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Building Trust and Cooperation through Technology Adaptation in Virtual Teams: Empirical Field Evidence

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Abstract *This article reports findings of a study of how leaders of virtual information systems development teams improve team trust and cooperation by managing adaptation of information and communications tools. Results indicate how Theory X (command and control) and Theory Y (facilitate and support) styles of leadership enable and hinder effective outcomes.*

Keywords collaboration, collaboration technology, information systems development, information technology, electronic collaboration, virtual teams

"For it is mutual trust, even more than mutual interest that holds human associations together."

-H. L. Menken (1880–1956)

Introduction

Project managers are responsible for making their teams successful, even if the members do not immediately fall within the same organization or get paid by the firm employing the leader. Common situations for group work have involved direct periodic face-to-face meetings, groups that know each other based on prior histories of co-work, and demarcated hierarchical command and control assigned to a single leader who may influence not only tasks assigned to individuals but perhaps also pay and promotion potential (Hackman, 2002). Increasingly common *virtual project* settings for group work contradict several of the traditional situational assumptions listed above, (Lipnack & Stamps, 2000). Virtual project work often involves multiple organizations collaborating or contractor-client relationships through which leaders lose the ability to directly influence workers' pay and performance. When groups are distributed over wide geographic areas, regular updates through face-to-face meetings are not possible due to cost and time required for travel. And, since project work is time-delineated and often cross-functional in nature (PMI, 2004), it often begets ephemeral relationships.

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Group leaders in businesses have traditionally employed mandate-oriented leadership strategies that use direct authority and control for directing tasks and motivating employees (Mintzberg, 1998; McGregor, 2006). In virtual project settings, the project managers (which we also refer to as leaders or virtual team leaders) will likely be constrained in applying traditional group leadership techniques as their authority is not likely to extend to all organizations in a team nor to all types of control (i.e., pay and performance) for all members.

Unlike their collocated counterparts involved in leading groups characterized by longer-term relationships and fewer organizational boundaries, the virtual team leaders must deal with team members via information and communication tools (ICTs). ICTs are the key enabler for core group communications. Does effective management of ICTs offer the Virtual Team (VT) leader a means for regaining some of the lost influence for achieving performance? We believe it may, especially in team project settings requiring high levels of interaction and shared understanding, such as information systems development teamwork. We conducted the study reported in this paper to explore this important topic.

Creating Trust in Virtual Teams Using ICTs

Information systems development (ISD) work often requires collaboration and successful resolution of task conflict between different groups (Tiwana & McLean, 2005). These groups are prone to raise social defenses

that disable cooperation (Wastell, 1999). Social defenses are negative reactions people enact in interpersonal communication settings when they perceive an undesirable attempt to affect their understandings of a situation or behavior. Failed cooperation resulting from social defenses, which interrupt the normal flow of communication necessary for cooperative work, manifests itself in trust and relationship breakdowns that cripple team performance. Leaders of distributed ISD project collaborations must act when confronted with trust and relationship breakdowns that halt productive team interaction. How can they best cultivate positive working relationships among distributed team members? How does the management of ICTs relate to this cultivation?

A primary area of concern in systems design research for many years has been how to create trust between a computer user and the computer or tool. While this has been a fruitful exploration, solidifying understandings of individual users and better designs of their tools (graphical user interfaces, data representations, etc.), there has been little research on creating and managing the relationships among multiple users using multiple ICTs, a much more dynamic situation, which is more characteristic of today's distributed collaboration environments. Some work in this area has focused on media synchronicity, the idea that a certain mix of ICTs enables core communicative needs, convergence and conveyance (Dennis & Valacich, 1999). This theory helps explain why a particular ICT may be more useful in a given situation than another. Some empirical research has supported the tenets of media synchronicity and called for research such as the present research that looks at how to make adaptations to use various ICTs (DeLuca & Valacich, 2005). In the process of such adaptations, we take the position that team members may perceive an undesirable attempt to influence their understandings and behavior, leading to social defenses and trust loss. From the perspective of a trust relationship, which we draw on prior research and treat trust broadly as a basis of cooperation required for any effective group work tackling a complex and interdependent task. Interpersonal trust in such a setting is a key to effective teamwork (Golembiewski & McConkie, 1975).

Researchers have explored how interpersonal trust may be produced (Zucker, 1986), but prior studies have not looked at how team leaders use ICTs among co-workers to mend differences and build trust, even though technology-mediated virtual environments do seem to display different trust characteristics than work environments characterized by more traditional face-to-face contact (Jarvenpaa & Leidner, 1999), and the methods of trust creation and maintenance are expected to be different in virtual settings and less susceptible to more traditional command and control leadership behaviors (Piccoli & Ives, 2003). To our knowledge, our study is the first field study of multiple, successful, project leaders engaged in the cultivation of cooperative working relationships via ICT adaptation management, though existing literature has called for field studies and a closer look at how leaders may use shared objects, such as ICTs, to create working environments that enable better group work (Wastell, 1999). It extends current literature on technology adaptation and trust formation via addition of an empirical investigation of how actual project leaders, not students, use ICTs for effective trust building and better outcomes in virtual teams.

This paper begins with a discussion of trust creation and relevant literature. We present three hypotheses developed from the literature on trust and virtual teams with an understanding of ICTs as transitional objects. We introduce and explain our critical incidents methodology in the next section followed by interpretive and quantitative empirical findings. We conclude with a discussion of how these findings elucidate paths for future research and improved ISD in virtual settings.

Trust Creation in Virtual Groups

The Oxford dictionary defines trust as "a firm belief in the reliability, truth, ability, or strength of someone or something" (www.askoxford.com/concise_oed/trust?view=uk). In general, trust is the key for cooperative relationships and effective teamwork (Hardin, 2004). Which conditions lead to its existence and maintenance has received some attention in virtual ISD literature.

Consistent with a body of work examining interpersonal trust in work settings (Hosmer, 1995), research on virtual work shows that perceptions of ability, benevolence, and integrity in others logically compose the antecedents of interpersonal trust and predict the existence of trust (Jarvenpaa, Knoll, & Leidner, 1998). These dimensions are defined as follows (emphasis added):

> *Ability* refers to the group of skills that enable a trustee to be perceived competent within some specific domain... *Benevolence* in the extent to which a trustee is believed to feel interpersonal care and concern, and a willingness to do good to the trustor beyond an egocentric profit motive... *Integrity* is adherence to a set of principles (such as study/work habits) thought to make the trustee dependable and reliable, according to the trustor (Jarvenpaa et al., 1998, p. 31).

In particular, perceptions of integrity between virtual team members have been found to exhibit the strongest effects on developing interpersonal trust with perceptions of benevolence showing the weakest. While these perceptions are critical for understanding what constitutes trust they do not explain the on-going process of trust maintenance in virtual ISD work groups and how it

may relate to the usage of ICTs. We turn to this topic next.

Technology Adaptation and Trust-Making

Based on prior work, we know that virtual ISD work requires adaptation of technology to be successful because:

- work in collocated projects requires technology adaptation (Majchrzak, Rice, Malhotra, King, & Ba, 2000);
- general group interaction through advanced communications technologies will involve technology adaptation (DeSanctis & Poole, 1994); and
- ISD work is intensive and interdependent in nature (Tiwana & McLean, 2003) and must have dynamic learning among team members in order to be successful (Wastell, 1999).

This learning dynamism necessitates continual cooperation across internal barriers and resolution of on-going conflicts (Metiu, 2006; Wastell, 1999). As mentioned above, trust is the key to cooperation. Conflict erodes cooperation (Barki & Hartwick, 2001). Conflict resolution may be enabled by successful technology adaptation (Sherif, Zmud, & Browne, 2006; Gopal, Bostrom, & Chin, 1993). So, if there must be cooperation, and technology adaptation is a given, and technology adaptation may influence the ability to cooperate, we ask what leaders may do to manage the relationship between technology adaptations during teamwork and the development and maintenance of positive cooperative working relationships.

While the presence of trust leads to cooperation, it is unclear how management of technology adaptation by leaders may relate to cooperation development and maintenance. There is no clear feature of any virtual team ICT to our knowledge that directly targets benevolence, ability, or integrity perceptions. Some research does point to particular ICTs, such as text messaging as useful for achieving access to otherwise occupied workers (Sivunen & Valo, 2006), but it is unclear how such research sheds light on leader adaptation management. Rather, such research helps clarify that there are various ICT features for modeling and representing information, jointly storing and processing information, and transmitting messages, which we can imagine being used to develop perceptions antecedent to trust.

For example, suppose one sub-group in a team does not perceive another as working toward the shared goal in earnest (integrity) nor effectively (ability). We can imagine some ICT adaptation, such as enabling a workflow system view into the sub-group's progress and adding a modeling technology that represented their work in a form a non-trusting other sub-group could understand, that would enable the non-trusting sub-group to see their counterparts' work, understand its merit and change integrity and ability perceptions.

Some prior literature does examine how the absence of trust disables cooperation in ISD work and may be influenced by ICT adaptation management. The absence of trust leads to social defenses that impede cooperation and which may be, conceptually, aggravated or minimized depending on the ICTs in use (Wastell, 1999). Overcoming social defenses may be accomplished with the imposition of transitional objects which compose transitional spaces in ISD work (Wastell, 1999). The concept of transitional objects derives from the field of psychoanalysis. Transitional objects are objects that convey comfort to individuals and can help in feeling secure engaging with new or unfamiliar environments (i.e., the other sub-groups within an ISD team that may be both physically distant and differentiated by area of expertise or organizational boundaries) (Winnicott, 1971). Classic examples or transitional objects include a child's teddy bear or Linus' blanket from the comic strip *Peanuts*. Linus can be comfortable anywhere he has his blanket with him. Transitional spaces are the multi-media collaboration and communications systems available to a virtual team (Wastell, 1999). How could a collaboration technology (ICT) serve as a transitional object?

Transitional objects have been shown critical in business organizations for effective cooperation and learning. They may be either animate or inanimate. As animate objects, we see trusted third parties—"trust facilitators"—can provide a critical value in rebuilding trust and cooperation in working relationships (Mesquita, 2007). As inanimate objects, models and methodologies play a transitional role for ISD work (Wastell, 1999). Models provide the ways of representing information critical to ISD work and will be instantiated and constrained according to the ICTs in use by a team, as different ICTs enable or disable the sharing and representation of different forms of models. Methodologies provide the procedures for accomplishing work and manipulating models and will also be instantiated and constrained according to the ICTs in use by a team. Thus, there seems to be a theoretical role for ICT adaptation management in the cultivation of team cooperation.

Technology adaptation involves the acquisition and usage of new ICTs or new features of existing ICTs, the disuse of ICTs, and the modified usage of existing features in existing ICTs. Leaders can act to influence these behaviors. It follows that leader influence on technology adaptation theoretically provides a lever for managing cooperation through the manipulation of the ICT-defined transitional space, as illustrated in the example of workflow view and modeling technology adaptation

given above. The workflow view provided a comfort method for team members to see a sub-group's progress and improve their perception of integrity, the modeling technology gave the non-trustors a comfortable model for understanding the quality of work to improve their perceptions of ability.

Management of technology adaptation is unlikely to be a straightforward band-aid for fixing trust and building cooperation. Technologies get adapted in ironic and sometimes contrary ways relative to intended usage (Poole & DeSanctis, 2004). Thus, we expect the dynamics of effective technology adaptation management for managing transitional spaces would likely be complex, at least contingent on the nature of *leader approach* to management. Still, we can also imagine a transitional object effect that might enhance cooperation by making team members feel more comfortable and secure interacting—an emotional effect over and above the effect of technical necessity explanations (Wastell, 1999), such as task technology fit effects (Goodhue & Thompson, 1995) or task closure effects (Straub & Karahanna, 1998). Next, we take a look at what we know about what virtual team leaders may do to influence technology adaptation during teamwork.

Virtual Team Leadership

Currently, we know little about team leadership in the distributed, multi-organization, computer-mediated communication work settings that characterize virtual team information systems project work. Some research suggests that virtual team leadership will be essentially the same as non-virtual team leadership (Hackman, 2002). Other research has found that leaders' exercise of behavioral control mechanisms had unexpected and unintended negative consequences on team trust in virtual team settings (Piccoli & Ives, 2003), suggesting that some of the appropriate leadership behavioral coping strategies in virtual settings may be different from non-virtual settings. Overall, while there has been research on the emergence of leaders in virtual team settings, there has been little research on what different skills and resources virtual team leaders will need to be successful (Pinsonneault & Caya, 2005; Martins, Gilson, & Maynard, 2004). Of the little there has been, very little has been empirical, field work.

Much leadership research has focused on leadership styles or situations. In this study, we focus specifically on leaders as managers of technology adaptation. Research on worker management and leadership has postulated appropriate leader behaviors based on Theory X and Theory Y as key descriptors of employee work motivation (McGregor, 2006). Theory X constitutes an approach to leading that assumes that workers are lazy and that managers need to monitor, command, and control them in order to ensure their progress toward task goals. A Theory Y approach assumes that workers are self-motivated and that managers need to facilitate, mentor and nurture relationships with and among them to maximize their productivity. These theories have become accepted paradigms for understanding leader and managerial approach and effectiveness regarding human resources, and the general understanding is that knowledge workers, such as ISD team members, will not respond as well to command and control as inspiration and facilitation (Mintzberg, 1998). The specific applicability of Theory X or Theory Y leader approaches in virtual team settings with knowledge work was called into question by Piccoli and Ives' empirical work (2003), suggesting that Theory X actions of command, control, and monitoring would not be effective in building trust during leader interventions to motivate team interaction and productivity.

Research Model and Hypotheses

Virtual settings present specific challenges to the formation of trust. Members of virtual teams tend to exhibit swift trust, grants of trust up front in the absence of personal knowledge of each other (Jarvenpaa & Leidner, 1999), while more durable, robust "high" trust takes longer than in comparable collocated, single organizational settings. Where high trust was found in student teams, key behavioral correlates appeared to be a proactive orientation, rotating leadership, a task focus, role clarity, and positive feedback (Jarvenpaa et al., 1998). No influence of the use of or change in use of technology was found in this study, perhaps because technology use was controlled and largely prescribed or because the use of students in a project shorter than 6 months precluded the formation of relationships found in the field, as some meta-analyses of computer-supported group research suggest (Fjermestad & Hiltz, 2001, 1999). Similarly, practitioner advice suggests means for managing trust relationships in teams but also focuses on factors other than technology adaptation (Galford & Drapeau, 2003).

While prior studies of virtual teams have described the formation of trust and working relationships as an independent process, this study takes an interest in leader agency in influencing improved team outcomes through technology adaptation and, thus, we focus on trust formation as it relates to leader actions and technology adaptation. Our research model is shown in Figure 1. Leaders encounter a situation in which they decide they must intervene. They take some mix of actions, which will be influenced by their personal style or preference for a Theory X or Theory Y approach. These actions results in team members adapting their technology usage to varying degrees or resisting and not adapting at

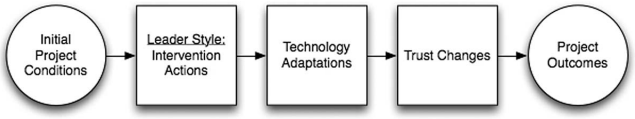

Figure 1. Research model.

all. Following these adaptations, there trust and cooperation changes may result, which would lead project outcome impacts. The idea that trust improvements result in improved project outcomes is well-established in research literature (Hosmer, 1995). Our emphasis is on how leader style couples with technology adaptations to influence trust changes in virtual teams studied in the field. Our hypotheses follow below.

A study of leader influence on trust behaviors in virtual work groups focused on initiation of student learning environments (Coppola, Hiltz, & Rotter, 2004), found that a more Theory Y oriented leader had a greater effect in getting people to be productive. A conceptual study has suggested that virtual team leader impact on worker trust will depend on interpersonal trait complementarities in virtual settings, such that certain mixes of workers would respond positively to Theory X style management and other would respond to Theory Y (Brown, Poole, & Rodgers, 2004). These papers suggest some contradictory influences with regard to team leader intervention effectiveness in motivating employees to engage in trust behaviors in virtual team settings. Leader approach efficacy may depend on worker traits or work virtuality. We find no field studies clarifying these effects. If Theory X command and control behaviors cause negative, unintended effects on knowledge workers such as ISD workers in virtual settings as previously reported in a student sample (Piccoli & Ives, 2003), then it follows that:

H1: Virtual team (VT) leader interventions employing a Theory X approach will lead to lower levels of trust than a Theory Y approach.

Similarly, if a more Theory Y oriented approach leads to better outcomes during leader interventions during the initiation phase of groups when technology adaptation is arguably most critical as teams begin using ICTs together, we can extend prior findings on managerial action to technology adaptation:

H2: VT leader interventions employing a Theory Y approach will lead to higher levels of technology adaptation than interventions employing more of a Theory X approach.

If indeed the adaptation of technology may serve as a reconfiguration of transitional space that enables better cooperation, we expect that leaders will seek this positive effect on cooperation and trust in intervening in technology adaptation. We expect this effect would be even greater the more teams must rely on ICTs, and as virtual teams must rely highly on ICTs, we would expect this technology adaptation management for cooperation cultivation lever to be strong in a VT setting. Thus,

H3: Technology adaptation will be positively related to increased trust and cooperation in VTs.

Design and Methodology

We needed to observe leader behaviors and their impact on team outcomes to test our model. Observational technology adaptation studies have typically required highly controlled circumstances to enable adequate observation. As a result, they have typically involved either a single context or student experiments or only a single, controlled technology being adapted (Poole & DeSanctis, 2004). None of these controls fit our need to be able to look across multiple examples of leader intervention in multiple contexts. Therefore, we turned to critical incident technique.

We conducted a critical incidents study between May 2004 and June 2005, to assemble a database describing incidents of leader technology adaptation intervention in actual virtual ISD teams. Critical incidents methodology provided a strong fit for our needs in that it enables in-depth inquiry into the functioning of individuals engaged in a job or job role using retrospective data which can be collected by interview (Flanagan, 1954). When compared with survey data taken at the time of action or objective observations, research has shown the critical incidents technique effective in eliciting equivalent data reliably (Andersson & Nilsson, 1964; Bitner, Booms, & Tetreault, 1985), and the technique has been applied to understand management of socioemotional dynamics during group technology usage (Kelly & Bostrom, 1998) as well as hundreds of other topics revolving around leadership and the impact of leader actions (Butterfield, Borgen, Amundson, & Maglio, 2005).

Critical incidents were defined as occasions on which leaders took specific actions including manipulating technology usage that were particularly effective or ineffective in improving team collaboration and led to clear impacts on project outcomes. The elements of each incident we captured were the initial triggering conditions, the intervention actions the leaders took, the adaptations in collaboration technology the leaders witnessed as a result of their actions, the changes in trust and relationship behaviors the leaders reported (as well as all other changes they reported), and the outcomes the leaders

detected in the teamwork as a result of their intervention (Figure 1).

Using an interview protocol refined through two pilot tests to fit all necessary questions into two-hour interviews, we collected 52 critical incidents from 13 veteran ISD team leaders. The data from these incidents were coded by six judges in a three-phase, multiple-stage-per-phase process that ultimately had the judges come together and converge on a final set of codes describing each of the four pieces coded in each incident: the triggers, the leader actions, the changes in group interaction, and the outcomes. We intentionally left respondents open to list all changes in group interaction without specifying trust, cooperation, or relationship outcomes, as we were interested in all possible impacts their technology adaptation interventions might have on team collaboration. In the first stage, multiple judges coded the statements from the transcripts by the four pieces of each incident, with an inter-rater reliability above 72% in all cases, as judged by agreement on presence of codes. In the end, a group of codes was identified as codes indicating trust and relationship changes in-group interaction that occurred during the interventions. All 52 of the incidents had codes indicating trust and relationship changes in-group interaction.

Like the changes questions, the leader actions questions were open in order to catch all actions executed by the leaders without biasing their responses. We ended up with 61 types of leader action (61 action codes), which were open-coded into five categories.

Constructs and Measurement

Two categories of actions roughly divided into actions that equate to a Theory Y leadership approach pursuing a strategy of linking workers to resources (found in 25 incidents, 48%) and a Theory X leadership approach pursuing a strategy of forcing workers to adhere to guidelines (found in 18 incidents, 35%). The Theory X *forcing* actions were identified by evidence of formal authority and control mechanisms to directly manipulate individuals' behavior. Action codes included in this measure were monitoring, enforcing rules, and reassigning people, primarily found in the setting and enforcing rules category that resulted from the open coding.

We defined the Theory Y *linking* actions as actions encouraging workers by providing additional resources or training, encouraging their use through incentives and trying to convince team members to use them based on the value they would personally gain. We matched many of the action codes from training and persuading with linking. To ensure minimal overlap, we screened the persuading codes to ensure the underlying data did not include examples of command persuasion (i.e., a coercion emphasis). The forcing variable ranged from 0 to 5 with 0 indicating no forcing actions evidenced in an incident and 5 indicating all types of forcing action evident including mandating new technology usage, reassigning people (changing task roles), escalating issues to higher management, confronting unacceptable use or blocking use of alternate tool. The linking variable ranged from 0 to 6 with 0 indicating no linking actions and 6 indicating all types of linking actions evident including training team on tool(s), encouraging open communication, developing consensus on usage benefits, or establishing/ initiating/modeling desired usage pattern.

Our first endogenous variable, technology adaptation, was developed from a direct output variable from the initial coding process performed by the judges in building the incident database. These technology adaptations in team interaction indicate conditions such as when a new ICT has been installed, an existing ICT is physically reconfigured and ready for changes in behavior, or tasks have been redefined through structures built into ICTs though people have not yet enacted them. Technology adaptation ranged from 0 to 6 with 0 indicating that no technology adaptations took place and 6 indicating that six major types of technology adaptation, such as introducing and using a new ICT, modifying the usage of an existing ICT, or stopping using an existing ICT, all occurred in a given situation.

The second endogenous variable, trust and cooperation, was selected from a sub-set of the high-level changes in group behavior initially reported by the leaders and coded by the judges. Codes for trust, cooperation, accountability, and communication changes, composed the indicators used for trust and cooperation changes. Excluded codes included information processing and coordination codes, as well as a variety of other unrelated behavioral change codes. Trust and cooperation ranged from 0 to 8 with 0 indicating that no trust and cooperation changes were found. Eight indicated that all indicators of trust and cooperation change occurred in a given incident, such as people began cooperating, people became more accountable, people started trusting information and decision accuracy, relationships among team members improved, morale improved, or trust between groups improved.

Our dependent variable, "outcome" represented the self-evaluation by the leader of how his or her facilitation impacted the team in the short and long-term. It was then checked against the actual reported outcomes in the transcript and coded by the judges into three levels, success, mixed result, and failure. Nine incidents resulted in failure (17%). Seven were mixed (13%), and the remaining 36 were successes (69%). We had expected a bias toward success reporting and were pleasantly

surprised that the leaders reported so many failures, giving us an adequate amount of variation in "outcome" for mathematical analysis.

Results

We present our results in two sections. The first is descriptive. The second is quantitative.

Descriptive Findings

No prior study we could find has examined trust management in a sample of field virtual team leaders. The 13 leaders interviewed had experience drawn from work at 6 of the top 10 IT outsourcing firms at the time (McDougall, 2005). They reported 52 incidents in 30 projects spanning the spectrum of ISD from five analysis or assessment projects and six legacy upgrade projects to 11 new systems development projects and six major packaged systems implementations (ERP and CRM systems). Two other projects focused on outsourcing a complete IT function and fixing year 2000 bugs respectively. The leaders each had at least two years of experience leading virtual ISD teams, and most were considered "fixers" in their organizations, senior project managers called in to fix ailing projects. Overall, the leaders were highly successful, veterans actively involved in the spectrum of large (>$600,000/month average budget per project; median 30 team members), virtual (median 4 organizations involved in each project; at least 3 locations; most had at least 2 countries; very few face-to-face meetings) ISD projects. They provided an ideal sample for our data.

The leaders reported ISD work conditions that present substantial challenges to forming and maintaining working relationships, supporting the notion that they must engage in trust management and that *any* potential lever for influencing improved trust would be highly valuable. Our data came from teams using more than 12 types of ICTs (median) with a median of four organizations involved, each organization often having its own variety of a particular type of ICT. Thus, even if a team leader reported that the team was using 12 ICTs such as email, fax, a content versioning system, an integrated development environment, or a wiki, this may be compounded by different organizations within the team using different, non-compatible types of the same ICT, as was especially noted with regard to calendaring and email systems that could not share encryption or invitations or meeting notices or jointly handle a number of other features desired. This variety of ICTs presented team leaders with a need to integrate and actively engage in technology adaptation management.

We explored what interaction breakdown situations the leaders encountered in their real, highly virtual ISD environments and how they dealt with them. Based on our qualitative analysis, we learned that relational trust breakdowns between team members were a critical and generally debilitating interaction failure type the leaders faced. This finding agreed with the prior literature indicating that cooperation is critical for ISD work. One leader gave a good example of how cooperation across internal team barriers involves trust and management of methodologies available through technology and becomes especially important in virtual ISD settings:

> [The remote, outsourced developers] have got access to our production systems and, basically, all our normal desktop applications and everything else... One of the things we recognized is... I have to trust that the agreement that I have in place with the outsourcer is going to cover my liability but still practice the right security prudence. So, again, I'm not going to give them access to my production systems, where they touch a button and they can impact the health care of our customers. But by the same token, to do their development, I'm going to enable the technology to the fullest extent.

In his case, the remote team was being blocked by local technical workers, causing a cooperation breakdown.

Another leader faced a problem getting his client to work with his analysts. He instituted a change in the use of synchronous electronic meeting technology expanding its usage to include the client and analysts. He reports that as a . . .

> . . . result of [this technology usage change], we were able to prove to the client that by and large, what we came up with was accurate and supportable. So, then, as a result of that the client, I use the word, trusted us a lot more than before. So, in subsequent meetings we didn't need to go to that level of detail.

In this case, the usage of the different ICT presented a methodology the client could accept as persuasive. We believe it served as a transitional object in this manner, enabling the client renewed ability to establish trust in the analysts' ability, integrity and benevolence.

Technology adaptation mattered, but leaders did not always recognize how to affect it though they recognized inherent tradeoff between more forceful or more facilitative leadership styles in getting people to change the way they do things through technology adaptation interventions. One leader stated, reflecting on his failure to get team members to use project management software that would have imposed a way of reporting status and problems:

> I should have driven more of how they report their status and what their problems were. You see the problem is

> you walk a fine line, right, because you can't really dictate to somebody how you want to see things . . . That would start jeopardizing cooperation.

He knew he needed to act to change the way people handled information (status and problems). He knew that getting the team to use the project management software would affect the desired change. He also knew that taking a dictatorial stance would likely damage cooperation. He did not know what actions to take to solve his problem. We believe our quantitative, normative findings help clarify this solution.

Quantitative Findings

Having found qualitative support for the notion that ICTs were used for transitional object effects to improve trust and cooperation, we focused on our analysis of the coded data to test our hypotheses. For all incidents, we mathematically analyzed the presence of Theory X (forcing) or Theory Y (linking) leader action codes and their correlation with the presence of technology adaptation, changes in trust and cooperation, and outcomes. The codes for these five variables are provided in the appendix. In order to preserve the power of our analysis, we needed to avoid splitting the sample into groups as we had five constructs and 52 data points and needed approximately 10 data points per construct. We used Spearman correlations due to the nominal, coded nature of our data. The results of these correlations are presented below (Table 1).

This data can also be mapped to the research model to graphically represent the relationships found (Figure 2).

We found several strong, significant relationships. As we had theorized, leader actions were related to technology adaptation and trust and cooperation changes, and these intermediate changes were related to outcomes. We tested all possible relationships for the variables, encountering two unexpected results. Forcing actions had a direct, significant relationship to outcomes, and they also had a strong, significant relationship to trust and cooperation changes, equivalent in magnitude to the relationship between linking actions and trust and cooperation.

The first hypothesis posited that forcing actions (Theory X leadership) would have a negative impact on trust and cooperation while linking actions (Theory Y leadership) would have a positive impact. This was not supported. Forcing actions showed a significant, positive relationship to trust and cooperation changes ($P < .05$, R-square = .317). Apparently, there is still a role for Theory X style leadership in current virtual settings. We checked whether monitoring, which could be argued as the most theoretically collinear of our codes indicating the two action groups, was making forcing actions appear significant when actual Theory X behaviors had not been employed. The relationship held, even when we removed the monitoring actions from the indicators of forcing actions.

The second hypothesis posited that linking actions would lead to more technology adaptation than forcing action. We found this to be supported. We also found a strong relationship between linking actions and technology adaptations ($P < .01$, R-square = .422) while there was no significant correlation between forcing actions and technology adaptations.

The third hypothesis was supported. Technology adaptations were significantly related to trust and cooperation ($P < .01$, R-square = .563).

Discussion

We found evidence that VT leaders do manage information and communication tools (ICTs) in order to affect changes in team cooperation, through trust and relationship improvements. Changes in trust and cooperation ($P < .01$, R-square = .350) as well as technology adaptations ($P < .01$, R-square = .405) were associated with better team outcomes. Effective management of technology usage by virtual team leaders was important in getting work done. This is an interesting first finding, because it supports the notion that any leader in a virtual world group work environment should have at least some basic awareness and skills for managing technology adaptation.

Table 1. Spearman Correlations

	Forcing	*Linking*	*Tech. Adapt.*	*Trust and Coop.*	*Outcome*
Forcing (Theory X)	1				
Linking (Theory Y)	−.099	1			
Tech. Adapt.	.030	.422 (**)	1		
Trust and Coop.	.317 (*)	.321 (*)	.563 (**)	1	
Outcome	.234 (*)	.147	.405 (**)	.350 (**)	1

*Spearman rho correlation significant at .05 level.
**Spearman rho correlation significant at .01 level.

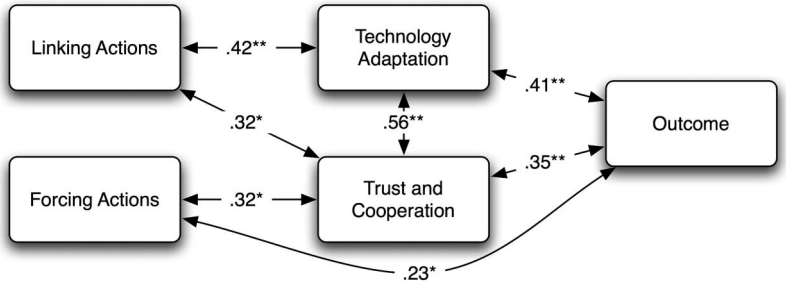

Figure 2. Correlations mapped to research model.

Prior research has indicated a variety of factors that may lead to improved trust in virtual settings, but neglected technology adaptation. Our data show that technology adaptation management provides an important lever for affecting improvements in trust and cooperation, both qualitatively ("as a result of [the change in technology usage] the client... trusted us a lot more") and quantitatively ($P < .001$, R-square = .563), supporting, with field, empirical evidence, prior conceptual work indicating that ICTs may have a transitional object role in forming trust in virtual settings (Wastell, 1999).

The nature of leadership style in achieving outcomes in virtual and knowledge work settings has come under scrutiny in recent years, with many suggesting that a more facilitative Theory Y orientation would be generally more important and effective (Mintzberg, 1998) especially when it comes to forming trust (Piccoli & Ives, 2003, Jarvenpaa et al., 1998). Our data draws a different conclusion that clarifies the relationship between these leadership styles. There remains an important role for Theory X style leadership involving mandates, controls, and command as these actions were significantly and directly related to improved outcomes ($P < .05$, R-square = .234), as well as improvements in trust and cooperation ($P < .05$, R-square = .317). The direct correlations between the Theory X and Theory Y style actions and trust and cooperation changes were approximately of the same significance and magnitude ($P < .05$, R-square $\approx .32$), suggesting that more facilitative and supportive Theory Y actions were not more important for affecting trust and cooperation directly.

On the other hand, our data show an indirect and important role for Theory Y style actions in affecting trust through technology adaptation (linking actions to technology adaptation: $P < .01$, R-square = .422; technology adaptation to trust and cooperation: $P < .01$, R-square = .563). This role has not been recognized in prior literature and opens a new pathway for understanding how collaboration systems may be better designed to enable leaders to lead virtual teams. It also provides a work outcome explanation grounded in psychological theory of transitional objects for why teams will adapt technologies during teamwork. Such an explanation has been largely absent from dialog regarding technology adaptation, which has focused on more abstract structural explanations of inadequate structures or discrepant events as causes for technology adaptation in groups (Poole & DeSanctis, 2004).

We propose that there exists a set of interaction dimensions for characterizing why teams engage in technology adaptation and that trust and cooperation improvement is one of them. This study raises the question of how basic leader styles matter in virtual settings and helps explain contradictory prior findings. Theory X style actions do appear to remain salient and important in virtual project settings, but they are not effective for managing technology adaptation. We offer our model as an approach for future research to further explore the development and management of group trust and cooperation in relation to both leader actions and technology adaptation. We expect further application of the model will yield insight into better designs for ICTs and improved guidelines for leading virtual teams as the relationships between intervention styles and ICT designs become clear in future work.

Limitations

Some limitations should be understood in interpreting and applying our findings. First, we have found quantitative data through a coding means. Inter-rater reliabilities in coding were adequate for exploratory work (>70%) but the data still represented classifications of types of actions or technology adaptations or trust and cooperation changes. We had to make an assumption that the higher the number of types of changes found the higher the actual level of the underlying construct. This may not be the case. There may have been a lot of Theory X (forcing) actions, for example, that were all mandating changed usage in a given incident while there was only one indication of several Theory Y (linking) actions. Our analysis technique would show that this hypothetical incident had more linking actions than forcing actions

though this would not be true. Our reading of the transcripts did not reveal this tendency to be the case, but the usage of retrospective data made it hard to rule out bias due to this effect.

Second, our data come from the team leaders alone. It would be beneficial to understand how team members understand improvements in trust and cooperation to ensure that the leader's reports are accurate in representing changes in its level.

Third, we analyzed 52 groups' technology adaptations and changes in trust and cooperation. To do so in a statistically valid manner and retain power with categorical data, we were limited in our techniques to Spearman correlations, which do not account for directionality of influence (thus, the bi-directional arrows on Figure 2).

Conclusions

Information and communication technology usage failures can have a domino effect that erodes team productivity. Virtual team leaders can affect improved outcomes by managing adaptation of their teams' information and communication technologies, as we found in the context of leaders achieving higher trust and cooperation through technology adaptation management. If they wish to do so, they should employ a Theory Y style of leadership characterized by more facilitative, supporting actions rather than command and control (Theory X). On the other hand, contrary to some prior work, we find evidence that Theory X style actions remain important for achieving outcomes in virtual teams, though they are not effective for technology adaptation management. Trust and cooperation characterize one central reason for technology adaptation, which we define and operationalize. Future work may build on our findings to extend this work identifying other dimensions that drive technology adaptation and further exploring the link between technology adaptation, trust, and improved project outcomes.

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Appendix

Codes for Five Variables Used in Quantitative Analysis

Category	*Code*
Forcing Actions	Mandates new technology usage
	Reassigns people (changing task roles)
	Escalates issues to higher management
	Confronts unacceptable use
	Blocks use of an alternate tool
Linking Actions	Trains team on tool
	Encourages open communication
	Develops consensus on usage benefits
	Initiates / models desired usage behavior
	Gets permissions / access arranged
	Suggests usage of tool as a solution for a member's problem
Technology Adaptation	Existing tool use stopped – existing ICT usage behavior stops
	Existing tool use changed – existing ICT usage behavior changes
	New tool introduced – new ICT becomes functional for team
	New tool used – new ICT is used by team during work
	Existing tool applied – existing ICT used in new context
	Existing task modified for tool – task modified to accommodate ICT usage
Trust and Cooperation	People began cooperating
	People became more accountable
	People started trusting information and decision accuracy
	Relationships among team members improved
	Morale improved
	Trust between groups improved
	People began using tools appropriately
	People began sharing information
Outcome	Success – teamwork improved and completed
	Mixed – teamwork improved in some ways but with some problems created
	Failure – teamwork did not improve or deteriorated