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# The Role of Communication and Trust in Global Virtual Teams: A Social Network Perspective

SAONEE SARKER, MANJU AHUJA, SUPRATEEK SARKER, AND SARAH KIRKEBY

SAONEE SARKER is an associate professor and interim chair of the Department of Entrepreneurship and Information Systems at Washington State University. She received a Ph.D. in management information systems from Washington State University, an MBA from the University of Cincinnati, and a B.A. (Honors) from Calcutta University. Her research focuses on globally distributed software development teams and other types of computer-mediated groups, technology adoption by groups, technology-mediated learning, and information technology capability of global organizations. Her publications have appeared in outlets such as *Information Systems Research*, *Journal of Management Information Systems*, *MIS Quarterly*, *Journal of the Association for Information Systems*, *Decision Sciences*, *European Journal of Information Systems*, *Decision Support Systems*, *Information Systems Journal*, *Journal of Computer-Mediated Communication*, and International Conference on Information Systems proceedings, among others. She is also the principal investigator of a National Science Foundation grant awarded to study work–life balance in globally distributed software development teams.

MANJU AHUJA is professor of computer information systems at the University of Louisville. She has previously held faculty positions at the Kelley School of Business, Indiana University, Florida State University, and Pennsylvania State University. She is involved in research related to virtual and outsourcing software development teams, online communities, mobile technologies, and effect of IT on work–life balance. Her publications have appeared in *MIS Quarterly*, *Management Science*, *Information Systems Research*, *Organization Science*, *Communications of the ACM*, *Journal of Management*, *European Journal of Information Systems*, *Journal of the Association of Information Systems*, and *Small Group Research*, among other outlets. She is an associate editor at *MIS Quarterly* and has recently served in this role at *Information Systems Research* and other journals. She has received three National Science Foundation grants totaling \$1,095,000 for her research on IT workforce issues. Her research has been cited by publications such as the *Wall Street Journal*, *Strategy & Business*, and *Computerworld*.

SUPRATEEK (“SUPRA”) SARKER currently holds the Philip L. Kays Distinguished Professorship of Information Systems at Washington State University, Pullman. He received a Ph.D. from the University of Cincinnati. One of his emerging areas of interest relates to the network view of organizations, and he has explored actor-network theory and social network analysis perspectives through empirical studies. Much of the work related to this study was undertaken when he held the position of visiting associate

professor (2004), and thereafter of Professor and Microsoft Chair of Information Systems (2009–2010), at the Copenhagen Business School. He is currently serving as a senior editor of *MIS Quarterly* and editor-in-chief of *Journal of Information Technology Case and Application Research*, and on the editorial boards of the *Journal of the Association of Information Systems*, *IEEE Transactions of Engineering Management*, and *IT & People*.

SARAH KIRKEBY is a Ph.D. candidate in the Department of Informatics, Copenhagen Business School. She studies social networks, entrepreneurship, and innovation. She is currently writing her Ph.D. dissertation on structure in action—linking entrepreneurs' action to structure in social networks.

**ABSTRACT:** The importance of communication and trust in the context of global virtual teams has been noted and reiterated in the information systems (IS) literature. Yet precisely how communication and trust influence certain outcomes within virtual teams remains unresolved. In this study, we seek to contribute some clarity to the understanding of the theoretical linkages among trust, communication, and member performance in virtual teams. To this end, we identify and test three proposed models (additive, interaction, and mediation) describing the role of trust in its relationship with communication to explain performance. In testing the relationships, we note that the concepts of communication and trust are inherently relational and not properties of individuals. Thus, we argue that a social network approach is potentially more appropriate than attribute-based approaches that have been utilized in prior research. Our results indicate that the “mediating” model best explains how communication and trust work together to influence performance. Overall, the study contributes to the existing body of knowledge on virtual teams by empirically reconciling conflicting views regarding the interrelationships between key constructs in the literature. Further, the study, through its adoption of the social network analysis approach, provides awareness within the IS research community of the strengths of applying network approaches in examining new organizational forms.

**KEY WORDS AND PHRASES:** communication, distributed teams, global virtual teams, hybrid teams, individual performance, mediation, networked individualism, social network analysis, trust.

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FEW WOULD DISAGREE THAT TRUST IS ONE OF THE KEY BEHAVIORAL THEMES of interest to organizational and information systems (IS) scholars today. McEvily et al., for example, contend that while “trust has long figured prominently in scholarly and lay discourse alike” [67, p. 1], it is only recently that organizational researchers have started devoting substantial attention to understanding the significance of trust. They suggest that this trend toward trust arises due to two primary developments: (1) an emphasis on collaboration and (2) changes in technology “that have reconfigured exchange and the coordination of work across distance and time” [67, p. 1]. Not surprisingly, an ICIS (International Conference on Information Systems) 2005 panel highlighted that trust has become a key topic of interest among IS researchers today, with 129 papers

being published in this area as of the end of 2005 [37]. Two recent issues in leading journals of the discipline further highlight the continuing interest in this topic (e.g., [8, 9, 24, 53]).

Nowhere is trust more critical than in teams where members bring divergent goals, values, and ideologies [18], and where trust has been viewed as an “efficacious means” for ensuring a successful collaboration [16, p. 45]. The issue of trust is even more problematic in the context of distributed teams where members (1) often do not have a shared history, (2) are “geographically dispersed,” (3) are initially unknown to each other and lack a “shared social context,” and (4) interact primarily through an electronic media, with very limited “face-to-face encounters” [48, p. 792; see also 89, 99]. O’Hara-Devereaux and Johansen [77] view trust as a “glue” that helps in creating virtual team relationships. Finally, McEvily et al. summarize the criticality of trust in distributed teams by arguing that individuals in such teams “become more dependent on, and more vulnerable to, the decisions and actions of others—both preconditions and concomitants of trust” [67, p. 1].

In light of this importance of trust in distributed teams, IS researchers have unquestionably made immense contributions (e.g., [46, 48, 49, 81]). However, a review of this literature, especially in the context of globally distributed teams, suggests that trust has predominantly been treated as a dependent variable, with few studies examining the effect of trust on outcomes in distributed teams (see Table 1 for a summary of this body of research).

For the most part, studies have primarily examined the effect of trust on the *performance of an entire group*, following Handy’s suggestions [41]. While examination of factors leading to group performance is important, in many globally distributed team contexts, the structure and composition is fluid, ad hoc, and loosely coupled, making it increasingly difficult and less meaningful to assess the performance of the entire collaborative unit [94]. We suggest that it is equally important, if not more so, to examine the *performance of individual members* so that the abilities, behaviors, and status of these individuals can be recognized and leveraged in distributed contexts to develop a more effective collaborative unit. In fact, a recent case study highlighted that even within a collaborative environment, organizations are increasingly focusing on new initiatives that introduce “individual productivity measures” and emphasizing individual performance, in contrast with the earlier practice of implementing team-based incentive systems [11, p. 197]. This recognition has led to recent calls for investigating *individual performance* [2, 68, 84].

Further, research investigating trust in distributed teams has so far adopted a trait-based, or behavior-based, approach. This approach can often provide incomplete results because teams are a collection of interacting individuals and taking into account the effects of such interaction is important [68]. Individual team members tend to influence each other in a way that can affect their performance. Thus, we propose that it is critical to incorporate this oft-missing element using the *structural approach* [101] in virtual teams. Brass defines the *structural approach* as one where “the focus [is] on relations rather than attributes, on structure rather than isolated individual actors” to predict outcome [10, p. 284]. Along similar lines, Rice argues that “by bringing

Table 1. Sample Prior Studies Examining Trust in Distributed Teams

Study	Overall summary of the study	Focus on group-level or individual-level performance	Relational/ structural approach?
Webster and Wong [108]	In this study, the authors compare trust, communication, and satisfaction in traditional teams, semi-virtual teams, and pure virtual teams. Results indicated that pure virtual team members enjoyed greater satisfaction than traditional team members. Further, semi-virtual team members demonstrated greater positive feelings toward their local members than their remote members.	Trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Lu et al. [61]	In this study, the authors use both qualitative and quantitative approaches to examine how different components of virtuality influence specific aspects of virtual team performance. Results indicated that different types of practice had several negative effects on performance, especially on communication and trust in team members, and on the ability of the team to meet project deadlines.	Focus on group level; trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Wilson et al. [110]	This study examined the development of trust in both computer-mediated and face-to-face teams. Results highlight that computer-mediated teams exhibit lower trust in the initial phases, but that over time, the trust levels in such teams increase to levels similar to face-to-face teams.	Trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Edwards and Sridhar [32]	This study reports an exploratory research involving 24 virtual teams based in Canada and India. The focus of the teams was to generate and define the business requirements for software projects. Results indicate that trust and task structure positively affect the effectiveness, satisfaction, and efficiency of such teams.	Focus on group level.	No
Ocker [76]	This study examined the creativity in and performance of asynchronous virtual teams. Results indicated that factors such as domain knowledge, downward norm setting, lack of shared understanding, and time pressure negatively affect the performance of such teams. On the other hand, factors such as stimulating colleagues, social influences, and a collaborative team climate were found to have the potential to improve performance.	Focus on group level.	No

Breu and Hemingway [11]	In this paper, boundary theory was used to examine the factors affecting organizational virtual teams. Results suggest that low levels of trust among team members and the technology used by the team affect performance and knowledge sharing in such virtual teams.	Focus on group level.	No
Brown et al. [12]	This paper builds on the interpersonal circumplex model (ICM) and examines the role of personal traits in virtual collaboration. The proposed model argues that interpersonal traits affect individual team members' disposition to trust, perceived trustworthiness, communication, and thereby their willingness to collaborate.	Focus on individual level; trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Jarvenpaa et al. [50]	This paper examines trust in global virtual teams during two different stages of team development. Findings indicate that a member's trusting beliefs have a positive effect on his or her trust in the team and perceptions of team cohesiveness in the early phases. However, in the later phases, a member's trust in his or her team operates as a moderator, indirectly affecting the relationship between communication and perceptual outcomes.	Focus on group level; trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Coppola et al. [19]	This paper presents a model of trust development in online/virtual courses. Specifically, it examines the development of swift trust in both highly rated and poorly rated online courses. Results indicated that course success depended a great deal on the early development of swift trust.	Focus on course (or group) level.	No
Panteli and Duncan [79]	This paper adopts a "dramaturgical" perspective on trust relationships and examines trust development in temporary virtual teams. The study's results argue that trust relationships in such teams are mutually negotiated and jointly constructed and emerge from the scripted, prescripted, coscripted, rescripted, and unscripted computer-mediated interactions of virtual players.	Focus on group level; trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No

(continues)

Table 1. Continued

Study	Overall summary of the study	Focus on group-level or individual-level performance	Relational/ structural approach?
Zolin et al. [111]	In this study, the antecedents of interpersonal trust in cross-functional globally distributed teams were examined. The study adopts a longitudinal approach and focuses on variables such as cultural diversity, perceived trustworthiness, trustor's propensity, and perceived follow-through as the antecedents of trust. In addition, perceived risk and reward serving were found to be important moderators.	Trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Piccoli and Ives [81]	This article reports on a longitudinal study exploring the effect of behavior control on trust in the temporary virtual teams. Results indicated that the behavior control mechanisms typically used in traditional teams have negative effects on trust in virtual teams.	Focus on group level; trust treated as a dependent variable as opposed to an independent variable for explaining performance; some hypotheses focused on the individual level.	No
Sarker et al. [92]	This study proposes and validates an instrument measuring the different bases of trust in global virtual teams. Drawing on the literature, three bases of trust applicable to virtual teams were identified: personality based, institutional based, and cognitive trust, with cognitive trust being further subdivided into three dimensions: stereotyping, unit grouping, and reputation categorization. In addition to confirming the conceptual bases of trust, the study's results also indicated that stereotyping in virtual teams can be of three distinct types: message based, physical appearance/behavior based, and technology based.	Focus on group level; trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No

Morris et al. [74]	This study investigates the effect of information technology and trust on the job satisfaction of virtual team members. Information technology was operationalized using user's satisfaction with the technology used. Results indicated that both user satisfaction and trust positively affect job satisfaction of virtual team members.	Focus on individual level.	No
Jarvenpaa and Leidner [48]	This study examined the challenges of creating and maintaining trust in global virtual teams, through a series of descriptive case studies. The results of the study suggest that global virtual teams experience "swift" trust, but such trust is typically very fragile and temporal.	Focus on group level; trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Coutu [20]	This study examined the formation and development of trust in virtual teams. Specifically, the study illustrated that trust does exist in virtual teams, but it develops differently from that of traditional teams.	Focus on group level; trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Jarvenpaa et al. [49]	In this study, the antecedents of trust in global virtual teams were examined. In the early stages of the team project, trust was predicted by perceptions of other team members' integrity. The effect of team members' perceived ability on trust decreased over time. The study's results also indicated the formation of swift trust in global virtual teams.	Focus on group level; trust treated as a dependent variable as opposed to an independent variable for explaining performance.	No
Iacono and Weisband [46]	This study examined how virtual teams where members have never met each other develop and maintain trusting relationships. Results indicate that high levels of trust were maintained in teams that engaged in continuous and frequent interaction, and that this level of trust positively affected their work effectiveness.	Focus on group level.	No



to bear measures and constructs of social structure, we can begin to understand how simple notions of . . . autonomous individuals are incomplete” [85, p. 181].

Finally, the research on mechanisms with which trust transmits itself (i.e., the nature of its influence) has been inconclusive. Some researchers suggest that “effects of trust [are] *transmitted* in a relatively straightforward manner,” implying *direct* effects [29, p. 450, emphasis added], while others suggest that “trust *facilitates* the effect of other determinants on desired outcomes” [29, p. 450, emphasis added] through *moderation* or *mediation* (e.g., [48, 64, 87]). One such critical determinant in the context of distributed teams is communication, given the lack of shared understanding and temporal/geographic dispersion (e.g., [2, 82, 100]). Kankanhalli et al. [52] highlight that important role of communication on task conflict in global virtual teams. Massey et al. [65] argue for the strong effect of communication and interaction on outcomes within global virtual teams. Martins et al. [64] as well as Panteli and Davison [78] suggest that communication is an important virtual team process, while Ridings et al. [87] empirically show the importance of communication in virtual communities. However, despite the acknowledged importance of communication and trust, few distributed team researchers have examined trust in conjunction with communication [48, 108]. In addition, the nature of their linkage and their effect on performance has remained unclear. While some research suggests that trust interacts with communication to affect performance [29, 50], others imply that trust plays a mediating role between communication and performance [111], and yet others argue that it plays an additive role along with communication [48, 49, 95].

Our primary objective in this paper is to understand the simultaneous effect of *communication* and *the closely related construct of trust* on *individual performance* within globally distributed teams. Consistent with the structural approach followed by Mehra et al. [68], we adopt the paradigm of *networked individualism* [109] to empirically examine the validity of the three competing models (*additive*, *interaction*, and *mediating*) relating to this effect. The *networked individualism* paradigm argues that an individual acts within the context of a network of other individuals and artifacts, rather than in isolation. Degenne and Forse state that within the *networked/structural approach*, behaviors are seen to “arise from the structural position of individuals or groups, because this position is sufficient to determine the opportunities and constraints which influence the allocation of resources and to explain the behavioral regularities observed” [26, p. 2]. It is worth mentioning that although researchers such as Cross et al. [21, p. 7] have suggested that the network analysis perspective can provide beneficial information regarding an individual, and regarding the “effectiveness of one’s personal network,” few IS studies [2, 58] have actually adopted this approach.

The remainder of the paper is organized as follows. First, we discuss the social network and structural approach adopted, followed by some boundary conditions of the study. Next, we discuss the concepts of trust and communication and present, from a network perspective, the three competing models, capturing their effect on individual performance. This is followed by a discussion of our research methodology, including details of the sample, data collection procedures, and the analysis techniques. Finally, we provide a discussion of our results and conclude with the contributions



of the paper, notably a clarification of the relationships among communication, trust, and performance using the perspective of “networked individualism,” considered by many scholars as more appropriate for examining these constructs within distributed groups [44, 109].

## Theoretical Foundations

AS MENTIONED ABOVE, THE *NETWORKED INDIVIDUALISM* PARADIGM relies on the notion that individuals do not act in isolation; rather, they act within the context of a network of other individuals and artifacts [109]. This paradigm utilizes the social network approach and provides the theoretical foundation for the notions of structural position, trust, and communication.

## Social Network Approach and Structural Position

Cummings and Cross argue that “despite a tremendous increase in the use of . . . groups in organizations over the past several decades” [23, p. 197], there has been little research adopting the social network analysis (SNA) perspective, especially when examining performance-related consequences. SNA “focuses on [the] relationships among social entities and on the patterns and implications of these relationships” [34, p. xii]. Through its focus on relationships, SNA captures the interactions and connections between different social entities (e.g., individuals, groups) and enables the researcher to study individuals’ actions and behaviors “within the context of larger structural configurations” [34, p. xiv]. Given that individuals are typically situated in a context and do not act in a vacuum, the structure of the context and the individuals’ relationships with other elements within the context have a significant bearing on their behaviors/actions, and vice versa. The strength of the SNA perspective lies in the fact that it bridges the attributional and structural aspects of individual actions/behaviors, as opposed to simply focusing on their behaviors as if they exist in isolation [34, 36].

Social network research related to individual performance in groups posits that one reason certain team members may perform better than their peers is the networks to which they belong, as networks often provide critical resources and social support to the team members. *Structural position* within a network may be more beneficial to a network member than the size of the network [13] because a specific position in the network may allow an individual to gain informational and other resources. Also, an individual’s structural position can enable him or her to exert more influence owing to his or her ability to control/mediate information and resource flows. Further, individuals in advantageous structural positions are more likely to be connected with other powerful actors in the network. Past research has corroborated performance implications of one’s structural position [2, 47]. For example, Ibarra [47] found evidence for a relationship between an individual’s centrality in a network and involvement in innovation, which in turn led to higher performance.

Noted researchers have observed that computer-mediated groups are slowly moving toward “networked individualism” [109], where the “network of relationships . . . are

as much, or more, the causal forces as the attributes of the actors” [10, p. 284]. Based on the recent literature, and consistent with our adoption of the relational/structural approach, we conceptualize a distributed team as a network of linkages among its members, with each team member holding a structural position (e.g., based on their communication patterns with team members) within that network [44].

## Boundary Conditions

This study focuses on *distributed work teams*, where members are geographically, temporally, and often even organizationally dispersed, but where the members share “mutual accountability” and “work interdependently to solve problems or carry out work” [54, p. 700]. Consistent with the work of Kirkman and Mathieu [54], we assume reciprocal interdependence among the distributed team members in our study.

We also suppose, consistent with the real world, that distributed groups tend to be “fluid, dynamic, multiplex” wherein members communicate with others “on the basis of tasks to be accomplished, and their levels of interests and commitment” [44, p. 232]. Indeed, in small projects, each member is free to communicate with any/all other team members, and often the teams are self-organizing [94].

A core focus of our study is on communication and how it interacts with trust to affect performance of members in distributed teams. The “babble hypothesis” argues that people who communicate the most are seen the most positively within a group [102, p. 281]. Evidence consistent with the babble hypothesis may be found in situations wherein individuals who quietly do much of the work are often not considered to be top performers or contributors. Instead, those who speak up in meetings are frequently acknowledged as the performers. This effect may be even greater in a virtual context, where work processes are even less visible than in situations involving collocated contributors [84, 91, 111]. However, we contend that communication alone will not determine perceptions of performance and suggest that members’ perceived performance will be high only when high communication is accompanied by their earning the team members’ trust by creating the impression (deceptively or otherwise) that they are adding value to the team project. Extending the research suggesting that trust (from the point of view of other team members) plays a key role in determining performance [48, 64, 108, 111], our investigation seeks to clarify the nature of this role in conjunction with communication.

## Trust and Trust Centrality

Trust has been defined as the “willingness of a party to be vulnerable to the actions of another party, based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party” [66, p. 712]. Knoll and Jarvenpaa [55] suggest that trust is based on the assumption that others will behave as expected. Trust can be seen in relationships between two or more people, or in relationships between two or more *collectives*, such as among

subteams or subgroups [55]. Cummings and Bromiley [22] view collective trust as the common belief among group members that a particular member will behave in accordance with the commitments, will be honest in the negotiations preceding those commitments, and will refrain from taking undue advantage of another. Prior research, as the above discussion highlights, indicates that a “statement about trust, therefore, always concerns at least two parties”: the trustor, “who holds certain expectations about another party, and, as a result, may or may not be willing to be vulnerable to the actions of the other party,” and the trustee, “who is assessed by the trustor” [7, p. 33]. Becerra and Gupta [7] argue that for any study involving trust, it is “critical” to differentiate between these two parties and explicitly state the direction of the trust. In this study, we focus on the *trustee (or the trusted party)* and examine how the trustee’s trustworthiness (as assessed by the potential trustors) plays a role in affecting his or her performance in globally distributed teams.

Trustworthiness is that quality of the trustee that makes the trustor willing to be vulnerable [58]. Tsai and Ghoshal [103] have found that individuals who enjoy more central positions within a network are likely to be perceived as more trustworthy. Drawing on this, it may be argued that within a network, a member’s trustworthiness (i.e., the extent to which a member enjoys the trust of each of the other members within a team) is reflected in his or her trust centrality. *Centrality* is defined as the “extent to which an actor is central [or core] to a network” [10, p. 288]. In the context of the current study, *trust centrality* may thus be defined as “the extent to which an individual enjoys a central position within a trust network in the globally distributed team.”

## Communication and Communication Centrality

While several characteristics of individuals have been examined in connection with trust, one trustee characteristic that has been identified as central is his or her communication with the trustor [7]. Communication has always been viewed as a key element in any group [57], whether collocated or distributed. In distributed teams, the lack of prior history, and thus an absence of shared understanding, and temporal/geographic dispersions makes communication “critical” [82, 100]. Kankanhalli et al. [52] suggest that communication affects the level of task conflict in virtual teams. Others also argue that communication is an important process within virtual teamwork and has important implications in terms of the outcomes [64, 87, 108]. Montoya et al. argue that communication helps distributed teams to “cope with the opportunities and challenges of cross-boundary work” [72, p. 139]. Indeed, Ahuja et al. [2] have noted that the only artifact of a distributed team’s existence is its communication; thus, development of a trusting relationship and task performance necessarily involve communication.

Given many of the unique challenges faced by distributed team members, it is important to examine the effects of communication (in conjunction with trust) on performance in such contexts. In line with our reliance on the SNA perspective, we consider an individual with high *communication centrality* as having communication linkages with many members within a globally distributed team.

## Communication and Trust in Distributed Teams: The Inseparable Relationship

While trust and communication are two separate behavioral constructs, in distributed teams, they often play out together. Much of a distributed team's existence relies on its interaction or communication through electronic spaces, where new behaviors are developed, practices are co-constructed, and relationships are created and nurtured [91, 96]. Given that distributed teams are typically assembled for the duration of a project to achieve interdependent tasks, there are greater dependencies among the team members. The temporary nature of these teams in conjunction with a high level of interdependencies can increase the chances of exploitation among team members [12]. In other words, there is a possibility of individuals behaving in an untrustworthy manner, typically by engaging in freeloading, and by not contributing meaningfully to the completion of project tasks.

Meyerson et al. [69] suggest that trust is formed based on behavioral evidence. Some argue that a high level of communication enables the trustor to better assess the characteristics of the trustee, thereby affecting "his/her evaluation of the trustee's trustworthiness" [7, p. 33]. Given that distributed teams utilize electronic media rather than face-to-face interaction, the only behavioral evidence available to team members is the communicative behaviors of other members [2, 111]. Thus, communication forms the basis for expressing and inferring trusting behaviors in these contexts [50].

Some researchers suggest that communication exchanges among team members through the electronic space over time leads to trust development. For example, Jarvenpaa and Leidner [48] highlight how certain types of communicative behaviors help in the creation or breaking of trust in globally distributed teams. Similarly, Ridings et al. [87] show that communication in the form of responses to posts of remote members, sharing of personal information, and so forth can help to increase the trustworthiness of the individual. Research has demonstrated that trust in distributed teams is often affected by silence (or lack of communication) from remotely located team members [48, 91]. The above discussion suggests that there is a close conceptual affinity between the constructs of trust and communication in the digital world. However, as we highlighted earlier, few studies have examined the effect of both of these variables on performance in one unifying study. Further, the exact nature of the relationship and how they (i.e., communication and trust) interact to affect individual performance has not been investigated formally. Our paper addresses this void.

## Hypotheses Development

Drawing on the SNA tradition, we propose that an individual will be perceived as a high performer if he or she has high trust and communication centralities. Our review of prior research on trust and communication, with respect to individual performance, in distributed teams or otherwise, suggests three different views regarding the role of trust. Following Mehra et al. [68], we capture and label these views as the "additive" model, the "interaction" or "moderation" model, and the "mediation" model. Below, we discuss each of these models in further detail.<sup>1</sup>

### The Additive Model

The additive model proposes “twin predictions”—that is, both trust and communication additively affect individual performance [48, 49, 95]. As Dirks and Ferrin [29] highlight, a majority of research on trust points to its direct main effect on performance. For example, a number of studies (e.g., [19, 45]) argue for a strong linkage between trust and performance. Consistent with these studies, Jarvenpaa et al. observe that the “prevailing view of trust in the IS literature contends that trust has direct positive effects on . . . performance” [50, p. 251]. Specifically, in distributed teams, given a lack of transparency of the work process, individuals who are considered more trustworthy tend to receive the benefit of the doubt with respect to performance more than those who are considered less trustworthy [91].

Simultaneously, higher levels of communication by an individual have also been linked positively to his or her level of performance. For example, Scarnati [95] suggests that inadequate communications may “hinder” performance. Further, Balthazard et al. [5] argue that communication is a key determinant of performance in distributed teams. Morgeson et al. [73, p. 588] argue that communicative individuals in the team would be viewed as high performers within teams for several reasons. First, “talkative” individuals are “likely to have a desire to work with others” and have higher confidence and ability to work in a team structure. Second, their communication is likely to enhance “discussions of performance strategies and development of norms”; thus, communicators are likely to be perceived as key contributors to their team’s success. Finally, communicative individuals have been shown to exhibit “elements of positive affectivity,” which promotes “positive and cooperative interactions with others” through a process of “emotional contagion.” Their contribution to creating this positive environment within the team would also enable them to be recognized as superior performers. Based on the above discussion on the importance of communication and trust, we propose the following in SNA terms (see Figure 1):

*Hypothesis 1: In globally distributed teams, trust centrality and communication centrality of a team member will have an additive effect on his or her performance as perceived by team members.*

### The Interaction (Moderation) Model

While a dominant body of literature suggests that trust has a direct effect on performance (additively with communication), another competing perspective is that trust is beneficial because it “facilitates” the effect of other variables on performance outcomes [29, p. 450]. Specifically, Dirks and Ferrin [29] argue that “trust provides the conditions under which certain outcomes, such as . . . higher performance, is likely to occur” [29, p. 450]. Dirks and Ferrin [29] also assert that the concept of trust as a moderator is not new, but it has received only “scant” attention from researchers. One of the reasons trust might play a moderating role is because it “also affects how one interprets the past or present actions of the other party” [29, p. 456]. Drawing on Dirks and Ferrin [29], Jarvenpaa et al. [50, p. 255] examined the role of trust in distributed teams and suggest that trust enables an individual to “interpret” the “communication

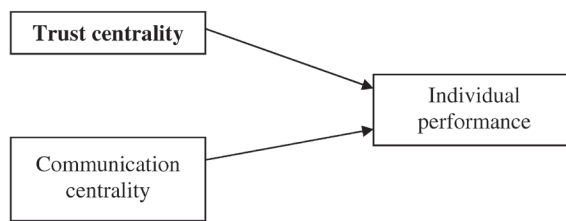


Figure 1. An Additive Model

activity” of other individuals, which together affects their “judgments about the work outputs” of other individuals. For example, the performance of a team member with a high frequency of communication will be amplified if he or she is also highly trusted [50]. In summary, researchers adhering to the moderating role of trust therefore view trust as “a necessary, not a sufficient condition” [29, p. 456] that “facilitates” performance, especially as perceived by distributed team members. Thus, adopting the SNA perspective, we may capture the essence of the above discussion through the following hypothesis (see Figure 2):

*Hypothesis 2: In globally distributed teams, trust centrality of a team member will play a moderating role on the relationship between his or her communication centrality and his or her performance as perceived by team members.*

### The Mediation Model

In contrast to the additive model and the interaction model, the mediation model argues that in global distributed teams, trust mediates the effect of communication on performance. In other words, a communicative individual will be more likely to be trusted and will therefore be more likely to be a high performer [19]. Independently, these conceptual linkages (i.e., communication → trust, trust → performance) have been supported in the literature. For example, Becerra and Gupta [7] suggest that the extent of communication that a trustee engages in will affect the perceptions of his or her trustworthiness. Of course, in distributed teams, where electronic communication can often be the only means of interaction, this effect is likely to be even more significant. Unlike traditional teams, in distributed teams it is difficult for team members to directly observe whether an individual member is working (even if progress is being made) or whether he or she is struggling with an issue (which might explain why progress is not being made) unless the member communicates. Clegg and Hardy [18, p. 434] also argue that trust develops and “exists as a result of frequent interaction” between the trustor and the trustee. A greater frequency of communication will expose the trustor to the trustee’s inner characteristics, and thereby enable him or her to better judge the trustee’s trustworthiness.

However, researchers also argue that only when an individual is trusted will he or she be viewed as being a high performer and contributor to the team’s success [111]. In fact, Zolin et al. assert that within globally distributed settings, only “if a worker is

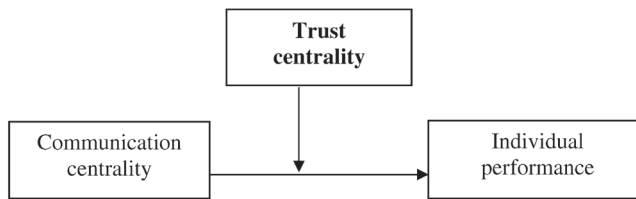


Figure 2. An Interaction (Moderation) Model

perceived as trustworthy, he or she will be perceived as delivering on work commitments” [111, p. 19]. We note that Dirks and Ferrin [29] also summarize a large body of research investigating the role of trust on individual performance, finding trust to play a significant positive effect on performance.

While the above discussion provides support for the independent linkages of communication → trust and trust → performance, thereby suggesting an indirect effect of communication on performance through trust, other researchers allude more directly to a full mediation of trust on many outcome variables. For example, Ridings et al. [87] found from their empirical study on virtual communities that trust plays a perfect mediating role within the relationship between *communication-related* variables such as individuals’ responses to message posts and disclosure of personal information and willingness to *share information*. While the outcome variable in the Ridings et al. study [87] is not individual performance, its conclusions are helpful in understanding the role of trust in globally distributed teams. Even Jarvenpaa and Leidner [48], in their seminal work on global virtual teams, allude to the effect of different communicative behaviors in elevating/deflating trust in virtual teams, finding that ultimately it was the level of trust within the team that made a difference on the members’ ability to deal with the uncertainties and to handle tasks, thereby suggesting a fully mediating effect of trust. Martins et al., in their review of the virtual team literature, explicitly state that it is only trust that is “a determining factor in the effectiveness” within such teams, and that “several attributes of team communication . . . facilitate the formation of trust” [64, p. 816], again pointing to the complete mediation of trust within this relationship. Drawing on the above discussion, and using SNA terminology, we summarize the above discussion as follows (see Figure 3):

*Hypothesis 3: In globally distributed teams, trust centrality of a team member will play a key mediating role between his or her communication centrality and his or her performance as perceived by team members.*

## Research Methodology

IN THIS SECTION, WE DISCUSS THE DATA COLLECTION EFFORTS, specific measures, data preparation, and our analysis techniques utilized to test the three competing propositions relating communication, trust, and performance—additive, interaction, and mediation.



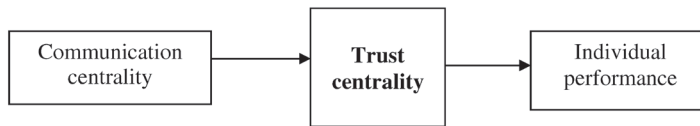


Figure 3. A Mediation Model

## Data Collection

Data for this study were collected from globally distributed student teams engaged in systems analysis and development projects. Before proceeding, we clarify what we mean by distributed/virtual teams. In the literature, Griffith et al. [40] and Saunders and Ahuja [93] have provided typologies that show that virtual teams can have diverse configurations. Specifically, Griffith et al. [40] propose three distinct team categories: traditional, hybrid, and pure virtual. This distinction is based on (1) the level of technological mediation used, (2) the percentage of work that the team does with its members distributed across time or space, and (3) the distribution of the physical locations occupied by the team members. Griffith et al. note that few virtual teams are purely virtual, and “most of today’s organizational teams are likely to fall into the large hybrid category of teams composed of members who interact over time, according to the needs of the moment, and through media and with the amount of face-to-face contact determined by their own adaptation and structuration of the process” [40, p. 268]. Our work seeks to examine the linkages between communication, trust, and performance in the hybrid category. Note that field studies on “real-world” distributed software development teams show that such teams frequently have a hybrid configuration, with team members distributed in two locations (e.g., [15, 75]), as in our empirical study. In addition, Armstrong and Cole [4] also suggest that in a distributed collaborative setting, it is often the case that multiple team members are located in each of the sites.

Two sets of hybrid virtual teams participated in the study: (1) distributed teams with members from the United States and Norway engaged in systems development projects, where the teams worked on developing IS applications for real clients located across the globe; and (2) distributed teams with members from the United States and Denmark engaged in systems analysis and design projects for real clients located in the United States or Denmark. Note that while the tasks of both the U.S.–Norway and U.S.–Denmark teams were related to information systems development (ISD), the U.S.–Norway teams were required to develop and test the system in addition to analyzing and designing it; the U.S.–Denmark teams were required to conduct the systems analysis and design only. Also note that both Scandinavia and the United States, for a long time, have significantly contributed to innovations in ISD and are often looked up to for leadership with respect to ISD processes and methodologies. Not surprisingly, many known U.S.-based technology companies (e.g., Microsoft) have established development centers in Scandinavia (e.g., Denmark), such that employees in the United States (e.g., Redmond, WA, and Fargo, ND) and Denmark (e.g., Copen-

Table 2. Description of Sample

Total sample	Sample size of each type of distributed team	Gender distribution	Age
111	58 U.S.–Norway team members		Majority in the age range of 18–25
	35 United States	6 females 29 males	
	23 Norway	6 females 17 males	
	53 U.S.–Denmark team members		Majority in the age range of 18–25
	22 United States	3 females 19 males	
	31 Denmark	9 females 22 males	

hagen) collaborate on projects. Given such arrangements in Microsoft and in many other companies in northern Europe (e.g., Nokia/Maemo, ABB, Telenor, Kvaerner), we chose to concentrate on U.S.–Scandinavia teams.

Given our individual level of analysis, the usable sample size was 111, with approximately 3 to 5 members taken from each location. For example, each U.S.–Norway team was typically composed of 3 to 5 members from the United States and 3 to 5 members from Norway. See Table 2 for a detailed summary of the sample.

## Measures

Given our SNA approach in this study, and the fact that our research objective is to assess the effect of an individual's extent of communication and trustworthiness on his or her performance, we take the ego-centric network view. One of the most common measures used in this perspective is "centrality," which is an indicator of an entity's structural position within the network [97]. It has been defined as an entity's "prominence" or "importance" within a network [106] and is assessed by evaluating the number of relationships in which an actor is involved.

Centrality in SNA may be measured using a variety of different indicators, with the three most common being degree, closeness, and betweenness. Degree centrality refers to the "number of connections to others" [26, p. 132]. Closeness refers to the extent of affinity of an individual with other members in the network. It is relatively more global than degree centrality, since it focuses on the closeness to "all network members, not just immediate neighbors" [26, p. 135]. Finally, betweenness refers to the extent to which an individual "is in a position to act as a gatekeeper for information that flows through the network" [56, p. 90]. We adopted *degree centrality* as the indicator of centrality because it is the "simplest" and the most "intuitive" measure of centrality [26, p. 132; see also 34].

It is important to note that for calculation of the degree centrality, the SNA approach requires "relational data," unlike other types of behavioral studies that uses "attribute

data.” Attribute data refer to data about attitudes, opinions, and behaviors of different actors, which are “regarded as the properties, qualities, or characteristics” of different individuals or groups. But “relational data” are the “contacts, ties, and connections, . . . which relate one agent to another and so cannot be reduced to the properties of the individual agents themselves” [97, pp. 2–3]. Typically, relational data are collected by asking each participant to “rate a single characteristic . . . in numerous targets” [27, p. 42]. Specifically, respondents “complete ratings of every network partner” on a particular dimension using a single item [27, p. 42]. Consistent with the above, in order to calculate the degree centralities of individual members on the dimensions of trust and communication, we sought to collect relational data by asking each team member to assess each other member in their team on their trustworthiness and extent of communication on a scale of 1 to 7.

We acknowledge that there may be some concerns surrounding the use of single items to measure key constructs, especially among scholars using the traditional attribute-based approach. Researchers respond to such concerns by noting that a “single-item measure eliminates item redundancy and therefore reduces the fatigue, frustration, and boredom associated with answering highly similar questions repeatedly” [88, p. 152]. Concerns about reliability surrounding the single-item measures have also been addressed in the literature. For example, Robins et al. [88] have demonstrated that single items have similar (or better) psychometric properties as multi-item scales, and Dennisen et al. [27] showed the same to be true in the context of social network designs. In fact, it is argued that in traditional questionnaires, “respondents rate a single target (i.e., themselves or a peer) on a number of characteristics (i.e., items)” [27, p. 42]. In the context of SNA, and relational data, “this logic is turned upside down,” with each respondent rating a single characteristic for multiple targets,” therefore making this approach not significantly different from traditional questionnaires. Rice further argues that “the patterns of these matrices are stable across time and highly correlated with a social communication network, . . . indicating test-retest reliability and predictive validity” [86, p. 14].

The relational data that we captured were next held in an adjacency matrix where the columns consisted of each team member and the rows consisted of the rating of that team member by each of the other team members. Given that the rating was done on a scale of 1 to 7, the data captured in the matrix were “valued.” Further, the data were directed. In other words, entity A rating entity B with a certain number did not mean that a reciprocal relationship existed (i.e., entity B gives the same rating to entity A). For convenience of analysis, valued data in the adjacency matrix were converted to binary data. For conversion to binary data, we followed standard SNA guidelines, which suggest selecting a cutoff (typically, the median) and using the cutoff to “slice” the data and “dichotomize” the matrix [97, p. 48]. Within a binary adjacency matrix capturing communication among team members, a 0 rating of entity A by entity B on communication, for example, indicated that entity B did not perceive there to be a communicative linkage between himself or herself and entity A.

Note that the conversion from a continuous 1–7 scale to a binary variable (using median split) is a standard practice in SNA [42, 97]. Measurement of a phenomenon

on a binary scale (0 or 1) represents the “mere presence” or “absence” of a relation as opposed to its strength [97, p. 52]. SNA researchers argue that by providing respondents the option to signify only a presence/absence of relational constructs (e.g., trust, extent of communication), researchers will tend to add undue “restrictions” to the respondents (and draw “narrow boundaries” around their response options), thereby leading to the “imperfect representation of the full network” [97, pp. 53–54]. Hanneman and Riddle argue that “much of the development of graph theory in mathematics, and many of the algorithms for measuring properties of actors and networks have been developed for binary data, . . . [and thus] it is not unusual to see data that are measured at a ‘higher’ level transformed into binary scores before analysis proceeds” [42].

While some researchers argue that conversion of a continuous scale to binary may lead to loss of information, Hanneman and Riddle argue that “very often, the additional power and simplicity of analysis of binary data is ‘worth’ the cost in information lost” [42]. Thus, it is often recommended that responses be collected using a continuous scale to assess the strength of a relation, followed by a conversion to a binary scale (e.g., [97]).

In a directed graph, as in our study, “lines are directed to or from the various points” [97, p. 68]. The simplest measure of degree centrality is the *absolute degree*, that is, half the sum of all the incident relations of the node considered:  $d = E_n / 2$ , where  $E_n$  is the relation set of the node being considered. However, use of this measure in a directed graph creates the risk of using both the connections to and from a node in calculating the degree. Thus, in directed graphs, there are two additional ways to assess absolute degree centrality: absolute in-degree ( $d^{\text{in}}$ ) and absolute out-degree ( $d^{\text{out}}$ ) [33]. The in-degree of an entity or a point is the “total number of points that have lines directed towards it” [97, p. 69]. In other words, the in-degree of an entity within a network refers to the “number of other people who choose that actor in the particular relationship” [56, p. 89]. But the out-degree of an actor is the “total number of points to which it directs lines” [97, p. 69] and reflects the “number of people chosen by the focal actor” [56, p. 89]. Thus, in our study, which seeks to understand, for example, the effect of an individual actor’s trust centrality (i.e., an individual member’s trustworthiness) and communication centrality on his or her performance, *in-degree centrality is more relevant*. Furthermore, in-degree centrality has been shown to be the most stable even at a low sampling level [104]. Thus, in this study, in line with prior research on teams, we use *in-degree centrality*, which captures the number of incoming lines to a particular node. UCINET 6.0 was used to calculate the centralities.

For measuring performance, we asked each team member to assess each other member in their team on their extent of task performance on the project on a scale of 1 to 7. The average of team members’ ratings of an individual team member was used as a measure of that individual member’s performance. We chose to adopt this relational measure of performance as opposed to using instructor ratings (or grade point average) in light of recent criticisms of using instructors/supervisors, which tends to “contain political aspects” [10]. Specifically, Brass [10, p. 309] argues that since supervisors and subordinates often have a “multiplexity of relationships” (i.e., they are linked by more than one relationship, such as both a working and a friendship

relationship), performance evaluations made by supervisors are often tainted. Also, in our study, the project coordinators (faculty at the two sites) had face-to-face (and, generally speaking, closer) interactions with half the participants and virtual interactions with the rest, making fair ratings of participants' ratings difficult.

Finally, adoption of a "network perspective on performance invites us to analyze the pattern of relationships (from multiple perspectives) rather than view individuals' performance in isolation" [10, p. 311]. This is particularly appropriate in a distributed computer-mediated setting, where no one individual has a complete understanding of another team member's contributions (e.g., [111]), and each perspective has value.

## Control Variables and Their Measurement

In this study we are interested in the effect of trust and communication on performance, but other factors could be argued to have an effect on the performance of team members in a globally distributed context; thus, it is important to include them as control variables. Ahuja et al. [2] suggest that certain individual characteristics can have an effect on performance. One potentially important individual characteristic is gender, given that gender can play an important role in both communication and performance. It is argued that women, due to their nurturing and good social behaviors, are more communicative and participative in contexts that require a high amount of social activity. However, in contexts where the group's focus is on a complex task completion (as in an ISD-related project similar to those used in this study), male members are usually more active [31]. The other control variable that we included was the location where the individual team member was based. It is known that the United States and Scandinavia, while Western nations, have differences in their work cultures [43]. Professionals in the United States tend to be more extroverted and communicative in their work environments and more active in taking up roles and responsibilities compared to professionals in Scandinavia [43]. Thus, it seemed to be an important variable to control for. Both gender and location were measured using a binary variable where, in the case of gender, 1 referred to females and 2 referred to males, and in the case of location, 1 referred to the United States and 2 referred to Scandinavia (i.e., Norway and Denmark).

Whenever we are focusing on performance, the inherent ability of the individual can be argued to play an important role [64]. Given our context of ISD, a key ability that should be taken into consideration is the ISD ability, which refers to issues such as a team member's ability to communicate with users and others, manage projects, and maintain relationships with users/clients. We thus used this as a control variable. ISD ability was assessed using five self-reported items that tapped into the above issues.

Finally, Gallivan and Benbunan-Fich [35] argue that whenever one observes or examines behaviors of team members after (or during) their group interaction, it is important to take the team that they belong to into consideration. Thus, we controlled for the team as well by including information about the team an individual belonged to as a control variable. We provide a list of the control variables and their measurement in Table 3.

Table 3. List of Control Variables and Measurement

Control variable	Measurement
Gender	Binary variable; 1 referred to females and 2 to males
Location of the team member	Binary variable; 1 referred to United States and 0 to Scandinavia (both Norway and Denmark)
Inherent information systems development ability	Five self-reported items capturing individual team members' ability to communicate with users and others, management of the project, maintaining relationships with users/clients
Team	Team number

Note, however, that in understanding the effects on individual performance within distributed teams, we examined the role of “endogenous variables” (i.e., trust centrality and communication centrality), which are “relational properties inherent in the focal network” [71, p. 55]. Specifically, it has been argued by SNA researchers that such endogenous network properties are “inherent in the network” itself, and “defined by the node’s relations,” as opposed to psychosocial attributes such as age or gender, which are “external to, and independent of, the network” [71, p. 57]. For example, when an individual communicates with another team member, the specific action not only changes the individual’s own position within the team structure (i.e., his or her centrality) but also changes the others’ relative positions. Thus, by changing one’s own position in the structure, an individual essentially changes the structure of the entire network to some extent [14]. Yet a change in the individual’s age has no bearing or effect on the ages of other team members. Thus, the use of the relational approach itself controls considerably for the group environment, and lessens its possible confounding effect on the final result.

### Analysis Technique

The three models presented earlier were tested using regression. Given our inclusion of control variables, and following guidelines of prior researchers in virtual teams (e.g., [17]), we used either a two-step or a three-step hierarchical regression to test the models. In the first step for each of the models, we only included the control variables, followed by the control and independent variables in step 2. For the interaction model, we used a three-step hierarchical regression, with the first step including the control variables, the second step including communication and trust centralities in addition to the control variables, and the third step including the two centralities and the interaction term in addition to the control variables [68, 70]. For interpreting the results with respect to the control variables, we drew on past research [17]. For interpreting the results of the interaction model, we relied primarily on the research of Miles and Shevlin [70]. For the mediation model, we followed the guidelines of Baron and Kenny [6].

Table 4. Descriptive Statistics

Variable	Frequency	Mean	Standard deviation
Trust centrality		3.80	2.017
Communication centrality		4.27	1.887
Performance		4.37	1.303
Gender	29 females, 79 males, 4 missing information		
Location	55 U.S. members, 51 Scandinavian members, 5 missing information		
Information systems development ability		4.80	0.866
Team	16 teams		

## Results

We provide the descriptive statistics on our independent and control variables in Table 4. In the test of the additive model, as the first step, we included the control variables. As the results indicate, location had a significant effect on performance, with team members located in Scandinavia having higher performance than the U.S. members. Also, gender and the teams they belonged to had an effect on team members' performance (though these results were significant at  $p < 0.10$ ), with males performing higher than females, and members of the U.S.–Norway teams seen as having higher performance than U.S.–Denmark teams. In the second step for the additive model, where all the control variables and the two independent variables were included, the control variables failed to have any significant effect, and the effect of communication centrality on performance was also not significant ( $b = -0.014$ ,  $p > 0.10$ ). However, the effect of trust on performance was significant ( $b = 0.517$ ,  $p < 0.01$ ). The overall  $R$ -square of the second model was 0.659 as opposed to a small  $R$ -square of 0.080 for the first model including the control variables only. Further, the  $F$ -change from the first to the second model was significant, suggesting that the second model (including the independent variables) was a much better predictor of performance than the first model (including only the control variables). Although trust had a significant effect, the test did not satisfy the “twin predictions” of both communication and trust on performance. Thus, the additive model was not supported. In the case of both models (step 1 and step 2), the variance inflation factors were all well below 3, and the condition index was within the recommended range of 30, suggesting that there were no significant problems of multicollinearity [70], despite the conceptual closeness among the constructs.



The results of the hierarchical regression (for testing the moderation model) suggested that the model with the interaction term had a higher  $R$ -square (by 0.129) than the model with just communication and trust and the control variables. Again, the control variables did not have any significant effect in the second model (control variables and independent variables), while only the team an individual belonged to had an effect in the third model (control and independent variables, and interaction term). Further, results indicated that the  $F$ -change from the second to the third model was significant, and the effect of the interaction term on performance was also significant (though trust continued to have a direct effect in the third model). However, surprisingly, the direction of the effect of the interaction was opposite to the one hypothesized. Thus, the hypothesized moderation model was not supported.

Results from the test of the mediation model provided strong support. In the first equation, communication centrality (the independent variable) had a significant effect on trust centrality (the mediating variable) ( $b = 0.792, p < 0.01$ ). In the second equation, communication centrality had a significant effect on performance (the dependent variable) ( $b = 0.396, p < 0.01$ ). Finally, in the third equation, trust centrality had a significant effect on performance ( $b = 0.507, p < 0.01$ ). As per Baron and Kenny's guidelines [6], we found that all the effects were in the predicted directions, and the effect of communication on performance disappeared ( $b = -0.014, p > 0.10$ ) when trust was introduced in the third equation. Thus, the mediation model was supported—in fact, the results indicated a *perfect mediation* of trust centrality on the relationship between communication centrality and performance. We summarize the results in Tables 5 and 6.

## Discussion of the Results

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IN THIS STUDY, WE IDENTIFIED THREE COMPETING MODELS capturing the conceptual linkages among communication, trust, and individual performance that are in evidence in the literature and subjected them to deductive empirical testing in the context of globally distributed ISD teams.

Our results indicate that the additive model does not explain the role of trust and communication on performance in distributed teams, given that both trust and communication do not have an effect on individual performance (i.e., only trust had a significant effect). The results cast doubt not only on the “twin predictions” made in the literature (regarding the effect of trust and communication on performance) but also on the “babble hypothesis,” where “talkative” individuals are argued to be perceived as key contributors to a team.

Indeed, our results indicate that the mediating model best explains the impact of trust and communication on individual performance in distributed teams. The strong support for the mediation model emphasizes the point that communication's effect on individual performance is *through* trust. We believe that this result highlights the prominent role of trust in distributed teams, where it (i.e., trust) has been viewed as facilitating “glue” by prior researchers (e.g., [12]). While much of the existing research

Table 5. Test of the Three Competing Models

Model/ variables	Step 1 Coefficient (standard error)	Step 2 Coefficient (standard error)	Step 3 Coefficient (standard error)
Additive model (dependent variable is Performance)			
Gender	-0.382 (0.278)	0.034 (0.178)	
Location	0.732*** (0.262)	0.161 (0.173)	
Information systems development ability	0.000 (0.149)	0.058 (0.094)	
Team	-0.038* (0.027)	0.021 (0.017)	
Trust		0.517*** (0.063)	
Communication		-0.014 (0.067)	
$R^2$	0.117	0.659	
Interaction model (dependent variable is Performance)			
Gender	-0.382* (0.278)	0.034 (0.178)	0.088 (0.142)
Location	0.732*** (0.262)	0.161 (0.173)	0.065 (0.138)
ISD ability	0.000 (0.149)	0.058 (0.094)	0.039 (0.074)
Team	-0.038* (0.027)	0.021 (0.017)	0.023** (0.014)
Trust		0.517*** (0.063)	0.568*** (0.051)
Communication		-0.014 (0.067)	-0.050 (0.050)
Trust $\times$ Communication			-0.433*** (0.058)
$R^2$	0.117	0.659	0.788
$\Delta R^{2a}$			0.129
$\Delta F^b$			18.85
Mediation model (Equation 1—dependent variable is Trust)			
Gender	-0.825** (0.430)	-0.226 (0.290)	
Location	1.134*** (0.405)	0.194 (0.281)	
ISD ability	-0.112 (0.230)	-0.098 (0.152)	
Team	-0.118*** (0.041)	-0.060** (0.028)	

Model/ variables	Step 1 Coefficient (standard error)	Step 2 Coefficient (standard error)	Step 3 Coefficient (standard error)
Communication on Trust (independent variable on mediating variable)		0.792*** (0.071)	
<i>R</i> <sup>2</sup>	0.177	0.643	
Mediation model (Equation 2—dependent variable is Performance)			
Gender	-0.382* (0.278)	-0.083 (0.232)	
Location	0.732*** (0.262)	0.261 (0.225)	
ISD ability	0.000 (0.149)	0.007 (0.122)	
Team	-0.038* (0.027)	-0.090 (0.022)	
Communication on Performance (independent variable on dependent variable)		0.396** (0.057)	
<i>R</i> <sup>2</sup>	0.117	0.415	
Mediation model (Equation 3—dependent variable is Performance)			
Gender	-0.382* (0.278)	0.036 (0.117)	
Location	0.732*** (0.262)	0.156 (0.170)	
ISD ability	0.000 (0.149)	0.057 (0.093)	
Team	-0.038* (0.027)	0.021 (0.017)	
Trust (mediating variable on dependent variable)		0.507*** (0.041)	
<i>R</i> <sup>2</sup>	0.117	0.659	
Mediation model (Equation 4—dependent variable is Performance)			
Gender	-0.382 (0.278)	0.034 (0.178)	
Location	0.732*** (0.262)	0.161 (0.173)	
ISD ability	0.000 (0.149)	0.058 (0.094)	
Team	-0.038* (0.027)	0.021 (0.017)	
Communication and Trust on Performance (independent variable and mediating variable on dependent variable)		0.517*** (effect of trust) -0.014 (effect of communication)	
<i>R</i> <sup>2</sup>	0.117	0.659	

Notes: <sup>a</sup>  $\Delta R^2$  shows change from the first model (without the interaction term). <sup>b</sup>  $\Delta F$  shows change from the first model (without the interaction term). \*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

Table 6. Nature of Hypothesis Support

Hypothesis	Type of model and nature of prediction	Nature of support
1	Additive; communication and trust centrality will both affect performance.	Trust had a significant effect, but communication did not; thus, H1 was <i>not</i> supported.
2	Interaction/moderation; trust centrality will play a moderating role on the relationship between communication centrality and performance.	While trust centrality did play a moderating role, its direction was opposite to that hypothesized; thus, H2 was <i>not</i> supported.
3	Mediation model; trust centrality will play a key mediating role between communication centrality and performance.	Trust centrality did play a mediating role; thus, H3 was supported.

has highlighted the importance of trust in ensuring a distributed team's success and performance, our study suggests that trust remains critical even when it comes to explaining or predicting the performance of the *individual* team member. Jones and George [51], for example, suggest that the trustworthiness of an individual may promote certain positive characteristics regarding that individual. Drawing on their ideas, it may be argued that an individual who is trusted in a distributed team will be viewed as one who has a preference for communal relationships "characterized by helpfulness and responsibility," and an initiative to contribute to such relationships; further, he or she is seen as one who engages in the "subjugation" of one's own "personal needs and ego" to "pursue a common goal" [51, pp. 541–542]. Such an individual is naturally a key contributor to the distributed team, and therefore will be seen as the high performer by peers. Given that distributed team members interact primarily through the electronic media, this trust will be formed primarily based on the communication they engage in with the other team members (e.g., [91]).

While the mediation model best described the relationships between communication and trust and their effect on individual performance, a test of the moderation model also revealed a significant effect of the interaction of trust and communication on performance, *albeit in a direction contrary to the one expected*. We believe that this opposite result leads to doubts regarding recent pronouncements suggesting that in knowledge economies communication is "real work" [25, pp. 90–91] and indicates that there are contexts in which more communication can lead to adverse results in terms of performance. To verify this, we split our full data into two groups: one with members having high trust centrality and the other with members having low centrality. In order to split the data, we calculated the median trust centrality and used the median for coding an individual as high or low. We then conducted a regression analysis to assess the effect of the interaction between trust and communication on performance within each of the two split data sets. Our results indicated that in the high trust centrality set, the interaction between communication and trust had a positive

effect on performance ( $b = 0.123, p < 0.05$ ), whereas in the low trust centrality set, the interaction between communication and trust had a negative influence on performance ( $b = -0.815, p < 0.10$ ). In testing this, we controlled for gender, location, ISD ability, and team. We believe that this result provides us with a clearer picture about the role of trust in globally distributed teams—when an individual has low trustworthiness (indicated by low trust centrality), his or her communicativeness (indicated by high communication centrality) is likely to be seen as unproductive or meaningless babbling, thereby leading to the communicator being perceived as a poor performer. In contrast, when an individual has high trustworthiness, communication and trust work in synergy to positively affect performance as perceived by other team members. Further, the high  $R$ -square in the low-trust model (0.483 as opposed to 0.094 in the case of high trust) suggests that in low-trust situations, the negative effect of communication on performance is extremely potent. To summarize, we believe that the results illustrate the central role of trust played in globally distributed teams and provide support to the not so commonly articulated view that more communication may not always be better [56]. In terms of the test of the competing models, we can thus conclude that *the moderation model holds true when the level of trust is high*.

## Limitations

THE USE OF STUDENT SUBJECTS IS A POTENTIAL LIMITATION of our research, given that findings based on student data have often been criticized for their artificiality and lack of external validity [38]. However, Dipboye and Flanagan [28], among many others, argue that student subjects represent a variety of backgrounds and goals, similar to organizational members, and usually reflect a typical working professional. Locke [60] also concluded from his study that results obtained from student samples are similar to those obtained from managers in studies related to industrial organization psychology and organizational behavior. Finally, we believe that the intense and longitudinal nature of the projects with real clients, to whom the virtual teams were accountable, prompted a majority of students to appropriate the roles of systems development professionals engaged in distributed ISD rather than act as “typical” students. Of course, future work should investigate these results in a variety of settings, including real-world distributed project teams, to ensure the broad generalizability of the findings.

Another limitation of this study is the fact that it involved only distributed teams with a hybrid configuration, where some members were collocated and others were distributed. It may be argued that in a “pure” distributed team, wherein each member is geographically separated from the others, the results may be different. Indeed, past research highlights that, owing to differences in the social presence of the media used for interaction and collaboration, face-to-face and distributed members interact differently, leading to different outcomes (e.g., [98]). However, in recent times, the premise of the social presence theory or media capacity theories has been contested [44, 72]. For example, Hollingshead and Contractor [44] take the position that there are no significant systematic differences between face-to-face and computer-mediated groups in terms of basic interpersonal behaviors such as communication, or in terms

of performance, especially when groups are observed longitudinally (which is the case in our study). Similarly, Walther and Burgoon [107] show that while members of computer-mediated groups felt less connected to one another initially, over time members of computer-mediated groups expressed more positive feelings about one another that approximated those expressed by members of face-to-face groups. Finally, Montoya et al. suggest that in “today’s advanced voice and data networks, increasingly pervasive network access, integrated technologies, or integrated devices that facilitate simultaneous multimedia use” [72, p. 143], oftentimes members’ behaviors toward (or interactions with) remote and collocated members are not necessarily different. Nevertheless, future research should test the relationships highlighted in this study using pure virtual teams.

Another limitation of the study was the sometimes unequal team sizes in the two dyadic locations (i.e., the United States and Norway, or the United States and Denmark) due to practical issues related to creating teams (e.g., unequal number of students in the two locations; students’ interests in certain projects due to which they may have requested to be moved to a different team from the one they were initially assigned to), as well as team member attrition. While the unequal team sizes (like numerous other variables) could have affected the team dynamics, we believe that the variations in teams do not necessarily weaken the study, but may actually strengthen it in terms of its generalizability. We note that the study was not designed as a laboratory experiment, with emphasis on controlling all factors.

While the use of the SNA approach is undoubtedly a strength of this study, the fact that key variables were assessed using a single item only may be viewed as a limitation of the study. However, given the acknowledgment among scholars that single items are as reliable and stable as multiple items [88], and the fact that in the SNA approach respondents rate a “single characteristic in numerous targets” [27], making it not so inconsistent with traditional questionnaires where respondents rate a single individual on multiple characteristics or items, we believe that the use of single items is not a significant shortcoming of the study.

Another potential limitation of our study could be that in analyzing our three competing models we used our entire data set, which consisted of two types of distributed teams: those that were engaged in systems analysis and design tasks only (U.S.–Denmark teams), and those involved in systems development in addition to systems analysis and design (U.S.–Norway teams). In order to assess whether this asymmetry in the data set tended to taint our results, we split our data into two sections: U.S.–Norway team members and U.S.–Denmark team members. We tested all three models using the separate data sets. The results (in terms of the relationships between the key constructs) were consistent with those using the full data set. We believe that this highlights the stability of our results and indicates the generalizability of our study across the two tasks.

A final limitation of the study could be an artifact of the specific data collection approach employed. We used a cross-sectional survey technique to collect the data, where the same respondent provided assessment of the predictor and the criterion variables. While this is not an uncommon practice, common method variance

concerns regarding such studies have recently been raised [83]. There are several known tests of common method variance. Initially, Harmon's single-factor test was suggested as the most suitable test for common method variance (e.g., [83]), but recently researchers have criticized it by arguing that "negative bias in this procedure is so large that . . . [it] would produce virtually meaningless results" [59, p. 114]. On similar lines, Malhotra et al. also argue that "this technique does not offer an acceptable means to estimate and control for methods effects" [62, p. 1868]. An alternate approach, using a "marker" variable was proposed by Lindell and Whitney [59], and this approach has received much support from IS researchers [62, 80]. The marker variable approach asks researchers to include a theoretically unrelated construct in the regression equation and observe its correlation with the primary variables. While it is recommended that this theoretically unrelated variable be measured during the original data collection, in cases where such a construct may not have been measured, Pavlou et al. [80] suggest a modified test where any "weakly related" construct that might have been measured can be used. Following the guidelines of prior researchers, we used the *country of origin* of the respondents<sup>2</sup> as the "marker variable." Our correlation results suggest that the average correlation between the marker variable and all the primary constructs of the study was 0.12 (with the highest correlation being 0.19), and none of the correlations were significant. This suggests that there are minimal common method variance problems in the study. Further, the correlations between the primary variables were well under 0.90, again indicating that common method variance did not affect the results [80]. Finally, it is worth mentioning that notable researchers have concluded from their empirical studies that even if there are some common method biases in organizational research, "the detected bias in observed correlations . . . [is] not sufficient to challenge the theoretical interpretation of the relationship" [30, pp. 399–400]. Further, Doty and Glick argue that in "most organizational research, we are happy to predict the directionality of the relationships," thus "common methods bias . . . may be something to avoid . . . but it is probably not sufficiently large enough to invalidate many of our theoretical interpretations and research conclusions" [30, p. 400].

## Contributions and Conclusion

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### Contributions to Research

TO PUT OUR WORK IN CONTEXT, we submit that different types of contributions are seen as valuable in different phases of knowledge on a research topic [39]. Consistent with this general pattern, early virtual teamwork was largely definitional and descriptive. Thereafter, as the research community's interest on virtual teams grew, studies identified key constructs relevant to virtual teams (e.g., trust, leadership, communication, task performance) and examined relationships among them, with the goal of systematically building and subsequently testing a set of propositions/theory. As a significant and diverse body of literature on virtual teams developed, there was a need for consolidation, in the form of in-depth reviews [93] that provide an understanding



of the trends and nuances regarding the phenomenon and in the form of empirical tests of competing/unresolved relationships among key constructs, which, in the virtual/distributed team context, include constructs such as communication, trust, and performance. Our study responds to this need. The current study specifically makes an important contribution to the literature on trust in global virtual teams, particularly in determining/predicting high-performing individuals, where communication forms the underlying basis for all social action [2, 91]. Overall, our empirical examination provides strong support for the mediation model, indicating that communication leads to performance through trust. Although the additive and interaction models were not supported, our study did add some nuances to the literature underlying the interaction model. In particular, it suggests that for trustworthy individuals, communication can enhance their performance; however, for those who are perceived as less trustworthy, high levels of communication can backfire. Our derivation of the propositions reflected in the three competing models (i.e., additive, interaction, and mediation) allowed us to proceed with Argyris's notion of "good science," wherein we could subject these competing relationships embedded in the literature "to the most rigorous tests available" [3, p. 250].

In a review of the literature on global virtual teams, Martins et al. recommend that while "researchers have made considerable headway into understanding factors contributing to the creation and destruction of trust within VTs [virtual teams], there is room for future research that . . . [examines] their roles in VT" [64, p. 822]. We believe that one of the important contributions of this study to the existing theory surrounding trust is that it clarifies the role trust plays within virtual teams, in particular by highlighting the point that trust holds an important position in terms of enhancing individuals' performance within distributed teams.

The contribution of our study, we believe, also goes beyond the validation of a proposition (i.e., communication  $\rightarrow$  trust  $\rightarrow$  performance). Our empirical study, we submit, advances our field's understanding of the interrelationships among key constructs in virtual team research by empirically reconciling conflicting views in the large body of published work, where researchers were unable to judge the validity of the competing posited models (involving the constructs of communication, trust, and performance). Such consolidation studies involving the test of competing models have been conducted in a number of areas with matured/maturing bodies of knowledge, including IS implementation [63], technology adoption [105], business process reengineering [90], and individual work performance [68].

A related strength of this study is its adoption of a network approach to investigating the issue at hand. As organizations are moving to the networked forms, it has been argued that a paradigm of "networked individualism," which enables the study of an individual in the context of the individual's existing relationships, facilitates the understanding of key behavioral phenomena associated with these new organizational forms. Indeed, we believe that one of the primary strengths of this study is its departure from the *individual trait/behavior-based* approach to trust and communication used in much of the prior research and the use of the complementary network-based perspective to study communication and trust—constructs that are inherently relational

in character. While network approaches in general, and SNA in particular, have much to offer in our discipline, SNA remains underutilized, especially in examining virtual organizations and teams [1, 2]. Gallivan and Benbunan-Fich [35] argue that one of the main shortcomings of many past studies of computer-mediated groups is that they tend to study team members' behaviors/actions without taking the members' context into consideration. We believe that our study can contribute to the awareness within the IS research community regarding the strengths of applying SNA. Within this approach, behaviors of individual team members can be examined, without isolating them from the social context.

## Contributions to Practice

While noting that the objective of this paper is primarily to provide a theoretical clarification of the interrelationships between the constructs of trust, communication, and performance within globally distributed teams using an arguably more appropriate methodological approach than the traditional attribute-based approach, we see some practical implications of the study as well.

The study clarifies the role of communication. Recent research and practice seems to promote the view that "in a knowledge-driven economy, talk is real work" [25, pp. 90–91] and recommend that one discard the traditional management principle of "stop talking and get to work" and begin the era of "start talking." A similar belief, the "babble hypothesis," which highlights the importance of communication, has also been popularized in the management literature. Our study urges caution on accepting the above views unreflectively, at least in the context of distributed team members. Members of virtual teams should understand that communication alone will not help in their being viewed as contributing and high-performing individuals. Through their communication, they need to secure the complete trust of their distributed members before they can be acknowledged as contributing and performing members of the team. Further, an awareness of the mediating role of trust will hopefully prompt virtual team members to refrain from freeloading and other deceptive behaviors, thereby increasing the effectiveness/productivity of the entire team.

The study's results also highlight the importance of networks and network centrality within organizations. To be viewed as important contributors to the virtual team and as high performers, it is important that individuals occupy a strong central position within their communication and trust networks. By occupying central positions through high levels of communication and trust-inducing behaviors, an individual team member is able to make him- or herself more visible to (and more relied upon by) the other distributed team members. Such visibility also helps highlight the individual's contributions to the team.

Finally, the study's results illustrate a suitable way to assess distributed team members' performance, not through objective supervisor ratings, but through ratings of their contribution by their distributed team members. Owing to the geographical distribution and differences in context [91], the "objective" performance evaluations are likely to be more biased and potentially tainted [10, 111].

## Future Research

We believe that the study points to several avenues for future research. Here, we have used one specific measure of an individual team member's structural position (i.e., the degree centrality) on his or her perceived performance, which was appropriate given that our objective was to test the three competing models. Apart from using degree centrality, structural roles (e.g., "gatekeeper," "liaison," "bridge") of an individual within a virtual team could have implications for individual-level and team-level outcomes [71, p. 32]. Thus, we invite future research that qualitatively or quantitatively examines the effect of individuals' structural positions in their respective teams on their performance.

Another point worth mentioning is that we adopted a relational approach to measuring performance in this study, especially given that supervisory ratings have been criticized for being too political [10, 62] and supervisory ratings may not be appropriate in distributed teams that are relatively flat, with emergent roles and responsibilities [94]. However, having said that, it must be acknowledged that some distributed teams do have assigned project managers, with some of these managers participating in the daily activities of the team, and with others serving in the role of external coordinators and evaluators. The evaluations by the project managers could be seen as more distant and objective (not relational), though not necessarily more accurate. Future research should thus investigate whether trust and communication centrality measures have a similar effect on individual performance when the performance ratings are assigned by the project managers rather than by peers in the team who are intimately aware of the individual's communicative behaviors and quality of contributions to deliverables.

In closing, we echo Jarvenpaa and Leidner's view [48] of trust and communication being two fundamental concepts associated with globally distributed teams undertaking knowledge work. Our hope is that this paper is able to provide clarification on how these two frequently used concepts come together to contribute to individual performance, a critical dependent variable for organizations operating in today's networked global economy.

## NOTES

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1. It is worth noting that each of these three models is in evidence in the literature, sometimes with the same authors' arguments shifting from one model to the other. In our opinion, a fundamental step to furthering knowledge in this area is to empirically determine which model, invoked overtly or implicitly in the discussions, can be considered valid.

2. There were 47 participants who were born in the United States, 23 in Norway, and 14 in Denmark; 22 participants were born in other countries; and 5 respondents did not indicate the country they originated from. We note that this variable is different from the location variable, where each respondent was associated with either the United States or Scandinavia.

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