly correlated ($p < .0001$) than were team leader performance and subteam trust ($p < .0264$). Similarly, subteam leader performance and team trust were also more significantly correlated ($p < .0001$) than were team leader performance and team trust ($p = .0001$). Therefore, Hypothesis 3c is supported.

DISCUSSION AND CONTRIBUTIONS

Quantitative analysis of the post survey failed to find differences in trust by leadership configuration. However, it should be noted that because of the failure of the leadership manipulation, there was an imbalance in the number of respondents from each configuration (Decentralized $n = 186$; Hierarchical $n = 54$; Centralized $n = 28$), limiting the power of the leadership contrasts. Therefore this hypothesis should be tested in future studies in which stronger leadership condition manipulation may result in a better representation of each condition. However, that the teams generally preferred being in the Decentralized condition is an important finding itself that warrants further exploration. It may be that the teams are more comfortable working in close proximity to leadership or it may reflect early formation of in-group/out-group effects that created a mistrust of possible leadership from outside the local subteam.

The result found in the literature for traditional and virtual teams that perceived performance is associated with trust (Jarvenpaa et al. 2004), was found in this study for PDTs as well. Additionally, scales previously validated in traditional and/or virtual teams to measure perceptions of performance and trust were validated for PDTs.

These results suggest that while we cannot yet say that leadership configuration matters for the development of trust within and between subteams in PDTs, trust is associated with member perceptions of team and subteam performance. Additionally, the type of leader (team or subteam) and his or her perceived effectiveness is associated with levels of team and subteam trust. There is also an association between trust and perceptions of team and subteam performance. Member

perceptions can be motivators (or de-motivators) and therefore are important for team functioning. However, leaders need to be aware that member perceptions of high performance may not reflect the reality of objective performance. Thus, leaders must develop metrics to objectively measure performance simultaneously with developing trust within and between subteams.

Thus, this study contributes to an understanding of trust in PDTs of a variety of configurations (Centralized, Decentralized, and Hierarchical).

LIMITATIONS AND FUTURE RESEARCH

Although the use of student subjects is a concern for generalizability, the fact that the teams spent four weeks on a realistic task and that the grade for the team report counted as 20% or more of their course grade lessens this concern. Nevertheless, although we did provide instructions for leader responsibilities, and exercises to increase awareness and understanding of issues of working in PDTs, it is possible that many of the chosen leaders did not have prior experience working in managerial positions and/or in PDTs. Also, because many of the teams did not implement their assigned leadership condition, the statistical power of the leadership contrasts was reduced.

Finally, although trust was measured in this study at the end of the four weeks, early trust is likely to be important for trust between subteams. Therefore, the next study in this series will also examine early trust which, between subteams, is likely to be a form of swift trust as team members across subteams will be interacting only virtually and will not have had a history together. This next study will also look at the effects of distance on trust as well as whether or not trust is associated with satisfaction with leaders and/or the team. Thus, this study is a first step towards understanding trust in PDTs.

Because of the limitations inherent in using students as subjects, the long term plans for this research include field studies with software development professionals in partially distributed teams.

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