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DETERMINANTS OF PARTIALLY DISTRIBUTED TEAM PERFORMANCE: A PATH ANALYSIS OF SOCIO-EMOTIONAL AND BEHAVIORAL FACTORS

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ABSTRACT

Distributed teams and their variant, globally distributed teams, are an increasingly common means of accomplishing work. A common team configuration is the partially distributed team (PDT), which has a hybrid structure consisting of two or more subgroups of geographically separated team members. Using partial least squares, we test a path model of the relationships among determinants of between-subgroup perceptions of PDT performance. The data are from a series of quasi-experimental field studies involving nearly 700 students working in PDTs that varied in distance between two subgroups separated by a few hundred miles to international distances that spanned cultures and multiple time zones. The factors examined in the model were shared identity, trust, competence, and conflict; the overall model explains 34% of the variance in perceived team performance.

Keywords

Partially distributed teams, hybrid teams, virtual teams, subgroup, trust, shared identity

INTRODUCTION

Distributed teams and their variant, *globally* distributed teams, are an increasingly common means of accomplishing work in today's corporate arena, as work environments have come to depend more and more on interactions and exchanges that span distances. The Gartner Group estimated that 41 million employees world-wide interact remotely with other team members a minimum of once a week (Dempster, 2005).

Distributed teams can have a variety of configurations (O'Leary & Cummings, 2007). One common configuration is the *partially distributed team* (PDT), which we define as a team consisting of at least two geographically distinct sites, with *multiple* members co-located at each site. In PDTs, team members must interact with both *co-located* and *distant* members. PDTs are a typical configuration for information technology (IT) project teams in general, and software development teams, in particular (e.g., Carmel & Abbott, 2007; Hanisch & Corbitt, 2007).

Prior research has examined a number of variables that influence the behavior and outcomes of distributed teams but this research has not differentiated among different possible team configurations (Pinsonneault and Caya, 2005). Research findings from studies of fully distributed teams (with every member located at a different site) have been conflated with those involving hybrid configurations (e.g., a mixture of co-located and distant members), and as a result have produced contradictory findings; (reviews include Martins et al., 2004; Pinsonneault & Caya, 2005; Powell et al., 2004). Given the increasing prevalence of PDTs, we report on research that examines the impact and relationship between four key facets of team processes on member perceptions of PDT performance: trust, shared identity, conflict and competence.

In the remaining sections of this paper, we present the empirical and theoretical basis for our research model and associated hypotheses, describe the research methods, present a path analysis of the four factors on team performance, including evidence that all research hypotheses were confirmed, and we discuss the implications of these results.

THEORETICAL BACKGROUND

Subgroups in partially distributed teams

Identification refers to an individual's sense of belonging to a social category (Ashforth and Mael, 1989). Social categorization theory (Tajfel 1981) and Social Identity Theory (SIT; Tajfel and Turner, 1986) suggest that people derive social identity primarily from membership in groups. Demographic differences spawn differences of opinion and divergent viewpoints which lead to people categorizing themselves into "us vs. them" groupings. Positive social identity results when one can make favorable comparisons between the group to which one is a perceived member (i.e., the ingroup) compared to other germane groups to which one is not a perceived member (i.e., the outgroups).

Decades of research indicates that *subgroups* form due to variation among members on demographic attributes (e.g., race, age, sex), psychological differences (e.g., beliefs) and affiliations (for a review, see Williams and O'Reilly, 1998). Subgroups develop separate identities and exhibit behaviors whereby members cohere and interact more with members in their subgroups. Ingroup bias, prevalent in this context, refers to the preferential treatment members may give to others who they perceive to belong to their ingroups. Ingroup dynamics reduce cooperation, threaten cohesiveness, increase cross-subgroup conflict, and can have dire consequences on overall group effectiveness (e.g. Jehn et al., 1997; O'Reilly et al., 1989).

Working by analogy to geological faultlines, Lau and Murnighan (1998) argue that a faultline based on the alignment of member attributes can divide a team into subgroups. Research suggests that PDTs may be especially prone to subgroup formation of this sort, where the subgroups are based on co-location (Armstrong & Cole, 2002; Huang & Ocker, 2006; Panteli & Davison, 2005). For example, in the only prior large-scale study of PDTs, Polzer et al. (2006) also found strong support for faultlines based on geographic location, which were most apparent in teams that had been configured as two (not three) subgroups. Co-located team members reported higher trust levels and lower conflict levels compared to teams where members were fully dispersed. Ingroup dynamics resulting from a geographic faultline were evident in the co-located subgroups; team members divided work according to geographic location, which reduced the interaction between location-based subgroups.

Thus, it appears that physical separation, coupled with the presence of co-located members at the distributed sites, creates the potential for a powerful geographic faultline (Polzer et al., 2006). The resulting subgroup dynamics threaten trust and cohesiveness between subgroups, which in turn may have a negative effect on the overall effectiveness and performance of the distributed team.

Variables likely to influence PDT interaction and performance

We explore four variables which have been shown to be key influencers of both traditional and virtual team interaction and performance, and that we thus expect to influence PDTs. Shared identification and trust are socio-emotional constructs, emphasizing how individuals feel about their team. Competence and conflict have a more behavioral construal, capturing aspects of how members see their team interacting and operating. In general, we will argue that the socio-emotional factors influence team performance indirectly, creating a context for team behavior, and that the behavioral variables have direct effects on performance.

Shared identification with the team by its members is important in terms of enhancing team cohesion, reducing conflict, and increasing motivation (Jehn et al., 1999). Due to the reduced contact of members in a virtual context, the cohesion that is promoted by shared identification may be especially important to team functioning (Hinds & Mortensen, 2005; Wiesenfeld et al., 2001).

Trust can be defined as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (Mayer, Davis, and Schoorman, 1995, p. 712). Trusting relationships in any team reduce transaction costs, increase cooperation, promote respect, and lead to better outcomes (Hung, Dennis, and Robert, 2004). However, trust is difficult to establish in a virtual context (Jarvenpaa and Leidner, 1998).

Competence is concerned with beliefs about the ability of the team. It melds aspects of group potency and collective efficacy. Group potency is the collective belief of group members that the group can be effective (Guzzo & Shea, 1992).

Similar to group potency, collective efficacy is the members' beliefs that the team can succeed at a specific task (Lindsley, Brass, & Thomas, 1995).

Conflict can be defined as disagreements among team members due to perceived incompatibilities or differing viewpoint or goals (Jehn, 1997; Polzer et al., 2006). Not surprisingly, conflict is normally problematic for team performance (Jehn, 1997). Research indicates that conflict may be more prevalent in virtual contexts (Mortensen & Hinds, 2001; Hinds & Mortensen, 2005). The lack of immediate feedback (Kankanhalli et al., 2007) as well as time zone and cultural differences may exacerbate conflict (Mannix et al., 2002).

HYPOTHESES AND RESEARCH MODEL

Shared identity and trust are emergent states – that is, they vary due to differences in team context, inputs, process, and outputs and can serve as inputs to or outcomes of team interaction (Marks et al., 2001). Perceptions of trustworthiness develop quickly in a virtual setting, based on initial interaction (Zolin et al., 2004). Exchanging social information early in the life of a virtual team has been found to foster team relationship building, cohesion and trust (Jarvenpaa & Leidner, 1999; Maznevski & Chudoba, 2000; Robey et al., 2000).

In an effort to foster swift trust and early feelings of shared identity, in this study all PDT members participated in a team building activity at the inception of their shared project. We expect that varying levels of trust and shared identity across subgroups emerged from these introductory activities, and that these variations in trust and identity influenced the team processes enacted by the student PDTs. The overall research model appears in Figure 1.

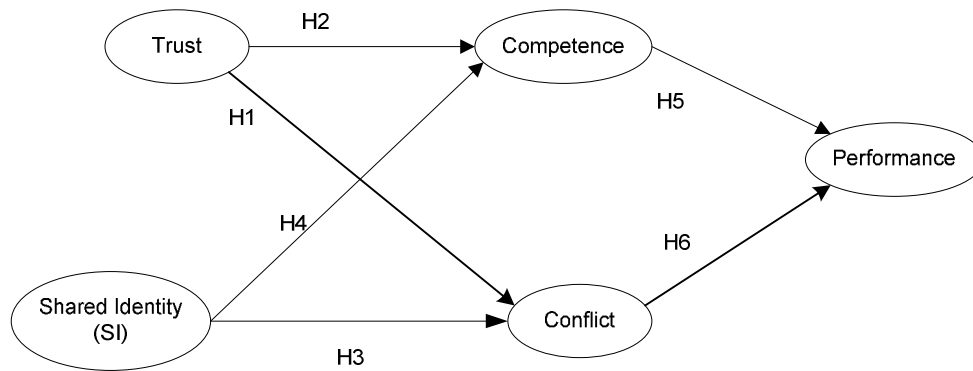


Figure 1. Research Model

The salience of trust in interdependent relationships (Smith and Barclay, 1999) suggests that trust is likely to influence intergroup conflict. Massey and Dawes, (2007) found that lack of trust increases relational conflict. Thus, we hypothesize:

H1. Members who trust the work of the distant subgroup will perceive less team conflict.

PDTs are susceptible to “co-location blindness,” where subgroup members may never realize or forget about the skills and contributions that could be made by their remote partners. In co-located groups, members are constantly reminded of their own subgroup’s contributions, but for remote partners a subgroup member must trust that task-related activities are taking place, and that the members of the distributed subgroup possess skills that they are applying to their part of the shared task. As a result variations in trust between subgroups should influence team members’ perceptions of their distributed subgroup’s competence (Bos et al., 2006), leading us to hypothesize:

H2. Members who trust the work of the distant subgroup will perceive them as more competent.

As noted earlier, PDTs are prone to location-based subgroup dynamics. Due to a shared physical location, subgroup members are able to conduct much of their team work via face-to-face interaction. Although the remote subgroups do not have the benefit of the rich social cues of face-to-face interaction, we expect that the initial activities will enable some teams to develop a shared identity. We hypothesize that if members at one site are able to identify with members at the distant site, subgroup dynamics will be diminished, resulting in less conflict between sites:

H3. Members who perceive a higher shared identity with the distant subgroup will perceive less conflict with the other subgroup.

Furthermore, identification with the distant subgroup should promote a breakdown of the “us vs. them” mentality, and thus we hypothesize:

H4. Members who perceive a higher shared identity with the distant subgroup will perceive them as more competent.

As members of the distributed subgroup gain ingroup status (i.e., through increased feelings of trust and shared identity), and are perceived as more competent, collective efficacy for the distant subgroup will increase, resulting in higher ratings of overall team performance:

H5. Members who perceive the distant subgroup as more competent will perceive their team as higher-performing.

While moderate levels of task-related conflict can be beneficial to performance (Jehn, 1997), the “us vs. them” subgroup dynamic is most likely to foster interpersonal conflict, and affective conflict of this sort reduces team functioning and performance (Jehn, 1997). Therefore:

H6. Members who perceive less conflict with the distant subgroup will perceive their team as higher-performing.

METHOD

The work presented here used a varied set of research methods and settings; it took place over three semesters of a field study conducted at multiple universities located in multiple geographic regions. The uniting factor across semesters was the shared course project activity conducted by subgroups of students in different classes.

Participants and Sites

Five domestic and four international universities participated in this field study. The domestic sites were: (1) Penn State University (2) New Jersey Institute of Technology (NJIT), (3) University of Alabama (Huntsville), (4) University of Hawaii (Hilo), and (5) California State University (Fullerton). The international sites were: (1) Carlos de Madrid III University (Spain), (2) Tilburg University (The Netherlands), (3) Yonsei University (South Korea), and (4) Zhejiang University (China). In total, 689 students participated, grouped into 84 teams. Teams had an average of 8 members, divided across two sites with about 4 members each.

Distributed Team Projects

To provide projects suitable for students from different geographic regions and cultures, and because homeland and global security is of growing importance world-wide, we developed two projects involving emergency management information systems (EMIS). The projects were designed to be isomorphic. Each project spanned a four-week time period and focused on the front-end activities of the system development cycle (high-level analysis and design).

We developed a custom system to support PDT collaboration. When students log in, the system presents them with a description of the PDT project with instructions, milestones, and deliverables. The system offers a threaded discussion board; a file sharing repository; shared document creation and editing; as well as a project calendar. Each team was set up with its own electronic workspace. The participants were free to use other technologies such as instant messaging, email, or phone.

As a field experiment spanning three academic semesters, it was impossible to randomly assign groups to conditions for the whole (combined) experiment, but in any case when instructions were varied systematically in a semester, random assignment of teams to conditions was made. In addition, small changes were made each semester to some of the procedures as well as the specifics of the task.

Data Sources and Instruments

The analysis presented here uses data collected from the post-project survey. *Competence* was measured using three items adapted from Jarvenpaa et al. (1998). *Conflict* was measured using three items and *shared identity* was measured using four items; both of these constructs were adapted from Mortensen and Hinds (2001). *Trust* was measured by four items adapted from Jarvenpaa and Leidner (1999). *Team performance* included six facets (efficiency, quality, creativity, adherence to schedule, coordination, and communication) and was adapted from Mortensen and Hinds (2001). The competence, conflict, and trust ratings gathered judgments about distributed subteams; shared identity and performance were judged with respect to the team as a whole. All items were measured using a 7-point semantic differential response scale.

DATA ANALYSIS AND RESULTS

We chose partial least squares (PLS) structural equation analysis to test the hypotheses. Compared with traditional Structural Equation Modeling, PLS aims for prediction in the traditional regression sense, by minimizing residual variance (Fornell & Larcker, 1981). The measurement model was tested by examining (1) internal consistency, (2) individual item reliability, and (3) convergent and discriminant validity.

Regarding internal consistency, in contrast to Cronbach’s alpha, composite reliability is not influenced by the number of items in the scale. Instead it relies on the ratio of construct variance to the sum of construct and error variance. All composite reliabilities were above the conventional threshold of 0.70. Individual item reliability was assessed by examining the loadings of the manifest variables on their corresponding latent variables. From the original questionnaire, two items were removed in order to achieve the standard 0.70 level of individual item reliability. Convergent validity in PLS was assessed by examining the average variance extracted (AVE) measure. All constructs’ AVE exceeded the customary 0.50 threshold. Discriminant validity refers to the extent to which a given construct is different from other constructs in the model. One criterion for adequate discriminant validity is that the construct should share more variance with its indicators than with other constructs in the model. This was achieved for all constructs.

Structural Model

Construct indices were formed using the factor scores for each set of items and then used to assess the structural model, building a path model that evaluates the hypothesized relationships depicted in the research model (Figure 1). Figure 2 shows this model with the path correlations of the hypothesized relationships (for this analysis, n=465) and variance accounted for by each hypothesized set of relations. Significance levels for the path correlations are indicated through the ** or * annotations; these levels were computed by PLS through a bootstrapping procedure.

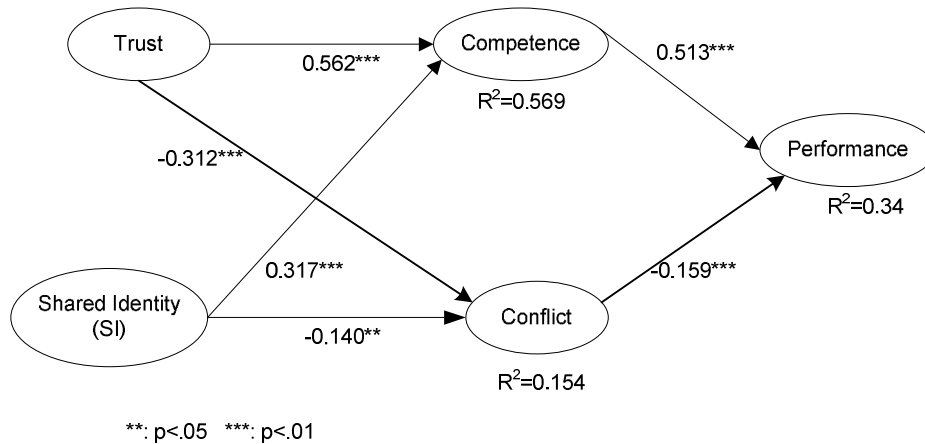


Figure 2. Path Diagram Showing the Test of the Research Model

The model and path correlations were estimated using 200 iterations of the bootstrapping technique in PLS Graph-3.0. The explanatory power of the overall structural model can be assessed by looking at the R² value associated with the final outcome measure (performance). That is, 34% of the variance of perceived overall team performance can be explained by perceived competence of the remote subgroup and perceived conflict between subgroups. Within these two factors, competence (β=0.51) has a stronger impact on performance than conflict (β=-0.16). The model also shows that trust and shared identity are important to members’ perceptions of their remote subgroups’ competence. 57% of the variance in competence is explained by trust and shared identity. Trust and shared identity also show the expected influence on conflict, although less variance is explained by these relationships (just over 15%).

To examine the specific hypotheses, t-statistics for the standardized path coefficients were obtained and associated significance values were examined; Table 1 summarizes these tests for the path coefficients. All coefficients were significant at p < 0.01, except for the relationship between shared identity and conflict, which is significant at p < 0.05.

Table 1. Results of Testing Hypotheses H1- H6

Hypothesis	β	t-statistics
H1: Trust \rightarrow Conflict	-0.31	4.79
H2: Trust \rightarrow Competence	0.56	13.16
H3: Shared Identity \rightarrow Conflict	-0.14	1.95
H4: Shared Identity \rightarrow Competence	0.32	6.45
H5: Competence \rightarrow Performance	0.51	9.99
H6: Conflict \rightarrow Performance	-0.16	2.85

DISCUSSION AND CONCLUSIONS

The field study methods, results, and structural model presented in this paper are among the first to examine how team dynamics and process variables influence team performance for virtual teams that depend on the coordinated work of both co-located and distributed subgroups. We measured several constructs known to influence the success of teams – shared identity, trust, conflict, and competence; with the general result that all six of our research hypotheses were supported. In this section we discuss our findings in more depth, and summarize limitations and open issues.

Determinants of PDT Performance

The structural model summarized in Figure 4 documents direct impacts of competence and conflict on team performance (H5 and H6 were confirmed), as well as indirect effects of trust and shared identity through their influences on competence and conflict (H1-H4 were confirmed). These findings are consistent with prior studies of teams, enabling us to synthesize different threads of research to consider the special case of PDTs, and providing a baseline model for future studies of this important type of virtual teams.

With respect to predicting performance ratings, the analysis revealed an influence of subgroup's perceptions of their distant subgroup's competence and conflict levels, with competence carrying the most weight in the model (57% versus 16%). It is not surprising to see a strong effect of competence.

With respect to indirect determinants of team performance, our multivariate analysis confirmed that both shared identity and trust were predictors of competence and conflict, but not a direct predictor of performance. This structural result suggests that these two variables may play an important role in setting the stage for conflict with distributed subgroups, and for perceptions of competence.

Implications for Research on PDTs

The work presented here is a first step within a longer-term research program. Our research team is specifically interested in the negative impacts of PDT distance variables (stemming from variations in geographic, cultural, and temporal characteristics across the subgroups) and with techniques for ameliorating these problems. However, in order to tease apart the effects of distance, we first needed to establish and validate a base model. We have now done that, and are currently engaged in gathering a larger set of data to use in refining the model and analyzing the complex set of distance factors

Implications for ICT Support of PDTs

Thus far, our research focus has not been on designing alternatives for promoting PDT productivity or team satisfaction. However, after several semesters of work using these online tools, and in light of our analysis of performance determinants, we can speculate about design features that might enhance PDT outcomes. . The system might be enhanced to gather “how is it going?” data on a more regular basis, which could allow team or subgroup members to detect and address emerging member conflicts before they become large enough to influence team performance.

Another direction concerns the influence of competence, as it was perceptions of the distributed subgroup's competence that had a major influence on ratings of team performance. This finding emphasizes the important role of staying aware of how a

remote partner group is doing with respect to their components of a shared task. In the case of student PDTs, this may be enhanced by making it easy for instructors to post intermediate grades or other progress indicators for all team members to see. Subgroups who recognize early on that their remote subgroups are lacking some skills deemed critical to success might then have the opportunity to adjust the collaborative process, for example contributing more effort to address team goals in the problem area.

Limitations

We recognize that we have much to do before we can systematically investigate the multiple aspects of distance that can influence PDTs. The U.S.A. and Western European cultures have been fairly well-represented in our sample thus far, but the representation of Asian cultures is quite limited.

The results of this study must also be considered in light of the standard caveats about research with student participants. However, we argue that the student's PDT project was realistic in many respects; it was assigned with a time frame of four weeks, and motivation to engage was high because the grade for the team project deliverable was a significant element of the students' course.

Contributions

This study is one of the first large-scale quantitative studies that examine factors that influence team performance in PDTs. The research model in this study helps us understand how socio-emotional factors (trust and shared identity) impact beliefs about competence in the remote subgroups and conflict between subgroups, which in turn influence the overall performance of the entire team.

Second, although the role of trust in teams has been studied extensively, very little research has considered the relationship between trust and competency, and between trust and conflict. Our model has shown that higher levels of trust for a remote subgroup are associated with stronger beliefs in the competency of the remote subgroup, as well as lower conflict between subgroups; this in turn leads to higher perceived performance. Thus, for PDTs, building trust at the beginning among remote groups is very important for better team process and higher performance.

Third, shared identity is still a relatively new construct in virtual team research. Our model confirms that shared identity is very important in PDTs. When group members feel they have higher shared identity with their remote subgroups, i.e., when they categorize the remote subgroup as "us" instead of "them", they will have a higher regard for them, and less conflict during the project process, leading to better performance overall.

Fourth, our research model conceptualized competence as related to the collective efficacy of a remote subgroup, and we accordingly used it as a predictor of performance. Consistent with collective efficacy theory (CET; Bandura, 1982), we found a positive relationship between perceived competence of the remote subgroup and overall team performance. Thus our study extends work related to CET to teams that are geographically distributed. Our finding shows that when there are subgroups in a team, perceptions of the collective efficacy of the remote subgroup will impact the performance of the entire team. When group members are uncertain about their remote partners, they may have lower expectations about performance, which may lower their motivation and effort in group process.

Future Research

Our long term interest is in articulating the different ways that "distance" can be operationalized in the context of PDTs, and how these different distance dimensions (e.g., geographic, cultural, temporal) influence PDT interaction and success. We are in the process of studying a more extensive set of student PDT projects (using the same materials and procedures introduced in this paper), so that we can obtain sufficient coverage of temporal and cultural distance variations. As we fill in the gaps in our dataset, future research will address the question:

How does temporal and cultural distance between subgroups interact with socio-emotional and task-related processes to determine the effectiveness of partially distributed teams?

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